CHAPTER 8

The Cardiovascular System

Heart disease remains the major cause of death in the United States and in other developed countries (Tabloski, 2014). Health problems in the cardiovascular system resulting from age-related changes and disease are often preventable. Primary modes of prevention include eating a healthy diet and exercising regularly. Data indicate that a consistent exercise program changes both heart functioning and heart size and lowers blood pressure levels as well. Maintaining weight within a normal range and effective management of existing health problems can also do much to decrease the likelihood of heart disease.

Risk factors for cardiovascular disease include those not modifiable by lifestyle changes and those we can modify or change. Nonmodifiable risk factors include family history, gender (men are more likely to have cardiovascular disease than women), ethnic origin, and age. Risk factors that can be modified by lifestyle changes include hypertension, diabetes, high cholesterol levels, obesity, alcohol use, smoking, a diet high in animal fats and calories, and a sedentary lifestyle (Jett, 2008; Little, 2013). Personality characteristics also influence the development of heart disease. Stress, a significant factor in heart disease, may be modified by the use of relaxation techniques, lifestyle changes, and psychosocial therapies.

ANATOMY AND PHYSIOLOGY OF THE CARDIOVASCULAR SYSTEM

The cardiovascular system serves as a pump moving arterial blood containing nutrients and oxygen through the arteries to the cells of the body where metabolism takes place. Waste products from cellular metabolic processes are then returned through the veins to be excreted by the excretory organs.

The Blood

Blood is a sticky, opaque fluid that accounts for about 8% of total body weight, and translates into about five or six liters in males and four or five liters in females (Marieb & Hoehn, 2013). The blood is composed of the following:

1. Red blood cells (erythrocytes), which carry oxygen to all the cells of the body
2. White blood cells (leukocytes), which protect the body from attack by viruses, bacteria, toxins, parasites, and tumor cells
3. Platelets (thrombocytes), essential for blood clotting
4. Plasma, the fluid component of the blood in which solute (substances dissolved in a solution) and elements are suspended and circulated

Functions of the Blood

Blood, the major medium for the transportation of fluids throughout the body, has four significant functions in the maintenance of life and health. These functions are as follows:

1. Respiratory, through the distribution of oxygen from the lungs to the tissues of the body for cell use, and carbon dioxide from the body tissues back to the lungs, where it is expelled.
2. Nutritive, through the transport of food substances such as glucose, fat, and amino acids, from storage places (the liver and intestines, for example) to body tissues where these materials are needed to produce energy and to maintain life.
3. Excretory, through the movement of waste products from body cells to the excretory organs.
4. Regulatory, through the control of body equilibrium (homeostasis) in general, and specifically through hormone distribution, maintenance of water balance, and temperature regulation; for example, excess heat generated in the body is transported continuously by the blood to the lungs and to body surfaces, where it is dissipated.

The Lymphatic System

The lymphatic system is composed of the following:

1. Lymph, a fluid originating in tissue spaces throughout the body
2. A one-way system of lymph vessels transporting lymph from tissue spaces to lymph ducts to the bloodstream

The smallest vessels are lymphatic capillaries, which flow into collecting vessels, lymphatic trunks, and the largest vessels, the lymphatic ducts.

The major function of the lymphatic system is to assist in preventing the spread of infection and disease by straining out foreign particles and bacteria as the lymph passes through special lymphoid organs such as lymph nodes, spleen, thymus, tonsils, and Peyer's patches in the small intestine (Marieb & Hoehn, 2013).

The Blood–Vascular System

The human blood–vascular organizational plan is a closed system in which damage to any part will ultimately affect the entire system. The major components of the blood–vascular system are the following:

- The heart, a pumping organ.
- The arteries, tubes that conduct blood from the heart to body cells; the smallest artery branches are called arterioles.
- The veins, tubes that conduct blood from body tissues back to the heart. Many veins contain one-way valves to prevent blood from flowing backward and thus help return blood to the heart. Valves are most common in veins of the limbs. The smallest vein branches are called venules.
- The capillaries, minute blood vessels connecting arterioles and venules.

The Heart

The pump of the blood–vascular system is the heart, a hollow organ with highly muscular walls, situated within the thorax (chest) between the lungs in the space that separates the right and left pleural cavities. In complex organisms such as humans,

the heart has four chambers: two *atria* (upper chambers) and two *ventricles* (lower chambers). A thick partition, the *septum*, separates the left side of the heart from the right. The largest artery of the body, the *aorta*, leads out of the left ventricle, and the *pulmonary artery* emerges from the right ventricle. The largest veins of the body *(superior and inferior vena cavae)* enter the right atrium, and the *pulmonary veins* enter the left atrium.

The atria and the ventricles are separated by atrioventricular (A-V) valves that control both the location and the amount of blood in each of the four chambers of the heart. The left valve is called the *mitral or biscuspid*, and the right valve is called the *trisucpid*. Other valves separate each ventricle and its specific artery (aorta or pulmonary); no valves are found between the atria and their respective veins (venae cavae or pulmonary). (See Fig. 8.1.)

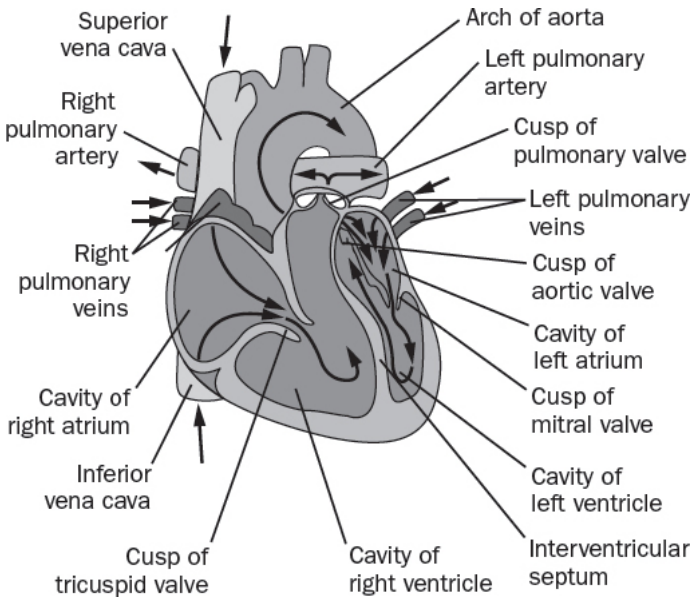

Figure 8.1. Anatomy of the heart and great vessels.

