

# Overview of Cardiopulmonary Disorders and Conditions

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- Myocardial Infarction
- Dysrhythmias
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- Pleurisy

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- Flail Chest

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## OBJECTIVES

Upon completion of this chapter, the reader should be able to do the following:

1. Compare emphysema and chronic bronchitis.
2. Define atelectasis and discuss possible causes.
3. Contrast the pathologic course of acute bronchitis with that of chronic bronchitis.
4. Describe the condition known as angina pectoris.
5. List the leading causes of lung cancer.
6. Distinguish among endocarditis, myocarditis, and pericarditis.
7. Compare left-sided heart failure with right-sided heart failure.
8. Name the causes of cardiac arrhythmias.
9. Describe the causes of pulmonary edema and explain how it affects oxygen levels.
10. Explain the possible consequences of emboli.

## KEY TERMS

Angina pectoris

Anoxia

Anthraxis

Arrhythmia

Asbestosis

Asthma

Atelectasis

Atherosclerosis

Bronchiectasis

Bronchiolectasis

Bronchiolitis

Bronchitis

Bronchogenic carcinoma

Carcinogens

Consolidation

Dyspnea

Dysrhythmia

Emphysema

Epithelial

Gag reflex

Granuloma

Hemagglutinin

Hemoptysis

Histoplasmosis

Hypercapnia

Hypoxemia

Ischemia

Myocardial infarction

Nasal flaring

Neuraminidase

Pathogen

Pleural effusion

Pleurisy

Pneumoconiosis

Pneumonia

Pneumothorax

Pulmonary edema

Pulmonary embolism

Pulmonary fibrosis  
Pulmonary hypertension  
Respiratory acidosis  
Respiratory failure  
Sepsis  
Silicosis

Stridor  
Surfactant  
Thrombus  
Tuberculosis  
Ventricular asystole  
Ventricular fibrillation

## INTRODUCTION

Cardiovascular disease is the number one cause of death in the United States. Coronary heart disease, as of 2000, is responsible for more than one out of every five deaths in the country annually. Common heart diseases include hypertensive heart disease, angina and heart attacks, cardiac arrhythmias, and congestive heart failure. Risk factors for heart diseases include obesity, smoking, alcoholism, and lack of exercise. Pulmonary diseases result from circulatory disorders, immune diseases, congenital defects, central nervous system damage or diseases, environmental conditions, and infection.

This chapter focuses on major cardiopulmonary disorders.

## Cardiovascular Disorders

Cardiovascular disease is described as any abnormal condition characterized by heart or blood vessel dysfunction. Cardiovascular disease is the leading cause of death in the United States.

### Coronary Artery Disease

Coronary artery disease is an abnormal condition that may affect the arteries of the heart and produce varying pathologic effects, primarily reduced flow of oxygen and nutrients to the myocardium. Atherosclerosis is the most common type of coronary artery disease, and it is now the leading cause of death in North America. Angina pectoris is the classic symptom of coronary artery disease; it results from myocardial ischemia.

### Angina Pectoris

**Angina pectoris** is a sudden outburst of chest pain frequently caused by myocardial **anoxia** as a result of **atherosclerosis** or coronary artery spasm. Atherosclerosis is a deposition of fat-containing substances collectively known as plaque in the lumen (opening) of the coronary arteries that causes them to narrow (see **Figure 2-1**). Anginal pain usually radiates along the neck, jaw, shoulder, and down the left arm. It is often accompanied by feelings of suffocation that may seem to indicate impending death.

Angina pectoris attacks are often related to emotional stress, eating, exertion, and exposure to intense cold. There are four types of angina:

- **Stable angina:** The pain is predictable in frequency and duration and is relieved by rest and nitroglycerin.

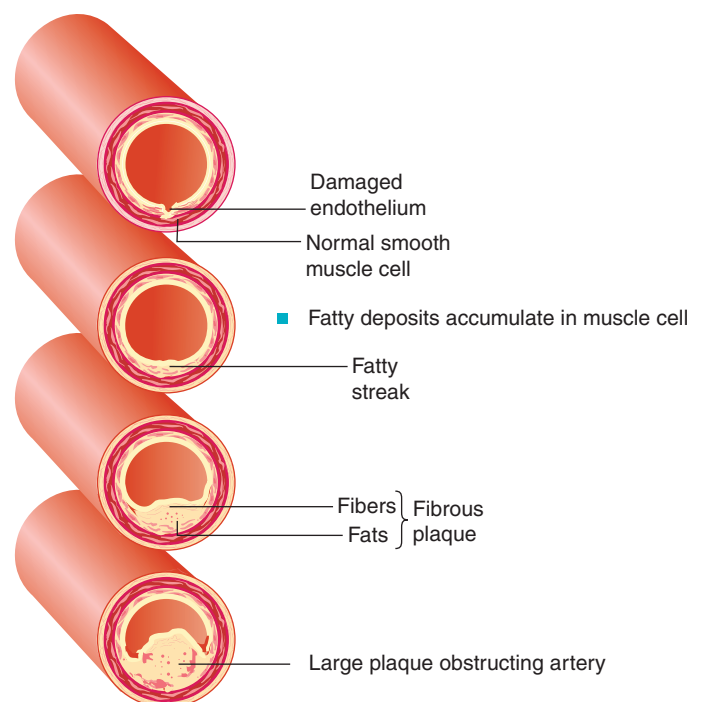
- **Unstable angina:** The pain increases in frequency and duration and is more easily induced. It indicates a worsening of coronary artery disease, which may progress to myocardial infarction.
- **Variant angina:** The pain is caused by coronary artery spasm and may occur spontaneously. It may not be related to physical exercise or emotional stress. It is also known as Prinzmetal angina.
- **Microvascular angina:** Impairment of the vasodilator reserve causes angina-like chest pain even though the patient's coronary arteries are normal.

The pain of angina may be relieved by rest and vasodilation of the coronary arteries with medication. Angina pectoris is also referred to as cardiac pain.

### Myocardial Infarction

When coronary blood flow is interrupted for extended periods, necrosis (tissue death) of part of the cardiac muscle occurs. Necrosis results in **myocardial infarction**. When the coronary arteries are obstructed, this may result in either atherosclerosis, a spasm, or a **thrombus**. Myocardial infarction (MI) is also called heart attack.

Of the various types of cardiovascular disorders, heart attack is the leading cause of death in the United States. When treatment is delayed, mortality is high. Nearly one-half of sudden myocardial infarction deaths occur before the patient can be hospitalized, usually within



**FIGURE 2-1** Development of a deposition of fat-containing substances which form plaque and lead to arterial occlusion.

1 hour of the onset of symptoms.

Risk factors for myocardial infarction include the following:

- family history of MI
- aging
- gender
- hypertension
- elevated total cholesterol
- obesity
- lifestyle
- smoking
- stress or type A personality
- drug use (especially cocaine and amphetamines)

The occlusion of a coronary artery may result in ischemia and infarct (death) of the myocardium, causing sudden and severe left-sided chest pain (see **Figure 2-2**).

