



CHAPTER
28

The Respiratory System

Learning Objectives

After completing this chapter, you should be able to:

- 28.1 Define and spell the terms for this chapter.
- 28.2 Explain the overall function of the respiratory system.
- 28.3 List the structures of the respiratory system.
- 28.4 Describe how the respiratory system changes during the life span of a child to an older adult.
- 28.5 Detail how the mechanism of breathing occurs.
- 28.6 Identify common pathology associated with the respiratory system.

Case Study

Collin McConnley is a 57-year-old businessman who travels 80 percent of his workweek. It is a hot summer day, and he has an appointment with Dr. Miller because he believes that he has the flu. His symptoms include severe headache, high fever, fatigue, and diarrhea.

Terms to Learn

alveoli	epiglottis	pertussis
apnea	expiration	pharynx
arterial blood gases (ABGs)	hay fever	pleura
asphyxia	hemoptysis	pleurisy
asthma	hilum	pneumonia
bronchi	hypoxia	pulmonary edema
bronchitis	influenza	pulmonary embolism (PE)
bronchodilators	inspiration	septum
chronic obstructive pulmonary disease (COPD)	larynx	severe acute respiratory syndrome (SARS)
cilia	Legionnaires' disease	sinusitis
common cold	lung cancer	surfactant
cyanosis	lungs	thorax
diaphragm	nares	trachea
dyspnea	orthopnea	tuberculosis (TB)
emphysema	paranasal sinuses	

The respiratory system is responsible for delivering oxygen to the cells of the body. The cells need oxygen to perform the cellular metabolism that sustains life. The respiratory system plays an equally important role by ridding the body of excess carbon dioxide. Carbon dioxide is a compound of carbon and oxygen that is a waste product of cellular metabolism. Both of these important functions—bringing oxygen to the cells and taking away carbon dioxide waste—occur as a result of breathing, or respiration.

OVERVIEW OF THE RESPIRATORY SYSTEM

When we breathe, an exchange of gases occurs between the **alveoli** (tiny air sacs) of the lungs and the capillaries that surround them. Oxygen from the air that we inhale passes from the alveoli into blood in the capillaries, which carry the oxygen to the body's cells. At the same time, we exhale carbon

dioxide that has been picked up as a waste product of the cells and that passed from the capillaries into the alveoli.

The mouth, nose, trachea, bronchi, bronchioles, and lungs constitute the respiratory tract, the pathway for respiration. Oxygen enters the respiratory system by this path (inhalation), and carbon dioxide exits the system by the same path (exhalation). The actions of inhalation and exhalation are achieved by the alternating contraction and relaxation of the respiratory muscles: the diaphragm, the muscles attached to the ribs (intercostal muscles), and sometimes the muscles of the neck.

STRUCTURES OF THE RESPIRATORY SYSTEM

The respiratory system is made up of structures and organs leading from the nasal passages to the lungs (Figure 28-1). There are two distinct divisions of the respiratory system; the upper respiratory tract and the lower respiratory tract.

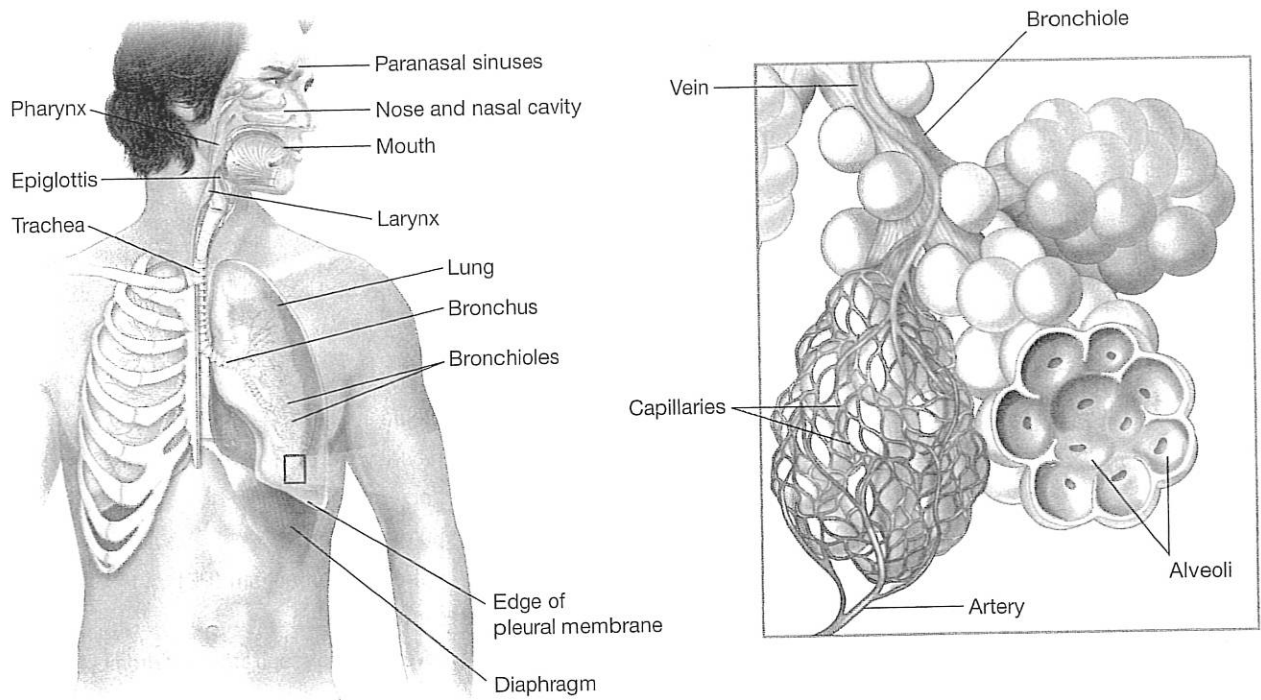


FIGURE 28-1 Structures of the respiratory system.

The nose, mouth, throat (or pharynx), and paranasal sinuses are components of the upper respiratory tract. The lower respiratory tract begins with the larynx, which is commonly known as the voice box. From the larynx, the tract extends to the trachea, and here the tract first splits into the bronchi. The split resembles two branches, similar to that of a tree. The tract farther extends and branches off from the bronchi into much smaller structures called bronchioles. The structural components of the lower respiratory tract end with the lungs, which are described as saclike and spongy.

Nose and Mouth

Air enters the body through the nose or mouth.

The nose, which is the organ of smell, also performs several other functions:

- Serves as a passageway for air
- Warms and moistens inhaled air
- Traps dust, pollen, and other foreign matter with hair-like projections (**cilia**)
- Assists in phonation (production of vocal sounds)

The nose has both external and internal characteristics. The term *nose* itself generally refers to the visible external portion. It is made up of bone and cartilage and is lined with a mucous membrane. The nasal openings that bring air into the nose are known as the **nares**, or nostrils.

Internally, there are two main nasal fossae (cavities). They are separated by a wall of cartilage known as the **septum**. There are three air passageways found on either side of the septum. These passageways are called turbinates, but may also be referred to as conchae:

- Inferior conchae
- Middle conchae
- Superior conchae

These passageways connect (via the eustachian tube) to the middle ear, to the paranasal sinuses, and to the nasolacrimal ducts (tear ducts). The conchae form a “maze” in which air moves around, allowing for warming of the air and removal of foreign particles by the mucus secreted by the mucous membranes (mucosae). The nasal mucosae produce about a quart of mucus per day, which moistens the air moving through the nose and traps pollen, dust, and other foreign matter. The nose is separated from the mouth by the palatine bones of the skull.

The mouth serves just two of the functions of respiration and voice: serving as a passageway for air and assisting in phonation. The mouth does not warm and moisten inhaled air or trap foreign matter as the nose does.

