Cardiovascular Nursing

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Jim Keogh RN-BC, MSN

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This book is dedicated to Anne, Sandy, Joanne, Amber-Leigh Christine, Shawn, Eric, and Amy. Without their help and support, this book couldn't have been written.

—Jim Keogh, RN-BC, MSN

About the Author

Jim Keogh, RN-BC, MSN, is Board Certified in Psychiatric-Mental Health and has written McGraw-Hill's *Nursing Demystified* series. These include *Behavioral Health and Psychiatric Nursing Demystified*, *Healthcare Informatics Demystified*, *Pharmacology Demystified*, *Microbiology Demystified*, *Medical-Surgical Nursing Demystified*, *Medical Billing and Coding Demystified*, *Nursing Laboratory and Diagnostic Tests Demystified*, *Dosage Calculations Demystified*, *Medical Charting Demystified*, *Pediatric Nursing Demystified*, *Nurse Management Demystified*, *Schaum's Outline of ECG Interpretations*, *Schaum's Outline of Medical Terminology*, and *Schaum's Outline of Emergency Nursing*. His books can be found in leading university libraries, including Yale School of Medicine, Yale University, University of Pennsylvania Biomedical Library, Columbia University, Brown University, University of Medicine and Dentistry of New Jersey, Cambridge University, and Oxford University. He is a former member of the faculty at Columbia University and is a member of the faculty of New York University School of Nursing and Saint Peter's University in New Jersey.

Contents

Introduction

Every patient knows how to seek medical help when his or her chest discomfort becomes too much to bear. However, how does the health care provider determine what is wrong and what to do to restore the patient to good health? The answer depends on the patient's signs and symptoms and the results from medical tests. In this book you will learn to identify these signs and symptoms, interpret the medical test results, and perform the nursing interventions that will assist in solving or alleviating the patient's cardiovascular problem.

Cardiovascular Nursing Demystified contains 10 chapters, each providing a roadmap to the cardiovascular system and the diseases and disorders that can affect that system. The discussion of each disease or disorder is divided into the following sections:

- What Went Wrong?
- Prognosis
- Hallmark Signs and Symptoms
- Interpreting Test Results
- Treatment
- Nursing Diagnoses
- Nursing Intervention
- Crucial Diagnostic Tests

The "What Went Wrong?" section presents a brief description of how the body is affected when the particular disease or disorder occurs. The "Prognosis" section discusses the possibilities of curing this disease and permanent damage that can occur.

The remaining sections present the information as lists of symptoms, diagnoses, etc that make it easy for you to learn and that also serve as a useful tool for later reference.

A Look Inside

Since cardiovascular nursing can be challenging for the beginner, this book was written to provide an organized, outline approach to learning about major cardiovascular diseases and the part the nurse can play in the treatment process. The following paragraphs provide a thumbnail description of each chapter.

Chapter 1 Cardiovascular Anatomy and Physiology

Think of the **vascular system** as a distribution mechanism that consists of blood vessels (pipes) and the heart (pump). Visualizing the vascular system as "pipes" and a "pump" helps you understand signs and symptoms of cardiovascular disorders and diseases.

Blood vessels touch every organ and tissue in the body, providing oxygen and nutrients such as glucose needed for cells to work. Work is performed inside the cell by enzymes. An enzyme causes a chemical reaction to occur quickly. The chemical reaction causes the cell to do the cell's specific task in the body. The by-product of the chemical reaction—waste—is removed from the cell into the blood vessel where the waste is carried to organs (eg, kidneys) and excreted from the body.

Blood is composed of cells and fluid called plasma that provides oxygen and nutrients to cells throughout the body and removes waste from cells. An average adult has about 5 L of blood. The high concentration of blood moves across cell membranes through the process of diffusion. Diffusion is a process by which a high concentrated area (ie, blood) moves to a low concentrated area (ie, inside the cell). Cell waste moves outside of the cell and into blood where the waste is transported to the kidneys and lungs for excretion. Blood pressure called hydrostatic pressure pushes blood from the blood vessels, enabling diffusion into the cells. Oncotic pressure keeps blood inside blood vessels to maintain constant blood volume. Oncotic pressure is controlled by the amount of albumin dissolved in the blood.