### Dysrhythmias

A **dysrhythmia** (**arrhythmia**) is a disturbance of heart rhythm. The sinoatrial (SA) node generates normal heart rhythms that travel through the heart's conduction system. This causes the atrial and ventricular myocardium to contract and relax at a regular rate. This rate maintains circulation during various levels of physical activity. Dysrhythmias range from mild to catastrophic ventricular fibrillation.

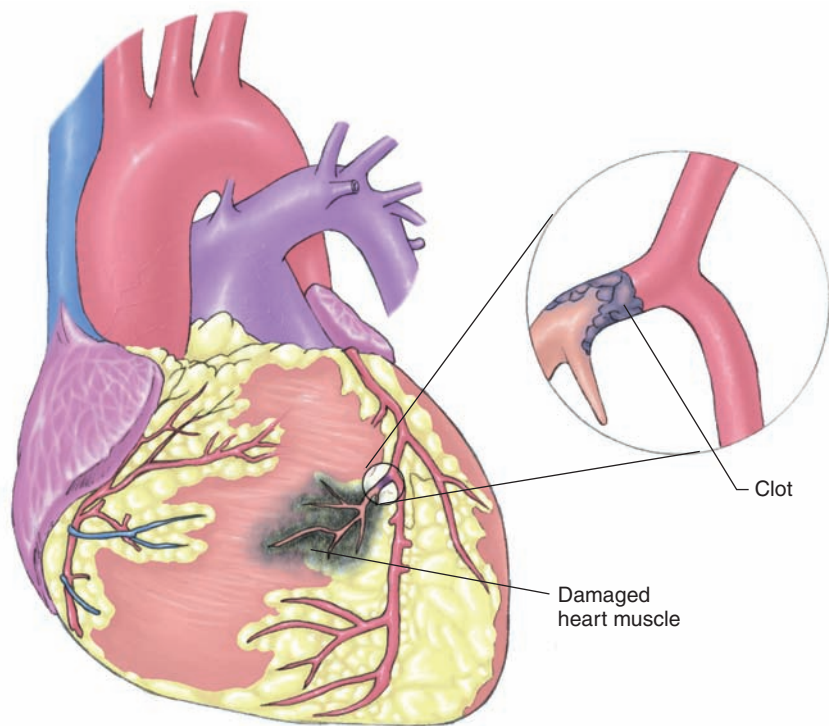
Arrhythmias are usually classified according to their origin (either ventricular or supraventricular). Their effect on blood pressure as well as cardiac output (which may be influenced from where they originate) determines how clinically significant they are. Common causes of arrhythmias include the following:

- congenital defects
- drug toxicity
- electrolyte imbalances
- myocardial infarction or **ischemia**

### Hypertension

Hypertension is an elevation in either systolic or diastolic blood pressure. It occurs as either essential (primary) hypertension or secondary hypertension. Primary hypertension is the most common type. Secondary hypertension results from renal disease or other identifiable causes. Malignant hypertension is a severe form of hypertension that may be either primary or secondary. Hypertension is a major cause of cardiac disease, renal failure, and stroke.

Hypertension affects nearly 20% of adults in the United States. Risks for hypertension increase with age. Hypertension is more prevalent in the black population



**FIGURE 2-2** Damage caused by myocardial infarction.

than in the white population. It is also more prevalent in people with less education and lower income. During young and middle adulthood, men have a higher incidence of hypertension, but thereafter, women have a higher incidence.

Risk factors for essential hypertension include the following:

- the aging process
- family history
- obesity
- high intake of sodium
- high intake of saturated fat
- sleep apnea
- stress
- excessive alcohol consumption
- sedentary lifestyle
- diabetes mellitus
- tobacco use

### Cardiomyopathy

Cardiomyopathy is a term that generally applies to a disease of the heart muscle fibers. It is the second most common direct cause of sudden death (after coronary artery disease). The most common type of cardiomyopathy is the dilated form. Men and blacks are at greatest risk for dilated cardiomyopathy. Other risk factors include coronary artery disease, hypertension, pregnancy, viral

infections, and use of alcohol or illegal drugs. Hypertrophic cardiomyopathy is different in that it is caused by a genetic abnormality.

## Carditis

Carditis is defined as inflammation of the heart and its surrounding structures. The several types of carditis include pericarditis, myocarditis, and endocarditis, each of which describes the portion of the heart that is inflamed in the specific condition. Common causes of the various forms of carditis include viral infections, bacterial infections, fungal infections, immune conditions, myocardial infarction, trauma, uremia, cancers, certain medications, radiation, and other causes.

## Heart Failure

Heart failure is the inability of the heart muscle to contract with enough force to properly circulate the blood throughout the body. Dysfunction of the left ventricle is the most common cause of heart failure. However, the right ventricle may also be dysfunctional, especially in pulmonary disease (right ventricular failure).

The most common form of heart failure is congestive heart failure. It is called this because of the collection of fluid (congestion) in the lungs and extremities. Heart failure may be classified as left- or right-sided heart failure according to the side of the heart that is affected. It may also be classified as systolic or diastolic dysfunction based on the cardiac cycle involved.

Left-sided heart failure is caused by ineffective left ventricular contraction. As the left ventricle's pumping ability fails, cardiac output falls. Because blood is no longer effectively pumped out, it backs up into the left atrium and then into the lungs. This causes activity intolerance and **dyspnea**. If the condition persists, pulmonary edema and right-sided heart failure can result. Common causes of left-sided heart failure include hypertension, aortic and mitral valve stenosis, and left ventricular infarction.

Right-sided heart failure is caused by ineffective right ventricular contraction. As a result, blood is not pumped with enough force through the right ventricle to the lungs. This causes blood to back up into the right atrium as well as the peripheral circulation. The patient gains weight, develops peripheral edema, and the kidneys (and other organs) become engorged. Right-sided heart failure may be caused by pulmonary hypertension, pulmonary embolus, or acute right ventricular infarction.

## Cardiac Arrest

Cardiac arrest is a sudden cessation of cardiac output and effective circulation. It is usually precipitated by **ventricular fibrillation** or **ventricular asystole**. When cardiac arrest occurs, delivery of oxygen and removal of carbon dioxide ceases. Tissue cell metabolism becomes

anaerobic, and metabolic and **respiratory acidosis** occurs. Immediate initiation of cardiopulmonary resuscitation (CPR) is required to prevent heart, lung, kidney, and brain damage and death. Cardiac arrest is also called cardiopulmonary arrest.

## Respiratory Disorders

A respiratory disorder is any abnormal condition of the respiratory system. Respiratory disorders are characterized by coughing, chest pain, dyspnea, **hemoptysis**, production of sputum, and **stridor**. Less common symptoms include anxiety, arm and shoulder pain, headache, hoarseness, and drowsiness. There are several varieties of respiratory diseases and disorders.

