Knol- Syncope

Introduction

Syncope is the medical term for fainting and is derived from an ancient Greek word meaning "to interrupt." Syncope is defined as the transient loss of consciousness and postural tone associated with spontaneous recovery. Syncope is common. It is estimated that about 19% of all adults will experience at least one syncopal episode at some point in their life. People who experience recurrent episodes of syncope have a reduced quality of life, similar to that caused by chronic conditions such as rheumatoid arthritis or severe low back pain. Each year in the U.S., syncope accounts for 3% of all emergency room visits and up to 6% of all hospital admissions. People who experience syncope without warning may suffer significant injuries when they fall, including fractures of the face, arms, legs and skull. In the elderly, a simple syncopal event can result in injuries of such severity that permanent placement in a nursing home may be necessary. As the American humorist Will Rogers once observed, "It's not the fall that hurts, it's the sudden stop at the end."

What Causes Syncope?

Syncope is a symptom rather than a specific disease or medical condition. Syncope usually occurs when there is a decrease in the amount of blood (and oxygen) going to the brain. A drop in blood flow to the brain for as little as 8-10 seconds may result in syncope. When the cells of the brain do not receive enough oxygen from blood to function adequately, syncope will occur. This decline in blood flow could result from an extremely large number of problems, making the diagnosis of syncope challenging.

Most investigators will tend to divide the causes of syncope into two large groups: Cardiovascular and Non-Cardiovascular. Why? This is because a number of studies have revealed that when syncope occurs due to a cardiovascular cause, it may lead to a premature death. The ancient Greek physician, Hippocrates, noted that "those who suffer from frequent and severe fainting often die suddenly," and so it is today. Syncope may be the only warning sign that person has prior to sudden death. Thus, determining if syncope is occurring due to a potentially lethal cause is paramount.

Cardiovascular Causes of Syncope

In order to maintain an adequate supply of blood (and thereby) oxygen to the brain, the heart must beat normally (figure 1). The heart itself is a four-chambered pump that receives deoxygenated blood from the veins into a small upper chamber (called an atria) on the right hand side of the heart. From here, it is pumped into a larger chamber below it (called a ventricle) and then to the lungs where carbon dioxide is exchanged for fresh oxygen. This newly oxygenated blood then returns to another atrium on the left side of the heart. From here, it is pumped into a large left-sided ventricle, and then to the rest of the body. To ensure this coordinated function, the heart relies on its own electrical system. A small cluster of cells in the right atrium (the sinus node) serves as the heart's

"pacemaker" and sets the rate at which the heart beats, (based on signals received from the brain). The electrical impulses originating in the sinus node travel through the atrium (causing them to contract) until they reach the junction of the right atrium with the right ventricle. They are separated from each other by a layer of filmous tissue (the "annulus fibrosis") that blocks electrical transmission. However, a bundle of nerve fibers crosses from the atria to the ventricles (the "atrioventricular node"), which allow transmission of the electrical impulse to both of the lower heart chambers. This then causes them to contract and pump the blood in them to the lungs and the rest of the body.

Any condition that obstructs the flow of blood through the heart or that alters normal electrical conduction such that the normal pumping sequence is disturbed, may result in syncope.

Each of the chambers of the heart contains a one-way valve to ensure that blood only flows in one direction. Different diseases may damage these valves and disrupt their normal function. For example, the valve that separates the left ventricle from the major blood vessel that it pumps blood into (the aorta) is called the aortic valve. In some individuals, diseases such as rheumatic fever, or just the effects of aging, may cause it to become so thick and hard that it cannot open properly, thereby preventing blood from leaving the heart. If sufficiently severe, this could result in syncope.

Another condition that can prevent blood from leaving the right ventricle is called "hypertrophic cardiomyopathy." In this condition, the heart muscle of the left ventricle grows so thick that it can impede blood from leaving the heart. In some patients, tumors can grow inside the heart (myxomas) that can occlude heart valves and impede the flow of blood, again resulting in syncope.

