CHAPTER 30

Acute Respiratory Disorders

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Objectives

After reading and studying this chapter, you should be able to:

1. Identify data to be collected in the nursing assessment of the patient with a respiratory disorder.
2. Identify the nursing implications of age-related changes in the respiratory system.
3. Describe diagnostic tests or procedures for respiratory disorders and nursing interventions.
4. Explain nursing care of patients receiving therapeutic treatments for respiratory disorders.
5. For selected respiratory disorders, describe the pathophysiology, signs and symptoms, complications, diagnostic measures, and medical treatment.
6. Assist in developing a nursing care plan for the patient who has an acute respiratory disorder.

Key Terms

Be sure to check out the bonus material on the Student CD-ROM, including selected audio pronunciations.

atelectasis (ă-tē-LĔK-tă-sĭs, p. 514)
crackles (KRĂK-ŭlz, p. 514)
dyspnea (DĬSP-nē-ă, p. 511)
hemothorax (hē-mō-THŌ-răks, p. 544)
hypercapnia (hī-pĕr-KĂP-nē-ă, p. 538)
hypoxemia (hī-pŏk-SĒ-mē-ă, p. 524)
hypoxia (hī-PŎK-sē-ă, p. 513)
orthopnea (ŏr-thŏp-NĒ-ă, p. 511)
pneumothorax (nū-mō-THŌ-răks, p. 514)
rhonchus (*pl.* rhonchi) (RŎNG-kăs, RŎNG-kī, p. 514)
tachypnea (tăk-ĭp-NĒ-ă, p. 528)
tissue perfusion (pĕr-FŪ-zhŭn, p. 547)

Respiration is basic to life. The respiratory system provides fuel for bodily activities and energy to sustain life. Respiration is defined as the exchange of oxygen (O_2) and carbon dioxide (CO_2) through the inspiration of air from the atmosphere and the expiration of air from the lungs. The function of the respiratory system is to supply oxygen for the metabolic needs of the cells and to remove carbon dioxide, one of the waste products of cellular metabolism.

ANATOMY AND PHYSIOLOGY OF THE RESPIRATORY SYSTEM

ANATOMY OF THE RESPIRATORY SYSTEM

To reach the lungs, air must travel through several passages, including the nose, mouth, pharynx, larynx, trachea, and bronchi (Fig. 30-1). Each passage has an effect on the quality of the air that reaches the lungs.

Nose

The nose includes the external nose, the part that is seen on the face, and the nasal cavity, which lies over the roof of the mouth. The external nose is made up of bones and cartilage that are covered with skin. The inside lining of the external nose consists of thick mucous membranes and small hairs. The mucous membranes also line the nasal cavity along with the cilia, which are small, hairlike projections.

The mucous membranes warm and moisten the air that enters the nose. If the air is not warmed as it enters the body, the tissue lining the respiratory tract functions poorly. The mucous membranes, the hairs in the external nose, and the cilia filter out dust particles and bacteria from the air. These cilia wave back and forth approximately 12 times per second to help the mucus clean the air. Air that enters via the nose is warmed and filtered, whereas air that enters via the mouth is not.

Pharynx

The pharynx, or throat, is a 5-inch tube extending from the back of the mouth to the esophagus. It is divided into three parts: nasal, oral, and laryngeal. The nasopharynx lies behind the nose, the oropharynx lies behind the mouth, and the laryngopharynx lies behind the larynx. The pharynx serves as a passage for both the respiratory and the digestive systems. It also has an important function in the formation of sounds, especially vowel sounds. The tonsils are located in the pharynx and may interfere with breathing, particularly nasal breathing, if they become enlarged. In addition, speech may have a nasal sound.

Larynx

The larynx, or "voice box," is the air passage between the pharynx and the trachea. It contains vocal cords