### Newborn and Adult Respiratory Distress Syndrome

Respiratory distress syndrome is an acute lung disease of newborns characterized by airless alveoli, inelastic lungs, a respiration rate greater than 60 breaths per minute, **nasal flaring**, intercostal and subcostal retractions, grunting on expiration, and peripheral edema. The condition occurs most often in premature babies. It is caused by a deficiency of pulmonary **surfactant**, resulting in alveolar collapse. Sometimes other symptoms include hyaline membrane formation, alveolar hemorrhage, decreased cardiac output, and severe hypoxemia. The disease is self-limited; infants either die in 3 to 5 days or recover completely with no aftereffects.

In adults, this condition causes severe pulmonary congestion characterized by diffuse injury to alveolar-capillary membranes. Fulminating sepsis, especially when gram-negative bacteria are involved, is the most common cause. Adult respiratory distress syndrome may occur after trauma, near drowning, aspiration of gastric acid, ingestion of certain herbicidal chemicals, and inhalation of corrosive chemicals (such as chlorine and ammonia) or certain drugs including barbiturates, chlorthalidone, heroin, methadone, propoxyphene, and salicylates.

#### POINT TO REMEMBER

Adults with sleep apnea may cease breathing for 10 to 20 seconds hundreds of times a night. The greatest danger of adult sleep apnea is the fatigue, headache, drowsiness, and depression that follows during waking hours.

## Influenza

Influenza is caused by a virus and manifests itself as the most common, yet serious, acute upper respiratory tract infection in humans. Prior to acquired immunodeficiency syndrome (AIDS), influenza was the most recent uncontrolled pandemic infection in human beings. Each year in the United States, nearly 36,000 people die because of influenza-related illness during nonpandemic



years. Although children are infected more than any age group, influenza causes serious illness and even death, most commonly in people aged 65 years or older.

Two types of influenza virus exist in humans: type A and type B. Type A is the most common form, causing the most severe disease symptoms. It is further divided into subtypes that are based on two surface antigens: **hemagglutinin (H)** and **neuraminidase (N)**. Influenza type B does not have any subtypes. Influenza is more contagious than respiratory tract infections that arise from a bacterial source. The disease is transmitted by aerosol droplets or by direct contact with an infected person.

A person may inhale as few as three infected particles and then contract influenza. Most people who become infected will develop symptoms of influenza, which increases the likelihood of contagion. Because young children are most likely to become infected with influenza, they are also most likely to spread the infection.

### Swine Flu (H1N1)

Swine flu was the original name used to describe novel H1N1, a new influenza virus that causes illness in humans. It was detected in the United States in April 2009, and also has been reported in Mexico, Canada, and other countries. This virus spreads from person to person, similar to the way that regular seasonal influenza viruses spread.

The term *swine flu* was originally used because laboratory testing showed that many genes in this new virus were very similar to influenza viruses that normally occur in pigs in North America. The virus has spread throughout the country as well as other parts of the world, and is very contagious.

The symptoms of the novel H1N1 flu virus in people are similar to the symptoms of seasonal flu and include fever, cough, sore throat, runny or stuffy nose, body aches, headache, chills, and fatigue. A significant number of people who have been infected with this virus also have reported diarrhea and vomiting. Also, like seasonal flu, severe illnesses and deaths have occurred as a result of illness associated with this virus. Vaccines that are currently available may be given either by injection or by nasal instillation.

There are everyday actions that can help prevent the spread of germs that cause respiratory illnesses like influenza. The CDC recommends the use of oseltamivir (Tamiflu) or zanamivir (Relenza) for the treatment or prevention of infection with novel H1N1 flu virus. Complications of H1N1 may include worsening of chronic conditions, such as heart disease, diabetes, asthma, pneumonia, and respiratory failure.

### Asthma

**Asthma** is a disease that is characterized by increasing irritability of the tracheobronchial tree. It involves acute, episodic paroxysmal (sudden, intense) narrowing of the

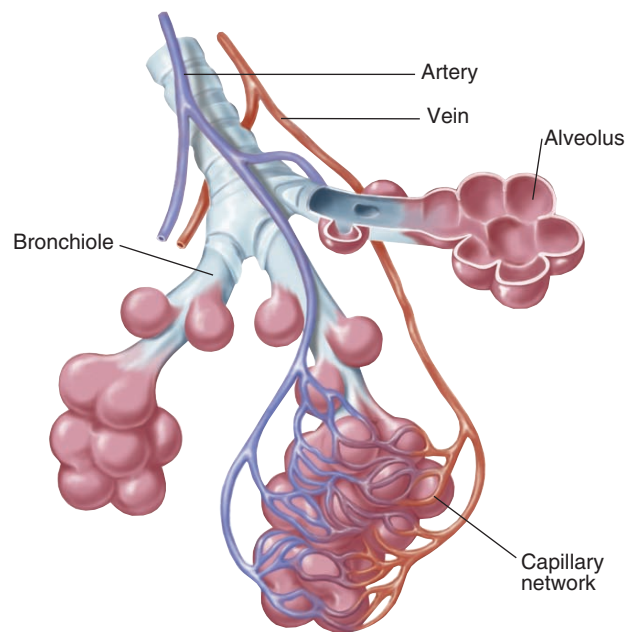
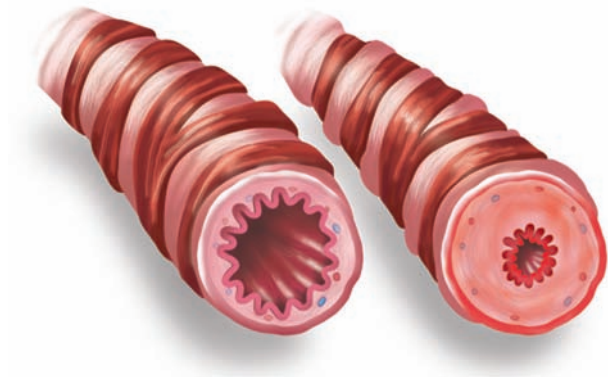


FIGURE 2-3 An acute episode of asthma.

airways. This narrowing may reverse spontaneously or as a result of pharmacologic therapy (see **Figure 2-3**). Asthma may result from either allergic or nonallergic stimuli.

Hyperreactivity in asthma may lead to airway obstruction because of acute muscle spasms in the smooth tracheobronchial tree muscles. In addition to muscle spasms, the mucosa swells, which leads to edema. The mucous glands then increase their production of thick mucous.

### Bronchitis

**Bronchitis** is defined as inflammation of the mucous membranes of the bronchi. Bronchitis is a type of chronic obstructive pulmonary disease of the larger airways. When the airway mucosa becomes inflamed, it leads to

edema and submucosal gland enlargement. Damage occurs to the epithelial cells and cilia in the respiratory tract. The most obvious symptom is the production of sputum.

