CHAPTER 9

The Respiratory System

Of all the body systems, the respiratory system is most exposed to damage from the environment. Here the oxygen taken into the lungs is transferred to the blood, and carbon dioxide is released from the lungs. It is extremely difficult to separate age-related changes in the lungs from environmental or outside insults such as pollution, smoking, diseases, or infections. Symptoms such as breathlessness or fatigue may be attributed to getting older when in reality they are sometimes caused by unrecognized diseases. Assessment, treatment, and outcome of respiratory diseases are closely linked to the health practitioner's knowledge of age-related changes, the effects of the environment, and relevant lifestyle issues.

STRUCTURES OF THE RESPIRATORY SYSTEM

Structures involved in the respiratory system are as follows:

1. The various air passageways, including the nasal cavities, mouth, pharynx, larynx, trachea, bronchi, and bronchioles
2. The lungs, which contain the tiny air sacs, (alveoli) and alveolar ducts

Air Passageways

Air enters the body primarily through the nasal cavities, where it is warmed, moistened, and filtered by the mucous membranes in the nose. Air may also enter through the mouth. Either way, incoming air enters the pharynx, a funnel-shaped passageway connected to the larynx. Seven cavities or tubes open into the pharynx: the mouth, trachea, esophagus, two nostrils, and two pharyngotympanic tubes (formerly called the Eustachian tubes) from the ears. The pharynx has three divisions: nasopharynx, oropharynx, and laryngopharynx. The tonsils are located near the pharynx and serve to help protect these cavities against bacterial infection.

Passing through the pharynx, air enters the larynx (or voice box). The larynx is about 2 inches long and contains vocal cords, which produce the voice. When food is being propelled through the pharynx, the opening of the larynx (the glottis) is closed by the reflex action of the epiglottis (a thin lid of fibrocartilage) to prevent food or liquids from entering the trachea (the windpipe). Anatomically, the larynx is composed of nine cartilages bound together by an elastic-like membrane. One of the cartilages, the thyroid cartilage, is ordinarily more prominent in men than in women and is referred to as the "Adam's apple." During puberty, the larynx becomes larger in males and the vocal cords become longer and thicker, causing men to have deeper voices than women. Human voice quality, with all its variations and complexities, involves not only the larynx but the pharynx, nasal cavities, mouth, teeth, and tongue; the resonating chambers in the head (sinuses); and the learned ability to control the inhalation and exhalation of air.

Extending downward from the larynx is the trachea, about 4 inches long and 1 inch in diameter. Situated in front of the esophagus, it is composed of elastic tissues and from 16 to 20 C-shaped cartilaginous rings. Hairlike projections called cilia line the trachea and help to push mucus containing debris and dust particles up toward the pharynx. The trachea, which is elastic and flexible, stretches when one breathes in and recoils when one breathes out, but the cartilage rings prevent it from collapsing and cutting off the air supply to the lungs.

Upon entering the chest region, the trachea divides into left and right bronchi (smaller tubes) leading into the lungs. The bronchi continue to divide into smaller and smaller tubes until, at about 1 millimeter in diameter, they become tiny elastic tubes called bronchioles. Bronchioles branch into even smaller alveolar ducts leading to many alveoli (air sacs). The tiny alveoli in the lungs are covered with many pulmonary blood capillaries where exchange of gases between alveoli and blood takes place. It is here that carbon dioxide, a waste product, is removed from the blood and a fresh supply of oxygen is picked up by the hemoglobin in the blood to be delivered to the heart and then to body tissues for immediate use. To summarize, the bronchial tree is composed of a series of tubes that become progressively smaller until they end in a network of alveoli surrounded by blood capillaries. The life-sustaining carbon dioxide–oxygen exchange occurs in the alveoli.