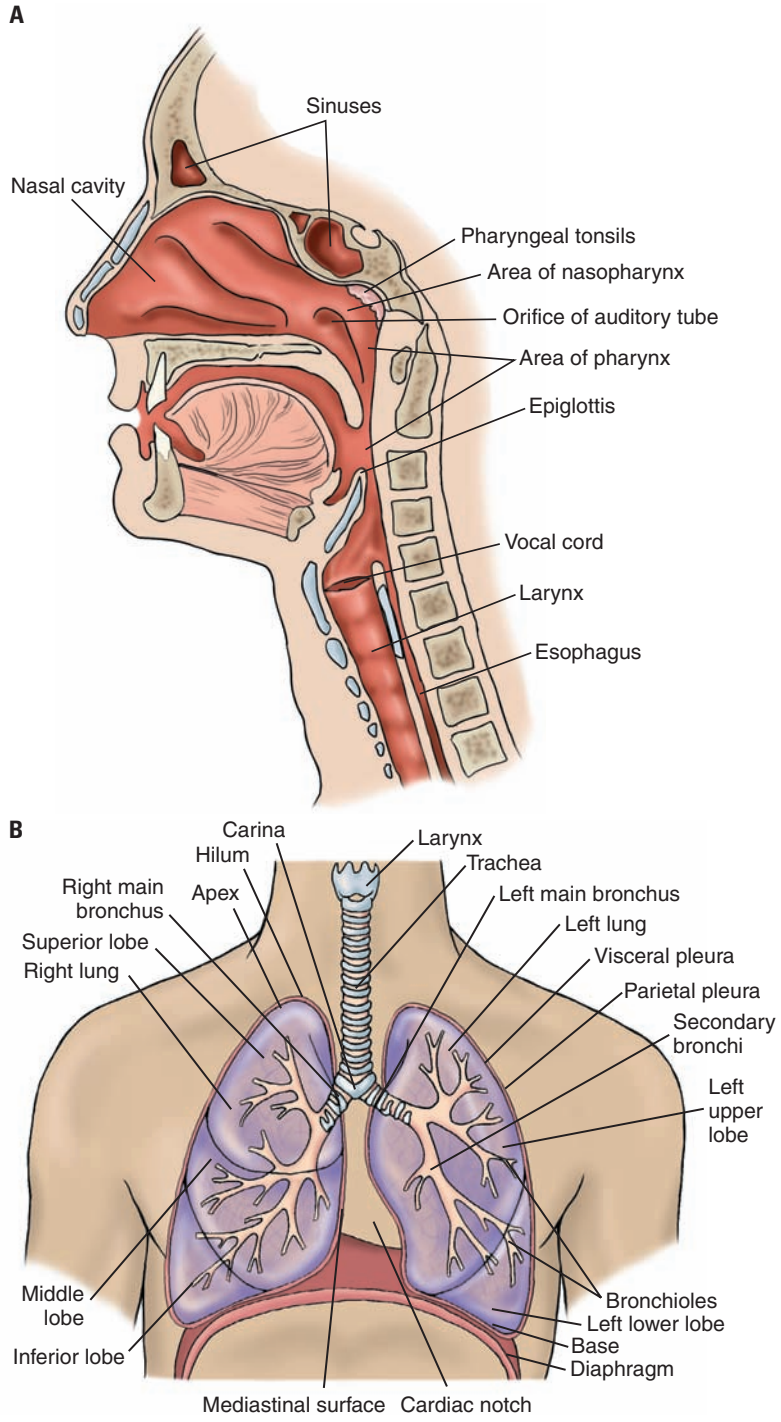

FIGURE **30-1** Structure of the respiratory system. **A,** Upper respiratory tract. **B,** Lower respiratory tract.

and several types of cartilage, including the thyroid cartilage and the epiglottis. The epiglottis has a hinged, doorlike action at the entrance to the larynx. During swallowing, it acts like a lid to help prevent aspiration of food into the trachea.

The vocal cords are folds of mucous membranes that are attached to cartilage and extend from the front to the back of the larynx. The space between the folds is known as the *glottis*. Sound is produced when air from the lungs causes a rapid, repeated opening and closing of the glottis. The sounds are transformed into speech through the movements of the lips, jaws, and tongue.

Trachea

The trachea, or windpipe, is a 4- to 5-inch tube descending from the larynx into the bronchi. It is made up of cartilage, smooth muscle, and connective tissue lined by a layer of mucous membrane. The trachea functions as a passageway for air to reach the lungs.

Bronchi

The bronchi provide a passageway for air going to and from the lungs. Two primary bronchi split to the right and left from the trachea. The right bronchus is shorter and wider and runs straighter up and down than the left bronchus. Therefore foreign bodies from the trachea usually enter the right bronchus.

The larger bronchi divide into smaller, or secondary, bronchi, which then divide again into even smaller tertiary bronchi. The tertiary bronchi divide into smaller units called *bronchioles,* which eventually lead into tiny air sacs called *alveoli* located in the lungs. It is through the walls of the alveoli that the exchange of oxygen and carbon dioxide takes place (Fig. 30-2).

Lungs

The lungs are located in the right and left sides of the thoracic cavity within the chest wall. The thoracic cavity is separated from the abdominal cavity by the diaphragm, a large sheet of muscle. The lungs are divided into lobes: three lobes on the right and two on the left. Each lung is covered by a membrane called the *pleura.* The pleura is a sac containing a small amount of fluid that acts as a lubricant for the lungs when they expand and contract.