Acute bronchitis has a short, severe course of duration, which subsides without any long-term effects. Chronic bronchitis leads to excessive mucous production and coughing. It can be reversed after the removal of the irritant and is complicated by respiratory tract infections. Chronic bronchitis can lead to right-sided heart failure, acute respiratory failure, and pulmonary hypertension.

Acute bronchitis is often caused by viruses, and the primary cause of chronic bronchitis is smoking or exposure to certain respiratory irritants. Risk factors include the following:

- history of smoking
- air pollution
- occupational exposure
- heredity
- reduced lung function

Children of parents who smoke are at higher risk for pulmonary infections, which may cause bronchitis.

### Bronchiolitis

**Bronchiolitis** (respiratory syncytial viral infection) commonly affects the lower respiratory tract and is usually caused by the respiratory syncytial virus (RSV). It causes inflammation that obstructs the small respiratory airways. Bronchiolitis can range from a minor infection lasting only a few days to a severe infection causing dangerous respiratory distress. In older children and adults, usually a mild upper respiratory infection occurs because these patients have larger airways and can tolerate the swelling of the airways with fewer symptoms than when it affects infants.

### Bronchiectasis

**Bronchiectasis** is characterized by permanent bronchi and bronchiole dilation. This occurs because of the destruction of muscle and elastic supporting tissue caused by inflammation and infection. Bronchiectasis is a secondary disease to either obstruction or a persistent infection. In past decades, necrotizing bacterial pneumonia conditions that were complications of measles, influenza, pertussis, or tuberculosis often caused

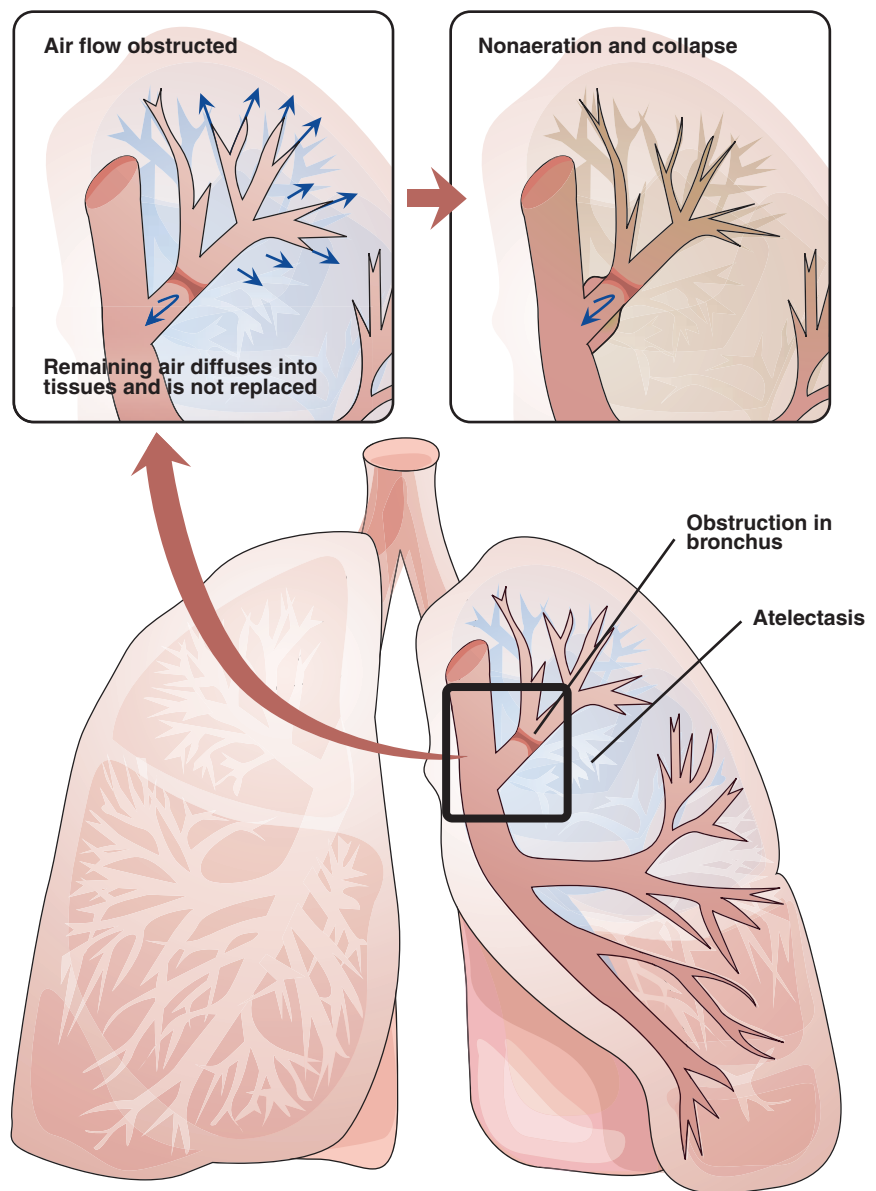


FIGURE 2-4 Obstructive atelectasis.

bronchiectasis. Today, more effective antibiotics exist to treat the conditions that previously led to bronchiectasis, so its occurrence is rarer.

### Atelectasis

**Atelectasis** is defined as imperfect expansion, which refers to incomplete expansion of a lung or part of a lung (see **Figure 2-4**). This condition can occur due to airway obstruction, increased lung recoiling (due to loss of pulmonary surfactant), or lung compression (which may occur in **pleural effusion** or **pneumothorax**). Atelectasis may be present at birth, develop in the neonatal period, or develop later in life.

## Emphysema

**Emphysema** causes the destruction of alveolar ducts, alveoli, and respiratory bronchioles, which creates enlarged air spaces. The loss of many of the alveoli reduces air exchange with the blood. As emphysema progresses, the patient experiences increased shortness of breath following only minimal exertion. The most common cause of emphysema is the inhaling of smoke from tobacco products. Stopping smoking usually stops, or at least slows, the progression of the disease. However, lung damage from emphysema is usually irreversible. Chronic obstructive pulmonary disease has, as its most common components, both emphysema and chronic bronchitis.

## Cystic Fibrosis

Cystic fibrosis is a chronic dysfunction of the exocrine glands that affects multiple organ systems. The disease affects both males and females, and it is the most common fatal genetic disease in white children. Cystic fibrosis is accompanied by many complications and now carries an average life expectancy of 32 years. The disorder is characterized by chronic airway infection leading to bronchiectasis, **bronchiolectasis**, exocrine pancreatic insufficiency, intestinal dysfunction, abnormal sweat gland function, and reproductive dysfunction. Cystic fibrosis is inherited, and the gene on chromosome 7 is responsible for the disease.

Signs and symptoms may become apparent soon after birth, or they may develop in childhood. Cystic fibrosis primarily attacks the lungs and digestive system, producing copious thick, sticky mucus that accumulates to block glandular ducts. Pancreatic changes occur, with fat and fiber replacing normal tissue. Sweat gland dysfunction results in increased concentrations of salt in the sweat, and normal growth and health are reduced.