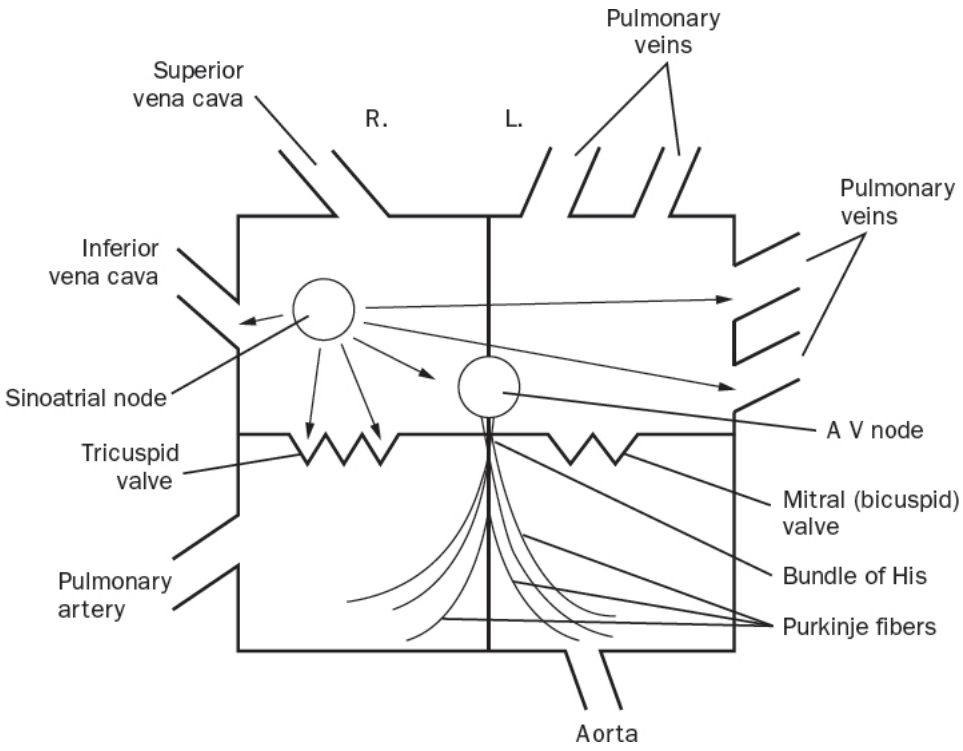

Figure 8.2. Schematic of the electric conduction system of the heart.

Because the heart is composed of muscle tissue, it needs a rich blood supply in order to maintain proper functioning. *Coronary circulation* involves specific coronary arteries branching from the base of the aorta and distributing blood to the heart muscle. Veins collect the blood to be returned to the right atrium through a large vein called the coronary sinus. If a coronary artery becomes occluded and blocks the supply of oxygen and nutrients to the heart muscle, a heart attack results.

Blood Circulation

In addition to coronary circulation, there are two blood circuits, one called systemic, supplying all body parts with blood, and the other called pulmonary, circulating blood through the lungs to purify it. The right side of the heart receives oxygen-poor blood from body tissues, whereas the left side of the heart receives oxygen-rich blood from the lungs.

Systemic circulation begins as oxygen-rich blood from the lungs enters the left atrium via the pulmonary veins. When the atrium fills with blood, it contracts. The mitral valve opens and blood flows into the left ventricle. Because the valve is a one-way device, blood normally flows only from the left atrium to the left ventricle. When the left ventricle fills with blood, the mitral valve closes, the ventricle contracts, the aortic valve opens, and blood is forced into the aorta, after which the aortic valve closes so blood cannot reenter the ventricle. Blood circulates throughout the body by way of the aorta and other arteries, connects with veins at the level of the capillaries, and returns, depleted of oxygen and carrying carbon dioxide to the heart via various-sized veins ending in the largest veins, the inferior and superior vena cavae, which empty into the right atrium. When the right atrium fills, the tricuspid valve opens and the deoxygenated blood passes into the right ventricle.

Pulmonary circulation begins after blood fills the right ventricle. The tricuspid valve closes, the ventricle contracts, and the pulmonary valve opens, forcing blood into the pulmonary artery to be carried to the lungs to be oxygenated. The pulmonary valve closes so that blood cannot reenter the ventricle. Oxygenated blood returns to the left atrium via the pulmonary veins, and the cycle begins again.

Various estimates suggest the body contains about 70,000 miles of blood vessels, most of which are capillaries. The normal pulse rate for the heart is between 60 to 90 beats a minute, with 72 beats a common average. This equates to more than 100,000 heart beats daily and more than 4,000 gallons of blood pumped through the heart each day.

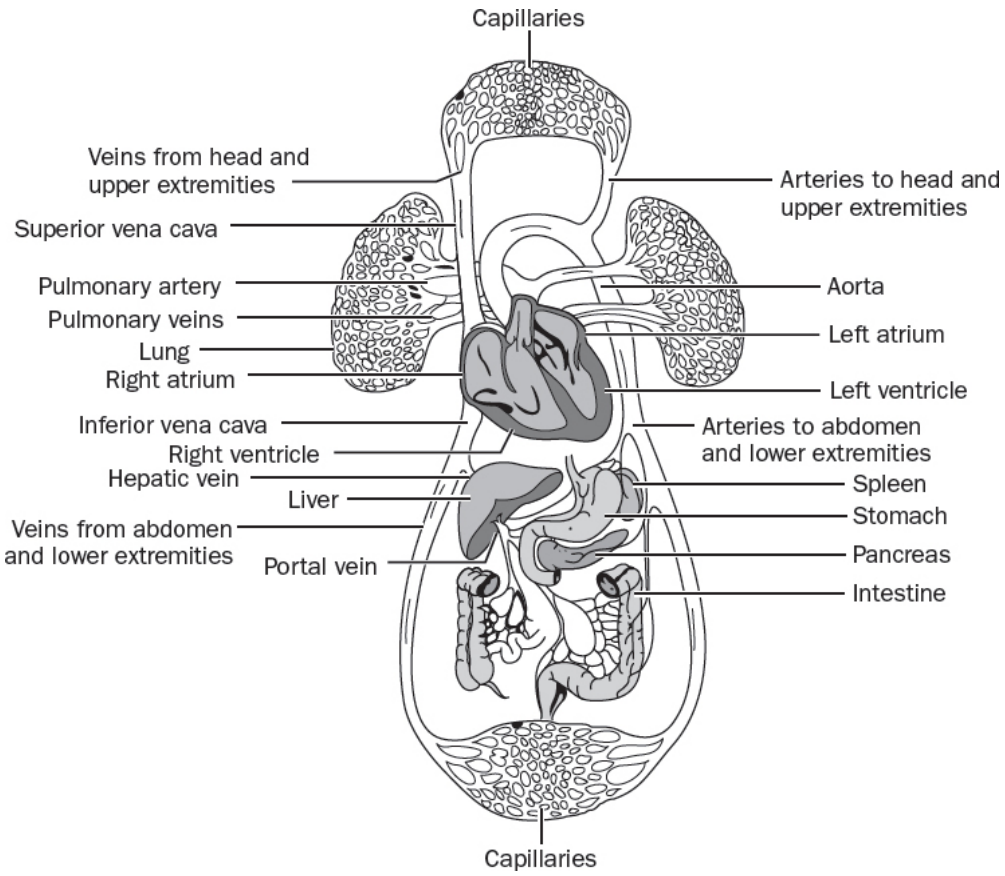

Figure 8.3. Diagram of the pulmonary and systemic circulations.