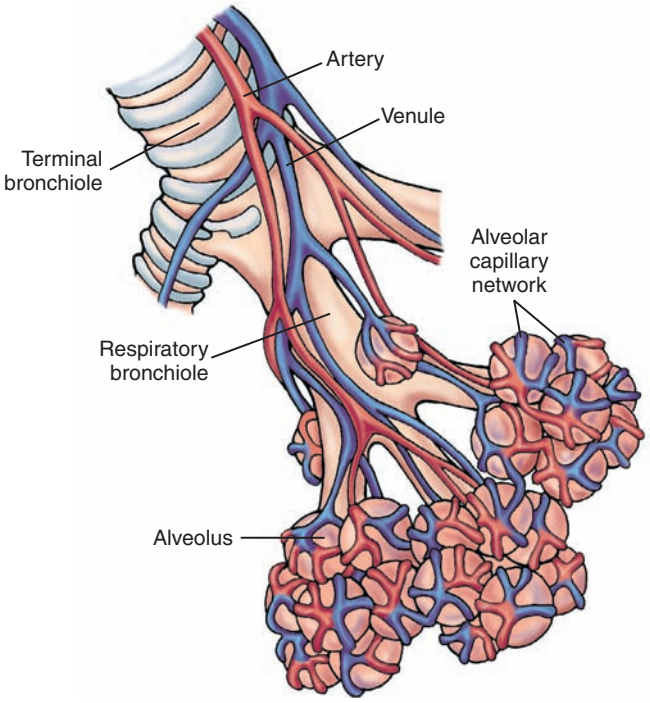

FIGURE **30-2** The terminal bronchioles, alveoli, and capillaries.

RESPIRATORY PHYSIOLOGY

Mechanism of Breathing

The process of air entering into the lungs is called *inspiration,* and the process of air leaving the lungs is called *expiration.* The terms *inhalation* and *exhalation* are used interchangeably with inspiration and expiration. Both of these processes are accomplished by the movement of the diaphragm and the muscles in the chest. Inspiration involves an active contraction of the muscles and diaphragm and can be noted by an enlargement of the chest cavity. Expiration is a passive process during which the muscles relax and the chest returns to its normal size (Fig. 30-3).

During normal, quiet breathing, approximately 500 mL of air is inhaled and exhaled. Most of the air movement occurs because of the contraction and relaxation of the diaphragm. A temporary interruption in the normal breathing pattern in which no air movement occurs is called *apnea.* Difficulty breathing, or shortness of breath, is called **dyspnea.** Difficulty with breathing in a lying position is called **orthopnea.** Different types of breathing patterns are described in Table 30-1.

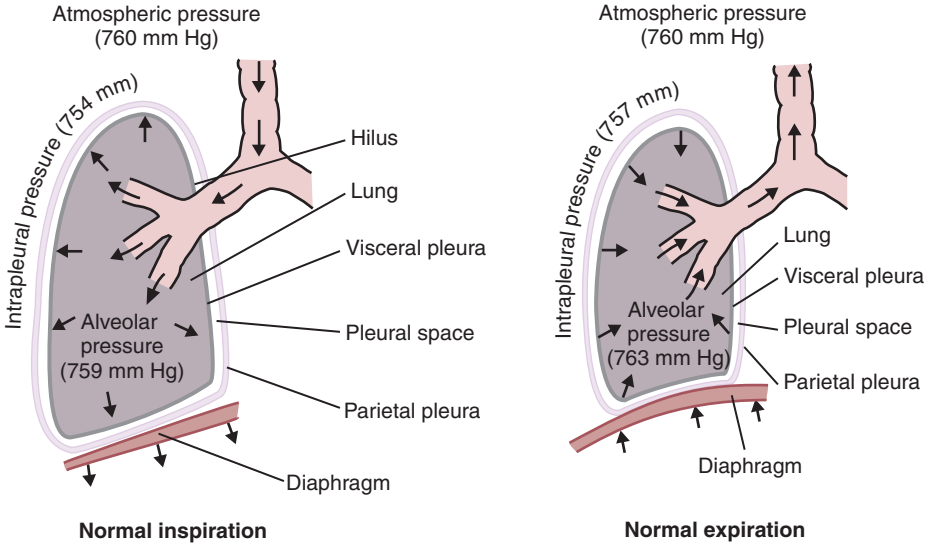

FIGURE **30-3** Normal inspiration (**A**) and expiration (**B**). Note the visceral pleura, pleural space, and parietal pleura and the changes in pressure in the alveoli and pleural space on inspiration and expiration.

Table 30-1 ***Types of Breathing Patterns***

PATTERN	CHARACTERISTICS	CAUSES
Normal	Pattern: regular Depth: even Rate: 12-20 breaths/min	Normal respiratory drive
Tachypnea	Pattern: regular Depth: even Rate: faster than 20 breaths/min	Fever, pain, anxiety
Bradypnea	Pattern: regular Depth: even Rate: slower than 12 breaths/min	Sedatives, narcotics, alcohol; brain, metabolic, and respiratory disorders
Sighing respirations	Pattern: regular Depth: uneven: periodic deep breaths (more than 3 sighs/min) Rate: 12-20 breaths/min	Severe anxiety
Cheyne-Stokes respirations, apnea	Breaths progressively deeper, then becoming more shallow, followed by period of apnea	Severe brain pathology
Kussmaul's respirations (with hyperventilation)	Pattern: regular Depth: deep Rate: faster than 20 breaths/min	Metabolic acidosis Diabetic ketoacidosis, renal failure
Biot's respirations; apnea	Pattern: irregular Depth: varies, sudden periods of apnea	Neurologic disorders
Obstructive breathing, rising end-expiratory level with forced rapid breathing	Gradual rise in end-expiratory level with each successive breath	Emphysema

Adapted from Kersten, L.D. (1989). *Comprehensive respiratory nursing* (pp. 279-281). Philadelphia: Saunders.