Paranasal Sinuses

The nose drains the four pairs of **paranasal sinuses**, air cavities in the cranial bones near the nose, which are often

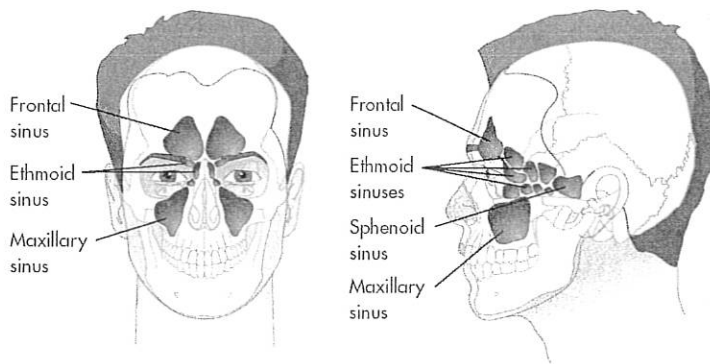


FIGURE 28-2 The four pairs of paranasal sinuses.

simply referred to as “the sinuses” (Figure 28-2). The four pairs of paranasal sinus cavities are:

- Maxillary sinuses over the medial portion on the cheekbones
- Frontal sinuses over the eyebrows
- Ethmoid sinuses in the area between and behind the eyes
- Sphenoid sinuses behind the ethmoid sinuses

The sinuses have important functions. Because they are pockets of air within the bone, they decrease the weight of the skull. Sinuses also aid in phonation and provide protection and insulation.

Pharynx

The **pharynx** is a tube about 5 inches long formed from muscle and membrane that lies behind and connects the nose, the mouth, and the larynx. There are three sections of the pharynx that are all connected with each other:

- **Nasopharynx**—Connects with the nose
- **Oropharynx**—Connects with the mouth
- **Laryngopharynx**—Located behind the larynx

The major function of the pharynx is to serve as a passageway for food to the esophagus and air to the larynx and trachea. The pharynx also plays a role in speech, as do the mouth and nose, by helping to form specific phonetic sounds from the initial sounds produced in the larynx.

Three pairs of tonsils reside in the pharynx:

- **Pharyngeal tonsils (adenoids)**—Located behind the nose and often blamed for snoring, especially in children
- **Palatine tonsils**—Often referred to as simply “the tonsils,” located on either side of the throat on the anterior portion of the oropharynx
- **Lingual tonsils**—Located at the base of the tongue

The tonsils are part of the immune system and help in infection control, as was discussed in the chapter titled “The Immune System.”

Larynx

The **larynx** (Figure 28-3) is also known as the voice box. It is a muscular, cartilaginous structure lined with mucous membrane and connected to the inferior (lower) end of the pharynx. The larynx has several cartilaginous structures, three of which help protect it from trauma:

- The thyroid cartilage, or Adam’s apple, is the largest of the cartilage structures and helps protect the walls of the larynx and the vocal cords. Both men and women have this structure, although the Adam’s apple is more prominent in men.
- The epiglottic cartilage, or **epiglottis**, covers the larynx during swallowing so that food is directed down the esophagus to the stomach rather than through the larynx to the trachea and into the lungs.
- The ring-shaped cricoid cartilage, the lowest cartilage in the larynx, wraps around it to protect it from pressure.

The interior of the larynx contains the false and true vocal folds and the glottis, which is the opening between the true vocal folds through which air passes. (Sometimes the glottis is defined as consisting of the space between the folds and the folds themselves.) The larynx functions in the production of vocal sounds. When the vocal cords are long and relaxed, low sounds are produced. Short, tense vocal cords produce higher-pitched notes. (As mentioned earlier, the nose, mouth, pharynx, and bony sinuses impact other aspects of sound production.)

Trachea

The **trachea**, or windpipe (Figure 28-3), is a cartilaginous tube about 1 inch wide and 4.5 inches long that extends from the larynx in the throat to the bronchi in the chest cavity. The cartilage rings in the trachea are C-shaped, with openings at the back bridged by elastic connective tissue. This structure allows the trachea to be flexible, to contract when you cough, and to be pushed inward when a bolus of food passes through the esophagus, which lies behind the trachea. The interior of the trachea is lined with mucous membrane and cilia (hairlike structures) that trap foreign matter. The most important function of the trachea is to serve as an open passageway through which air reaches the lungs.

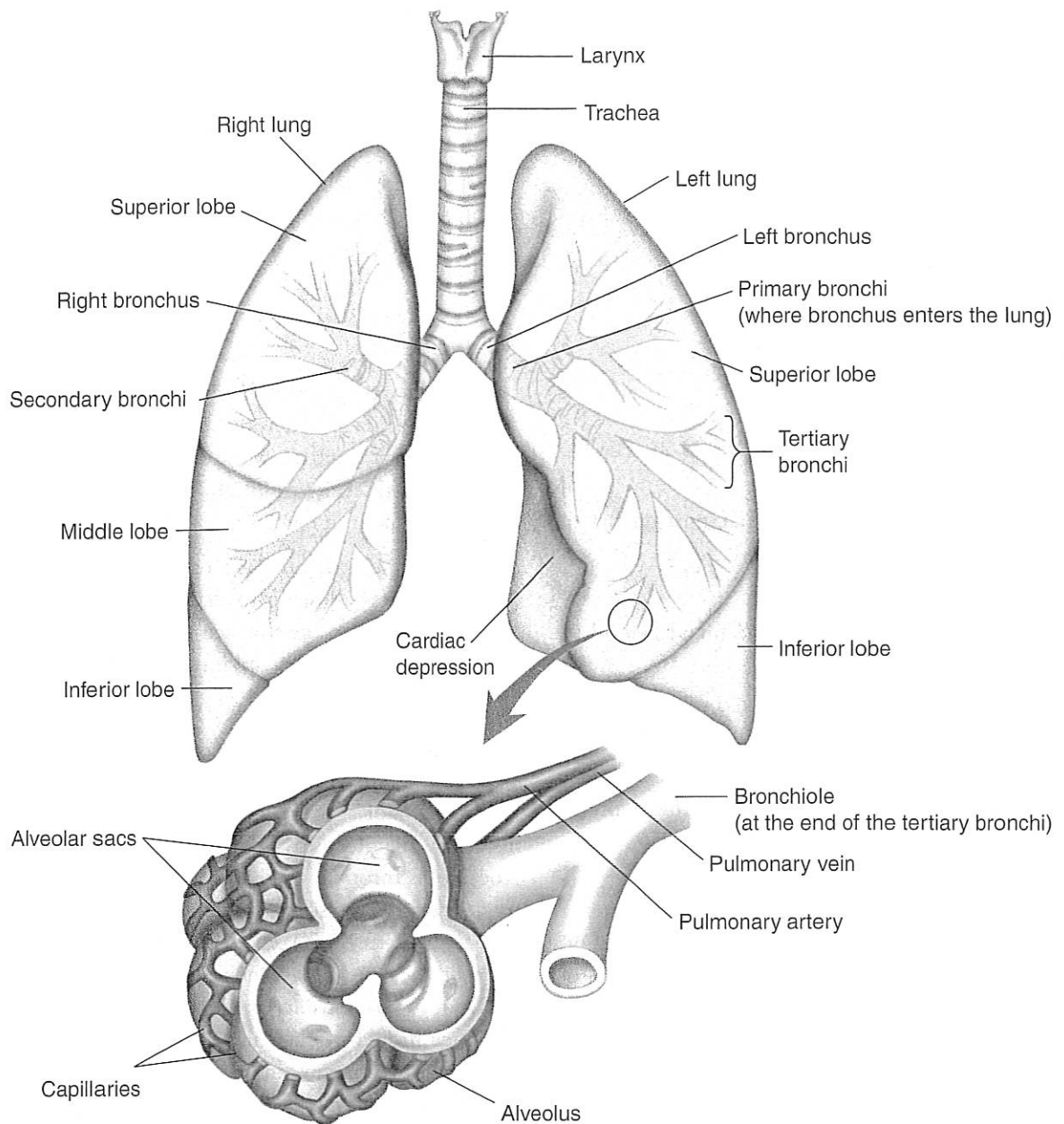


FIGURE 28-3 The larynx, trachea, bronchi, and lungs with an expanded view showing the structures of the alveolus and the pulmonary blood vessels.