The normal heart sounds, S1 (“lub”) and S2 (“dub”), are produced by the closure of the heart valves. The first heart sound (S1) is produced by the closing of both the mitral (bicuspid) and the triscupid valves. The second heart sound (S2) is produced by the closure of the aortic and pulmonary valves. These sounds help health professionals assess the functional status of the heart.

Maintenance of Circulation

Circulation is maintained through the continuous rhythmic action of the heart. Although the nervous system affects heart rate, heart muscle is unlike other muscles of the body because it is self-excitatory and has its own built-in pacemaker mechanism to maintain rhythmic and coordinated activity. Specifically, the heart beat is initiated by a segment of tissue in the right atrium designated as the sinoatrial (S-A) node. Excitation begun at the S-A node spreads to similar nodal tissue, the atrioventricular (A-V) node at the junction of the right atrium and right ventricle, and then through a bundle of fibers (the bundle of His) to the ventricle walls, causing the heart to beat. Normally the atria and ventricles beat in a coordinated rhythm at approximately 72 times a minute. If injury or disease interferes with impulse transmission between the S-A and the A-V nodes, the atria and ventricles beat at different rates and heart block results. Sometimes, if heart rhythm is disrupted, random contractions (fibrillation) occur (see Figs. 8.2 and 8.3).

Blood Pressure

The contraction of the left ventricle forces blood into the aorta with a definite force or pressure. The pressure resulting from ventricular contraction is called “systolic” and represents the upper number of a blood pressure reading. During the subsequent brief relaxation of the ventricle, pressure decreases, representing the diastolic pressure (or resting phase), the lower number of a blood pressure reading.

According to most authorities, average blood pressure for a healthy young or middle-aged person at rest should be less than 120/80, although blood pressure fluctuates according to the individual’s physiological and psychological status of the moment and a variation of readings occurs throughout the day. High blood pressure is defined as a systolic reading of 140 mmHg or higher over a diastolic reading of 90 mmHg or higher. Hypotension is defined as a systolic reading less than 90 mmHg and diastolic reading less than 60 mmHg. Generally, hypotension is not a concern unless it leads to inadequate blood flow to tissues (Marieb & Hoehn, 2013). Several blood pressure readings need to be taken at different times before hypertension or hypotension (too high or too low blood pressure) can be diagnosed. Variables influencing primary hypertension are heredity, diet, obesity, diabetes, stress, and smoking. Following are some of the other factors that influence blood pressure:

(a) Age (blood pressure tends to increase with age)
(b) Pumping action of the heart (this varies with age and health)
(c) Blood volume (the amount of blood pumped)
(d) Elasticity of arterial walls (which determines how easy or difficult it is for blood to flow)
(e) Thickness or thinness of the blood (this affects rate of blood flow)
(f) Peripheral resistance (especially in the limbs)

AGE-RELATED CARDIOVASCULAR CHANGES

Although some cells, such as skin or blood cells, are self-replenishing, cardiac (heart) cells are not replaced once damaged or destroyed. However, it is especially difficult to determine which changes in the circulatory system are “normal” aging changes and which are pathological. More research on healthy older adults is needed to clarify this issue. Therefore, we include changes commonly reported in the literature, realizing the distinction between aging and disease is not completely clear.

Age-Related Structural Changes

Substantial evidence now indicates that overall heart size in healthy older adults does not change significantly with age. Contrary to some popular opinion, an enlarged heart is not normal in older age and may instead suggest a pathological condition (Eliopoulos, 2014). Age-related changes commonly occurring include the following:

1. Increase in fatty tissues in the outermost layer of the heart muscle
2. Some increase in the thickness of the left ventricular wall
3. Increase in collagen and elastin tissues in the heart and arteries, which causes the vessels to become more rigid and thick

4. Decreased efficiency in contractile strength of the heart muscle and decreased maximum heart rate, stroke volume, cardiac output, ejection fraction (the percentage of blood leaving the heart during a contraction), and oxygen uptake (Oskvig, 1999)
5. Accumulation of lipofuscin, a pigment giving a brown appearance to heart myocardium (middle layer of heart muscle)
6. Thickening and sclerosis (hardening) of the valve flaps of the heart, especially the tricuspid and mitral (bicuspid), but also in the aortic and pulmonary valves, causing them all to be less efficient and possibly resulting in heart murmurs
7. Significantly decreased number of pacemaker cells (cells that generate impulses and determine the rate of heart activity in the S-A node), with a concomitant decrease in the S-A node rate (Tabloski, 2014)
8. Some loss of muscle cells in the A-V node and the bundle of His, an increase in fatty fibrous tissue, and amyloid (starchlike protein) infiltration associated with degeneration
9. Increased elastic collagen-type tissue in all parts of the conduction system
10. Thickened and stretched veins and less efficiently functioning valves in the veins, slowing return of blood through the veins to the heart
11. Calcified, less elastic coronary arteries

Although not substantiated as a definite age-related change, atherosclerosis (fatty deposits on inner walls of arteries) is also associated with age. Additional factors such as lack of exercise, smoking, obesity, and other diseases contribute to vascular changes with age (House-Fancher & Lynch, 2007; Tabloski, 2014).

Age-Related Functional Changes

The following functional age-related changes in the cardiovascular system have been identified:

1. Longer recovery. Older heart muscle requires a longer time to recover after each heartbeat; in other words, the heart requires a slightly longer rest period between beats. This fact is not significant in most activity, but it may limit behavior in situations where the heart is stressed and required to beat faster than normal. Maximum attainable heart rate declines, but those who exercise do not show as much decline (Marieb & Hoehn, 2013). Generally, though, older people may be more prone to heart failure than younger adults, who have greater reserve capacity in heart functioning.
2. Slight arrhythmias. At rest, heart rate in people of older age is essentially the same as in younger people. However, some evidence suggests arrhythmias such as skipped or extra beats become more common with age. Arrhythmias sometimes produce anxiety in older adults who fail to understand the condition is not necessarily indicative of heart disease.
3. Decline in cardiac output. Cardiac output (the amount of blood pumped from the heart in 1 minute) declines somewhat with age, causing less oxygen to be delivered to body tissues and organs. Reduced cardiac output occurs both at rest and with exercise, but the decline usually has little significance for normal everyday behavior (Tabloski, 2014). Nevertheless, this fact may help to explain why most older adults tire more quickly than the young and why endurance, especially when doing strenuous work, tends to decline with age.