Respiratory Center

Breathing is controlled by the respiratory center, which is located in the medulla. The medulla is part of the brainstem immediately above the spinal cord. The respiratory center is stimulated by changing levels of carbon dioxide and oxygen in arterial blood. Chemoreceptors in the aorta and carotid artery monitor the pH and the amount of carbon dioxide and oxygen in the bloodstream. Changes in the pH, increased levels of carbon dioxide, or decreased levels of oxygen cause signals to be sent to the phrenic nerves, which in turn send signals to the respiratory muscles to carry out the major work of breathing.

AGE-RELATED CHANGES

Changes that occur with aging in the pharynx and larynx include muscle atrophy, slackening of the vocal cords, and loss of elasticity of the laryngeal muscles and cartilages. These changes may result in a gravelly, softer voice with a rise in pitch. Older adults who are hard of hearing may have a difficult time communicating with one another when they must try to understand speech that is less clear and more muted. Older adults may have a deviation of the trachea if they suffer from scoliosis of the upper spinal column.

Older people may experience difficulty with respiration because they may have loss of lung elasticity, enlargement of the bronchioles, and a decreased number of functioning alveoli. Older adults are also more susceptible to lung infections because of less effective respiratory defense mechanisms. In addition, the respiratory muscles atrophy, the rib cage becomes more rigid, and the diaphragm flattens. The consequences of these changes include reduced chest movement and ability to inhale and exhale, less effective cough, increased work of breathing, and less tolerance for exercise and stress.

NURSING ASSESSMENT OF THE RESPIRATORY SYSTEM

HEALTH HISTORY

The health history encompasses the chief complaint and history of the present illness, the past medical history, the review of systems, and the functional assessment. If the patient is in respiratory distress, the nurse focuses on the immediate problem, any conditions that might affect treatment, and allergies. Detailed assessment may be deferred until the patient's respiratory status improves. The components of a complete assessment of the patient with a respiratory disorder are discussed here.

Chief Complaint and History of Present Illness

Common complaints associated with respiratory disorders are cough, dyspnea, and pain. To describe a cough, include the onset, duration, frequency, type

(wet or dry), severity, and related symptoms such as sputum production and pain. Document the frequency of expectoration and the sputum characteristics (color, consistency, odor, amount). Record the patient's effort to treat the cough with measures such as medication, vaporizers, and humidifiers, as well as the response to the treatments.

If the patient complains of dyspnea, determine the onset, duration, severity, and precipitating events. Note whether the dyspnea becomes worse with activity or certain positions and whether it is more frequent during certain seasons. Identify associated symptoms such as fatigue or palpitations. Describe the effectiveness of methods used to manage dyspnea, which might include medications, oxygen, and positioning.

When the patient has chest pain, describe the location, severity, onset, duration, and precipitating events (trauma, coughing, inspiration). Determine whether the pain causes shallow breathing and whether it radiates up to the jaw or down the arms. Record the presence of fever, sweating, or nausea. Document measures that bring relief such as splinting, heat, analgesics, and antitussives.

Past Medical History and Family History

The patient's past medical history determines previous respiratory disorders, allergies, trauma, and surgery. Conditions that are important to document when a patient has a respiratory disorder include allergies, colds, pneumonia, tuberculosis, chronic bronchitis, emphysema, asthma, cancer of the respiratory tract, cystic fibrosis, sinus infections, ear infections, diabetes mellitus, and heart disease. It is especially important to note conditions that suppress the immune response, making the patient more susceptible to infection. Record all recent and current medications, including the use of over-the-counter drugs, and the dates of the most recent chest radiograph and tuberculosis test. Inquire about immunizations against pneumonia and influenza. Include questions regarding family history. Also describe any major respiratory conditions and the smoking history of members of the household.

Review of Systems

The review of systems assesses signs and symptoms that may be directly or indirectly related to the respiratory disorder. Ask about fatigue, weakness, fever, chills, and night sweats. Other data that may be significant are earaches, nasal obstructions, sinus pain, sore throat, hoarseness, edema, dyspnea, and orthopnea.

Functional Assessment

Describe the patient's occupational history, including any exposure to pathogens or to substances that might irritate or harm the respiratory tract. Document exposure to any fumes, toxins, coal dust, silica, or sawdust. Ask the patient to describe a typical day and to give particular attention to any limitations imposed by the respiratory disorder. Ask about the usual diet and fluid intake. A smoking history is important and for the cigarette smoker is usually reported in pack years. Pack years are calculated by multiplying the number of years the patient smoked cigarettes times the number of packs smoked each day. To illustrate, a person who smoked two packs a day for 30 years would have a 60-pack-year smoking history. The functional assessment also includes the patient's role in the family, sources of stress, and coping strategies.

What Does Culture Have to Do with Smoking?