Bronchi

The **bronchi** (Figure 28-3) are the two main branches (right bronchus and left bronchus) from the trachea that extend into the lungs. These structures are the passageways for air between the trachea and the lungs. The right bronchus is the wider, shorter branch. The left bronchus is longer but smaller in diameter. After entering the lungs, the bronchi subdivide into the bronchial tree, which continues to branch into smaller and smaller branches.

The right and left bronchi are also called the primary bronchi. The sections that branch off these primary bronchi

enter specific lobes of the lungs and are referred to as secondary bronchi. Bronchi that branch from the secondary bronchi are called tertiary bronchi. At the ends of the tertiary bronchi, the smallest components of the bronchial tree—the bronchioles—are formed.

Bronchioles and Alveoli

Bronchioles are composed of a thin layer of epithelium and smooth muscle. These tiny structures are only 1 millimeter (mm) or less in diameter. Eventually, the bronchioles terminate at the alveoli, the small air sacs in the lungs that

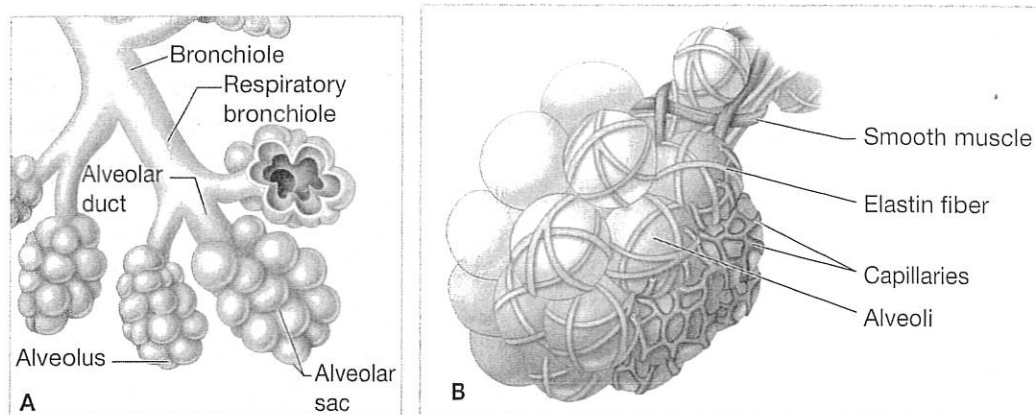


FIGURE 28-4 (A) Alveolar sac; (B) alveoli with capillaries.

support a network of capillaries where (as described earlier) the exchange of oxygen and carbon dioxide takes place between the air in the alveoli and the blood in the adjoining capillaries (Figure 28-4). The average pair of adult lungs contain about 600 million alveoli.

In healthy individuals, the alveoli resemble small balloons that inflate and deflate as air moves in and out. The cells of the alveoli produce a fatty substance known as **surfactant**. Surfactant reduces the surface tension of the fluid in the wet surfaces of the air-filled sacs, which helps keep them open. Without surfactant, the alveoli would collapse after each breath, making it harder to reinflate with the next breath, thereby increasing the work of breathing, leading to exhaustion and, eventually, an inability to continue breathing.

Lungs

The **lungs** are large, somewhat cone-shaped organs within the chest (review Figure 28-3). At birth the lungs are pinkish in color, but as adulthood approaches they turn a dark, slate-gray. The lungs are porous and spongy in texture and highly elastic. The right lung is made up of three lobes: the superior, middle, and inferior lobes. The left lung has only two—a superior lobe and an inferior lobe—allowing room for the heart, which takes up chest space on the left. Each lung is between 10 and 12 inches in length. The two lungs are separated by the mediastinum, a space behind the breastbone that contains the heart, trachea, esophagus, and blood vessels.

The **hilum** is a wedge-shaped area on the central portion of each lung where the primary bronchus, arteries, veins, and nerves enter and exit the lung. The rounded point at the top of the lung is called the apex, and the wide lowest portion of the lung that rests on the diaphragm is called the base.

The **pleura** (plural *pleurae*) is one of a pair of thin sheets of epithelium that line the inside of the thorax and the outside of the lungs. The pleural space is a tiny area that separates

Professionalism The Life Span



The Child

- Infants born before 24 weeks of gestation are frequently administered surfactant, a substance that the body produces in more mature lungs to decrease surface tension in the alveoli, making oxygen exchange more efficient. Administering this fluid to immature lungs decreases the occurrence of respiratory distress syndrome and lung damage in these infants.
- Respiratory rates decrease as a child grows and develops. A newborn has a respiratory rate of 30 to 80 breaths per minute. As the infant matures, the respiratory rate drops to 20 to 40 by the first birthday. A 5-year-old has a respiratory rate of approximately 20 to 25 breaths per minute, whereas a 15-year-old usually demonstrates a rate of 15 to 20 breaths per minute. Healthy adults also breathe in the range of 15 to 20 breaths per minute.
- The lungs continue to develop and mature through childhood, adolescence, and early adulthood. The lungs experience their maximum functioning capacity between the ages of 20 and 25 years.

The Older Adult

- After age 35, lung function begins to decline because of anatomical and physiological changes within the aging respiratory system.
- The respiratory rates in older adults may rise as the combined effects of pollution, smoking, and disease wear on the integrity of the tissues. Mucous membranes begin producing less mucus, and the cilia function less effectively. As a result, less foreign matter is trapped before entering the lungs, and infections are more likely.
- With the skeletal changes that come with aging, breathing in older adults is often diaphragm-based rather than rib-based. The lungs also lose their flexibility and become stiffer, so the volume of air that can be moved decreases. As a result, older adults are less able to move out foreign and disease-causing materials and are more susceptible to bronchitis and pneumonia.

the parietal pleura (covering the inner thoracic cavity and diaphragm) from the visceral pleura (covering the outer surface of the lungs). The pleural space normally contains a small amount of lubricating fluid, which allows the lungs to slide easily over the inner chest as they expand and contract during breathing.

The pleurae are sometimes referred to as pleural membranes.

MECHANISM OF BREATHING

Ventilation is the term for the movement of air to and from the lungs. The two processes of ventilation are inhalation and exhalation (also called inspiration and expiration), which are brought about by the nervous system and the respiratory muscles. The respiratory centers of the brain are located in the medulla oblongata and the pons. The major respiratory muscles are the diaphragm and the internal and external intercostal muscles.

The **diaphragm** is the dome-shaped muscle below the lungs that separates the thoracic cavity from the abdominal cavity. The diaphragm can contract and relax to enlarge and reduce the size of the thoracic cavity. The intercostal muscles are located between the ribs. The external intercostal muscles pull the ribs upward and outward, and the internal intercostal muscles pull the ribs downward and inward. Figure 28-5 illustrates the mechanism of breathing.

Difficulty breathing is known as **dyspnea**. This is a common sign and symptom of many respiratory diseases and disorders. The absence of breathing for more than 19 seconds is termed **apnea**. If a patient has trouble breathing unless a certain position is maintained (such as with head elevated), it is termed **orthopnea**.