4. Increase in atrial fibrillation (irregular, rapid heartbeat) and incidence of heart block (a blockage of the impulse conducted from the atria to the ventricle). These occur as a result of age-related changes in the conduction system (which controls the rate and coordination of the heartbeat).
5. Changes in arteries and veins. The aging process seems to affect the arteries more than the heart itself because the arteries, and to a lesser extent the veins, become more rigid, less elastic and flexible. Elasticity of arteries is a major factor in regulating blood pressure. For instance, when exerted, the heart beats faster and more blood is pumped through the body at an increased rate. The elastic arterial walls normally expand to accommodate the greater force of blood pushed through and thus arterial resistance is decreased, but if the arterial walls are rigid and cannot expand, the heart must pump harder to move more blood through the system quickly. Blood pressure increases as arterial resistance is increased. Such increases in blood pressure are a common corollary of the aging process. Changes in the veins predispose individuals to a slower return of venous blood to the heart, venous stasis (stagnation of venous blood), varicose veins, and thrombophlebitis (clotting in a vein caused by phlebitis or inflammation of a vein).
6. Blood components. Only slight changes are evident in the blood components with age. The volume of blood decreases as it relates to a lower plasma volume. Hemoglobin and hematocrit levels are only minimally diminished and the red and white blood cells and prothrombin (coagulation) time remain unchanged (House-Fancher & Lynch, 2007).

In summary, in nonstressful conditions the normal aging heart functions quite adequately unless there is severe damage to the heart from disease. However, under stress the effects of age become increasingly more obvious and gradually lead to limitations in activity. Research highly recommends regular systematic exercise to promote continued adequate cardiac functioning in the later years. Walking is one of the best and safest ways for elders to exercise and requires no expensive equipment or special locations.

AGE-RELATED DISORDERS OF THE CARDIOVASCULAR SYSTEM

Arteriosclerosis and Atherosclerosis

Arteriosclerosis (hardening of the arteries) is the most common disease of arteries and involves a lessened elasticity and a thickening of the walls of the arteries, especially the small arteries and arterioles, resulting in high blood pressure. *Atherosclerosis*, the most prevalent type of arteriosclerosis, involves small white patches that thicken (atheromas) and protrude into the blood vessel. This is the leading factor for cardiovascular disease. Fatty, fibrous lesions and complicated plaques of scar tissue, calcium salts, and blood-clot formation in the vessel cause hypertension, myocardial infarcts (heart attacks), strokes, aneurysms, and angina attacks (Little, 2013; Marieb & Hoehn, 2013). Arteriosclerosis and atherosclerosis usually occur together, and it is rare to find one without the other. Their progress is not continuous but involves a building up and a breaking down of plaques. An increased level of low-density lipoproteins (LDLs) influences the building up of the fatty streaks on the vessel walls causing atherosclerosis, whereas high-density lipoproteins (HDL) transport excess lipids from the peripheral tissues to the liver. Atherosclerosis is often found in the aorta (which arises from the heart and supplies blood to the entire body), the coronary vessels (which supply blood to the heart muscle), and the arteries (which supply blood to the brain, abdomen, and legs).

Risk factors include age, gender (males are more at risk), African American or Hispanic ethnicity, and a family history of the disease. Reversible risk factors include cigarette smoking, obesity, diabetes, elevated lipids, psychological state,

hypertension, and inactivity. Prevention should begin early in life, but it is never too late to initiate health promotion behaviors.

Diagnosis is made through assessment of cholesterol, triglyceride, and C-reactive protein levels and electron beam computed tomography (EBCT) to identify the presence of plaques. Initial treatment focuses on lifestyle changes such as stopping smoking, regular exercise, weight loss, and a low-fat/low-cholesterol diet. If these are not adequate, various cholesterol-reducing medications (statins are especially helpful but must be used judiciously), a low dosage of aspirin often referred to as “baby aspirin” (81 mg), balloon angioplasty, stents, and bypass surgery are other commonly used options.

Both arteriosclerosis and atherosclerosis lead to ischemic heart disease (lack of adequate blood supply to the heart) as well as cerebral ischemia (lack of adequate blood supply to the brain). They also cause increased blood pressure, produce extra stress on the heart muscle, and set the stage for other diseases of the cardiovascular system. The heart must work harder, but with less overall effectiveness, resulting in insufficient oxygen delivered to body cells and therefore decreased efficiency of body organs in performing their necessary functions.

Hypertension

Hypertension (HTN) is defined as a systolic blood pressure (SBP) greater than 140 mmHg or a diastolic blood pressure (DBP) greater than 90 mmHg on two separate occasions. An estimated 30% of Americans older than age 50 are hypertensive, although many do not know it until they experience a heart attack, stroke, or heart failure or it is discovered during a physical examination. Other complications of hypertension are peripheral vascular disease, chronic kidney disease, and retinal damage; thus early diagnosis and treatment are imperative (Marieb & Hoehn, 2013).

Normal blood pressure is less than 120 mmHg systolic and less than 80 mmHg diastolic; prehypertension is defined as 120 to 139 mmHg systolic or 80 to 89 mmHg diastolic. Early treatment of prehypertension is highly recommended because it can readily progress to serious health complications (Little, 2013).

Hypertension may be differentiated into (a) primary (essential) hypertension, the most common, in which there is no obvious or apparent explanation for the sustained elevation in blood pressure; or (b) secondary hypertension, high blood pressure caused by such entities as endocrine, neurologic, renal, and liver disorders, as well as certain medications (Little, 2013).

Persistent abnormally high blood pressure, prevalent in many middle-aged and older adults, can be associated with other factors or systems involved in regulating blood pressure: (a) the circulatory or cardiovascular system, because of its tendency toward sclerosis (hardening of the arteries); (b) the endocrine system, when it acts to retain sodium chloride in the body; (c) the excretory system, when renin (an enzyme involved in raising blood pressure) is released into the blood or when the kidneys do not excrete sodium chloride and water is drawn back from the urinary tubules into the blood; and (d) the nervous system, because it responds to excessive and prolonged emotional tension by increasing peripheral resistance to blood flow, often reflected as high blood pressure. Unfortunately, many individuals have hypertension but do not experience symptoms (*“silent”*) until body functions become impaired. Even if they experience headaches, dizziness, or fatigue, these may or may not be associated with hypertension. Blood pressure should be checked regularly at each health care visit, plus opportunities are available at churches, senior centers, clinics, and other locations.

Risk Factors for Development of Cardiovascular Disease

Nonmodifiable

Age. Blood pressure tends to increase gradually with age until the 60s, when it tends to level off unless other factors cause it to continue to increase.

Gender. Men are more likely to be hypertensive in early and middle age and women in the 55+ years.

Heredity. A family history of hypertension and heart disease increases the risk of other family members also developing hypertension.

Ethnicity. African Americans have the highest incidence of hypertension and suffer from more cardiovascular and major organ complications than Caucasians.

Diabetes. People with diabetes are especially prone to hypertension and cardiovascular disease. When these coexist, the risk for complications is greater.

Modifiable

Obesity. Overweight individuals have a greater tendency to develop hypertension than those of average weight.

Alcohol. Excessive ingestion of alcohol increases the incidence of hypertension. Older persons with hypertension should limit their intake of alcohol to 1 ounce daily.

Smoking. Numerous research studies associate cardiovascular disease with smoking and those with hypertension are at greater risk for cardiovascular disease.

Elevated lipids and cholesterol. A diet high in these increases the incidence of atherosclerosis, which tends to narrow blood vessels and cause both hypertension and cardiovascular disease.