The Lungs

The two lungs, the major organs of respiration, are soft, spongy, elastic tissue able to change shape during respiratory movements. Located in the thoracic cavity (the chest), they are somewhat cone shaped. The top, or apex, of each lung extends into the base of the neck, and the lower part rests on the diaphragm, a large muscle forming the partition between the thoracic and abdominal cavities. The left lung is divided into two lobes because the heart is located on the left side, whereas the right lung has three lobes.

Each lung is enclosed in a thin, double-layered membrane called the pleura. Pleural fluid is found between the layers and creates an adhesive force that holds the lungs close to the thorax wall. Negative pressure in the pleura, along with positive pressure equal to atmospheric pressure in the lungs themselves, allow the lungs to expand and recoil as the size of the chest cavity increases and decreases (see Fig. 9.1).

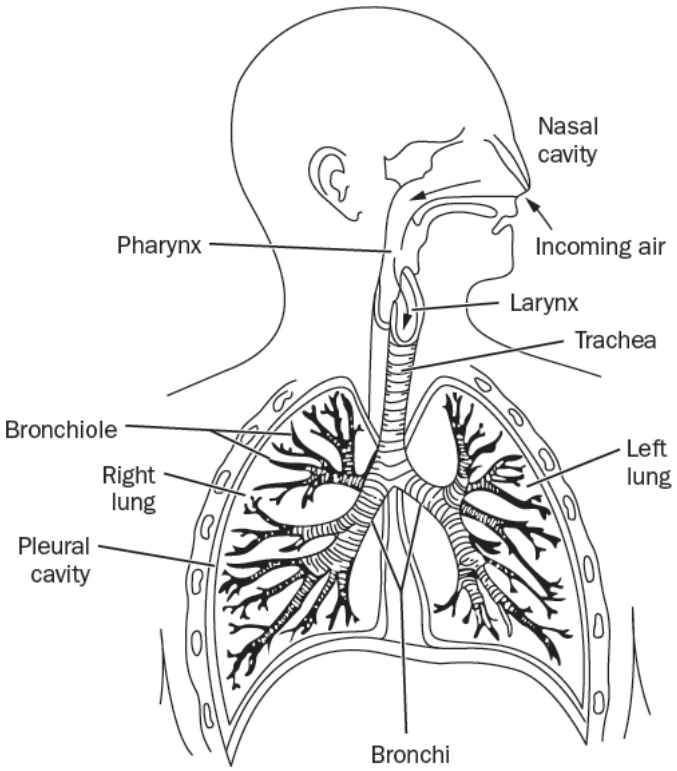

Figure 9.1. Respiratory system.

FUNCTIONS OF THE RESPIRATORY SYSTEM

Breathing

Movements of the respiratory muscles allow for changes in the size of the chest or thoracic cavity and make breathing possible. During inspiration (inhalation), for example, the size of the chest is increased by the contraction and flattening of the diaphragm and contraction of the ribcage muscles, which causes the ribs to move upward and forward. As a result, chest capacity or volume increases, pressure within the lungs decreases, and air is sucked in. As the respiratory muscles relax, the diaphragm resumes its normal dome shape, the ribs move back to resting position, and chest volume (size) decreases. As the size of the chest cavity becomes smaller, pressure in the lungs increases and air is forced out (expiration or exhalation). Breathing thus is not a function of the lungs alone but also is due to the action of diaphragm and ribcage muscles. The lungs are not muscular tissues but act more like balloons subject to pressure differences between the lung cavity in the body and atmospheric pressures outside the body. They are sometimes compared with a bellows in action.

Respiration rate is essentially under involuntary control by brain centers in the medulla and pons (at the base of the brain), although it is also subject to substantial voluntary control mediated by the cerebral cortex. We cannot voluntarily breathe while swallowing, though, because of a powerful reflex that prevents food or liquids from passing down the trachea to the lungs instead of down the esophagus to the stomach. When this reflex is interfered with in any way, we choke. Another strong reflex regulating breathing is controlled essentially by carbon dioxide levels in the blood. When the amount of carbon dioxide exceeds a certain level, we are forced to breathe. The carbon dioxide level in the blood, then, controls breathing more than the level of oxygen in the blood. Other nonbreathing processes such as coughing, sneezing, hiccupping, crying, laughing, and yawning also move air in and out of the lungs (Marieb & Hoehn, 2013).