Inhalation

Inhalation, or **inspiration**, is an active process that involves a precise sequence of events. First, the nervous system sends

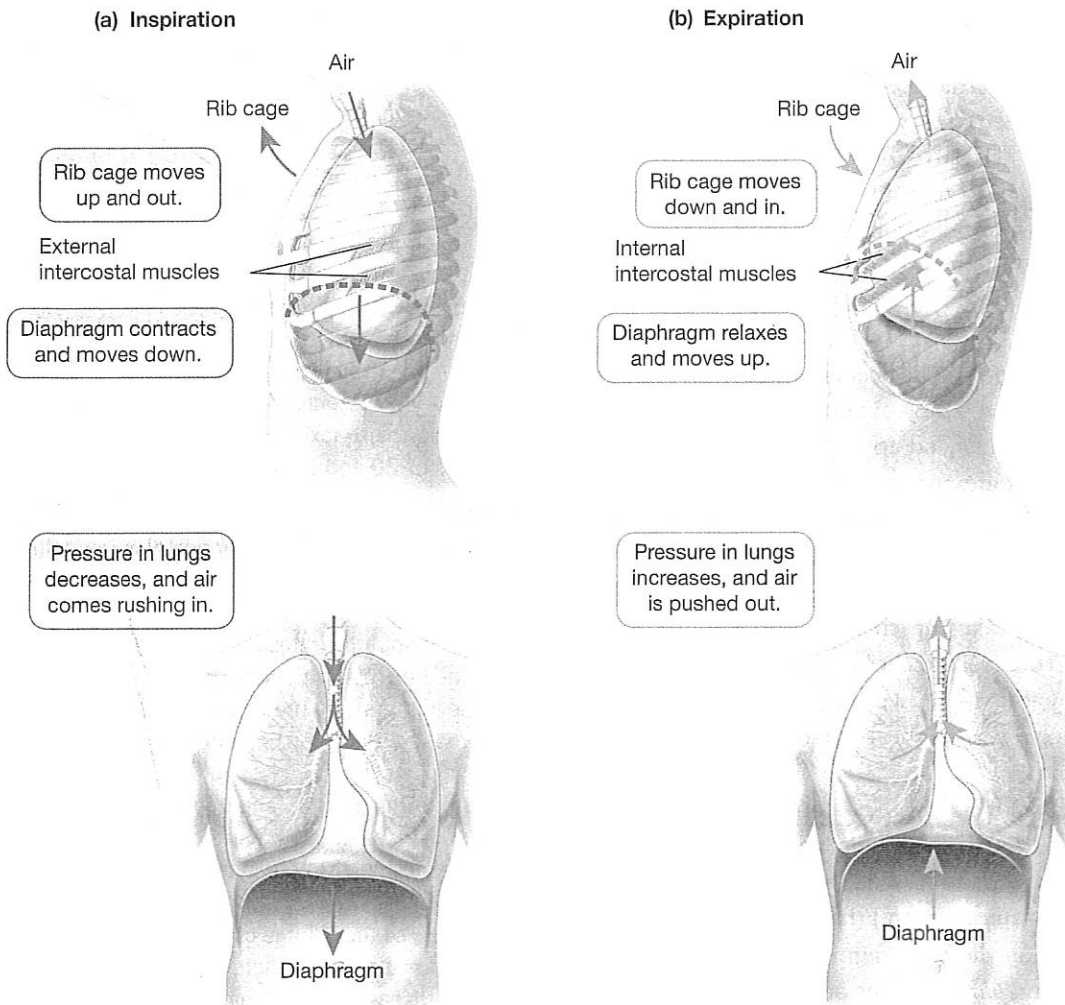


FIGURE 28-5 The process of ventilation: inspiration and expiration.

an impulse to the diaphragm and external intercostal muscles. This causes the diaphragm to contract and flatten, which results in an elongation of the **thorax** (the chest). At the same time, the external intercostal muscles contract to pull the ribs upward and outward, which increases the size of the thorax from the front to the back and from side to side. The increase in the size of the chest cavity reduces pressure within the chest, so that environmental air, which is now under greater pressure, flows into the lungs. Refer, again, to Figure 28-5.

Exhalation

Quiet *exhalation*, or **expiration**, is ordinarily a passive process. During expiration the diaphragm and the intercostal muscles relax and the thorax returns to its resting size and shape. The reduction in the size of the thoracic cavity builds pressure inside the chest cavity until it is greater than environmental air pressure, which causes air to flow out of the lungs. The elastic recoil of lung tissues aids in quiet expiration. Forceful expiration involves the internal intercostals and abdominal muscles.

COMMON PATHOLOGY ASSOCIATED WITH THE RESPIRATORY SYSTEM

Respiratory diseases have a wide range of presentation, from life threatening to mildly irritating. Some diseases are contracted through bacteria, viruses, or injury, whereas others develop as a result of the aging process. In addition to the

diseases discussed next, Table 28-1 provides descriptions of some additional respiratory diseases and disorders.

Any lack of oxygen in the body, known as **hypoxia**, can be serious because our bodies require oxygen to survive. It can lead to **asphyxia**, or suffocation. **Arterial blood gases (ABGs)** are drawn by taking blood out of the arteries. If ordered, they must be processed immediately to truly ascertain the level of oxygen and carbon dioxide (CO₂) in the blood, because these gases evaporate quickly.

Asthma

Asthma is a chronic inflammatory disease of the bronchi and is related to the same process that causes allergic reactions. The general etiological factor related to asthma is an allergic reaction, though allergens are the actual offenders. Asthma is typically caused when allergens or other irritating substances cause swelling in the lining of the trachea and bronchial tubes, aggravating sensitive tissues. Common irritants include pet dander, dust mites, cigarette smoke, pollen, and other substances. When exposed to the irritant, tissues within the respiratory tract create mucus in an attempt to trap the offending intruder. The presence of excessive mucus can cause coughing or a sense of struggling to breathe, which, in turn, causes more swelling and more mucus production. A vicious cycle results.

Asthma is commonly seen during childhood, but adult-onset asthma is also common.

Signs and Symptoms. Difficulty breathing, or dyspnea, and cough are classic signs of asthma. Additionally, congestion, wheezing and tightness in the chest may occur, which

TABLE 28-1 | Diseases and Disorders of the Respiratory System

Condition	Description
Atelectasis	A collapse of all or part of the lung; usually caused by blocked airways, deflated alveolar sacs, or increased pressure outside the lung.
Hyperventilation	Rapid, deep breathing that often occurs with panic and anxiety.
Laryngitis	Inflammation of the voice box resulting in a loss of voice, or hoarseness.
Mesothelioma	A cancer that develops on the pleura of the lungs that develops years after exposure to asbestos.
Obstructive Sleep Apnea	Characterized by periods of decreased air flow and breathing cessation during sleep when the airway becomes blocked or narrowed because of the relaxation of throat muscles.
Pneumoconiosis	Known as Black Lung disease, it is caused by inhalation of coal dust, which causes inflammation of the alveolar sacs. Continual inflammation causes scar tissue to develop, which results in a stiffening of the lung tissue.
Pneumothorax	A collapse of the lung caused by a buildup of air between the wall of the chest and the lungs that usually results when the pleura has been punctured allowing air to escape.
Respiratory Distress Syndrome	A breathing disorder, characterized by a lack of necessary oxygen, that usually affects premature infants as a result of their body's inability to produce surfactant.

can cause anxiety in the patient. It is common for the patient's symptoms to be worse in the morning and at night.

Treatment. Bronchodilators, which open the bronchial passages, are the treatment of choice when a patient is experiencing an active asthma attack, or episode. Bronchodilators are often administered via an inhaler. Most individuals with asthma carry an inhaler of a beta-2 medication (bronchodilator), either albuterol or pirbuterol.