High sodium intake. Sodium intake promotes fluid retention and increases the likelihood of developing hypertension.

Stress. Prolonged high stress may increase blood pressure. The length of time the stress exists, the intensity of the stress, and the individual’s response to stress are all modifiable factors.

Sedentary lifestyle. Regular systematic exercise can reduce blood pressure and weight as well as the risk of developing cardiovascular disease.

Prevention and Treatment of Hypertension

Early diagnosis and treatment are imperative to prevent extensive damage to major organs. Nonpharmacological measures are usually prescribed initially for older adults, depending on the blood pressure reading. They include weight reduction if obese, 30 minutes of regular systematic aerobic exercise daily, moderate alcohol consumption, reduced sodium and caffeine intake, and no smoking. The Dietary Approaches to Stop Hypertension diet (DASH) limits sweets and meats, is rich in calcium and potassium while reducing total and saturated fats, and includes stress reduction and pharmacological treatment.

If lifestyle changes are not effective, medications are prescribed. Initially a thiazide diuretic is usually the drug of choice; however, individuals taking these non–potassium-sparing drugs should be encouraged to eat potassium-rich foods such as bananas, oranges, dried prunes, and raisins or take potassium supplements. Beta blockers, angiotensin-converting enzyme (ACE) inhibitors, and calcium channel blockers (CCB) may be used alone or in combination to reduce blood pressure levels. Teaching older adults about the particular drug, its action, side effects, how and when to take it, what foods and drinks are not compatible, and the need to check blood pressure levels frequently is necessary. Many of these drugs may not be stopped suddenly, so contact with a primary care provider is very important if one has questions or unexpected drug reactions. Other nonpharmacological measures to consider for older adults include biofeedback, yoga, meditation, and relaxation exercises, all of which may be effective in reducing blood pressure (Eliopoulos, 2014).

Postural Hypotension

Postural hypotension (orthostatic hypotension) occurs when systolic and diastolic blood pressure drops at least 20 or 10 mmHg, respectively, within 1 to 4 minutes of standing after being in a recumbent position for a minimum of 5 minutes (Miller, 2009). Thirty to forty percent of adults older than age 75 experience postural hypotension. It may be caused by age-related changes such as reduced sensitivity of the baroreceptors (receptors that sense blood pressure) and a lessened responsiveness of the sympathetic autonomic nervous system. Other prime causes include medications such as diuretics, antihypertensives, vasodilators, antidepressants, alpha and beta blockers, and calcium channel blockers. Certain disease states such as hypertension, atherosclerosis, Parkinson’s disease, arrhythmias, anemia, dehydration, and fluid and electrolyte imbalance might also precipitate the symptoms (House-Fancher & Lynch, 2007). Symptoms include dizziness, lightheadedness, fainting, impaired vision, inability to walk properly, fatigue, and confusion, all of which may predispose elders to fall or experience other types of accidents.

Preventive measures. Care must be taken to prevent blood pressure from falling too low and impairing coronary circulation. Medication regimens need to be continually monitored and evaluated. In addition, older adults should be taught to rise slowly from a lying position and to sit for a short time before standing. Putting on elastic stockings before getting out of bed and reducing physical activity for an hour after a meal are also helpful.

Acute Coronary Syndrome

Even though large amounts of blood continually pass through the heart, this blood does not provide the heart muscle with nutrients and oxygen. Instead, this function is carried out by a group of arteries called coronary arteries that branch off the aorta and envelop the heart. Coronary heart disease results when the blood supply through these arteries is reduced or blocked in any of the following ways:

1. Too high blood pressure in the coronary arteries may result in hemorrhage if a coronary blood vessel should rupture.
2. An aneurysm (a weakened area in the coronary arterial wall) may protrude and rupture, causing a hemorrhage.
3. If blood clots form, they may restrict or block blood flow through the coronary arteries, depriving the heart muscle of blood.
4. Fatty deposits (atherosclerosis) in the inner walls of coronary arteries may interfere with blood flow to the heart muscle and are the most common cause of heart disease in older persons.

Angina Pectoris

The term *angina pectoris* is Latin for "chest pain." It is a symptom of coronary artery disease and occurs when the heart muscle is not receiving an adequate blood supply for effective functioning because of occlusion (closure) or vasospasm (spasm of a blood vessel) of the coronary arteries. Attacks usually last 3 minutes or less and are characterized by pain radiating primarily down the left side of the jaw, neck, between the shoulder blades, and down the arms. Pain, however, may also be on the right side, and individuals may complain of feelings of tightness or pressure in the chest over the sternum or feelings of suffocation. Note that these classic symptoms of angina may not be experienced by older adults and therefore make detection and diagnosis more difficult (Eliopoulos, 2014).

Chronic stable angina (exertional angina) is described as episodic (3–5 minutes) chest pain that occurs over a long period. The symptoms, onset, intensity, and duration are similar but increase when causative factors such as cold weather, physical exertion, or a heavy meal are present (Martinez & Bucher, 2007). Because of decreased subcutaneous fat, older adults can develop symptoms of angina more rapidly than younger individuals and should therefore wear an extra layer of clothing in cold weather. Chronic stable angina is usually relieved by rest or nitroglycerin and is managed with drug therapy.

Unstable angina is characterized by pain at rest and occurs with the slightest provocation. It occurs with increasing frequency and represents an emergency requiring immediate attention (Dechant, 2013; Martinez & Bucher, 2007).

Diagnosis of angina involves a careful history, observing whether the pain is relieved by nitroglycerin, plus an electrocardiogram, stress testing, chest x-ray examination, or ambulatory heart monitoring. If medications are not effective, procedures such as cardiac catheterization, angioplasty (in which a catheter is inserted into a coronary vessel and plaque is compressed against the vessel wall by the inflation of a balloon), placing a stent in the coronary artery to open up an occlusion in the vessel, or coronary bypass surgery may be indicated.

The initial treatment is aspirin with nitroglycerin, which is considered the cornerstone of anginal therapy because it inhibits spasms of the coronary vessels and improves collateral circulation to the heart muscle. Nitroglycerin is placed under the tongue, and relief should occur in about 3 minutes. If not, the dosage is repeated for a total of three times. However, medical attention is advised if the medication is not effective in relieving the discomfort. Other medications that may be prescribed are beta blockers, calcium channel blockers, statins, ACE inhibitors and ranolazine. Aspirin plus clopidogrel may be used as an ongoing treatment. Stress reduction and avoiding caffeine, heavy meals, and physical exertion are also advised.

Instructing older adults regarding precipitating factors, signs and symptoms of angina, and how and when to take medication or seek medical care are important. If sublingual nitroglycerin is prescribed, it should be carried by the person at all times, stored in a capped dark-glass bottle, and a new supply obtained every 3 months.

