

13.5 Cardiovascular Disorders

Cardiovascular disease (CVD) is the leading cause of untimely death in the Western countries. Modern research efforts have resulted in improved diagnosis, treatment, and prevention. This section discusses the range of advances that have been made in these areas.

Atherosclerosis

Atherosclerosis is an accumulation of soft masses of fatty materials, particularly cholesterol, beneath the inner linings of arteries. Such deposits are called **plaque**. As it develops, plaque tends to protrude into the lumen of the vessel and interfere with the flow of blood (see Fig. 13A). In certain families, atherosclerosis is due to an inherited condition. The presence of the associated mutation can be detected, and this information is helpful if measures are taken to prevent the occurrence of the disease. In most instances, atherosclerosis begins in early adulthood and develops progressively through middle age, but symptoms may not appear until an individual is 50 or older. To prevent the onset and development of plaque, the American Heart Association recommends a diet low in saturated fat and cholesterol and rich in fruits and vegetables, as in the Health Focus on page 257.

Plaque can cause a clot to form on the irregular arterial wall. As long as the clot remains stationary, it is called a **thrombus**, but when or if it dislodges and moves along with the blood, it is called an **embolus**. **Thromboembolism**, a clot that has been carried in the bloodstream but is now stationary, must be treated, or complications can arise.

Stroke, Heart Attack, and Aneurysm

A cerebrovascular accident (CVA), also called a **stroke**, often results when a small cranial arteriole bursts or is blocked by an **embolus**. Lack of oxygen causes a portion of the brain to die, and paralysis or death can result. A person is sometimes forewarned of a stroke by a feeling of numbness in the hands or the face, difficulty in speaking, or temporary blindness in one eye.

A myocardial infarction (MI), also called a **heart attack**, occurs when a portion of the heart muscle dies due to a lack of oxygen. If a coronary artery becomes partially blocked, the individual may then suffer from **angina pectoris**, characterized by a squeezing sensation or a flash of burning. Nitroglycerin or related drugs dilate blood vessels and help relieve the pain. When a coronary artery is completely blocked, perhaps because of thromboembolism, a heart attack occurs.

An **aneurysm** is the ballooning of a blood vessel, most often the abdominal artery or the arteries leading to the brain. Atherosclerosis and hypertension can weaken the wall of an artery to the point that an aneurysm develops. If

a major vessel such as the aorta should burst, death is likely. It is possible to replace a damaged or diseased portion of a vessel, such as an artery, with a plastic tube. Cardiovascular function is preserved, because exchange with tissue cells can still take place at the capillaries.

Coronary Bypass Operations

Each year thousands of persons have coronary bypass surgery because of an obstructed coronary artery. During this operation, a surgeon takes a segment from another blood vessel and stitches one end to the aorta and the other end to a coronary artery past the point of obstruction. Figure 13.17 shows a triple bypass in which three blood vessels have been used to allow blood to flow freely from the aorta to cardiac muscle by way of the coronary artery.

Gene therapy is now being used experimentally to grow new blood vessels that will carry blood to cardiac muscle. The surgeon need only make a small incision and inject many copies of the gene that codes for VEGF (vascular endothelial growth factor) between the ribs directly into the area of the heart that most needs improved blood flow. VEGF encourages new blood vessels to sprout out of an artery. If collateral blood vessels do form, they transport blood past clogged arteries, making bypass surgery unnecessary.

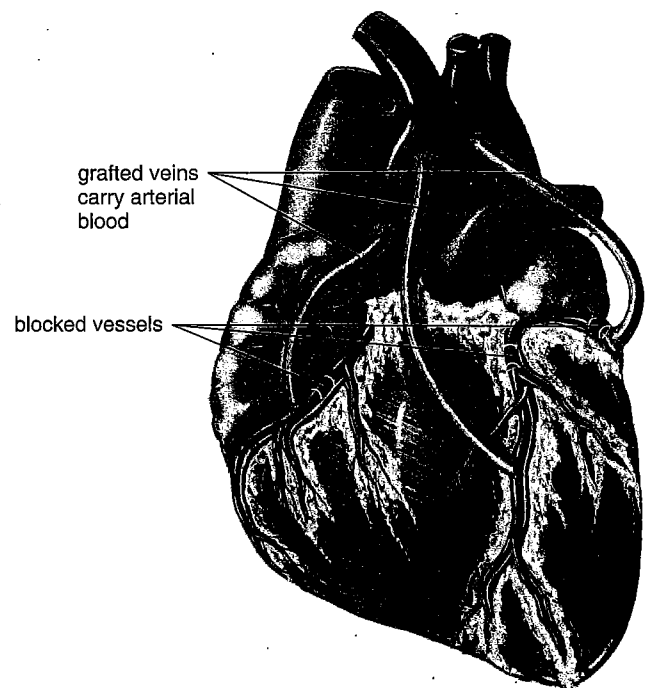


Figure 13.17 Coronary bypass operation.

During this operation, the surgeon grafts segments of another vessel, usually a small vein from the leg, between the aorta and the coronary vessels, bypassing areas of blockage. Patients who require surgery often receive two to five bypasses in a single operation.