Long-term, preventive medications include long-acting beta-2 medications such as salmeterol (Serevent); eicosanoid lipid mediators such as leukotrienes (Singulair); and inhaled corticosteroids such as Flovent, Intal, and beclomethasone. These medications do not stop an already occurring asthma episode. Rather, they are taken daily to prevent asthmatic episodes by keeping effective levels of medication within the tissues. In response to a severe asthma attack, a course of treatment with steroids such as prednisone may be prescribed to help reduce the inflammation, speed healing, and reduce complications.

Chronic Obstructive Pulmonary Disease

Chronic obstructive pulmonary disease (COPD) consists primarily of two related diseases: chronic bronchitis and emphysema. Both diseases are characterized by chronic obstruction of the flow of air in and out of the lungs. The obstruction is generally permanent and progressively worsens over time. Air pollution and certain occupational pollutants, such as cadmium and silica, may increase the risk of COPD. Smoking is responsible for 85 to 90 percent of cases in the United States. Smokers also suffer more frequent respiratory symptoms, such as coughing and shortness of breath, and more deterioration in lung function from COPD than nonsmokers. Genetics, including a familial risk for reduced airway and airflow limitations, is also a causative factor for this disorder.

A diagnosis for COPD is established after a medical history of the symptoms and a physical examination detect

Professionalism

Cultural Considerations



In current U.S. culture, tobacco smoking has become less acceptable, especially as researchers continue to discover more links to chronic, life-threatening diseases. However, not every patient (or medical assistant) is part of a culture that accepts these tenets. In certain cultures, habits such as cigarette smoking are not only acceptable but expected. These choices are each patient's own, and, although medical professionals may present factual information, they should never force this information on patients. Medical assistants should be perceived as nonjudgmental and accepting of all patients, regardless of their lifestyle decisions.

signs of COPD. Tests used to make or confirm the diagnosis include chest X-ray, computed tomography (CT or CAT scan) of the chest, pulmonary function tests, and the measurement of oxygen and carbon dioxide levels in the blood.

Signs and Symptoms. Signs and symptoms include shortness of breath and difficulty breathing, particularly with exertion, an increased number of respiratory infections, wheezing, a persistent cough, regular (and sometimes an excessive) production of mucus, fatigue, tightness in the chest, and the inability to catch one's breath.

Treatment. Unfortunately, there is no cure for COPD. The goals of COPD treatment are to prevent further deterioration in lung function, alleviate symptoms, and improve the patient's performance of daily activities and quality of life. Treatment strategies include smoking cessation, bronchodilators to open the airways and decrease airway inflammation, vaccination against influenza and pneumonia, regular oxygen supplementation, and pulmonary rehabilitation. Proper nutrition and minimal exercises—which help to strengthen muscles required for breathing—are both beneficial to COPD patients for overall health.

Bronchitis

Bronchitis is a respiratory disease marked by inflamed mucous membranes in the bronchial passages. As the irritated membrane swells and grows thicker, it narrows the airways of the lungs. The disease occurs in two forms: acute (lasting less than six weeks) and chronic (defined as recurring frequently for more than two years). Chronic bronchitis is considered to be a form of COPD.

Acute bronchitis is generally caused by viral lung infections but can also be caused by bacterial infections. Chronic bronchitis may be caused by repeated attacks of acute bronchitis, which irritate and weaken the bronchial airways over

Professionalism

The Law



Many children may require a supply of their asthma medication to be kept at school for administration by the school nurse. Be aware of the medication requirements of the local school district. Most do not allow students to self-administer or carry any prescription or over-the-counter medications on school grounds. Be ready to write a special note for the physician to sign, giving the school nurse an explanation of the physician's orders so that medications may be given appropriately at school.

time, and by industrial pollution. Coal miners, grain handlers, metal molders, and others who are continually exposed to fine dust particles often develop chronic bronchitis at higher-than-normal rates. However, the chief cause is heavy, long-term smoking, which results in continual irritation of the bronchial tubes. It also results in excessive mucus production.

Signs and Symptoms. Signs and symptoms of acute bronchitis include a hacking cough; yellow, white, or green phlegm, which usually appears 24 to 48 hours after the cough begins; coughing up blood (**hemoptysis**); low-grade fever and chills; soreness and tightness in the chest; pain below the breastbone during deep breathing; and shortness of breath. Chronic bronchitis is characterized by a persistent cough that produces yellow, white, or green phlegm (for at least three months of the year and for more than two consecutive years) and sometimes wheezing and breathlessness.

Treatment. Conventional treatment for acute bronchitis may consist of simple measures such as getting plenty of rest, drinking lots of fluids, avoiding smoke and fumes, and use of an inhaled bronchodilator and/or cough suppressant. Antibiotics may be prescribed if there is a bacterial infection present. In chronic bronchitis, routine use of inhaled or oral steroids to reduce inflammation of the airways may be implemented, expectorants to thin mucus may be used, and in severe cases supplemental oxygen may be necessary.

Emphysema

Emphysema is a long-term, progressive disease of the lung. As mentioned earlier, along with chronic bronchitis, it is also a form of COPD. The disease attacks the structure of the alveoli in the lungs. Permanent holes develop in the alveolar walls, making them unable to hold their shape properly on exhalation. This decreases the amount of oxygen-rich blood that is able to circulate through the body.

Professionalism The Workplace



Medical assistants should be aware of the location of oxygen tanks and emergency supplies within their office or facility. Many offices have established protocol that outlines emergency procedures as well as circumstances when oxygen may be administered. Also, it is a good idea for the working team to rehearse what to do when a patient needs oxygen so all members are prepared in the event of an emergency.

As with medications, the administration of oxygen must always be ordered by a physician.

Regarding etiology and causative factors related to emphysema, smoking tobacco is by far the most common cause of emphysema—and also the most preventable. Other risk factors include a deficiency of the enzyme alpha-1 antitrypsin, air pollution, airway reactivity, heredity, gender (male), and age.

Signs and Symptoms. Shortness of breath is the most common symptom of emphysema. At times, the shortness of breath is so severe that a person is unable to talk. If severe breathing difficulties persist, the patient's complexion, lips, or nail beds may turn bluish in appearance. This is called **cyanosis** and results from a lack of oxygen in the tissues. Coughing, sometimes caused by the production of mucus, and wheezing may also be symptoms. Rapid heart-beat, decreased cognition, and intolerance for exercise are also common.

Treatment. Treatment for emphysema can take many forms. Smoking cessation is a treatment that most doctors require of patients, as it may halt the progression of the disease and improves lung function to some extent. Bronchodilators are usually the first medications prescribed. Steroids and antibiotics, when infection is present, may also be prescribed. If the patient experiences shortness of breath, oxygen therapy may be given. Patients may undergo pulmonary rehabilitation in which they are taught exercises and techniques to help counter shortness of breath, and possibly enable them to exercise. In very severe cases, surgery to remove a lung may be required.

Common Cold

A **common cold** is a viral infection of the upper respiratory tract. More than 200 viruses can cause a common cold; however, the rhinovirus is the most common culprit. Many cold viruses are highly contagious, because it is transmitted through droplets. It is estimated that infectious droplets can travel 4–6 feet through the air. These droplets can be transmitted through sneezing and coughing, hand-to-hand contact with someone who has a cold, or the use of shared objects, such as utensils, towels, toys, or telephones.

Signs and Symptoms. Because any one of over 200 viruses can cause a common cold, symptoms can vary greatly. Signs and symptoms usually appear one to three days after exposure to a cold virus. They may include a runny or stuffy nose, itchy or sore throat, cough, congestion, slight body aches, mild headache, sneezing, watery eyes, low-grade fever of less than 102°F, and mild fatigue. Nasal discharge may become thicker and turn yellow or green as the cold runs its course. Unlike other viral infections, the common cold is not accompanied by high fever or significant fatigue.