The heart is a muscle that pumps blood throughout the vascular system. Health care providers need a thorough understanding of what can go wrong with the cardiovascular system; in this chapter you will learn to recognize the anatomy and physiology of the cardiovascular system.

Chapter 2 Cardiovascular Assessment and Tests

The cardiovascular assessment is a focused assessment that typically follows a comprehensive assessment of the patient. The focused assessment follows up information that leads the nurse to suspect that the patient may have a cardiovascular disorder or is at risk for developing a cardiovascular disorder.

The cardiovascular focused assessment begins with a review of the patient's medical history. The patient's medical history can reveal symptoms of a cardiovascular disorder or risk factors that, if left unaddressed, can lead to cardiovascular disorders.

The patient's cardiovascular history will guide you through a focused cardiovascular physical examination. For example: A patient may report chest pain or other symptoms associated with cardiovascular disease, which is why the patient is being assessed. This is referred to as an episode, which causes the nurse and practitioner to focus on the reported problem rather than the overall health of the patient.

Cardiovascular tests and procedures are a key element in assessing the patient for cardiovascular disease. The cardiovascular history and physical assessment may or may not identify signs and symptoms of cardiovascular disease. The patient may report symptoms or you may identify signs that lead you to believe that cardiovascular disease may exist. However, the patient may be asymptomatic and your physical assessment may not reveal any signs of a cardiovascular problem. The practitioner may order cardiovascular tests to rule out a cardiovascular problem and may perform procedures if such a problem exists.

In this chapter you will learn how to perform a cardiac assessment and how to use cardiac tests to assess the cardiovascular system.

Chapter 3 Electrophysiology and Electrocardiogram

Electrophysiology is the study of electrical properties of tissues and cells that cause the heart muscles to contract (depolarize) and relax (repolarize), forcing blood throughout the body. The electrophysiological activity of the heart is measured and recorded by an electrocardiograph (ECG). The heart is composed of striated involuntary muscles called cardiac muscles consisting of cells called cardiomyocytes commonly referred to as pacemaker cells.

The ECG tracing is an image of the electrophysiology of cardiac muscle in the form of a line that is automatically drawn on graph paper by the ECG. Initially, the line is aligned to a baseline on the graph paper. This is referred to as zeroing or calibrating the ECG and is performed before recording a patient's ECG.

The baseline is called the isoelectric line, which is a straight horizontal line on the graph paper commonly called a flat line. The graph paper consists of small and large boxes. Each small box is 1 mm^2. There are five small boxes in one large box. The patient's cardiac function is analyzed by measuring both the height (deflection) of the isoelectric line and the width of the wave (duration of the deflection). In this chapter you will learn how to apply concepts of electrophysiology and how to use an ECG.

Chapter 4 Cardiac Arrhythmias

All cells in the heart are capable of stimulating the heart to contract. In a regular cardiac rhythm, the sinoatrial (SA) node of the heart stimulates cardiac contractions. An arrhythmia is an irregular cardiac rhythm caused when a cardiac cell other than the SA node stimulates cardiac contractions. The SA node is called the ectopic pacemaker. There are three common ectopic pacemakers. These are atrial ectopic: atrial ectopic pacemaker located in the atria; junctional ectopic: junctional ectopic pacemaker located in the atrioventricular (AV) junction; and ventricular ectopic: ventricular ectopic pacemaker located in the ventricles. In this chapter you will learn how to recognize different cardiac arrhythmias using the ECG.

Chapter 5 Cardiac Inflammatory Disorder

The heart can become inflamed resulting in cardiac malfunction. Inflammation is the immune response to a localized infection caused by a microorganism; however, the immune response typically continues after the infection resolves. The extended immune response may impair cardiac contractions resulting in decreased flow of the blood throughout the body, and increase the risk of blood clots because of pooling blood.

Myocarditis is inflammation of the middle layer of the heart wall called the myocardium. Pericarditis is inflammation of the fluid sac that contains the heart called the pericardium. The increase in blood by the inflammation process causes the pericardium to swell, resulting in layers of the pericardium rubbing together causing irritation. Endocarditis is an infection of the inner lining of the heart called the endocardium. Endocarditis is less common in patients who do not have a history of cardiac defects.

In this chapter you will learn how to recognize and treat cardiac inflammatory disorders.