Myocardial Infarction

A myocardial infarction (MI) results when there is reduced or no blood flow to the heart muscle via the coronary arteries, depriving the heart muscle of oxygen and causing the heart rhythm to become erratic or cease altogether. Most MIs are caused by atherosclerosis of a coronary artery, rupture of the plaque, and blockage of blood flow. Inflammation may also contribute to heart attack if coronary artery walls become inflamed, increasing the buildup of fatty plaques. It may only damage a small area of the heart or it can be extensive. Older adults are more likely to develop complications such as heart failure, arrhythmia, pulmonary edema, and rupture of the heart (House-Fancher & Lynch, 2007). Those with an MI require close observation in an intensive care unit to prevent further complications.

Typical symptoms of an MI include severe, vicelike, continuous, constrictive, chest pain that commonly radiates to the jaw, neck, arm, and back. The pain often occurs in the early morning; is unrelieved by nitrates, position change, or rest; and

lasts about 20 minutes or more. Other signs and symptoms include profuse perspiration, moist clammy skin, pallor, and nausea and vomiting. Anxiety, restlessness, drop in blood pressure, arrhythmias, shock, and heart failure may also be present (Martinez & Bucher, 2007). It is important to note that 25% to 68% of MIs are not identified as an MI; this is especially the case for older adults and women, who may not display the usual clinical symptoms of a heart attack, called a "silent MI." Rather, they may have gastric disturbances, dizziness, nausea and vomiting, fatigue, behavioral or mental changes, or an arrhythmia (Meiner, 2011; Miller, 2009). The course of the illness is more complex and the mortality rate is higher among older adults; therefore early, definitive diagnosis and treatment are imperative (House-Fancher & Lynch, 2007).

Early treatment is vital but is sometimes delayed because of the atypical presentation of symptoms in older adults. A chest radiograph, electrocardiogram, various scans (CT or MRI), serum cardiac markers and other blood tests, an angiogram, or stress test may be used to diagnose an MI. The treatment may involve fibrolytic therapy such as tissue plasminogen activator (t-PA) administered within a rigid time frame; however, these drugs have multiple contraindications. Seeking medical attention immediately is crucial because these drugs should only be administered within a 3-hour period from the time the symptoms first appear. Other treatments include intravenous nitroglycerin, ACE inhibitors, beta blockers, anticoagulants, antiarrhythmics, cholesterol-lowering agents, and possibly calcium channel blockers. Aspirin can help to prevent new clots from forming. Procedures such as coronary angioplasty, intracoronary stent placement, or coronary bypass surgery may be necessary treatment choices (Martinez & Bucher, 2007; Tabloski, 2014).

Rehabilitation. Cardiac rehabilitation along with dedication to a healthy lifestyle is paramount in preventing coronary artery disease. Cardiac rehabilitation programs are now widely available throughout the country where individuals are introduced to monitored exercise and educated regarding stress reduction, smoking cessation, modified alcohol ingestion, and weight control. Dietary teaching includes sodium and fat restriction, eating fruits and vegetables, and education about whole-grain, high-fiber foods (Sherman, 2008). Psychosocial issues such as risk modification, psychological support, socialization, and resuming sexual activity are important considerations.

Congestive Heart Failure or Heart Failure

Two thirds of those with heart failure are older than age 65, and the incidence increases with age (Eliopoulos, 2014). About 6 million people in the United States have heart failure, and it is the leading cause of hospitalization in both men and women older than age 65. Congestive heart failure (CHF) usually develops gradually and progresses over time, with a high morbidity and mortality rate. Often it is undetected in the early stages because symptoms of fatigue and shortness of breath may be expected and equated with growing older (Jett, 2008; Tabloski, 2014). Heart failure occurs when the heart is no longer able to pump adequate blood and oxygen to body tissues during exercise or even at rest. There may be left-sided heart failure as a result of the failure of the left ventricle to adequately pump the blood it is receiving from the lungs, resulting in a buildup of fluid in the lungs and less blood pumped through the body. Right-sided heart failure occurs when the right side of the heart cannot adequately empty itself of the blood coming from the venous circulation and less blood enters the heart, producing a backup of fluid (edema) in the extremities or in the abdominal cavity. The signs and symptoms include coughing, shortness of breath, wheezing, edema, loss of appetite, nausea, and tachycardia. Other less common signs include fatigue, disorientation, and weakness (Mauk, 2006). Diagnosis involves a history and physical examination; assessing for pulmonary and systemic congestion plus measuring the output of the heart; chest radiographs; urinalysis; an echocardiogram, including calculation of the ejection factor (EF) to measure how well the heart pumps with each beat; electrocardiogram; Doppler ultrasound; blood

chemistries; exercise or stress testing; nuclear imaging studies; and cardiac catheterization (Jett, 2008; Martinez & Bucher, 2007). Classification systems can be helpful in determining therapies for heart failure patients that emphasize the progression of heart failure and the need for different therapies as the disease progresses.

Risk factors for CHF include the following:

1. Cardiac factors. Coronary artery disease, myocardial infarction, hypertension, and valvular heart disease all reduce the efficiency of the pumping action of the heart.
2. Noncardiac factors. Pathological conditions that increase the risk for CHF are chronic obstructive pulmonary disease, pulmonary emboli, kidney disease, liver disease, diabetes, and anemia.
3. Iatrogenic factors (caused as a result of treatment). Medications used by elders, such as digoxin, steroids, hormones, and anti-inflammatory drugs, often increase the risk of CHF.
4. Other factors such as malnutrition severe enough to produce fluid and electrolyte imbalances, obesity, alcohol abuse, and prolonged high-stress situations may also cause CHF.

Treatment of CHF includes medications such as ACE inhibitors, beta blockers, digitalis, diuretics, lifestyle and dietary management, and rest. The goals of treatment are (a) to reduce the body's demand for high cardiac output (through a balanced exercise/rest program and weight reduction); (b) to increase the cardiac output if possible (usually through the use of medication); and (c) to reduce body congestion (water and sodium retention) by sodium restriction and medications such as diuretics. Digoxin (digitalis) is used to increase the force of the heart's contractions and slow down the rate. It is important to teach individuals how to take an accurate pulse and not to take digoxin if the pulse rate is less than 60 unless otherwise instructed by a primary care practitioner. Digitalis toxicity is common among older adults, thus blood levels need to be monitored regularly.

If prescribed diuretics deplete potassium, foods rich in potassium such as bananas should be encouraged. Sodium restriction helps to decrease the workload on the heart. For heart failure to be adequately managed, older adults and family need to understand as much as possible about the disease, its treatment, medications, and a healthy lifestyle. Possible surgical treatments include coronary artery bypass, heart valve surgery, implantable left ventricular assist device (LVAD), and heart transplant. Ongoing education and monitoring and psychological support are crucial in preventing exacerbations of the disease. The prognosis in older adults is guarded because CHF or heart failure is an end-stage heart disease reflecting the accumulative effects of other serious pathological conditions.