Treatment. There is no cure for the common cold. Antibiotics are useless against cold viruses because they are only effective against bacterial infections. Over-the-counter medications can relieve some symptoms, though they can't shorten the duration of the illness. For fever, sore throat, and headache, mild pain relievers may be helpful. For runny nose and nasal congestion, antihistamines or decongestants may be useful.

Because so many different viruses can cause a common cold, no effective vaccine has been developed. Taking certain precautions can help to slow the spread of cold viruses: washing the hands; scrubbing countertops clean, especially when someone in the household has a cold; sneezing and coughing into tissues and discarding them immediately; and not sharing drinking glasses or other utensils with family members who may be sick.

Hay Fever

Hay fever, sometimes called seasonal allergic rhinitis or pollenosis, is a seasonal allergy in which the mucous membranes of the nose become inflamed. The most likely cause of hay fever is the pollen of trees, plants, and weeds carried by the wind and air. High pollen counts in the air occur with weather changes, particularly exceptionally hot and dry days or cool and wet days. About 50 million Americans experience hay fever symptoms each year.

Signs and Symptoms. Common signs and symptoms of hay fever include repeated and prolonged sneezing; a stuffy and watery nose; redness, swelling, and itching of the eyes; itching of the nose, throat, mouth, and ears; and other ear problems. It is also common for patients to experience impaired senses of smell and taste. At bedtime, patients may experience difficulty breathing and increased coughing from postnasal drip.

Treatment. Hay fever is best controlled by avoiding the substance that causes the reaction. Air filters that are able to purify and remove airborne allergens can be very effective. Antihistamine medication may be prescribed that, as the name suggests, counteracts the histamine that is released by the body during the allergic reaction. In more severe cases, corticosteroids may be taken. Immunotherapy, or allergy shots, are also helpful in these cases by assisting to reduce symptoms in about 85 percent of patients.

Influenza

Influenza, commonly called the flu, is an illness caused by viruses that infect the respiratory tract. Influenza is more severe than other viral infections, having a rapid and quick progression of symptoms, which is usually a recognizable

factor. There are three types of the influenza virus: A, B, and C. Typically, influenza Type A is most problematic for humans. These influenza viruses mutate and change over time, making them a continual source of susceptible infection to the body. Because the body is able to defend itself only against a virus it has already been exposed to, viral mutations present new sources for infection to which the body has not been exposed.

It is important to note that gastrointestinal (GI) illness is often mistaken for the flu. Flu is a respiratory condition, not gastrointestinal (although children may have GI symptoms associated with a respiratory flu). GI illnesses are caused by different infectious organisms, not by influenza viruses.

Signs and Symptoms. Typical symptoms of influenza include fever (usually 100°F to 103°F in adults, often higher in children); dry cough, sore throat, and runny or stuffy nose; headache; muscle aches; chills; and extreme fatigue.

Treatment. Antiviral medications can shorten the course of influenza, but only if medication is prescribed and taken within the first two days after the onset of the first symptoms. Medications to treat and alleviate symptoms may be prescribed, including pain relievers (analgesics) and fever reducers (antipyretics). Most people affected by the flu recover completely in one to two weeks, but some people develop serious and potentially life-threatening medical complications such as pneumonia.

The best defense against influenza is an annual influenza vaccination. Because there are many strains of influenza, the three most lethal strains are identified each year. This is accomplished through surveillance-based forecasts that are conducted throughout the year at influenza centers that have been established in 101 different countries. These centers focus on common strains and disease trends to establish which vaccines will be most effective against the most powerful strains for the upcoming influenza season. The patient who receives an influenza vaccination may succumb to other strains of influenza, but the immune system will be more efficient from having developed a defense against the strains in the vaccine. Health care workers, older adults, those who are immunosuppressed, and children have the highest risk of contracting this sometimes fatal disease and should be vaccinated every year.

Legionnaires' Disease

Legionnaires' disease is a type of lung infection caused by breathing in a mist of water that has been contaminated with the *Legionella* bacterium. This bacterium tends to thrive in stagnant water that is found in air conditioning units for large buildings, hot tubs, and showers. The disease came to be known as Legionnaires' disease, or legionellosis,

in 1976 after numerous attendees at an American Legion convention became ill in a Philadelphia, Pennsylvania, hotel. The microbe causing the illness was isolated, identified, and named. More than 40 different strains of the *Legionella* bacterium have since been identified.

Legionnaires' disease usually affects middle-aged or older adults and more commonly affects smokers or people with other respiratory problems. The disease is not transmitted via person-to-person contact, but rather through a direct exposure to the bacteria.

Signs and Symptoms. The symptoms of Legionnaires' disease generally start 2 to 10 days after exposure and infection. They include high fever with sweating, severe headache, shortness of breath, a productive cough, fatigue, and muscle aches and pains. In severe cases, other body systems may be affected, leading to diarrhea, vomiting, mental confusion, and kidney and liver damage.

Treatment. Treatment normally consists of administration of antibiotics that will fight the *Legionella* infection. In severe cases, oxygen therapy may be necessary to help with breathing difficulties. Also, fluid and electrolyte replacement might be indicated if the patient is dehydrated because of extreme illness. In the United States, *Legionella* is considered a reportable health condition. Therefore, out of concern for the safety of the general public, health care professionals follow appropriate reporting protocol when their patients are diagnosed with Legionnaires' disease.

Lung Cancer

Lung cancer affects the lung tissue (Figure 28-6). It is the leading cause of cancer deaths in both women and men in the United States and throughout the world. Smoking is the most significant factor in the development of lung cancer. About 90 percent of lung cancers occur in smokers or former smokers. The risk of developing lung cancer is related to the number of cigarettes smoked, the age at which a person started smoking, and how long a person has smoked (or smoked before quitting).

Another cause of lung cancer is secondhand smoke. An estimate from the Centers for Disease Control and Prevention states about 7,300 nonsmokers die each year from secondhand smoke. Other high-risk causes of lung cancer include exposure to asbestos and radon gas, excessive levels of air pollution, arsenic in drinking water, and exposure to certain carcinogens (cancer-causing agents) including cadmium, mustard gas, diesel exhaust, uranium, and coal products, to name a few.

There are two main types of lung cancer: nonsmall cell lung cancer (NSCLC) and small cell lung cancer (SCLC).



FIGURE 28-6 An X-ray image of lung cancer.

Small cell lung cancer is less common, accounting for only about 10 to 15 percent of total lung cancer cases, but is faster-growing and spreads much more quickly than nonsmall cell lung cancer.

Signs and Symptoms. The early stages of lung cancer can be asymptomatic (without symptoms). As the cancer progresses, patients experience a persistent cough, coughing up blood, shortness of breath, wheezing, chest pain, recurring lung infections (pneumonia or bronchitis), and excessive fatigue. Additionally, many patients experience decreased appetite and weight loss (without trying—that is, weight loss not caused by dieting or other deliberate attempts to lose weight). Symptoms of advanced stage cancer, as evidence of metastasis, includes bone pain, neurological changes, and jaundiced (a yellowish tint) skin or eyes.

Treatment. Treatment depends on the type of lung cancer and the stage at which it is diagnosed. The most widely used therapies for lung cancer are surgery, chemotherapy, and radiation therapy. Surgical treatments may include removal of a lobe of the lung (lobectomy), removal of a small segment of the lung, and the possibility of removing the entire lung (pneumonectomy).

Pertussis

Pertussis, or whooping cough, is a bacterial infection of the upper respiratory tract. It is characterized by intense and uncontrollable coughing spells. It is caused by *Bordetella pertussis*, a highly contagious bacterium that is spread through

airborne droplets. A vaccination is available for pertussis that is often first administered when an infant is 2 months old. The infant receives a combination vaccination to protect against pertussis, diphtheria, and tetanus in what is commonly referred to as the DTaP immunization. Even though there is an effective vaccination against pertussis, some people choose not to vaccinate their children for various reasons. If they decide against vaccination, their child may not be able to enter public schools. Because most children have been immunized, pertussis used to be very rare. Recently more cases of pertussis are arising in unvaccinated adults and children. Pertussis is a very serious condition. Infants afflicted with the disease may have permanent disability, and it could be fatal.