Cystic fibrosis is considered a fatal disease. However, early diagnosis and treatment have greatly increased life expectancy during the past few decades. Treatment involves supportive measures that help the child to lead as normal a life as possible, along with the prevention of pulmonary infections.

## Pneumonia

**Pneumonia** is defined as lung inflammation with fluid that fills the alveoli and bronchioles. It may develop either as a primary acute lung infection or secondary to another condition that reduces lung tissue resistance (either a respiratory or systemic condition). Pneumonia is a risk after any aspiration or lung inflammation, when fluids may collect, or when defense mechanisms (such as the cilia in the trachea) are reduced.

Primary pneumonia may be caused by the inhalation or aspiration of a bacterium or virus. Bacterial pneumonia is caused by a bacterium such as staphylococcus, klebsiella, or streptococcus. Viral pneumonia

is caused by a virus that attacks bronchiolar **epithelial** cells, eventually spreading to the lung alveoli. Secondary pneumonia ensues from lung damage caused by bacteria spreading from another infection (anywhere in the body) or a noxious chemical. Aspiration pneumonia occurs from the inhalation of foreign matter (such as food or vomitus) into the bronchi. An impaired **gag reflex**, old age, debilitating diseases, decreased levels of consciousness, and surgical procedures are all potential causes of aspiration pneumonia.

## Legionnaires' Disease

Legionnaires' disease is a type of bronchopneumonia. It is caused by a gram-negative, rod-shaped microorganism known as *Legionella pneumophila*. It is one of the three or four most common causes of community-acquired pneumonia. The microorganism is often found in warm standing water.

It was recognized for the first time as an epidemic of severe (and even fatal) pneumonia that developed among delegates to the 1976 American Legion convention, hence its name. The convention was held in a Philadelphia hotel, with the infection traced to the hotel's water-cooled air conditioning system. Healthy people can contract legionnaires' disease, but the risk is highest among those who smoke tobacco products and persons with chronic diseases and impaired cell-mediated immunity.

## Pulmonary Vascular Disease

Vascular lung disorders include pulmonary edema, pulmonary hypertension, and pulmonary embolus, all of which are discussed in the following sections.

### Pulmonary Edema

**Pulmonary edema** is a condition wherein fluid collects in the lung alveoli and interstitial tissues. This accumulation of fluid reduces diffused oxygen levels in the blood and interferes with the lungs' ability to expand. Pulmonary edema may result from predisposing factors, such as acute respiratory distress syndrome, heart disease, and inhalation of toxic gases. Of these factors, heart disease is the most common cause of pulmonary edema.

### Pulmonary Hypertension

**Pulmonary hypertension** is the elevation of pressure in the pulmonary vessels. This condition is common in preexisting cardiac or pulmonary diseases, but it may also result from the condition known as **pulmonary fibrosis**. The actual cause of pulmonary hypertension is unknown, but it tends to occur in members of the same family. Conditions that produce **hypoxemia**, such as alveolar hypoventilation, chronic obstructive pulmonary disease, high altitudes, and smoke inhalation, often cause secondary pulmonary hypertension.



### Pulmonary Embolism

**Pulmonary embolism** is a condition resulting from a blood clot or fat (lipid) deposit that has formed in a peripheral blood vessel and then broken free to lodge in a blood vessel in one of the lungs (see **Figure 2-5**). Pulmonary embolism is a potentially life-threatening condition. Its major risk factors include any conditions that produce venous stasis, increased coagulation ability, or changes in the walls of blood vessels.

Pathological changes that can cause pulmonary embolism include dehydration, immobility, decreased venous return, or injury. Conditions that are related to the previously mentioned risk factors include pregnancy, **sepsis**, congestive heart failure, and tumors.

### Tuberculosis

**Tuberculosis** is the main cause of death from a single infectious agent throughout the world. More than 8 million new cases of tuberculosis occur every year worldwide, with approximately 3 million people dying from the disease. It is caused by *Mycobacterium tuberculosis*, a bacterium resistant to destruction that can survive in calcified, necrotic lesions for long periods of time.

Tuberculosis mostly affects the lungs, but the **pathogen** can also invade other body organs, such as the bones, gastrointestinal tract, and kidneys. Tuberculosis lesions cause the death of affected tissue, which is sloughed off, and the formation of cavities.

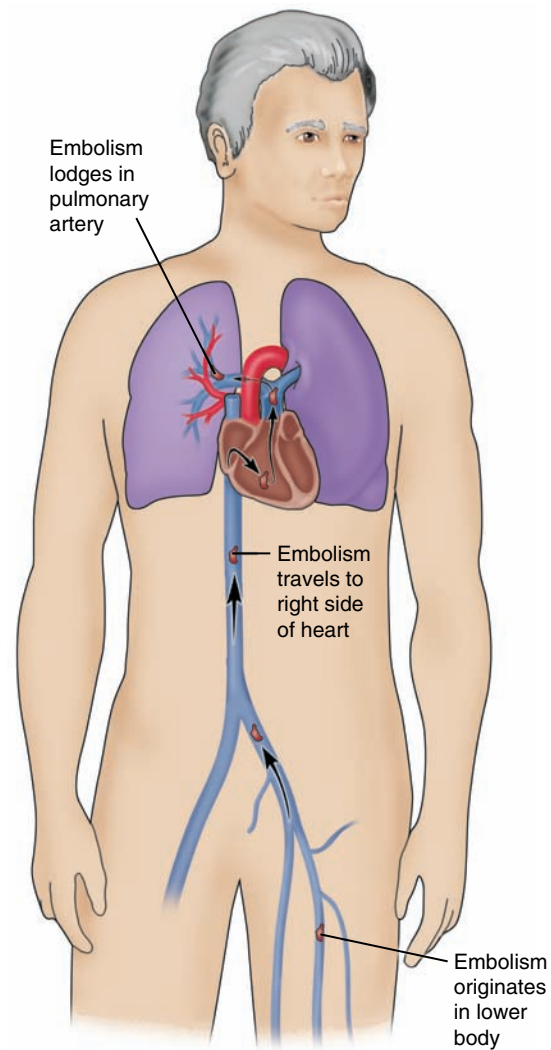
Resistance to secondary tuberculosis depends on the patient's environment and health status. Reinfection occurs more often when a patient is malnourished, in poor health, living in crowded or unsanitary conditions, or has various other illnesses. An increase of tuberculosis has been seen in the United States due to the prevalence of human immunodeficiency virus (HIV) infection and acquired immunodeficiency syndrome (AIDS).