Among adolescents, smoking is most prevalent among whites, followed by Hispanics, and then African Americans. However, programs aimed at smoking prevention and cessation need to target all segments of the population because smoking is a health threat to everyone that typically begins before high school. On a positive note, people who practice Mormonism abstain from using tobacco.

Put on Your Thinking Cap!

A patient has smoked one pack of cigarettes each day for 15 years. Calculate the pack years of his smoking history.

PHYSICAL EXAMINATION

Begin the physical examination with observation of the patient's general appearance. Note facial expression, posture, alertness, speech pattern, and any obvious signs of distress. Take the vital signs, and measure height and weight. Be alert to unusually rapid or slow breathing and to tachycardia, which may be a sign of **hypoxia.** The normal respiratory rate is 12 to 20 breaths per minute.

Head and Neck

Examine the head and neck. Inspect the nose for symmetry and for deformity, and gently palpate for tenderness. The patency of each naris can be assessed by closing one at a time and asking the patient to breathe in through the nose. Note flaring of the nares, because it is a common sign of air hunger. Use a nasal speculum to inspect the nasal cavity for swelling, discharge, bleeding, or foreign bodies. The nasal mucosa is normally light red in color. Tilt back the patient's head to inspect for deviation of the nasal septum, the structure that separates the nares. A deviation may be seen as a hump in the nasal cavity. Palpate the sinuses for tenderness by using the thumbs to apply pressure over the frontal and maxillary sinuses (see Chapter 53).

Inspect the lips, the tip of the nose, the top of the auricles, the gums, and the area under the tongue for cyanosis, a bluish color related to inadequate tissue oxygenation. Document the presence of pursed-lip

breathing, a common technique for decreasing dyspnea with chronic respiratory disease. Inspect the pharynx for redness and tonsil exudate or enlargement, which are signs of infection.

Inspect the trachea to see if it is midline; if not midline, it is said to be *deviated*. A deviated trachea can be indicative of a large **atelectasis,** pleural effusion, aortic aneurysm, enlargement of part of the thyroid gland, and/or tension **pneumothorax.** Place the thumbs on either side of the trachea just above the clavicles, and gently move the trachea from side to side. Compare the spaces between the sternocleidomastoid muscles on either shoulder and the trachea. An experienced examiner palpates for enlargement and tenderness of the lymph glands in the neck.

Thorax

Inspect the chest for deformities and lesions, and observe the breathing pattern and effort. The rise and fall of the chest should be regular and symmetric. Table 30-1 illustrates the different types of breathing patterns. Palpate the thorax for tenderness and lumps. Additional, more sophisticated aspects of the examination that require special training include palpating for symmetric chest expansion and tactile fremitus. The skilled examiner also may percuss (tap) the thorax in a systematic manner to elicit sounds that give clues about the density of underlying tissues.

Using the diaphragm of the stethoscope, auscultate the lungs bilaterally in a systematic manner (Fig. 30-4), usually the posterior, the sides, and then the anterior chest. Listen for the normal movement of air in and out of the lungs and for abnormal breath sounds: wheezes, rhonchi, and **crackles.** A wheeze is a high-pitched sound caused by air passing through narrowed passageways that may be present with asthma or chronic obstructive pulmonary disease. A **rhonchus** is a dry, rattling sound caused by partial bronchial obstruction. Crackles, also called *rales*, are abnormal sounds associated with many cardiac and pulmonary disorders. Fine crackles are due to fluid accumulation in the alveoli and do not clear with coughing. To demonstrate the sound of fine crackles, rub a few strands of hair between the thumb and forefinger next to the ear. Coarse crackles are described as sounding like a Velcro fastener being separated. Course crackles are due to secretions accumulating in the larger airways and usually clear with coughing. One other abnormal sound that may be heard on auscultation is a pleural friction rub, which is indicative of pleurisy.