External and Internal Respiration

Each day the intact respiratory system exchanges about 2,600 gallons of oxygen from the air with carbon dioxide from the blood. This exchange, which takes place in the lungs, is called external respiration. The exchange in the body cells of oxygen from the blood and carbon dioxide from the tissues constitutes internal respiration. Body cells are highly dependent on a constant supply of oxygen for metabolism and on the regular pickup and excretion of carbon dioxide, a major waste product of the body’s metabolic processes. Because body cells and tissues are unable to store any significant amount of oxygen over time, a new supply must be delivered continuously to all tissues of the body via the hemoglobin in the bloodstream. Cells die rapidly without oxygen. This process is infinitely more complicated than this brief description implies.

AGE-RELATED CHANGES IN THE RESPIRATORY SYSTEM

Age-related changes in the respiratory system are often indistinguishable from changes in the system arising from such factors as air pollution, occupational hazards, smoking, and other lifestyle and environmental factors. Respiratory efficiency, though, does decrease with age.

Specific age-related changes identified in this system include the following:

1. Calcification of the laryngeal and tracheal cartilage occurs, resulting in a stiffening of those structures. The number of cilia and their activity in the bronchial mucosa is reduced. Glandular cells in the large airway are reduced, resulting in decreased production of protective mucus to help ward off respiratory infections (Tabloski, 2014). The cough reflex is blunted, causing decreased effective coughing. Because coughing is beneficial in clearing the upper airway of small or large particles, there is a greater risk of choking or aspirating materials into the lungs, possibly resulting in aspiration pneumonia. Because there are fewer nerve endings in the larynx, the gag reflex may also be less efficient and older adults may then be prone to develop respiratory tract infections.
2. The actual number of alveoli do not change significantly with age, but their structure is altered. With age, the number of functional alveoli decreases as alveolar walls thin, alveoli enlarge, and fewer blood capillaries are available for gas exchange. Overall, there is a decrease in the surface area available for oxygen–carbon dioxide exchange (Davies & Bolton, 2010; Linton, 2007).
3. *Presbylaryngis* refers to aging changes in voice pitch caused by thinning or aging of the vocal cords. This results in a higher, reedy voice that is difficult to hear and requires more effort for an older adult to produce. If needed, voice therapy may help older adults learn to speak with greater breath support. Greater variability in the pitch of the voice occurs more often in older individuals in poor health. Breathiness in speech can also result from less air reaching the throat, incomplete closure of the glottis, or decreased joint mobility of the jaw (Jett, 2012).
4. Skeletal changes such as calcification of the costal (rib) cartilages, osteoporosis, and weakened respiratory muscles all affect respiratory functioning. Kyphosis (humpback), scoliosis (lateral spinal curvature, S-shaped), a shortened thorax, and chest wall stiffness all contribute to limiting chest expansion and reducing effective ventilation. The resulting greater dependence on the use of the diaphragm in breathing requires increased energy expenditure and promotes fatigue.
5. The muscles responsible for inhalation and exhalation lose strength and endurance as a part of the aging process, and there is increased stiffness of the chest wall. Because these muscles are primarily responsible for increasing and decreasing the size of the thoracic cavity, age-related muscular changes are extremely important in regulating the amount of air actually in the lungs (Aldwin & Gilmer, 2004; Davies & Bolton, 2010).
6. The lungs decrease in size, become flabbier, and decrease in weight (Miller, 2009). They have less elastic recoil because the elastic fibers decrease, and there is an increase in cross-linked collagen. Forced vital capacity, or the maximum amount of air that can be expelled from the lungs after a full inspiration, is diminished somewhat in older age. In addition, residual volume, the amount of air left in the lungs after a forced expiration, increases (Linton, 2007; Rees, 2013). The alveolar ducts and alveoli become enlarged, leading to decreased efficiency of the oxygen–carbon dioxide exchange.
7. The decreased effectiveness of the oxygen–carbon dioxide exchange causes increased levels of carbon dioxide and decreased levels of oxygen in the blood, predisposing the older adult to a lower oxygen supply available to vital organs in acute respiratory conditions and perhaps also to increased incidence of sleep disorders.