### Histoplasmosis

**Histoplasmosis** is a fungal disease that originates in the lungs from the inhalation of dust containing *Histoplasma capsulatum*. It is common in the midwestern United States and occurs as an opportunistic infection, commonly in AIDS patients. In these cases, the fungus disseminates or spreads quickly throughout the entire body. Histoplasmosis is similar to tuberculosis in that its first stage usually involves an asymptomatic, limited infection followed by a second active infection. This second infection involves the formation of **granuloma** and necrosis and **consolidation** in the lungs, sometimes spreading to other organs.

### Pneumoconiosis

**Pneumoconiosis** involves any change in the lungs due to inhaling inorganic dust particles (usually in the workplace). Environmentally acquired lung diseases such as



**FIGURE 2-5** The development of pulmonary embolism.

pneumoconiosis relate to the patient's history of exposure, and this factor is important in correctly diagnosing the patient's individual lung condition. Pneumoconiosis often occurs after years of inhaling inorganic dust particles, resulting in progressive fibrosis of lung tissue. The most common causes of pneumoconiosis are the dusts of coal, asbestos, and silica. Other potential causes are beryllium, cadmium, cement, clays, fiberglass, cobalt, aluminum, iron, and talc. The most common types of pneumoconiosis are discussed in the following sections.

### Silicosis

**Silicosis** affects workers who have continually inhaled the inorganic dust compound known as silicon dioxide, which is found in sand, flint, quartz, and many other



stones. Silicosis is characterized by the development of nodular fibrosis in the lungs. The incidence is highest among industrial workers exposed to silica powder during manufacturing, in those who work with ceramics, sand, or stone, and in those who mine silica. Silicosis is also known as grinder's disease or quartz silicosis.

### Anthracosis

**Anthracosis** is a chronic lung disease characterized by the deposit of coal dust in the lungs. It is also characterized by the formation of black nodules on the bronchioles that result in focal emphysema. The condition occurs in coal miners and is aggravated by cigarette smoking. There is no specific treatment for anthracosis, which is also known as black lung disease or coal worker's pneumoconiosis.

### Asbestosis

**Asbestosis** is a chronic lung disease caused by the inhalation of asbestos fibers, resulting in the development of alveolar, interstitial, and pleural fibrosis. Asbestos miners and workers are most frequently affected. Asbestosis sometimes occurs in others who have been exposed to asbestos building materials. The disease is characterized by small linear opacities throughout the lungs, as shown on chest X-rays. The disease is progressive, results in shortness of breath, and eventually develops into respiratory failure. Cigarette smoking and continuous asbestos exposure aggravate the condition, and fatal mesothelial tumors sometimes occur. There is no treatment for asbestosis.

### Berylliosis

#### POINT TO REMEMBER

Severe altitude sickness includes a condition called high-altitude pulmonary edema. This condition causes nausea and vomiting, rapid heart rate and breathing, and a cyanotic (blue) cast to the skin.

Beryllium is an element used in fluorescent powders, metal alloys, and in the nuclear power industry. A small percentage of workers exposed to beryllium dust or vapor develop an immune response, which damages the lungs. Symptoms include fever, fatigue, cough, shortness of breath, night sweats, loss of appetite, and weight loss. Radiographs show granuloma scars in the lungs, and pulmonary function tests show impaired breathing.

### Respiratory Failure

**Respiratory failure** is the inability of the cardiovascular and pulmonary systems to maintain an adequate exchange of oxygen and carbon dioxide in the lungs. It may be caused by a failure in either oxygenation or ventilation. Oxygenation failure is characterized by hypoxemia, which can initially lead to hyperventilation.

However, oxygenation failure is not caused by hyperventilation. Oxygenation failure occurs in diseases that affect the alveoli or interstitial lung tissues. These diseases include the following:

- alveolar edema
- emphysema
- fungal infections
- leukemia
- lobar pneumonia
- lung carcinoma
- tuberculosis
- various pneumoconioses

Ventilatory failure is characterized by increased arterial carbon dioxide. Ventilation may also be reduced by the following:

- depression of the respiratory center by barbiturates or opiates
- hypercapnia
- hypoxia
- intracranial diseases
- lesion of the neuromuscular system or thoracic cage
- trauma

Respiratory failure in preexisting chronic lung diseases may be precipitated by added stress, such as with cardiac failure, anesthesia, surgery, or upper respiratory tract infections.

## Pleural Disorders

The pleura is a double-layered membrane that encases the lungs. The mediastinum separates the right and left pleural cavities. Pleural disorders include pleurisy, pleural effusion, pneumothorax, hemothorax, and flail chest.

### Pleurisy

**Pleurisy** is an inflammation of the pleura, also called pleuritis. It causes intense pain during breathing and is usually secondary to other diseases or infections. Pleurisy also may result from injury or the presence of a tumor.

### Pleural Effusion

Pleural effusion is defined as the presence of excessive fluid in the pleural cavity. Normally, small amounts of fluid are present, providing lubrication for the pleural membranes. Usually only one lung is affected by pleural effusion, but sometimes both lungs are affected. This is because each lung is enclosed in a separate pleural membrane. The effects of pleural effusion depend on the amount, rate of accumulation, and type of fluid.

### Pneumothorax

Pneumothorax is a collection of air or gas in the pleural cavity. This results in a collapsed or partially collapsed lung (see **Figure 2-6**). When pneumothorax is caused by

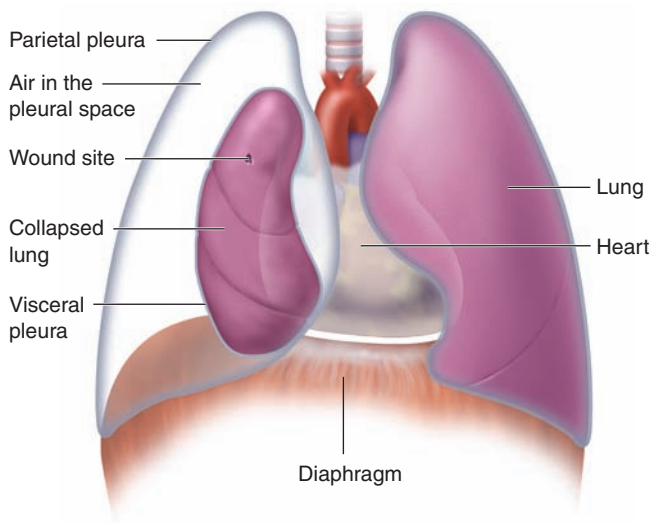


FIGURE 2-6 Pneumothorax.

trauma or a malignant tumor, blood or fluid may also be present in the cavity. Tension pneumothorax describes a life-threatening condition of excessive pleural cavity pressure.

#### POINT TO REMEMBER

Pneumothorax may be treated by covering the chest wound with an impermeable bandage, passing a chest tube through the thoracic wall into the pleural cavity, and applying suction to the tube.

Pneumothorax can be either spontaneous or traumatic. Spontaneous pneumothorax occurs when an opening is present on a lung's surface. It can be caused

by erosion of the alveoli (due to disease or tumors), increased respiratory pressure, or a spontaneous tear in tissue. Traumatic pneumothorax occurs when the pleural cavity's integrity is breached due to trauma (including stabbing, gunshots, or crushing of the chest).