Heart Valve Disease

The incidence of heart valve disease is increasing as larger numbers of people are living longer with degenerative heart diseases. Heart valve disease is thought to be caused by valvular or muscle dysfunction, endocarditis (inflammation of the lining of the heart), or rheumatic diseases. Valvular incompetence or regurgitation occurs when a valve doesn't close properly and blood leaks back into the chamber. Aortic stenosis, the most common valve disorder in older adults, is caused by sclerosis of the aortic cusps or abnormal tissue in the septum or aorta, both of which restrict blood flow (Tabloski, 2014).

Risk factors are high cholesterol, hypertension, and diabetes. Diagnosis depends on physical examination, history, echocardiogram, and possibly cardiac catheterization. Treatment often requires mechanical or surgical procedures and possibly valve replacement (Tabloski, 2014).

Cardiac Arrhythmias and Conduction Disorders

With aging, cardiac arrhythmias (irregular heartbeat) and conduction disorders become more common. Arrhythmias and conduction disorders (disorders affecting the heart's ability to regulate a synchronized heartbeat) are more serious in older adults because vital body functions are already less efficient and reduced blood supply to tissues is less well tolerated. Disturbances found more often in the older age group include premature atrial and ventricular contractions, atrial fibrillation (extremely rapid incomplete contractions), and abnormal rhythms of the atrial pacemaker mechanism. Impaired functioning of the S-A node may cause "sick sinus syndrome," resulting in arrhythmias, sinus bradycardia (slow heartbeat), heart block, palpitations (rapid throbbing pulsations), weakness, and dizziness or fainting. These disorders often are first identified during a routine health examination.

Treatment involves antiarrhythmic drugs such as digoxin; sodium, potassium, or calcium channel blockers; beta blockers; and other medications. Sometimes the use of a manual or automatic external defibrillator, or synchronized cardioversion, is warranted to interrupt the dysfunctional rhythm and restore normal heart rhythm. A permanent pacemaker or a cardioverter-defibrillator may also be implanted to maintain or restore normal heart rhythm.

Transient Ischemic Attack

A transient ischemic attack (TIA, or ministroke) is an early warning of impairment in the blood supply to the brain and of a possible imminent major stroke. The greatest risk for a stroke is in the first week after a TIA (Tabloski, 2014). TIAs are caused by a sudden interruption in the circulation of blood and oxygen to the brain, usually lasting less than 24 hours, with no permanent brain injury. Symptoms last from a few minutes to 24 hours, with recovery often in 3 hours. TIAs often go unnoticed because symptoms are minimal and of short duration. Typical signs of a TIA include the following (Eliopoulos, 2014):

(a) Sudden temporary weakness or numbness of the face, arm, or leg
(b) Difficulty understanding speech
(c) Brief vision loss in one or both eyes
(d) Double vision
(e) Unexplained headaches or a change in type of headache
(f) Temporary dizziness or unsteadiness
(g) Nausea, vomiting
(h) Change in personality or mental abilities such as confusion

If TIAs lead to small strokes, tissue damage will accumulate and eventually produce changes in behavior. Sometimes behavior changes after accumulated ministrokes are so slight that only close family members are aware of the subtle changes taking place, usually in personality or mood. Any unusual or persisting change in normal behavior patterns or unusual symptoms should be evaluated immediately by a professional because early diagnosis and treatment are important.

At risk for TIAs are those age 60 and older with hypertension, obesity, or diabetes; those who are smokers or alcoholics; and those with sleep apnea, high cholesterol, and cardiovascular insufficiency. Guidelines of the American Heart Association /American Stroke Association (2011) recommend treating a TIA in the same way as an ischemic stroke. Initially there should be a complete diagnostic workup and the use of the same preventive treatments for a stroke. Various medical options should

be considered, including the use of blood thinners and interventional therapies such as endarterectomy (surgical removal of a blood clot from the carotid artery), angioplasty (when a balloon attached to a catheter is blown up to compress the plaque against the vessel wall), or the placement of a stent in the carotid artery. Such interventions carry some risk of a stroke; thus it is important to select a surgeon who has a low rate of complications and who has performed large numbers of these procedures. Individuals taking blood thinners should be carefully monitored for signs of bleeding in the urine, feces, or under the skin. The individual should also be counseled to adopt healthy behaviors such as a low-cholesterol, low-fat diet; not smoking; minimal alcohol intake; and a consistent exercise regimen.

Cerebrovascular Accident

A cerebrovascular accident (CVA, stroke, brain attack) results when the blood supply to any part of the brain is reduced or completely shut off. Strokes are the third leading cause of death and a significant cause of disability in older adults (Eliopoulos, 2014). The majority of elders experience an *ischemic stroke (occlusive)*, which includes either a thrombotic or embolic stroke. A thrombotic stroke occurs when a cerebral artery is narrowed by plaque (fatty deposits) in the artery, causing a clot to form (cerebral thrombosis) that either reduces or closes off the blood flow to an area of the brain. An embolic stroke is caused by air, fat tissue, blood clot, or other foreign matter circulating in the blood, which blocks blood flow in a cerebral vessel. A *hemorrhagic stroke* occurs when a weak spot in a blood vessel of the brain bursts, causing bleeding into the brain tissue.

Significant risk factors associated with a stroke include hypertension, heart disease, previous TIAs, smoking, diabetes, atherosclerosis, high cholesterol, sedentary lifestyle, high-fat diet, and family history of strokes. Those of African American ancestry have a higher incidence of strokes, and more men than women have strokes, although postmenopausal women are also at significantly increased risk. Individuals with one or more of these risk factors should be especially attentive to their health and lifestyle because the best treatment for stroke is prevention.

Strokes affect behavior in many different ways depending on location and the amount of brain tissue damaged. Injury to the right half of the brain may result in impaired movement and sensation on the left side of the body, spatial–perceptual difficulties, and memory problems. Conversely, strokes on the left half of the brain affect movement and sensation on the right side of the body. Language or speech aphasia, impaired vision and comprehension, or emotional problems may also result.

After a thorough history and physical examination, careful screening must begin immediately using angiography; a computed tomography (CT), positron emission tomography (PET) scan, MRI or other scans; and laboratory tests. Brain imaging is most important in diagnosing strokes. If the individual has an ischemic stroke and meets the specific criteria, early intervention with fibrinolytic therapy (clot-busting drug) or other drugs may be given intravenously to help reestablish blood flow through the occluded artery. This therapy must be initiated within a 3-hour period beginning at the time the individual shows the first clinical signs of a stroke. Thus immediate attention is necessary by calling an emergency number such as 911 and getting the individual to a designated stroke center or an acute care hospital. Initially the person’s status is stabilized in the intensive care unit (ICU). Depending on the type, location, and extent of tissue damage, poststroke management can include anticoagulants or antiplatelet therapy and prolonged physical and psychological rehabilitation to help improve functioning and to prevent the many complications of a stroke. A team approach is initiated with medical and nursing care; physical, occupational, and speech therapy; and psychological and social therapy, ideally at a rehabilitation center. Most neurological recovery takes place within the first 3 to 6 months after a stroke. Family functioning is greatly influenced after a stroke in a family member. Because the healing process is often prolonged, family need to assume added responsibilities of

caregiving, managing a household, transportation, cooking, and managing finances. The family experiences many of the same psychological responses as the patient; thus they too need continual social and psychological support. Patient and family teaching are paramount to assist them in understanding the importance of a healthy lifestyle regarding diet, exercise, medication adherence, and stress-free living.