Overall, with age less oxygen is delivered to body cells and consequently there is a lessened reserve capacity in the respiratory system when dealing with high-demand situations. These changes contribute to the greater fatigability of most older persons. Many factors contribute to lung degeneration and disease. Cigarette smoke, both active and secondhand, causes reduced ciliary action, inflammation of the respiratory tract, constriction of the bronchioles, and reduced breathing capacity. The air breathed into the lungs contains irritating and toxic gases from cigarette smoke, as well as gases such as carbon monoxide, nitrogen dioxide, and hydrogen cyanide. A smoker's forced expiratory volume (the amount of air that can be

expelled forcefully) declines at double and triple the rate of nonsmokers. Smoking increases the risk of developing chronic debilitating or fatal diseases such as cancer of the larynx or lung, chronic obstructive pulmonary disease, and other serious lung infections as well as cardiovascular, urinary, and other organ system dysfunctions (Eliopoulos, 2014; Miller, 2009).

Other risk factors for respiratory difficulties include environmental hazards such as pollution in the environment and in the workplace, immobility, and the presence of chronic diseases that predispose an individual to lung problems. The use of feeding tubes and the aspiration of food or liquids could also lead to pneumonia. Age-related changes in the skeletal and muscular systems, obesity, and immobility decrease breathing effectiveness and increase the likelihood of developing respiratory infections and impaired lung function. Some medications may also increase the risk of respiratory impairment.

AGE-RELATED DISORDERS OF THE RESPIRATORY SYSTEM

Chronic Obstructive Pulmonary Disease

Chronic obstructive pulmonary disease (COPD) is a classic disease of older individuals because it may very likely result from age-related changes, disease processes, and lifestyle. *COPD* refers to a group of diseases in which there is (a) reduced flow of air in and out of the respiratory system; (b) excessive secretions of mucus within the airways; (c) chronic infection; (d) an increase in the air spaces beyond the terminal bronchioles, with an accompanying loss of the alveolar walls; (e) decrease in recoil ability (elasticity) of the lungs; and (f) narrowing of the bronchi as a result of factors such as allergies. Included in COPD are chronic bronchitis and pulmonary emphysema. Older individuals often have a combination of COPD diseases. Asthma is sometimes included in COPD, and it occurs more often in older adults than previously recognized.

COPD ranks as the third leading cause of death in the United States, with the death rates for women exceeding the death rates for men (Tabloski, 2014). COPD not only leads to respiratory impairment but also to work disability and hospitalization, placing a tremendous economic burden on individuals, families, and society. The major risk factor in the development of COPD is smoking (more than 80% are smokers) and exposure to secondhand smoke. It should be noted that some of the damage to the respiratory system is reversible in the individual who stops smoking, no matter what the person’s age. Actual lung damage caused by emphysema, though, cannot be remedied significantly. Other factors contributing to COPD are a genetic risk factor, air pollution, lower socioeconomic status, infections, and occupational exposure to toxic materials.

An early symptom is an intermittent cough, usually in the mornings. Later, labored or difficult breathing (dyspnea) is characteristic, mostly during exertion, but dyspnea is progressive and eventually occurs at rest as well. Wheezing and increased sputum production are also common in COPD. Often those with advanced COPD experience anorexia and weight loss. Unfortunately, commonly about 50% of lung function is lost before definite symptoms appear and the individual seeks medical care (Jett, 2012).