Signs and Symptoms. Signs and symptoms include a cough, runny nose, and a low-grade fever. Within two weeks of infection, breathing takes a turn for the worse and becomes difficult. Violent coughing develops that ends in a noise that sounds like a “whoop.” However, adults and infants under 6 months of age do not often have the “whooping” sound with their cough. During the intense coughing episodes, some patients may vomit or even lose consciousness for a short period of time. Infants also tend to experience episodes of choking.

Treatment. Antibiotics can be effective if pertussis is diagnosed early on. However, because of the severity of the disease and because decreased oxygen levels are common with the violent coughing spells, many infants and children are hospitalized and monitored. At the hospital, respiratory support including oxygen therapy, oxygen tents with high levels of humidity, IV fluids, and sedatives may be administered to promote healing and relieve symptoms.

Pleurisy

Pleurisy, or pleuritis, is an inflammation of the pleura (membrane that surrounds and protects the lungs). Pleurisy can result from a number of diseases and disorders including lower respiratory infections caused by viruses or bacteria such as pneumonia or tuberculosis; an injury to the chest; a pulmonary embolism; and disorders such as rheumatoid arthritis, lupus, and pancreatitis. Complications from heart surgery may also cause pleurisy.

Signs and Symptoms. The chief symptom of pleurisy is sudden, intense shooting or stabbing chest pain. More often than not, the pain is located directly over the area of inflammation. The pain is most severe with inhalation, whereas holding the breath often provides relief from the pain. Talking, coughing, and sneezing also produce intense pain. In

some cases the pain may be referred—that is, felt in other areas, such as the neck, shoulder, or abdomen.

Patients also display distinct respiratory signs including a shallow breathing pattern as a response to the pain. Cyanosis of the patient’s lips or nail beds may also occur as a result of severe breathing troubles and decreased oxygen intake.

Treatment. Pleurisy will not be cured unless the underlying disease or disorder is treated. However, pain associated with pleurisy is often treated using two routes. First, overall chest pain associated with breathing is controlled with the use of analgesics and antiinflammatory medicines. Also, codeine-based cough syrups are prescribed to help ease the pain associated with a painful cough. Pneumonia is a concern for patients with pleurisy as they are unable to clear chest congestion because coughing is too painful. When a patient begins to feel relief from pain, it is important for them to practice deep breathing and try to clear congestion by coughing.

Pneumonia

Pneumonia is an inflammation of the lung or lungs. The etiology of pneumonia is various as it can be caused by bacteria, viruses, fungi, or chemical irritants. The most common cause of bacterial pneumonia in the United States is *Streptococcus pneumoniae* (pneumococcus); the influenza virus is the most common cause of viral pneumonia. Individuals with weak immune systems and respiratory disorders are more prone to developing pneumonia.

Signs and Symptoms. Signs and symptoms include chest pain, especially when coughing, increased tiredness and fatigue, a cough that produces green mucus or pus-like sputum, muscle aches, fever, chills, and rapid and labored breathing. Diagnostic procedures including sputum cultures, and chest X-rays may be indicated to confirm diagnosis.

Treatment. Pneumonia is treated with fluids, rest, antibiotics (if the pneumonia is caused by bacteria), and nonprescription drugs for pain relief. Oxygen therapy and respiratory treatments can be administered to thin out and remove secretions as necessary. Cough medicines may be counterproductive, because they may inhibit the patient’s ability to cough and expel excessive sputum. Patients suffering from severe pneumonia may require hospitalization for careful monitoring and treatment. Prevention of pneumonia is ideally achieved with the administration of pneumococcal vaccines.

Pulmonary Edema

Pulmonary edema is a condition in which fluid accumulates in the alveoli of lungs. Often it is caused by inadequate pumping of the left ventricle of the heart, as seen with

congestive heart failure. Some other causes of pulmonary edema include but are not limited to heart attack, lack of oxygen supply to the heart muscle (ischemia), hypertension, pneumonia, kidney failure, and major injuries. Pulmonary edema can be a chronic condition; however, it can develop suddenly and become life threatening.

Signs and Symptoms. Signs and symptoms of pulmonary edema include shortness of breath brought on by activity; difficulty breathing in positions other than sitting upright; frothy bloody sputum containing pus; increased respirations; cold, clammy, cyanotic skin; leg swelling; decreased alertness; and increased anxiety.

Treatment. The overall treatment goal is to remove excessive fluid from the lungs. Often in severe cases emergency intervention is required. High levels of oxygen will immediately be administered while the patient sits in an upright position. Diuretics (which increase the excretion of water from the body) are often administered. Medications to improve heart function are also prescribed when heart failure is the underlying issue. When pulmonary edema stems from other issues, the underlying cause must be treated to prevent further pulmonary complications.

Pulmonary Embolism

A **pulmonary embolism (PE)** is a blood clot in the lung that occurs when a clot breaks away from the wall of a vein in the leg, pelvis, arm, or, sometimes, the right side of the heart and travels throughout the bloodstream. As it continues through the circulation, eventually it reaches the vessels of the lungs that continually become smaller and smaller. Finally, the clot becomes lodged in a vessel that is so narrow it cannot pass through (Figure 28-7). The wedged clot prevents blood flow to a section of the lung. Deprived of oxygen, that portion of the lung suffers an infarct (necrosis, or death, of the tissue), which is referred to as a pulmonary (or lung) infarct.

The risk of clot formation is higher when a person is immobilized because of illness, injury, or prolonged sitting, such as on an airplane or a long car trip. Immobility allows the blood to pool in the legs, providing an opportunistic environment for blood clot formation. Other factors that contribute to the risk are recent surgery, trauma or injury (especially to the legs), obesity, smoking, hormone replacement therapy and hormonal contraceptives (such as birth control pills), heart disease, burns, and a previous history of blood clots in the legs.

Signs and Symptoms. Shortness of breath is the most common symptom of pulmonary embolism, which is caused by

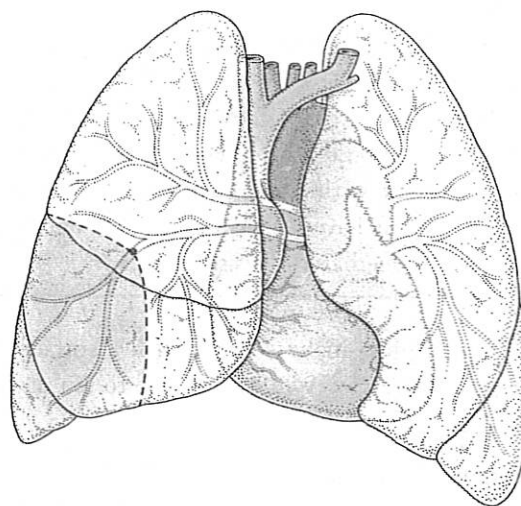


FIGURE 28-7 Pulmonary embolism. The purple shaded section shows the area of the lung that is dying from lack of blood supply caused by the embolism.

the sharp, stabbing pain that occurs when the patient tries to take a deep breath or cough. Other signs and symptoms that accompany a PE include rapid breathing and rapid heart rate; anxiety or apprehension; dry cough or coughing up mucus or blood; sweating; cyanotic lips and/or nailbeds; and low blood pressure resulting in loss of consciousness.

Treatment. Pulmonary emboli can be life threatening and are often treated in emergency care settings. Thrombolytics, which are clot-buster medications, are used to help dissolve the embolus. Blood-thinning medications are administered to prevent the formation of new clots, a process termed anticoagulation therapy. Warfarin and heparin are medications commonly used for this purpose. Oxygen therapy is initiated to assist with breathing. Medications to raise blood pressure levels may also be necessary, depending on the severity of the event.