Chapter 6 Cardiac Valve Disorder

There are four chambers of the heart: right atrium, right ventricle, left atrium, and left ventricle. The right atrium receives deoxygenated blood from the circulatory system and sends deoxygenated blood to the right ventricle. The right ventricle sends deoxygenated blood to the lungs. The left atrium receives oxygenated blood from the lungs and sends oxygenated blood to the left ventricle. The left ventricle sends oxygenated blood to the circulatory system.

Each chamber of the heart has a one-way valve that allows blood to flow in one direction. The valve also prevents blood from flowing backward. These valves are the tricuspid, pulmonary, mitral, and the aortic valves. The tricuspid valve allows blood to flow from the right atrium into the right ventricle. The pulmonary valve allows blood to flow from the right ventricle to the pulmonary artery. The mitral valve allows blood to flow from left atrium to the left ventricle. The aortic valve allows blood to flow from the left ventricle to the aorta.

A cardiac valve disorder is a condition when a valve malfunctions. In this chapter you will learn how to recognize and treat cardiac valve disorders.

Chapter 7 Hematology and Hematologic Disorders

The hematologic system refers to the blood and blood-forming organs. The formation of red blood cells (RBCs), white blood cells (WBCs), and platelets begins in the bone marrow. Stem cells are produced in the bone marrow. Initially, these cells are not differentiated and may become RBCs, WBCs, or platelets. In the next stage of development, the stem cell becomes committed to a particular precursor cell, to become either a myeloid or lymphoid type of cell, and will differentiate into a particular cell type when in the presence of a specific growth factor.

In this chapter you will learn about the hematologic system, and how to recognize and treat hematologic disorders.

Chapter 8 Vascular Disorders

Vascular disease is a disruption of blood flow through the blood vessels, which prevents adequate blood to reach tissues and organs. As a result, tissues and organs are deprived of nutrition and oxygen leading to tissue necrosis and organ failure. Vascular disease can involve the arteries and veins. Nearly half the population will experience vascular disease as result of age, obesity, and type 2 diabetes.

A buildup of fat and cholesterol on the walls of blood vessels, referred to as plaque, decreases blood flow through the vessel for patients who have atherosclerosis. Eventually plaque could block blood flow referred to as a blockage. A blocked blood vessel can be called an ischemic attack that results in the patient becoming symptomatic. Some ischemic attacks last for a fraction of a second. These are referred to as transient ischemic attack (TIA) that usually has no prolonged effect on the patient.

Other ischemic attacks can have long-term effects. Ischemic attack of coronary arteries causes chest pains (angina) that can lead to a heart attack. Ischemic attack of the carotid arteries that supply blood to the brain can lead to a stroke. Ischemic attack of arteries supplying the legs can result in cramps during activities (claudication), leg pain, and can lead to ulcers, gangrene, and amputation. Ischemic attack of renal arteries can lead to hypertension, congestive heart failure, and kidney failure.

In addition to disorders that decrease circulation, there are other vascular diseases that affect circulation, which you will learn about and how to treat vascular disorders in this chapter.

Chapter 9 Cardiac Disorders

A *cardiac disorder* is a term used to describe many different conditions that cause the heart to function abnormally. A cardiac disorder disrupts the heart's ability to pump blood throughout the body. As a result, the patient may experience shortness of breath, light-headedness, and irregular heart beats and chest pains.

There are a number of underlying causes of a cardiac disorder. These include trauma, infection, postoperative effects, myocardial infarction, and heart disease. These underlying causes may lead to fluid retention in the lungs, around the heart, and in the legs. Some cardiac disorders are idiopathic and have no obvious underlying cause. In this chapter you will learn about how to recognize and treat cardiac disorders.

Chapter 10 Cardiovascular Emergencies

A cardiovascular emergency is a condition that has the potential of disrupting circulation throughout the patient's body, resulting in decreased blood flow to organs causing malfunction of other systems in the body. This can be from hypertension, thrombosis, embolus—anything that disrupts the oxygen and nutrients from reaching tissues and organs.