Diagnosis is made with a thorough medical history, physical examination, sputum studies, pulmonary functioning studies, scans, x-ray examination, measurement of arterial blood gases, and other blood tests. Treatment begins by removing the individual from irritants such as cigarette smoke and pollution. Bronchodilators also may help to relieve breathing difficulties so prevalent in these individuals. Corticosteroids in aerosol form (inhalers), anticholinergics, beta-adrenergic drugs, antibiotics, respiratory therapy, diaphragmatic or pursed-lip breathing, oxygen, proper nutrition, and appropriate exercise are also often prescribed. For some patients, surgical treatment called lung volume reduction surgery may help, but it is only used in severe cases of COPD (Workman, 2013b). It is recommended that those with COPD take the vaccine for pneumonia and be given a yearly influenza vaccination. Most necessary is the complete cessation of smoking by those who have this disease. Psychological support is of utmost importance because COPD is usually present for the rest of one’s life. Pulmonary

rehabilitation centers have comprehensive programs to meet the physical and psychosocial needs of the individual and his or her significant others. Most involve exercise training, breathing retraining, education about the disease, medication information, nutrition information, and smoking cessation (Hendrix, 2011). Such interventions have proven to be very helpful in managing and coping with these difficult and frightening diseases.

Chronic Bronchitis

An estimated 9.9 million Americans have chronic bronchitis (Tabloski, 2014). Defined as a recurrent, persistent cough with excessive mucus secretions for at least 3 months per year for 2 consecutive years, or for 6 months during 1 year, chronic bronchitis is an inflammation of the bronchi with small airway obstruction caused by hypersecretion of mucus and the presence of edema. This interferes with the flow of air in and out of the lungs. The more years a person has smoked, the greater the likelihood of having chronic bronchitis. However, it may also be caused by other irritants. Treatment includes rest, use of cough suppressants, acetaminophen for pain, and humidification of the air. Antibiotics may be used to prevent the bronchitis from progressing to pneumonia (Tabloski, 2014). Chronic bronchitis often coexists with emphysema and in many instances it is difficult to distinguish between them.

Emphysema

It is estimated that more than 4.3 million people in the United States have emphysema. Emphysema is defined as an enlargement and destruction of alveolar walls in the lungs. The lungs lose their ability to stretch and relax, thus remaining partially filled with stale, oxygen-poor air. The flow of air is impeded during breathing as the alveolar walls are gradually destroyed and air spaces expand. Often mucus and infected material pool in these structures, causing coughing, sputum production, infection, and greatly increased effort to breathe. The disease usually progresses, especially if individuals continue to smoke, and they experience lethargy, weight loss, weakness, and respiratory acidosis (excessive acidity of body fluids) as a result of decreased oxygen in the body. The incidence of emphysema increases with age, and by age 90 most individuals are likely to have some signs of the disease. Smoking is a major initiating factor; other factors of importance are secondhand smoke, air pollution, allergies, poor nutrition, and alcohol consumption. Patient education to learn to deal as effectively as possible with this disease is very important.

Pulmonary Tuberculosis

Tuberculosis (TB) is an infectious disease transmitted by inhalation of the microorganisms causing tuberculosis that may attack any organ of the body but usually develops in one or both lungs. Twenty-five percent of all those identified with tuberculosis are age 65 or older. In the United States, people at greatest risk for TB are those in frequent contact with an untreated person; those with decreased immune function or HIV; those who live in crowded areas such as long-term care facilities (the incidence rate among nursing home residents is two to seven times higher than in those living in other settings), mental health facilities, or prisons; older homeless people; those who abuse injection drugs or alcohol; lower socioeconomic groups; and some foreign immigrants (Workman, 2013a). Often tuberculosis in older adults is not a new infection but a reactivation of a long-dormant TB infection. Predisposing factors for reactivation include smoking, alcohol abuse, reduced immune system efficiency, long-term corticosteroid therapy, type 1 (insulin-dependent) diabetes, and malnutrition (Miller, 2009). As the immune system of those previously infected with tuberculosis declines with aging, inactive tuberculosis often becomes an active disease.