### Hemothorax

Hemothorax is the accumulation of blood and fluid in the pleural cavity. The patient experiences symptoms that are similar to those of pneumothorax. Hemothorax is life threatening and requires emergency medical care. Trauma or the erosion of a pulmonary vessel may cause blood to enter the pleural space.

### Flail Chest

Flail chest is a condition of instability in the chest wall due to multiple rib fractures. If it is not corrected, hypoxia will occur. The most common chest injuries occur from automobile accidents and falls (see **Figure 2-7**). This condition is characterized by sharp pain, shallow and rapid

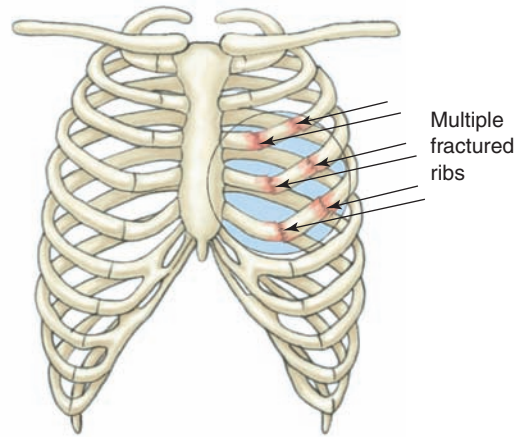


FIGURE 2-7 Flail-chest injury.

respiration, decreased breath sounds, and uneven chest expansion. Flail chest is a medical emergency and may be life threatening.

## Lung Cancer

The lungs are common sites of both primary and secondary types of cancer. Lung cancer is the leading cause of cancer deaths in both men and women in the United States. Increases in lung cancer incidence and deaths during the past 60 years are closely related to increased smoking of tobacco products. Nearly 95% of primary lung tumors are of the type known as **bronchogenic carcinoma**. The remaining 5% includes bronchial gland tumors, fibrosarcomas, and lymphomas. The lung is also a common site of metastasis from cancers in other parts of the body. There are four major categories of bronchogenic carcinomas:

- adenocarcinoma
- large cell carcinoma
- small cell carcinoma
- squamous cell lung carcinoma

Secondhand smoke in the environment has resulted in a significant number of cases of bronchogenic carcinoma. The risk of developing cancer is higher in persons who begin smoking early in life, continue for many years, and smoke more than one pack of cigarettes per day (considered to be heavy smokers).

Not all smokers develop lung cancer; therefore, there is probably a genetic factor involved. Occupational exposure to **carcinogens** such as silica, asbestos, or vinyl chloride is another major cause of lung cancer. The risk is greatly increased if a second factor (such as cigarette smoking) is also present in an occupationally exposed individual.

## Patient Education

Respiratory therapists must be up to date on the latest information concerning H1N1 flu (commonly referred to as swine flu). They should advise patients who are at highest risk of contracting H1N1 flu to be especially careful. These include pregnant women, children younger than age 5 years, adults older than age 65 years, and those with chronic medical conditions, such as diabetes, heart disease, asthma, and kidney disease. Respiratory therapists must educate patients about proper hand washing, wearing protective masks, avoiding using utensils that other family members might use, and avoiding going to work if they show signs of infection.

## SUMMARY

Cardiovascular diseases include carditis, coronary artery disease, hypertension, heart failure, and myocardial infarction. Angina pectoris is a condition of chest pain often caused by anoxia, atherosclerosis, or coronary artery spasm. Hypertension is a major cause of cardiac disease, renal failure, and stroke. A common form of heart disease is called congestive heart failure, which may be related to pulmonary conditions. Common respiratory conditions include asthma, bronchitis, and emphysema—all of which are aggravated by smoking. Common forms of pulmonary vascular disease include edema, hypertension, and embolism, as well as other potentially deadly pulmonary conditions, including pneumonia, tuberculosis, histoplasmosis, and pneumoconiosis. When the lungs cannot adequately exchange oxygen and carbon dioxide, respiratory failure may occur. Lung cancer is the deadliest type of cancer in the United States.

## LEARNING GOALS

These learning goals correspond to the objectives at the beginning of the chapter, providing a clear summary of the chapter's most important points.

1. Emphysema causes the destruction of alveolar ducts, alveoli, and respiratory bronchioles, causing enlarged air spaces. As emphysema progresses, the patient experiences increased shortness of breath following only minimal exertion. The most common cause of emphysema is the inhaling of smoke from tobacco products. Lung damage from emphysema is usually irreversible. Chronic obstructive pulmonary disease has, as its most common components, both emphysema and chronic bronchitis. Bronchitis is defined as inflammation of the mucous membranes of the bronchi. Bronchitis is a type of chronic obstructive pulmonary disease of the larger airways. The most obvious symptom is the production of sputum. Chronic bronchitis leads to excessive mucous production and coughing. Chronic bronchitis can lead to right-sided heart failure, acute respiratory failure, and pulmonary hypertension.
2. Atelectasis is defined as imperfect expansion, referring to incomplete expansion of a lung or part of a lung. This condition can occur due to airway obstruction, increased lung recoiling (due to loss of pulmonary surfactant), or lung compression (which may occur in pleural effusion or pneumothorax). Atelectasis may be present at birth, develop in the neonatal period, or develop later in life.
3. Acute bronchitis has a short, severe duration, which subsides without any long-term effects. Chronic bronchitis leads to excessive mucous production and coughing. It can be reversed after the removal of the irritant and is complicated by respiratory tract infections. Chronic bronchitis can lead to right-sided heart failure, acute respiratory failure, and pulmonary hypertension. Acute bronchitis is often caused by viruses, and the primary cause of chronic bronchitis is smoking or exposure to certain respiratory irritants. Risk factors include history of smoking, air pollution, occupational exposure, heredity, and reduced lung function.
4. Angina pectoris is a sudden outburst of chest pain frequently caused by myocardial anoxia, atherosclerosis, or coronary artery spasm. Anginal pain usually radiates along the neck, jaw, shoulder, and down the left arm. It is often accompanied by feelings of suffocation that may seem to indicate impending death. Angina pectoris attacks are often related to emotional stress, eating, exertion, and exposure to intense cold. Angina pectoris is also referred to as cardiac pain.
5. Increases in lung cancer incidence and deaths during the past 60 years are closely related to increased smoking of tobacco products. Second-hand smoke in the environment has resulted in a significant number of cases of bronchogenic carcinoma. The risk of developing cancer is higher in persons who begin smoking early in life, continue for many years, and smoke more than one pack of cigarettes per day (considered to be heavy smokers). Not all smokers develop lung cancer; therefore, there is probably a genetic factor involved. Occupational exposure to carcinogens, such as silica, asbestos, or vinyl chloride, is another major cause of lung cancer. The risk is greatly increased if a second factor (such as cigarette smoking) is also present in an occupationally exposed individual.
6. Endocarditis is inflammation of the inner layer of the heart, known as the endocardium. Myocarditis is inflammation of the middle layer of the heart, known as the myocardium. Myocarditis is the type of carditis that is most likely to

cause sudden death. Pericarditis is inflammation of the outer layer of the heart, known as the pericardium.