A cardiac emergency is a condition that disrupts the function of the heart. The patient is asymptomatic or experiences discomfort, chest pain, back pain, jaw pain, increased urination at night, swelling of the ankles and feet, heart pounding, missing heart beats, and shortness of breath. However, there are times when a patient is in respiratory distress or respiratory arrest. This is not a cardiac emergency because the patient's heart is working although respiratory arrest can lead to a cardiac emergency if rescue breathing does not occur. In this chapter you will learn about how to recognize and treat cardiovascular emergencies.

chapter 1

Cardiovascular Anatomy and Physiology

LEARNING OBJECTIVES

1. Vascular System
2. Blood
3. The Heart

KEY TERMS

Blood Flow Through the Heart
Blood Group
Blood Pressure (BP)
Blood Supply to the Heart
Blood Transfusions
Blood Vessels
Blood Vessel Walls Arterioles
Cardiac Contractions
Electrolytes
Mean Arterial Pressure (MAP)
Narrow Pulse Pressure
Plasma
Platelets (Thrombocytes)
Pulse Pressure
Red Blood Cells (Erythrocytes)
White Blood Cells (Leukocytes)
Wide Pulse Pressure

Vascular System

Think of the **vascular system** as a distribution mechanism that consists of blood vessels (pipes) and the heart (pump). Visualizing the vascular system as "pipes" and a "pump" helps you understand signs and symptoms of cardiovascular disorders and diseases.

Blood vessels touch every organ and tissue in the body, providing oxygen and nutrients such as glucose needed for cells to work. Work is performed inside the cell by enzymes. An **enzyme** causes a chemical reaction to occur quickly. The chemical reaction causes the cell to do the cell's specific task in the body. The byproduct of the chemical reaction—waste—is removed from the cell into the blood vessel where the waste is carried to organs (ie, kidneys) and excreted from the body.

Blood Vessels

The vascular system consists of a network of high-pressure "pipes" (arteries) and low-pressure "pipes" (veins). **Arteries** carry oxygenated blood under high pressure away from the heart. Arteries close to the heart are large and gradually reduce in diameter as arteries branch out away from the heart and closer to organs and tissues. Small arteries are called *arterioles* that deliver blood to capillaries.

NURSING ALERT

A superficial cut typically results in blood oozing from capillaries. A deeper cut may result in blood slightly pulsating from the wound. The pulsation implies that blood is flowing from an arteriole.

Capillaries are small and thin blood vessels that border organs and tissues and exchange with the cells oxygen and nutrients for waste products through capillary action, which is the ability of fluid (blood) to pass through a thin membrane.

Capillaries are connected to small veins called *venules*, which in turn are connected to progressively larger veins that return deoxygenated blood to the heart and waste to organs that process and excrete the waste.

Veins work differently than arteries. Arteries are relatively thick, strong enough to handle fluid (blood) that is under pressure from the heart. Pressure drops appreciably at the capillaries. There is little pressure from the heart to move blood through the veins. Think of looking at the end of a long garden hose where the water is slowly pouring out and this is similar to what happens at the capillaries.

Veins move blood back to the heart through gravity and contractions of skeletal muscles when a person moves around. Movement is not consistent. Sometimes we sit for a while and then move. Inconsistent flow within the veins can result in blood flowing backward. Many veins have **one-way valves** that prevent backflow of blood. These valves are similar to one-way valves used in sewage systems to prevent the backflow of waste.

NURSING ALERT

Blood has difficulty returning to the heart when a patient is immobile such as when a patient lies in bed. Blood pools in the vein, becoming stagnated. Stagnated blood can clot along the walls of the veins, which is called a *thrombosis*. Veins further away from the heart such as in the feet are at high risk for thrombosis called *deep vein thrombosis* (DVT). The clot increases in size the longer the blood stagnates. The clot can dislodge—called an *emboli*—and travel through the bloodstream blocking small blood vessels in the brain, resulting in a stroke, or in the lungs.

Blood Vessel Walls

Blood vessel walls have three layers:

- **Outer layer (tunica externa):** The outer layer is made of collagen. *Collagen* is a long fibrous protein that strengthens blood vessels and anchors nerve fibers, lymphatic vessels, and capillaries that support the blood vessel.
- **Inner layer (tunica media):** The middle layer contains smooth muscle and neurons that collectively constrict and dilate the blood vessels in response to physiological activities.

- **Inner layer (tunica interna):** The inner layer, called the *endothelium*, is smooth and delicate, enabling free flow of blood.