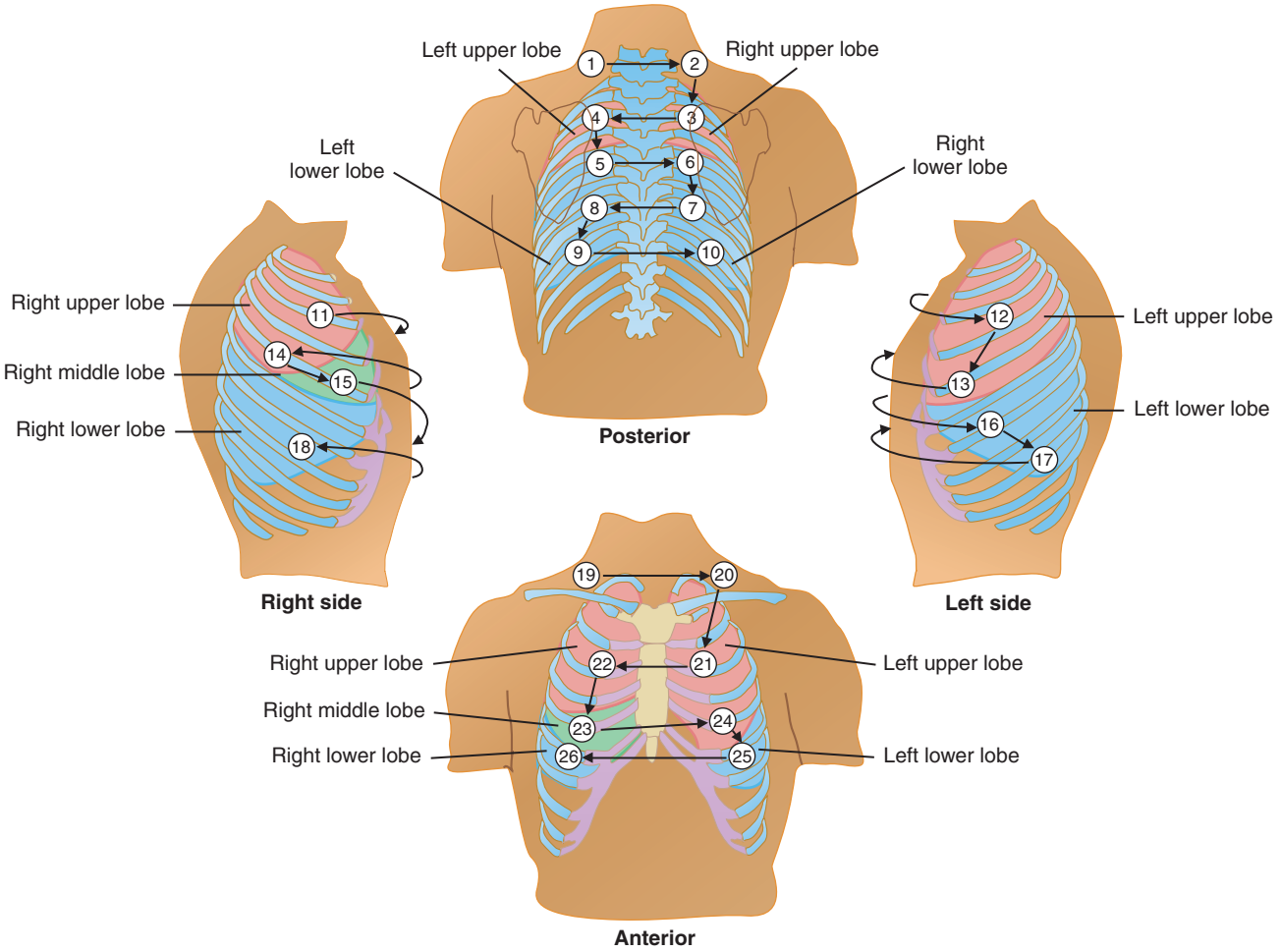

FIGURE **30-4** Sequence for percussion and auscultation of the lungs.

A pleural friction rub is a grating, scratchy noise similar to a creaking shoe.

In addition to the examination of the thorax and the auscultation of lung sounds, assess for signs of circulatory disorders that could affect respirations. Inspect the abdomen for distention that might interfere with full expansion of the lungs. Inspect the extremities for color, and palpate for edema. Examine the fingers for clubbing, which is associated with chronic respiratory problems (Fig. 30-5). Assess Homans' sign by passively dorsiflexing the patient's foot. Suspect thrombophlebitis if this maneuver elicits pain behind the knee or in the calf. This is important because the deep veins in the legs and pelvis are the source of most pulmonary emboli. It is important not to vigorously dosiflex the foot because this could potentially dislodge a clot from the leg. A negative Homans' sign does not completely rule out venous inflammation, nor does a positive sign always indicate inflammation. Nevertheless, it is one piece of data that should be documented.

The nursing assessment of the patient with a respiratory disorder is summarized in Box 30-1.

DIAGNOSTIC TESTS AND PROCEDURES

A variety of tests and procedures may be performed to diagnose disorders of the respiratory system. These tests and procedures are described briefly here. Details of patient preparation and postprocedure care are presented in the Diagnostic Tests and Procedures table on p. •••.

Put on Your Thinking Cap!

A patient in respiratory distress usually has tachycardia. Explain why this happens and what purpose the increased heart rate serves.

RADIOLOGIC STUDIES

Chest Radiography

Radiographic examination of the chest is one of the most frequently used methods for respiratory screening and diagnosis. It also is used to assess progression of a disease and response to treatment. The radiograph or roentgenogram produces a picture in which the bony structures (e.g., ribs, sternum, clavicle), heart shadow, trachea, bronchi, and blood vessels are visible. Bone appears white on the film because it is very dense and does not absorb much energy. In contrast, the lungs appear black because they are filled with air and absorb the x-ray energy. Chest films usually are taken posteroanterior (back to front), anteroposterior (front to back), and lateral (side) to view the chest cavity from different angles.