Some of the most common, and at the same time most serious causes of cardiovascular syncope involve disturbances of the hearts normal rhythm. As was mentioned previously, the upper chambers of the heart (the atria) normally contract first, pumping blood to the two lower chambers (the ventricles), which then pump their blood to the lungs or to the rest of the body. Several conditions can disturb this normal sequence. One common cause of this kind of disturbance is when the heart's electrical conducting system is damaged after a heart attack. Here a blockage in an artery of the heart deprives one segment of the heart of blood and oxygen, causing the cells there to die. Electrical impulses can become "short circuited" in the dead area causing the heart to beat abnormally, reducing the heart's ability to pump blood to the brain (ventricular tachycardia and ventricular fibrillation). If the disturbance in heart rhythm lasts long enough, loss of blood to the brain will cause loss of consciousness (i.e. syncope). The normal rhythm can be disturbed by other heart complications, such as when the muscles of the heart become too thick (as in hypertropic cardiomyopathy) or when they are weakened by viral infections or toxins (dilated cardiomyopathy). Some inherited disorders affect the ion channels of the heart leading to serious heart rhythm problems, long QT syndrome. Cardiovascular causes of syncope are often serious medical problems which can lead to death if untreated.

Non-Cardiac Syncope

Syncope may also occur due to an inability of the body to maintain adequate blood pressure due to non-cardiac causes. When a normal individual stands, gravity will try to displace around 25% of the body's blood volume to the lower parts of the body (such as the legs, lower arms, and abdomen). If this displacement is not corrected immediately, then the fall in blood to the brain will result in syncope. However, in normal individuals, the displacement of the blood volume that occurs with standing will stretch the blood vessels in the lower part of the body. The brain can monitor this stretch via special cells called mechanoreceptors that are located inside blood vessels (and inside the heart). These mechanoreceptors increase their electrical output when stretched. During standing, the mechanoreceptors in the lower part of the body increase their firing rates (due to the greater stretch caused by the increase in blood there) while those in the upper half diminish. Segments of the brain responsible for blood pressure regulation then respond to this change in mechanoreceptor firing by sending impulses through nerves that cause an increase in: 1) heart rate, 2) the force with which the heart contracts, and 3) the tightness (constriction) of blood vessels in the lower half of the body. The combination of these three actions cause blood to be pushed back upward into the upper half of the body, thereby maintaining a constant flow of blood to the brain. An additional mechanism to maintain blood pressure is provided by contraction of the leg muscles, which compresses veins and helps return blood to the heart.

The aspect of the nervous system that performs these "automatic" regulatory functions is referred to as the "autonomic" nervous system (ANS). It controls the involuntary functions of the body (those that occur without you having to think about them). The ANS has two major parts, the sympathetic division and the parasympathetic division. The ANS always tries to maintain a constant state of balance, referred to as "homeostasis." Another example of this (besides blood pressure) is body temperature, as internal body temperature remains constant at around 98.6° F irrespective of the outside temperature. In order to maintain homeostasis, the two divisions of the ANS have opposing effects. In general, sympathetic nerves enhance activities and processes that use energy. In contrast, parasympathetic nerves foster actions that save and restore energy to the body. This normal maintenance of body functions such as regulation of blood pressure, body temperature, sweating, bowel, and digestive function, as well as urinary and sexual function, all require a delicate and ever-changing balance between these two divisions of the ANS. Proper autonomic control of any function requires adequate sensory input, proper processing and output to the necessary organs, and adequate feedback. A failure of any aspect of this loop will cause a loss of hemostasis.

A series of different conditions occur due to disturbances in the ability of the ANS to regulate blood pressure adequately. All of these can be referred to as forms of "orthostatic intolerance." The term orthostatic intolerance refers to the production of symptoms upon standing (occasionally sitting) that are relieved by lying down, and are due to a fall in blood pressure. Symptoms vary according to the amount that the blood pressure (and amount of oxygen received by the brain) declines. These symptoms include lightheadedness, dizziness, difficultly concentrating, fatigue, and ultimately syncope.

One of these disorders occurs because the body does not make the necessary corrections (discussed perviously) upon standing. This condition is called "orthostatic hypotension," and is defined as a fall of 20 mmHg or more in systolic blood pressure (or 10 mmHg or more in diastolic blood pressure) upon standing. This condition tends to

affect older adults (although on occasion younger people may also be affected). People suffering form orthostatic hypertension will experience syncope shortly after standing. A wide range of diseases and conditions can cause orthostatic hypotension.