NURSING ALERT

Cholesterol is a waxy, fat-like substance regulated by the liver that is needed to form hormones and substances that help digest food. *Low-density lipoproteins* (LDLs) are proteins that carry cholesterol from the liver to organs and tissues via blood vessels. *High-density lipoproteins* (HDLs) are proteins that carry cholesterol from organs and tissues throughout the body to the liver for recycling via blood vessels. Cholesterol can break off and fatty streaks of cholesterol can attach to the inner layer of blood vessels—a precursor to cholesterol plaque. White blood cells (WBCs) digest the cholesterol. However, WBCs become intertwined with cholesterol, forming **cholesterol plaque**. Over years cholesterol plaque builds up, reducing blood flow in a process called *atherosclerosis*. Cholesterol plaque can break off, forming emboli that could block small blood vessels.

Blood

Blood is composed of cells and fluid called *plasma*; it provides oxygen and nutrients to cells throughout the body and removes waste from cells. An average adult has about 5 L of blood. The high concentration of blood moves across cell membranes through the process of diffusion. *Diffusion* is a process by which a substance moves from an area of high concentration (ie, blood) to an area of low concentration (ie, inside the cell). Cell wastes move outside of the cell and into the blood, where the waste is transported to the kidneys and lungs for excretion. Blood pressure called **hydrostatic pressure** pushes blood from the blood vessels, enabling diffusion into the cells. **Oncotic pressure** keeps blood inside blood vessels to maintain constant blood volume. Oncotic pressure is controlled by the amount of albumin dissolved in the blood. **Albumin** is a protein in plasma that keeps blood from leaking out of blood vessels. Albumin also binds to hormones and drugs, carrying them throughout the body.

Plasma

Plasma is the yellowish fluid portion of blood, making up of half the volume of blood. Plasma is 90% water; the remaining 10% is dissolved substances that are needed for cells throughout the body to function.

NURSING ALERT

Depending on the nature of a blood test, the blood sample is allowed to clot, causing blood cells and the clotting factors to fall to the bottom of the test tube and serum to rise to the top of the test tube. **Serum** is then analyzed for amounts of various substances.

Plasma contains substances that float in it. These are red blood cells (RBCs) (see Red Blood Cells [Erythrocytes]), WBCs (see White Blood Cells [Leukocytes]), and platelets (see Platelets [Thrombocytes]).

Plasma contains substances that are dissolved in it. The **dissolving process** causes a substance to become part of the liquid. There are many substances dissolved in plasma, including glucose, hormones, cholesterol, and vitamins. The two primary substances dissolved in plasma are listed follows:

1. **Proteins (10%):** Proteins attract water and are larger than water molecules, giving proteins a unique ability to maintain plasma levels within the blood vessels. Proteins have a relatively difficult time leaking from blood vessels because of their size. Proteins are used for oncotic pressure, transport nutrients and other substances throughout the body, to maintain pH balance, and to foster chemical reactions. The primary proteins in plasma are the following:
   - Albumin that is produced in the liver and is used for oncotic pressure (60% of the proteins)
   - Globulins for the immune system (see White Blood Cells [Leukocytes])
   - Fibrinogen for clotting
2. **Electrolytes:** Electrolytes (see Electrolytes) are substances required for nerve conduction, blood clotting, fluid balance, muscle contraction, and pH balance. Electrolytes dissolved in plasma are the following:
   - Sodium
   - Potassium
   - Chloride
   - Bicarbonate
   - Calcium
   - Magnesium

NURSING ALERT

Three percent of oxygen from the lungs is dissolved in plasma.

Red Blood Cells (Erythrocytes)

Red blood cells make up 40% of the volume of blood and contain hemoglobin. **Hemoglobin** is a protein that attaches to oxygen and carbon dioxide. The number of RBCs that are produced is determined by the hormone **erythropoietin**. When the oxygen level is low, there is an increased production of erythropoietin by the kidneys. Erythropoietin stimulates pluripotential hematopoietic stem cell production and the speed at which these cells mature.

Mature RBCs remain in plasma for 120 days. Afterward RBCs are removed from plasma in the spleen and liver.

Folate, iron, and vitamin B_{12} are required for RBC production. Iron atoms in the hemoglobin bind with oxygen. Iron also gives RBCs their color.