Fluoroscopy

Fluoroscopy is a radiograph of the chest taken to observe deep structures in motion. It is possible to observe both lungs at the same time during inspiration and expiration. Instead of producing a single, still image, the screen registers a constant image of the chest. The fluoroscopic examination can give information about

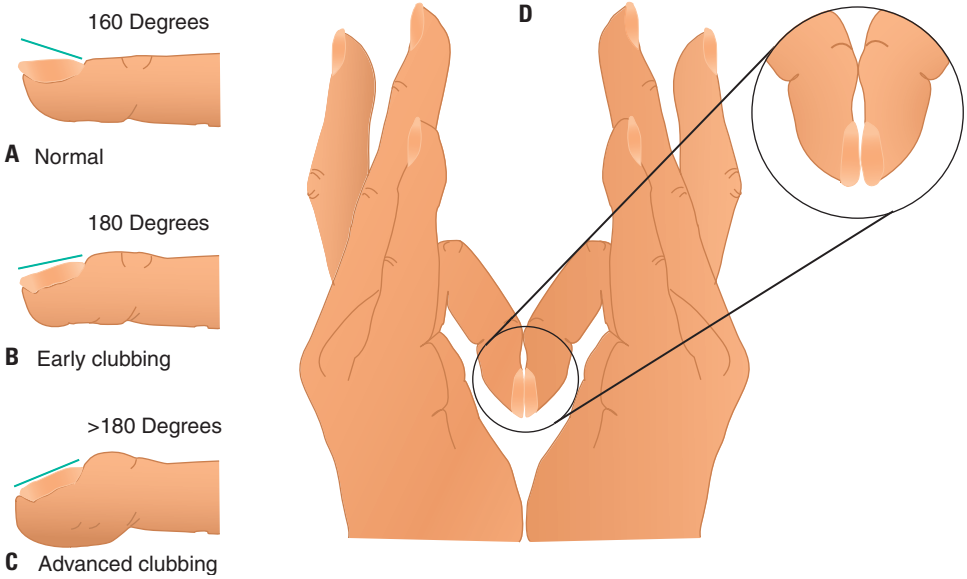

FIGURE 30-5 Clubbing is a flattening of the angle between the nail and the skin. **A,** Normal angle of 160 degrees. **B,** Early clubbing: the angle is flattened to 180 degrees. **C,** Advanced clubbing: the angle is greater than 180 degrees. **D,** The Schamroth technique: the patient puts the nails of the ring fingers of each hand together and holds the other fingers straight up. The examiner looks at the space between the touching nails. If there is no clubbing, the space is diamond shaped.

Box 30-1 *ASSESSMENT of the Patient with a Respiratory Disorder*

HEALTH HISTORY

Present Illness:

Cough: Onset, duration, frequency, type, severity, sputum production and characteristics, pain

Dyspnea:

Onset, duration, severity, precipitating events, associated symptoms

Pain:

Location, onset, duration, precipitating events, effects on breathing, measures that reduce or relieve, associated symptoms

Past Medical History:

Colds, pneumonia, tuberculosis, chronic bronchitis, emphysema, asthma, cancer of the respiratory tract, cystic fibrosis, sinus infections, ear infections, diabetes mellitus, heart disease, allergies, trauma, surgeries, hospitalizations, conditions that suppress the immune response, immunizations against pneumonia and influenza, last chest radiograph, last tuberculosis test, recent and current medications

Family History:

Major respiratory conditions, smoking history

Review of Symptoms:

Fatigue, weakness, fever, chills, night sweats, earaches, nasal obstruction, sinus pain, sore throat, hoarseness, edema, dyspnea, orthopnea

Functional Assessment:

Occupation, exposure to pathogens or respiratory irritants, typical day, usual diet and fluid intake, smoking history, role in family, stressors, coping strategies

PHYSICAL EXAMINATION

General Survey:

Appearance, facial expression, posture, alertness, speech pattern, obvious distress

Vital Signs

Height and Weight

Head and Neck:

Nose:

Nasal shape, tenderness, patency, flaring; swelling, discharge, bleeding, foreign bodies in nasal cavity, septal deviation

Sinuses:

Tenderness

Lips:

Pursed-lip breathing, color

Pharynx:

Redness, tonsil exudate or enlargement

Trachea:

Midline

Lymph Nodes:

Enlargement, tenderness

Thorax:

Breathing pattern and effort, accessory muscles, lung sounds

Abdomen:

Distention

Extremities:

Color, clubbing, edema, Homans' sign

the speed and degree of lung expansion and structural defects in the bronchial tree.

Ventilation-Perfusion Scan

When the lungs are working efficiently, there is a balance in the ventilation-perfusion ratio, which means that areas receiving ventilation are well perfused with blood and areas perfused with blood are well ventilated. When the alveolus and pulmonary blood flow are normal, ventilation and perfusion are said to match (Fig. 30-6).

A lung scan or ventilation-perfusion scan is used to assess lung ventilation and lung perfusion. Its chief purpose is to detect pulmonary embolism or some other obstruction The patient is given a radioactive substance either by inhalation (to evaluate ventilation) or intravenously (to evaluate perfusion). Ventilation images are compared with the pictures taken during the perfusion scan to determine whether there is an equal amount of radioactivity on both the ventilation and the perfusion pictures. Any areas indicating good ventilation but poor perfusion suggest the presence of a pulmonary embolus or obstruction.