Another group of orthostatic intolerance syndromes are called "reflex syncopes." Each of the reflex syncopes is characterized by a sudden fall in blood pressure (and sometimes heart rate) to such low levels that syncope ensues. As opposed to orthostatic hypotension, syncope may occur at any time while sitting or standing. There are several different types of reflex syncope, the most common of which is called neurocardiogenic (or vasovagal) syncope. Other types include carotid sinus hypersensitivity, micturition (urination) syncope, and defection syncope or cough syncope. The common feature that links a group of mechanoreceptors is suddenly activated causing the brain to react as if the person was hypertensive. The special fibers called mechanoreceptors that allow the brain to determine stretch on blood vessels are also used to measure stretch within the bowel, bladder, lungs and other areas.

Neurocardiogenic syncope can occur when the skeletal muscle pump fails to provide adequate blood return to the right ventricle, which responds by contracting much more vigorously then normal. This can then actuate the mechanoreceptors of the heart as if they had been stretched, sending a surge of electrical activity to the brain that mimics the condition seen in hypertension (even though the blood pressure at this patient is quite low). In an attempt to lower the perceived "hypertension," the brain reduces sympathetic nerve output causing the blood pressure and heart rate to decline rapidly, resulting in a lack of blood to the brain and thereby syncope.

Sudden activation of the mechanoreceptors in other areas can also be wrongly interpreted by the brain as reflecting hypertension. For example, straining hard to have a bowel movement may suddenly activate rectal mechanoreceptors causing a similar effect (deification syncope), as can straining to urinate (micturition syncope). The bifurcation of the carotid arteries is the neck contains a large number of mechanoreceptors that help the brain monitor blood pressure. In some people these may become hypersensitive, and become stimulated by actives such as turning the (carotid hypersensitivity syncope).

Through mechanisms that are not fully understood, sudden emotional stimuli (such as the sight of blood) can also trigger a reflex syncope.

Several factors can increase the likelihood of an episode of neurocardiogenic syncope. Prolonged standing, dehydration, hot climate, warm showers or baths, or consumption of alcohol can precipitate episodes of neurocardiogenic syncope in susceptible individuals. Reflex syncope is characterized by intermittent periods of syncope. Patients are asymptomatic between episodes.

Another type of orthostatic intolerance that may result in syncope is referred to as Postural Tachycardia Syndrome (POTS). These individuals have an inability to maintain adequate constriction of the blood vessels in the lower part of the body while standing. Blood begins to pool in the lower half of the body, however, the heart rate and the force of the heart's contraction increase markedly as compensation. While this prevents the blood pressure from initially falling to very low levels, it does not maintain it at normal values. Thus the patient experiences a sensation that the heart is racing and beating forcefully upon standing (palpations), fatigue, shortness of breath, headache, and inability to concentrate. Patients who stay upright long enough will exceed the ability of the heart to compensate leading to a fall in blood pressure which, if sufficiently profound, will

result in syncope. There are other causes of syncope as well, the full scope of which are beyond the scope of this discussion, and the interested reader is directed elsewhere.

Evaluation

The evaluation of syncope first involves taking a careful clinical history. When do the episodes of syncope occur? How often? Are there any warning signs prior to loss of consciousness? How long is the loss of consciousness? Is there any convulsive activity? This should be followed by a thorough physical examination.

One of the major issues to address is whether the heart is normal. This is accomplished by history and often by obtaining an electrocardiogram and echocardiogram. If a cardiac cause of syncope is suspected, further testing such as stress testing, cardiac catheterization, or electrophysiologic study may be needed.

It is important that blood pressures be measured lying, sitting, and immediately upon standing, as well as after standing for two minutes.

When the diagnosis is unclear, it may be useful to undergo head upright tilt table testing to help determine if some form of orthostatic intolerance is present. The test is preformed by placing a person on a special table that is capable of being tilted upward, The patient is gradually inclined to an angle of 70° and heart rate and blood pressure are then measured continuously. The purpose of the test is to inhibit the skeletal muscle pump, thereby making the autonomic nervous system function as the sole mechanism by which blood pressure is maintained. Since the only stress on the individual is gravity, most people can comfortably remain in this position for prolonged periods of time. However, those patients with poor autonomic tone will be unable to tolerate even this modest stress, and will experience a displacement of significant amounts of blood to the lower half of the body which, if sufficiently profound, will result in a decline in blood pressure.

In some patients, it will be very difficult to determine the cause of recurrent syncope. In these individuals, a small heart rhythm monitoring device can be implanted (an implantable loop recorder). This small device can continually record a person's heart rhythm for up to three years. If a person is experiencing syncope due to periods where the heart rate drops to very low levels, the device can detect and record these episodes.