Chemical reactions in cells produce **carbon dioxide** that leaves the cells, enters the plasma, and attaches to hemoglobin. The carbon dioxide is carried to capillaries in the lung where it is exchanged for oxygen. An insufficient amount of hemoglobin (**anemia**) results in fatigue due to low levels of oxygen available in the blood. An abnormally high amount of hemoglobin (**polycythemia**) results in a high risk of clots due to the thickness of blood. RBCs change shape without rupturing and can pass through capillaries.

NURSING ALERT

Kidney disease can lead to anemia due to the decline in erythropoietin production.

White Blood Cells (Leukocytes)

White blood cells are a primary component of the immune system. Plasma transports WBCs to organs and tissues that are damaged or infected. WBCs make up 1% of blood and protect the body from infection. The number of WBCs increases as an inflammation response by the immune system to an infection or injury to the body. There are six main types of WBCs, listed as follows:

1. **Neutrophils (58%):** Neutrophils kill and ingest bacteria in a process called *phagocytosis*. Neutrophils can have a nucleus that is **segmented**, **multi-lobed**, or **polymorphonuclear** in form, leading to neutrophils described as **segs**, **PMNs**, or **polys**.

2. **Bands (3%):** Immature neutrophils form **bands**. There is an increase in bands and neutrophils when the patient has a bacterial infection.
3. **Lymphocytes (4%):** Lymphocytes move freely between blood, lymph fluid, and lymph tissues and can live for 1 year. Lymphocytes recognize bacteria and viruses that have previously invaded the body, enabling lymphocytes to target specific bacteria and viruses. There are three main types of lymphocytes, listed as follows:
   i. **T cells:** T cells develop from bone marrow or liver stem cells and mature in the thymus, which is located between the breastbone and heart. T cells are involved in cell-mediated immunity. There are four types of T cells, listed as follows:
   ii. **Helper T cells:** Helper T cells, referred to as *CD4,* identify viral infected cells. Helper T cells then secrete lymphokines that cause stimulation of killer T cells and B cells that attack the pathogen. The AIDS virus infects and kills helper T cells.
      a. **Cytotoxic T cells:** Cytotoxic T cells release chemicals and kill invading microorganisms.
      b. **Memory T cells:** Memory T cells can identify specific microorganisms that have previously invaded the body and remain in blood to swiftly attack should the microorganisms invade the body again.
      c. **Suppressor T cells:** Suppressor T cells reduce the immune response once the invading microorganism has been destroyed. This prevents the immune system from attacking normal cells.
   iii. **B Cells:** B cells develop from bone marrow stem cells and mature in the bone marrow. B cells transform into plasma cells when an invading microorganism is detected. B cells produce antibodies referred to as *immunoglobulins* or *gamma globulins* that are considered **humoral immunity**. There are five types of immunoglobulins, listed as follows:
      a. **Immunoglobulin A (IgG):** Found in mucous membranes, lining of the gastrointestinal tract, lining of the respiratory system, tears, and saliva.
      b. **Immunoglobulin M (IgM):** First to fight a new infection and found in the plasma and lymph fluid.
      c. **Immunoglobulin E (IgE):** Reacts to allergens and found in mucous membranes, lungs, and skin.

d. **Immunoglobulin G (IgG):** Protects against bacterial and viral infections (most abundant).

e. **Immunoglobulin D (IgD):** Found in the blood (least amount in blood).

Antibodies bind to the microorganism, causing them to clump together and break open. B cells also activate the complement system. The **complement system** consists of enzymes that attack and activate neutrophils and macrophages, which attack the invading microorganism. There are also memory B cells that remain active, looking for the reappearance of the microorganism.

4. **Monocytes (4%):** Monocytes defend against many infectious microorganisms, including bacteria, and ingest damaged cells. Monocytes remain in blood for up to 20 hours before entering tissues throughout the body, where they can remain active for years.
5. **Eosinophils (2%):** Eosinophils respond to allergies and kill parasites. Eosinophils are referred to as *granulocytes*. A granulocyte has digestive enzymes used to kill microorganisms.
6. **Basophils (1%):** Basophils are a type of WBC that contain histamine and serotonin. Basophils react to allergens by releasing histamine, which causes blood vessels to dilate, resulting in increased blood flow to tissues affected by the allergen.