Severe Acute Respiratory Syndrome

Severe acute respiratory syndrome (SARS) is a recently identified respiratory illness that first infected people in parts of Asia, North America, and Europe in early 2003. This new virus is known as SARS-CoV (severe acute respiratory syndrome coronavirus). It is possible that outbreaks of SARS are seasonal, appearing during winter months. The virus has been found in a catlike wild animal that is eaten as a delicacy in China. This has led experts to believe that SARS first developed in animals rather than humans.

SARS is a highly contagious illness spread via airborne droplets. During extensive research on the disease, it was found that the virus can remain alive for up to six hours after

JUDGMENT CALL

SARS (severe acute respiratory syndrome) was spread from China to North America by infected persons traveling by airplane. How can we control the entry of microbes into a country? What should China have done to prevent the spread of the disease within and outside China? Should the Chinese government have shared information about SARS with the world immediately in case it spread?

the airborne droplets make contact with a surface. Most patients begin to display symptoms three to ten days after becoming infected with the virus.

Signs and Symptoms. Shortness of breath, a dry cough, and difficulty breathing are key signs of SARS. Fevers greater than 100.4°F, muscle aches, headaches, fatigue, and chills are also common symptoms.

Treatment. Treatment of SARS usually consists of high doses of steroids to reduce inflammation of the lungs and oxygen therapy. More than two-thirds of patients infected with the virus require hospitalization for treatment. A patient with SARS is placed in isolation during treatment to prevent spread of the disease. Antiviral medications are also used, which are not able to cure the disease but help to treat the associated symptoms. In 2004, the World Health Organization (WHO) released a report indicating that about 1 out of 10 people who contract SARS are unable to survive the disease.

Sinusitis

Sinusitis is an infection or inflammation of the mucous membranes that line the inside of the nose and the sinus cavities. When a mucous membrane becomes inflamed, it swells, blocking the drainage of fluid from the sinuses into the nose and throat and causing pressure and pain in the sinuses. Sinuses that do not drain properly are more vulnerable to bacterial and fungal growth.

Sinuses can become blocked during a viral infection such as a cold, and sinus inflammation and infection can develop as a result. Sinusitis also is caused by abnormal tissue growth in the nose (nasal polyps), which hinders drainage; deviated septum; trauma to the face, which could result in blockage and drainage issues; allergies; and bacterial infections.

One key distinction between a cold and sinusitis is that cold symptoms begin to improve within five to seven days. Sinusitis symptoms last longer and worsen after seven days. There are two types of sinusitis: acute (sudden) and chronic (long term). Acute sinusitis clears up within four weeks; chronic sinusitis may last for three months or longer.

Professionalism



Teamwork is one of the most important aspects of working in the medical field. Always remember that no matter how different the personalities of staff members are, each member's purpose is to help the patients. Learn your own strengths and the strengths of your teammates so that work can be fairly divided and so that each team member can take on responsibilities at which they excel. This helps the team to be more successful. If everyone is working for the benefit of the team, then the whole team will succeed.

Signs and Symptoms. Pain and pressure in the face surrounding the sinus cavities, a stuffy or runny nose, and greenish or yellow nasal discharge are the main symptoms of sinusitis. Sore throat, postnasal drip, and a cough that worsens at night are also common. Other common signs and symptoms, which may seem unusual, include bad breath, tooth pain, and a decreased sense of smell.

Treatment. Medications most commonly used to treat sinusitis include a combination of antibiotics, decongestants, analgesics, corticosteroids, and mucolytics. This combination is used because the goals of treatment are to thin mucus and promote drainage, reduce sinus swelling, alleviate pain and pressure, eliminate infection, and avoid permanent damage to the tissues lining the nose and sinuses. Length of treatment with medications ranges from three days to several weeks or longer. Home remedies to alleviate symptoms include moist heat application to the face, steam baths, increased rest and fluid intake, and using a humidifier in the home to eliminate dry air.

Tuberculosis

Tuberculosis (TB) is a contagious disease caused by the bacterium *Mycobacterium tuberculosis*. The bacteria are spread when infected droplets are inhaled. These infected droplets are expelled from their infected host through talking, laughing, singing, coughing, sneezing, and spitting. TB bacteria are most commonly found in the lungs, where they produce granulomas (granular tumors), but they can be found elsewhere in the body. Individuals who are immunosuppressed, such as those with HIV/AIDS, infants, older adults, diabetics, and individuals receiving chemotherapy have the highest risk of developing TB. Health care workers are often required to be tested for TB, because they are in contact with high-risk population groups. TB is a disease that requires mandatory reporting to local health departments.

TB may be considered inactive in patients who carry the bacteria but do not have signs or symptoms. A patient with inactive TB is not considered to be contagious to others.

Signs and Symptoms. Signs of active tuberculosis include a long lasting cough, hemoptysis, and night sweats. Other signs and symptoms can include fatigue, chills, weakness, pain when coughing and sometimes simply breathing, and loss of appetite (anorexia). Those with advanced TB may have clubbing (enlargement of the ends) of the fingers and toes.

The Purified Protein Derivative (PPD) skin test, also known as the Mantoux tuberculin skin test, is done to check if an individual has ever been exposed to the tuberculosis bacterium and if it is lying dormant; however, this test does not indicate whether the person has an active case of TB. Active TB can be diagnosed only by a chest X-ray and sputum cultures.

Treatment. Treatment of this disease is long term, as it usually takes 9 to 12 months to eradicate the bacteria. The first period requires that the patient take respiratory precautions to prevent the spread of the bacteria; patients may be ordered to practice isolation and stay homebound or hospitalized to prevent the spread of infection. Multidrug therapy is used to kill the bacteria. Four antibiotics that are taken at the same time—usually rifampin, isoniazid, pyrazinamide, and ethambutol—are used to begin eradication of the bacteria.

After the patient shows negative sputum cultures, antibiotic treatment must continue for another four to seven months to prevent the development of multidrug-resistant TB, which is more difficult to treat. The total treatment time is determined by the physician and requires the patient to strictly follow the medications as prescribed for a successful outcome.

SUMMARY

The respiratory system is divided into the upper respiratory system and the lower respiratory system. The upper system includes the nose, paranasal sinuses, and pharynx. The lower respiratory system includes the larynx, trachea, bronchi, bronchioles, alveoli, and lungs. The entire system is lined with mucous membranes and cilia, which serve a protective function. Through the lungs, carbon dioxide is expelled (exhalation) and oxygen is drawn in (inhalation). Multiple disease processes can result from infection and inflammation within the system. Among the often debilitating diseases of the respiratory system are asthma, chronic obstructive pulmonary disease, hay fever, pleurisy, and lung cancer. Microbes cause the common cold, influenza, Legionnaires' disease, pertussis, pneumonia, some sinusitis, severe acute respiratory syndrome, and tuberculosis. Pulmonary edema and pulmonary emboli can also cause severe damage if not promptly and properly treated.

28 CHAPTER REVIEW

COMPETENCY REVIEW

1. Define and spell the terms for this chapter.
2. List the organs of the respiratory system.
3. What is the primary function of the respiratory system?
4. Which two gases are exchanged in the lungs?
5. What are the five functions of the nose?
6. What are the functions of the pharynx?
7. What is the function of the epiglottis?
8. Describe the bronchi. What are the differences between the left and right bronchi?
9. What are the alveoli?
10. Why is immobility a risk factor for developing an embolism?

PREPARING FOR THE CERTIFICATION EXAM

1. What organ is shared by both the respiratory and digestive systems and connects the nose, mouth, and voice box?
 - a. pharynx
 - b. nares
 - c. trachea
 - d. bronchi
 - e. epiglottis