Treatment of Syncope

To prevent a person from experiencing further episodes of syncope it is necessary to first determine the cause. Therapy for cardiac syncopes is directed at correcting the underlying cause, if possible. Some patients with recurrent syncope from a cardiac cause may be found to be at a high risk for sudden death. In these individuals. it may be necessary to place an Implantable-Cardioverter-Defibrillator (ICD) to help prevent this. Further information on these devices can be found elsewhere.

In patients suffering from some form of orthostatic intolerance, one should first try correcting any factor that could be lowering their blood pressure. Trying to avoid situations that provoke episodes (prolonged standing, extreme heat) should be avoided if at all possible. Patients should be encouraged to begin a program of gentle reconditioning with both aerobic and resistance training designed at strengthening the skeletal muscle

pump. In patients who experience a sufficient amount of warning symptoms (referred to as a "prodrome"), they can try performing physical counter-maneuvers to prevent syncope. A person can cross their legs and tighten them against each other or tighten the arm muscles as a way to activate the skeletal muscle pump and facilitate blood return to the heart.

When the conservative treatments above are not effective in preventing syncope, some patients may benefit from medications that attempt to help maintain blood pressure at a constant level. A detailed description of these is beyond the scope of this discussion and the interested reader can find more information elsewhere.

Of all the medications that can be used in the treatment of syncope, only one, midodrine, is approved by the FDA for the treatment of orthostatic hypotension. The other drugs used are approved for other indications, but have been shown to be useful in preventing syncope.

These include:

1. Fludrocortisone
2. Midodrine
3. Methylphenidate
4. Serotonin re-uptake inhibitors
5. Norepinephrine reuptake inhibitors
6. Pyridostigmine
7. Beta blockers
8. Octreotide
9. Erythropoietin

More in-depth discussions of these and other medications can be found elsewhere. In some patients with neurocardiogenic syncope associated with very low heart rates, placement of a permanent cardiac pacemaker can be of benefit.

Summary

While syncope is often benign, it may sometimes be the warning sign of a more serious condition. However, recurrent syncope, even from benign causes, can impair the ability to operate a motor vehicle and lead to injury from falls. Most causes of syncope can be identified and treated.