7. Left-sided heart failure is caused by ineffective left ventricular contraction. As the left ventricle's pumping ability fails, cardiac output falls. Because blood is no longer effectively pumped out, it backs up into the left atrium and then into the lungs. This causes activity intolerance and dyspnea. If the condition persists, pulmonary edema and right-sided heart failure can result. Common causes of left-sided heart failure include hypertension, aortic and mitral valve stenosis, and left ventricular infarction.

Right-sided heart failure is caused by ineffective right ventricular contraction. As a result, blood is not pumped with enough force through the right ventricle to the lungs. This causes blood to back up into the right atrium as well as the peripheral circulation. The patient gains weight, develops peripheral edema, and the kidneys (and other organs) become engorged. Right-sided heart failure may be caused by pulmonary hypertension, pulmonary embolus, or acute right ventricular infarction.

8. A dysrhythmia (arrhythmia) is a disturbance of heart rhythm. Common causes of arrhythmias include congenital defects, drug toxicity, electrolyte imbalances, and myocardial infarction or ischemia.
9. Pulmonary edema is a condition wherein fluid collects in the lung alveoli and interstitial tissues. This accumulation of fluid reduces diffused oxygen levels in the blood and interferes with the lungs' ability to expand. Pulmonary edema may result from predisposing factors, such as acute respiratory distress syndrome, heart disease, and inhalation of toxic gases. Of these factors, heart disease is the most common cause of pulmonary edema.
10. An emboli may cause eventual death if untreated. When an embolism occurs in the pulmonary system, it may be caused by any conditions that produce venous stasis, increased coagulation ability, or changes in the walls of blood vessels. Pathological changes that can cause pulmonary embolism include dehydration, immobility, decreased venous return, or injury. Conditions that are related to the previously mentioned risk factors include pregnancy, sepsis, congestive heart failure, and tumors.

### CRITICAL THINKING QUESTIONS

1. Explain why there is an extensive network of capillaries in skeletal muscles and in the liver.
2. Explain why an embolus may cause a larger infarction than an atheroma with a thrombus.

3. Describe how cystic fibrosis affects the lungs and the sweat glands.
4. List the factors that interfere with oxygenation of the blood in patients with emphysema.

### WEB SITES

<http://hypertensionweb.info/result.php?Keywords=Hypertension>

[http://www.cancer.org/docroot/PED/content/PED\\_10\\_2X\\_Cigarette\\_Smoking.asp](http://www.cancer.org/docroot/PED/content/PED_10_2X_Cigarette_Smoking.asp)

<http://www.cdc.gov/niosh/topics/pneumoconioses/>

[http://www.emedicinehealth.com/angina\\_pectoris/article\\_em.htm](http://www.emedicinehealth.com/angina_pectoris/article_em.htm)

[http://www.healthnewsflash.com/conditions/respiratory\\_failure.php](http://www.healthnewsflash.com/conditions/respiratory_failure.php)

<http://www.lungcancer.org/>

[http://www.medicinenet.com/high\\_blood\\_pressure/article.htm](http://www.medicinenet.com/high_blood_pressure/article.htm)

<http://www.nei.nih.gov/health/histoplasmosis/index.asp>

<http://www.webmd.com/asthma/>

<http://www.webmd.com/a-to-z-guides/pneumonia-topic-overview>

### REVIEW QUESTIONS

#### Multiple Choice

Select the best response to each question.

1. Cancer in which of the following sites is the leading cause of cancer death in males?
  - A. prostate
  - B. pancreas
  - C. lung
  - D. colon
2. Chronic dilation and distention of the bronchial walls is called
  - A. hemoptysis
  - B. pneumoconiosis
  - C. bronchiectasis
  - D. atelectasis
3. An area of dead cells due to lack of oxygen is called
  - A. ischemia
  - B. infarction
  - C. atresia
  - D. gangrene
4. A collection of air or gas in the pleural cavity that results in a collapsed lung is referred to as
  - A. emphysema
  - B. pneumoconiosis
  - C. bronchiectasis
  - D. pneumothorax
5. When the heart is pumping inadequately to meet the needs of the body, the condition is called
  - A. cor pulmonal
  - B. congestive heart failure
  - C. arrhythmia
  - D. myocardial infarction



6. An abnormally slow heart rate is known as
  - A. bradycardia
  - B. tachycardia
  - C. heart block
  - D. ventricular fibrillation
7. Stasis of blood flow from immobility, injury to a vessel, or predisposition to clot formation increases the risk of
  - A. pulmonary embolism
  - B. emphysema
  - C. pneumothorax
  - D. chronic obstructive pulmonary disease
8. Which of the following is an occupational disease that causes progressive, chronic inflammation and infection in the lungs due to inhalation of inorganic dust?
  - A. emphysema
  - B. pneumothorax
  - C. pneumoconiosis
  - D. bronchiectasis
9. Fluid shift into the extravascular spaces of the lungs with accompanying dyspnea and coughing is indicative of
  - A. myocardial infarction
  - B. pulmonary edema
  - C. angina pectoris
  - D. pneumothorax
10. Which of the following is a common disease of the lower respiratory tract that frequently is caused by the respiratory syncytial viral infection?
  - A. bronchiolitis
  - B. atelectasis
  - C. bronchiectasis
  - D. pulmonary edema
11. Which of the following is a major cause of cardiac disease, renal failure, and stroke?
  - A. emphysema
  - B. heart failure
  - C. hypertension
  - D. asthma
12. Which of the following is the most common cause of emphysema?
  - A. bronchogenic cancer
  - B. pneumothorax
  - C. pulmonary edema
  - D. smoking cigarettes
13. Which of the following cardiovascular disorders is the leading cause of death in the United States?
  - A. myocardial infarction
  - B. hypertension
  - C. stroke
  - D. angina pectoris
14. Which of the following is the cause of primary pulmonary hypertension?
  - A. hypoxemia
  - B. pulmonary embolism
  - C. pneumonia
  - D. unknown
15. Tuberculosis primarily affects the
  - A. brain
  - B. liver
  - C. kidneys
  - D. lungs

### CASE STUDY

A 52-year-old man who worked for 15 years in the nuclear power industry began to have symptoms of lung problems, including coughing, shortness of breath, fatigue, loss of appetite, fever, night sweats, and weight loss. Chest X-rays showed granuloma scars in his lungs. His pulmonary function tests revealed impaired breathing.

1. What is the probable diagnosis of his condition?
2. What medication should this patient receive to relieve his symptoms?