Clearing Clogged Arteries

In **angioplasty**, a cardiologist threads a plastic tube into an artery of an arm or a leg and guides it through a major blood vessel toward the heart. When the tube reaches the region of plaque in an artery, a balloon attached to the end of the tube is inflated, forcing the vessel open (Fig. 13.18). However, the artery may not remain open because the trauma causes smooth muscle cells in the wall of the artery to proliferate and close it.

Two lines of attack are being explored. Small metal devices—either metal coils or slotted tubes, called **stents**—are expanded inside the artery to keep the artery open. When the stents are coated with heparin to prevent blood clotting and with chemicals to prevent arterial closing, results have been promising.

Dissolving Blood Clots

Medical treatment for thromboembolism includes the use of t-PA, a biotechnology drug. This drug converts plasminogen, a molecule found in blood, into plasmin, an enzyme that dissolves blood clots. In fact, t-PA, which stands for tissue plasminogen activator, is the body's own way of converting plasminogen to plasmin. t-PA is also being used for thrombolytic stroke patients but with limited success because some patients experience life-threatening bleeding in the brain. A better treatment might be new biotechnology drugs that act on the plasma membrane to prevent brain cells from releasing and/or receiving toxic chemicals caused by the stroke.

If a person has symptoms of angina or a stroke, aspirin may be prescribed. Aspirin reduces the stickiness of

platelets and thereby lowers the probability that a clot will form. Evidence indicates that aspirin protects against first heart attacks, but there is no clear support for taking aspirin every day to prevent strokes in symptom-free people. Even so, some physicians recommend taking a low dosage of aspirin every day.

Heart Transplants and Artificial Hearts

Heart transplants are usually successful today but, unfortunately, there is a shortage of human organ donors. A functional, mechanical heart would give some persons their only hope of continuing to live. It's been nineteen years since an artificial heart, which needed a cumbersome external power supply, was implanted in a patient. In a medical breakthrough, a patient has recently received a self-contained artificial heart. A rotating centrifugal pump moves silicone hydraulic fluid between left and right sacs to force blood out of the heart into the pulmonary trunk and the aorta. An internal battery holds only a half hour charge and then has to be recharged by an external power source. The heart was considered successful because the patient lived longer than expected.

Sometimes it is possible to repair a weak heart instead of replacing it. For example, a back muscle can be wrapped around a heart to strengthen it. The muscle's nerve is stimulated with a kind of pacemaker that gives a burst of stimulation every 0.85 second. One day it may be possible to use cardiac muscle cell transplants to strengthen a heart.

Hypertension

It is estimated that about 20% of all Americans suffer from **hypertension**, which is high blood pressure. Included in this group are individuals with atherosclerosis. Hypertension is present when the systolic blood pressure is 140 or greater or the diastolic blood pressure is 90 or greater. While both the systolic and diastolic pressures are considered important, the diastolic pressure is emphasized when medical treatment is being considered.

Hypertension is sometimes called a silent killer because it may not be detected until a stroke or heart attack occurs. It has long been thought that a certain genetic makeup might account for the development of hypertension. Now researchers have discovered two genes that may be involved in some individuals. One gene codes for angiotensinogen, a plasma protein that is converted to a powerful vasoconstrictor in part by the product of the second gene.

At present, however, the best safeguard against the development of hypertension is to have regular blood pressure checks and to adopt a lifestyle that lowers the risk of hypertension.

Stroke, heart attack, and aneurysm are associated with both atherosclerosis and hypertension.

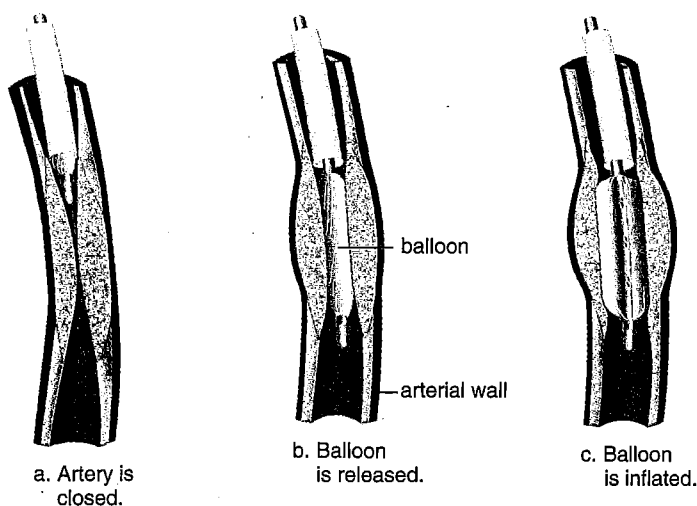


Figure 13.18 Angioplasty.

a. A plastic tube is inserted into the coronary artery until it reaches the clogged area. b. A metal tip with a balloon attached is pushed out the end of the plastic tube into the clogged area. c. When the balloon is inflated, the vessel opens. Sometimes metal coils or slotted tubes, called stents, are inserted to keep the vessel open.