The older person with TB may merely feel tired without exhibiting a cough or other respiratory signs. However, other common signs of the disease are weight loss, malaise, night sweats, low-grade fever that lasts for months, cough, and depression. The sputum is often green or yellow and may be blood streaked. Shortness of breath and dull chest pain may also be present (Marieb & Hoehn, 2013). Symptoms develop slowly in older adults, and the disease is often misdiagnosed and far advanced before it is identified. Skin testing is the most common diagnostic tool, followed by other procedures such as chest radiographs, CT scans, and isolating the organism from sputum or tissue analysis if skin tests are positive. A quick test for TB has now been approved by the World Health Organization in which results are available in about 2 hours (Workman, 2013a). As for treatment, special care should be taken to identify and treat tuberculosis in nursing home settings before the disease spreads to other residents. Various drug regimens, especially antibiotics, infection control, and patient education are recommended to treat tuberculosis.

Pneumonia

Pneumonia is an inflammation of the lungs caused primarily by bacteria, viruses, or chemical irritants. Bacterial pneumonia is most common in older adults and leads all the infectious diseases causing death in this age group. Those most susceptible have chronic diseases such as COPD, cardiovascular disease, diabetes mellitus, and alcoholism. Most bacterial pneumonias develop from breathing in disease-causing bacteria that have survived for some time in the oropharynx.

Rather than the typical symptoms of difficulty breathing, chest pain, fever, chills, and productive cough, older adults with pneumonia often have weakness, confusion, lethargy, poor appetite, rapid breathing, mild fever, and lower heart rate (Miller, 2009; Workman, 2013a). The most common type of nosocomial pneumonia (pneumonia acquired in a hospital) in older adults is streptococcal pneumonia, with a 20% to 30% death rate. Individuals older than 60 have a two to three times higher risk of developing nosocomial pneumonia, especially if they have had surgery, diagnostic procedures, mechanical ventilation therapy, or tube feedings. Viral influenza pneumonia, with a fatality rate of about 50%, is common in older adults as well. Pneumonia can also be caused by the aspiration of fluid or food particles into the lungs, and older adults are more susceptible because of less efficient gag and cough reflexes. Pneumonia typically is diagnosed through x-ray examinations and sputum specimen studies. Abnormal lung sounds may also be present. Treatment includes the use of antibiotics, respiratory therapy, and rest. Vaccinations for pneumonia are recommended for everyone older than age 65, especially if the individual has an accompanying chronic illness. In addition, yearly influenza vaccinations are highly recommended for older adults.

Lung Cancer

Lung cancer is the primary cause of cancer death for both men and women in North America. Today in the United States more people die of lung cancer than any other cancer (Tabloski, 2014). About 20% of those diagnosed with lung cancer are older than age 70. Eighty-five to ninety percent of all lung cancers are correlated with smoking, but other causative factors include asbestos exposure, occupational hazards, dust, and chronic lung damage.

Early symptoms include cough, difficulty breathing, blood in the sputum, weight loss, and frequent lung infections. More bothersome symptoms often occur later, when the possibility of cure is drastically reduced. Too often lung cancer remains undetected until it has spread and hope for cure is minimal; thus the cure rate for this type of cancer is low, with most people dying within 1 year of diagnosis (Marieb & Hoehn, 2013). Removal of the affected lung is the most effective treatment, but often the cancer has spread beyond the lungs before it is diagnosed. Chemotherapy and radiation, then, are the other available treatment choices, and they have only moderate success rates. New therapeutic approaches becoming more common for later-stage lung cancer include antibodies that may disrupt the cancer cell division, cancer vaccines to stimulate the immune

system, gene therapy to replace defective genes that cause tumor cells to divide continuously, and photodynamic therapy to remove smaller bronchial tumors accessible by bronchoscopy (Marieb & Hoehn, 2013).