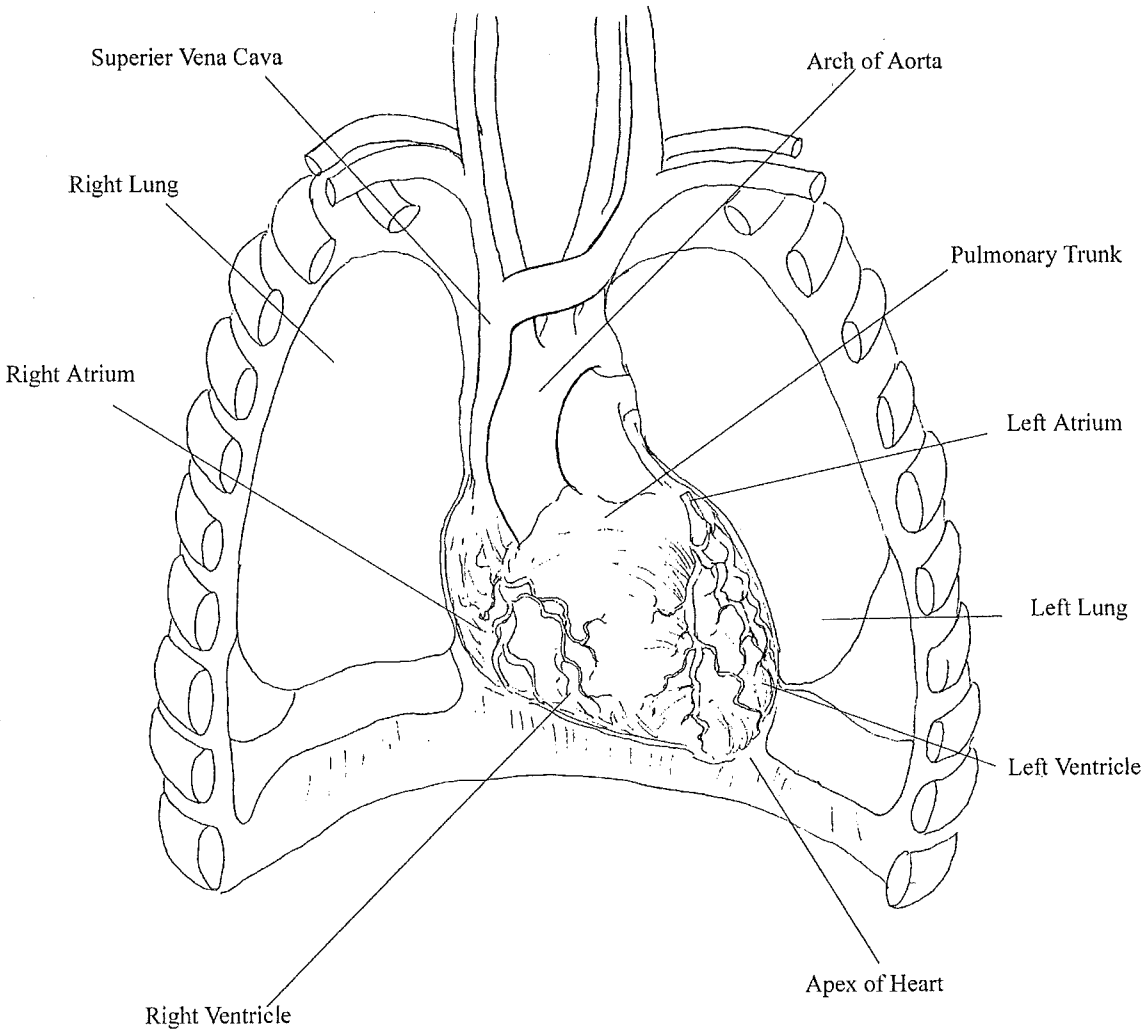


Figure 1

Drawing by Helen Grubb

Web Resources

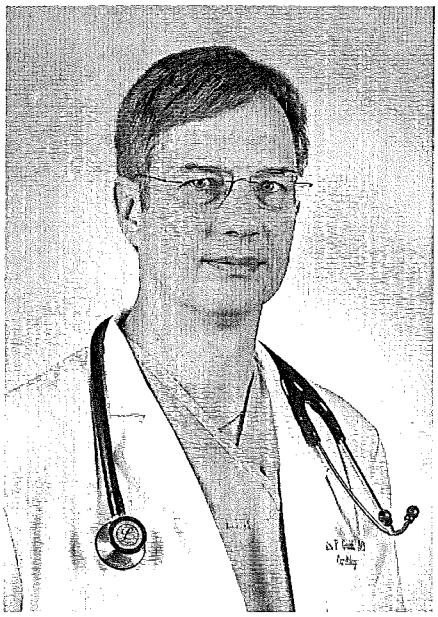
www.utoledo.edu	The University of Toledo Medical College
www.hrspatients.org	The Heart Rhythm Society
www.americanheart.org	American Heart Association
www.DINET.org	Dysautonomia Information Network
www.dynakids.org	Dysautonomia Youth Information Network
www.NDRF.org	National Dysautonomia Research Foundation
www.STARS.org.uk	Syncope Trust and Reflex Anoxic Seizure

Books About Syncope

1. Grubb BP. The Fainting Phenomena (second edition) Blackwell/Futura Press. Malden MA 2007
2. Grubb BP, Olshansky B. Syncope: Mechanisms and management, (second edition). Blackwell/Futura Press. Malden MA 2005
3. Benditt D, Brignole M, Raviele A, Wieling W. Syncope and Transient Loss of consciousness: Multidisciplinary Management. Blackwell/Futura Press. Malden MA 2007

References

1. Shukla GJ, Zimetbaum PJ. Syncope circulation. 2006; 113:e715-e717
2. Olshansky B. Syncope: Overview and approach to management in Grubb BP, Olshansky B (eds) Syncope Mechanisms and management (2nd edition) Blackwell/Futura press Malden MA 2005 pp1-46
3. Grubb BP. Neurocardiogenic Syncope and related disorders of orthostatic tolerance. Circulation 2005:111:2997-3006
4. Grubb BP. Neurocardiogenic Syncope. New England Journal of Medicine 2005;1004-10
5. Eltahawy E, Grubb BP. Neurocardiogenic Syncope: Mechanisms, evaluation and treatment Future Cardiology 2006:113-e715-e717



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