Platelets (Thrombocytes)

Platelets are particles that form a platelet plug to seal a ruptured blood vessel and promote the clotting process. A low number of platelets (**thrombocytopenia**) results in bruising and bleeding that takes a long time to stop. A high number of platelets (**thrombocythemia**) places the patient at risk for blood clots unless the patient is actively bleeding.

Blood cells are produced by red bone marrow through a process called *hematopoiesis*. Blood cells begin as a stem cell called a *pluripotential hematopoietic stem cell* that can form RBCs, WBCs, or platelets.

NURSING ALERT

Aging of bones diminishes the ability of bone marrow to produce blood cells to parts of the extremities, ribs, pelvis, sternum, and spine. **Yellow bone marrow** does not produce any stem cells.

Blood Group

A blood group, also known as a *blood type*, is a classification of blood based on a substance on the surface of RBCs called an *inherited antigen* (also *agglutinogens*). This is referred to as the *ABO blood group system*. The blood type of a person is contributed from both parents. Table 1–1 contains the four major blood groups. Plasma contains the antibody opposite of the antigen that is on the surfaces of RBC, which is called *agglutinin*. These antibodies are formed during infancy but are not present at birth.

The **Rh blood group system** is another classification of blood based on the Rh antigen. The **Rh antigen** may be present on the surface of RBCs. There are many Rh antigens, but the most common is the **D antigen**. The Rh blood group system classifies blood as:

- **Rh+:** The Rh antigen is present (85% of the population in the United States).
- **Rh–:** The Rh antigen is not present (15% of the population in the United States).

NURSING ALERT

A person with Rh– blood can develop the Rh antibodies through a blood transfusion. A pregnant woman who is Rh– and has a fetus who is Rh+ can develop Rh+ antibodies through the placenta, which results in **hemolytic disease of the newborn (HDN)** or **erythroblastosis fetalis**.

TABLE 1–1 ABO Blood Groups and Anti-Blood Type Antigens

Blood Group		Anti-Blood Type Antigen in Plasma
A	The A antigen is on the surface of RBCs	Anti-type-B
B	The B antigen is on the surface of RBCs	Anti-type-A
AB	Both the A and B antigens are on the surface of RBCs	No anti-type
O	Neither the A nor the B antigen is on the surface of RBCs	Anti-type-A and anti-type-B

Blood Transfusions

A blood transfusion is replacement of all or a portion of blood with either the patient's own blood prior to surgery or from donor blood. Before a patient undergoes the scheduled surgery, one or more pints of a patient's blood are taken in a process called *apheresis*. Specific components are removed from the blood and used as needed during and after the surgery.

A patient can experience a transfusion reaction if it contains RBCs. Antibodies in the patient's plasma can react to antigens on the donor's RBCs if donor blood is a different blood type from the patient's blood type. Antibodies attach to the antigen causing RBCs to clump together. RBCs are then destroyed in a process called *hemolysis,* causing hemoglobin to enter the bloodstream, and eventually metabolized into bilirubin.

Blood type O negative is called the *universal donor* because anyone can receive it because the blood has no antigen. Blood type AB is called the *universal recipient* because the recipient has no antibodies.

Blood components that can be used in a blood transfusion are the following:

- **Packed red blood cells:** RBCs are thawed and transfused when the patient has severe anemia or has lost a massive amount of blood.
- **Fresh frozen plasma:** Fresh frozen plasma is transfused when the patient has a bleeding disorder, liver failure, or is overly medicated with anticoagulant medication (ie, Coumadin) that results in severe bleeding.
- **Platelets:** Platelets are transfused when the patient experiences a low platelet count (thrombocytopenia).
- **White blood cells:** WBCs are rarely transfused except when a patient has extremely low WBCs placing the patient at risk for infection.
- **Albumin:** Albumin is infused when the patient experiences severe bleeding, severe burns, or has liver failure resulting in decrease blood volume and other fluids have not worked.
- **Immunoglobulins:** Immunoglobulins are transfused when the patient has hepatitis.
- **Cryoprecipitate:** Cryoprecipitate is the part of plasma that contains fibrinogen and other substances that create blood clots and is transfused when the patient has low blood clotting factors.
- **Whole blood:** Whole blood consists of all components of blood and is transfused when there is massive bleeding when more than 10 units of RBCs are required in a 24-hour period.