VASCULAR DISORDERS

Peripheral vascular disease is primarily a result of generalized atherosclerosis causing a narrowing of the arteries in extremities as well as the neck, head, abdomen, and legs. Both aneurysmal and occlusive vascular disease result from atherosclerosis.

Aneurysm

Aneurysms tend to occur after age 60, with men more likely candidates than women. Those with hypertension and atherosclerosis are more prone to aneurysms. *Aneurysm* is the term for a “pouch” formation in a weakened arterial wall. The pouch fills with blood and may burst, especially if the arterial wall is weak and blood pressure is high; the larger the aneurysm, the more likely it is to rupture. When aortic and cerebral aneurysms rupture, shock and death often result. Other areas commonly affected include the femoral and popliteal arteries in the leg. Although significant pain does not always accompany an aneurysm, some individuals experience chest, back, and abdominal pain or leg weakness and cramping when walking, which is relieved by rest. Treatment involves supportive treatment and dissection of the aneurysm, replacing the area with a synthetic graft material.

Arterial Occlusion

The major causes of arterial occlusion are thrombosis, embolism, or trauma. An occlusion develops inside an artery near an area of plaque formation. Most often occlusions occur in the coronary vessels, causing a coronary infarction, or perhaps in the legs. When the legs are involved they become cold, pale, and bluish colored; severe pain is present along with intermittent cramping, especially after walking. Diagnosis requires vascular studies, scans, ultrasound, a thorough history, and physical examination.

Treatment involves increasing the flow of blood to the area through exercise, anticoagulant therapy, or surgery. Older adults should be advised not to cross their legs or wear tight clothing, and shoes should be well fitted and comfortable. Feet should be kept clean and dry, and foot care should be provided by a podiatrist. Any break in the skin, trauma, or blister needs to be reported immediately to a primary care practitioner.

Varicose Veins

Varicose veins (varicosities) are caused by inefficiency of one-way valves in peripheral veins that return blood from the peripheral to central circulation. Blood then pools, especially in the lower extremities, vein walls become weak, and swollen “knotted” veins result from the slowed circulation. Varicose veins are more prevalent in women and in those who are obese, with a predisposition to varicosities occurring in families. Treatment involves keeping the affected limb elevated; avoiding trauma to the leg; wearing support hose; and the use of sclerotherapy, laser, high-intensity pulsed-light therapy, endovenous occulsion, or saphenofemoral ligation. Surgical removal of the vein is possible if other treatment modalities are not effective.

Varicose veins in the lower part of the rectum and anus are called hemorrhoids.

Phlebitis and Deep Vein Thrombosis

Phlebitis is an inflammation of a vein, often in the leg, producing conditions favorable for the formation of blood clots (thrombi) that can break loose and occlude a major vessel in the lungs (pulmonary embolism), heart, or brain and they may be life threatening. Particularly at risk are postoperative knee or hip surgery patients who are older, obese, or smokers, and those who are dehydrated or have major heart or circulatory problems. Signs and symptoms include a bluish-red color in the leg and a leg that is warm to touch, tender, swollen, and painful. Appropriate leg exercises, antiembolic stockings, intermittent compression devices (ICDs), and anticoagulant therapy are among the appropriate treatment choices.

SUMMARY

Heart disease remains the most common cause of death in individuals older than age 65 but is often preventable, especially if health promotion behaviors are initiated early in life. However, positive results can be attained even if they are begun in later life. Maintaining an active exercise regimen, weight control, and managing stress are all necessary for optimal cardiac health.

Cardiovascular disease often leads to fear and anxiety, increasing self-preoccupation and impatience with those who are healthy and active. It is important that efforts be directed toward assuming a normal lifestyle after each episode of cardiac dysfunction. Many individuals with cardiovascular disease live normal, well-balanced lives under medical supervision. Participation in a cardiac rehabilitation program is especially recommended to promote a longer, healthier life.

REFERENCES

American Heart Association/American Stroke Association. (2011). Guidelines for the prevention of stroke in patients with stroke or transient ischemic attack: A guideline for healthcare professionals from the American Heart Association/American Stroke Association. *Stroke*, *42*, 227–276.

Dechant, L. (2013). Care of patients with acute coronary syndromes. In D. Ignatavicius & L. Workman (Eds.), *Medical–surgical nursing* (7th ed., pp. 828–854). St. Louis, MO: Saunders Elsevier.

Eliopoulos, C. (2014). *Gerontological nursing* (8th ed.). Philadelphia, PA: Wolters Kluwer Health /Lippincott Williams & Wilkins.

House-Fancher, M.A., & Lynch, R.J. (2007). Cardiovascular system. In A. D. Linton & H. W. Lach (Eds.), *Matteson & McConnell's gerontological nursing* (3rd ed., pp. 313–352). St. Louis, MO: Saunders Elsevier.

Jett, K. (2008). Chronic disease in later life. In P. Ebersole, P. Hess, T. A. Touhy, K. Jett, & A. S. Luggen (Eds.), *Toward healthy aging* (7th ed., pp. 222–268). St. Louis, MO: Mosby Elsevier.

Little, T. (2013). Assessment of the cardiovascular system. In D. Ignatavicius & L. Workman (Eds.), *Medical–surgical nursing* (7th ed., pp. 686–710). St. Louis, MO: Saunders Elsevier.

Marieb, E. N., & Hoehn, K. (2013). *Human anatomy and physiology* (9th ed.). San Francisco, CA: Pearson Benjamin Cummings.

Martinez, L. G., & Bucher, L. (2007). Nursing management: Coronary artery disease and acute coronary syndrome. In S. L. Lewis, M. M. Heitkemper, S. R. Dirksen, P. G. O'Brien, & L. Bucher (Eds.), *Medical–surgical nursing* (7th ed., pp. 784–820). St. Louis, MO: Mosby Elsevier.

Mauk, K. (2006). Management of common illnesses, diseases, and health conditions. In K. Mauk (Ed.), *Gerontological nursing* (pp. 391–474). Sudbury, MA: Jones & Bartlett.

Meiner, S. (2011). Gerontological nursing (4th ed.). St. Louis, MO: Mosby Elsevier.

Miller, C. (2009). *Nursing for wellness in older adults* (5th ed.). Philadelphia, PA: Wolters Kluwer/Lippincott Williams & Wilkins.

Oskvig, R. M. (1999). Special problems of the elderly. *Chest, 115* (Suppl. 2), 158–164.

Sherman, C. (2008). Reducing the risk of heart disease in women. *Clinical Advisor, 11*(1), 49–53.

Tabloski, P. (2014). *Gerontological nursing* (3rd ed.). Upper Saddle River, NJ: Pearson Education.