PREVENTION OF RESPIRATORY DISEASE

The first line of defense in preventing respiratory disease is to maintain good health by drinking 1.5 to 2 quarts of fluid each day and eating a well-balanced diet. Annual physical examinations can help to detect health problems early and thus initiate treatment in time to be maximally effective. It is imperative that individuals stop smoking because smoking (and being exposed to secondhand smoke) is a major cause of lung diseases. Smoking-cessation programs and the use of the nicotine patch, pill, or newer medications are quite effective but do require motivation and social support. Avoiding respiratory infections is especially important for those with respiratory disease. The pneumonia vaccine is recommended to help prevent individuals from contracting various types of pneumonia. Because influenza is often accompanied by bacterial pneumonia, a yearly influenza vaccination is also advisable. A regular exercise regimen will help maintain and improve lung functioning and is extremely important in older age.

SUMMARY

Even though age-related changes do occur in the respiratory system, they usually do not handicap older adults significantly in the performance of normal daily activities unless disease, strain, or stress is imposed on the system. As is true in so many of the body systems, most people have enough reserve capacity to be able to tolerate some degree of reduced organ efficiency without producing substantial or even noticeable limitations.

Those who have a respiratory disease, however, may be weak and short of breath, resulting in fear, anxiety, and an inability to participate in activities of daily living. Because chronic lung conditions are often increasingly disabling as they progress, the need for continued health monitoring and for caregivers places considerable stress on the family and finances. The American Lung Association offers substantial assistance with physical needs and also provides individual and group therapy. For most people, adequate respiratory efficiency may be retained well into older age by regular systematic exercise and general physical fitness. Stress situations accentuate the reduced efficiency of the aging body, whereas exercise and physical fitness at least partially offset the effects of aging.

REFERENCES

Aldwin, C. M., & Gilmer, D. F. (2004). *Health, illness, and optimal aging*. Thousand Oaks, CA: Sage.

Davies, G., & Bolton, C. (2010). Age-related changes in the respiratory system. In H. Fillit, K. Rockwood, & K. Woodhouse (Eds.), *Brocklehurst's textbook of geriatric medicine and gerontology* (7th ed., pp. 97–100). Philadelphia, PA: Saunders Elsevier.

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

Hendrix, T. (2011). Respiratory function. In S. Meiner (Ed.), *Gerontological nursing* (4th ed., pp. 432–461). St. Louis, MO: Mosby Elsevier.

Jett, K. (2012). Physiological changes. In T. A. Touhy & K. Jett (Eds.), *Ebersole & Hess' toward healthy aging* (8th ed., pp. 44–61). St. Louis, MO: Mosby Elsevier.

Linton, A. (2007). Respiratory system. In A. Linton & H. Lach (Eds.), *Matteson & McConnell's gerontological nursing* (3rd ed., pp. 353–405). St. Louis, MO: Saunders Elsevier.

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

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

Rees, H. (2013). Assessment of the respiratory system. In D. Ignatavicius & L. Workman (Eds.), *Medical–surgical nursing* (7th ed., pp. 543–563). St. Louis, MO: Saunders Elsevier.

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

Workman, L. (2013a). Care of patients with infectious respiratory problems. In D. Ignatavicius & L. Workman (Eds.), *Medical–surgical nursing* (7th ed., pp. 640–661). St. Louis, MO: Saunders Elsevier.

Workman, L. (2013b). Care of patients with noninfectious lower respiratory problems. In D. Ignatavicius & L. Workman (Eds.), *Medical–surgical nursing* (7th ed., pp. 600–639). St. Louis, MO: Saunders Elsevier.