IMAGING PROCEDURES

Computed Tomography

Tomography or tomograms allow visualization of slices or layers of the chest. A computed tomography scan is a computerized method of tomography in which a camera rotates in a circular pattern around the body to provide a three-dimensional assessment of the thorax. The test usually is used to look for the presence of lesions or tumors.

Radioactive dye containing iodine may be injected intravenously. Each layer of the chest is photographed before and after the injection of the dye. It is extremely important to find out whether the patient is allergic to iodine before the procedure is carried out. Failure to determine sensitivity to iodine could result in an allergic reaction, anaphylaxis, and death.

Magnetic Resonance Imaging

A magnetic resonance imaging (MRI) scan is similar to a computed tomography scan but without the harmful radiation. The MRI scanner encloses the patient in a doughnut-shaped magnet and picks up signals from the body to make electronic images. The patient must

DIAGNOSTIC TESTS and PROCEDURES *The Respiratory System*

TEST/PURPOSE	PATIENT PREPARATION	POSTPROCEDURE CARE
General nursing implications: Always tell the patient what to expect before, during, and after the procedure. When a venous blood sample is required, tell the patient to expect a venipuncture.		
PULMONARY FUNCTION TESTS (PFTS)		
Evaluate lung function, gas exchanges, pulmonary blood flow, and acid-base balance.	Advise not to smoke or eat a heavy meal 4-6 hr before test. Patient should be dressed comfortably and should void before the tests. Determine whether any medications or treatments should be withheld.	Resume medications. No special care.
FIBEROPTIC BRONCHOSCOPY		
Used to visualize abnormalities, take biopsy samples of lesions, or remove foreign bodies.	Obtain signed consent. NPO 6-8 hr or as specified. Have patient remove dentures and provide oral hygiene. Document loose teeth. Ask the patient not to smoke. Administer sedatives and anticholinergics as ordered.	NPO until gag reflex returns. Semi-Fowler's position. Monitor vital signs. Monitor for gross hemoptysis, swelling of face and neck, stridor, decreased or asymmetric chest movement, diminished lung sounds, dyspnea. Report abnormal findings to physician.
THORACENTESIS		
Pleural fluid is aspirated and examined for pathogens, other abnormal components. Cells studied for malignancy.	Obtain signed consent. Stress the importance of not moving or coughing during the procedure. Support the patient during the thoracentesis, and monitor skin color, respiratory rate, and general response. Label specimens and send to laboratory.	Monitor vital signs, lung sounds, chest movement. Report dyspnea, asymmetric chest movement. Assess for bleeding. Document amount and color of fluid removed. Check dressing for bleeding.
TUBERCULIN SKIN TEST		
Determine past or present exposure to tuberculosis.	Inform patient the procedure causes pain briefly. Cleanse skin and inject intradermally in lower anterior forearm. Mark and record site. Tell patient skin reaction may persist for a week, do not scratch. Stress need to return in 48-72 hr to read reaction. A reaction (swelling, redness) of 5 mm or more is positive for tuberculosis exposure. A patient who has ever been vaccinated with BCG will test positive regardless of actual exposure.	Follow-up depends on response. If positive, patient will be evaluated for active tuberculosis.
RADIOGRAPHIC AND IMAGING STUDIES		
Chest Radiography		
Used to screen and diagnose some respiratory disorders.	Patient will be asked to remove jewelry on neck and chest and clothing above waist and to put on hospital gown.	No special care.
Fluoroscopy		
Motion radiographs of lungs.	Same as chest radiography.	No special care.
Ventilation-Perfusion Scan (Lung Scan)		
Demonstrates lung ventilation and perfusion. Detects pulmonary embolism and other obstructive conditions.	Assure patient that radiation dose is small and that isotope is quickly eliminated. Procedure is painless except for venipuncture. If sedation is needed for agitated patients or small children, the patient is usually maintained NPO for 4 hr. The procedure takes approximately 2 hr. Monitor patient for 1 hr for anaphylaxis.	Check venipuncture site. Apply small dressing and pressure if needed. Radioactive material is excreted in the urine. Tell patient to wash hands after voiding. Anyone who handles patient's urine should wear rubber gloves. Gloves and hands should be washed after urine is discarded.

(Continued)

DIAGNOSTIC TESTS and PROCEDURES *The Respiratory System—cont'd*

TEST/PURPOSE	PATIENT PREPARATION	POSTPROCEDURE CARE
Computed Tomography (CT, CAT, or CAT Scan) Used to visualize lesions and tumors.	Inform the patient that the procedure is painless. Stress the importance of remaining still during the scanning. Assess iodine allergy and report to radiologist in case contrast medium is to be used. NPO status may be required.	Assess for side effects of contrast: headache, nausea, vomiting.
Magnetic Resonance Imaging (MRI) Produces images of multiple body planes without radiation. Used to detect abnormalities, lesions, and tumors.	Obtain signed consent. Inform patient: will lie on a stretcher that slides into a tubelike device. Mechanical clanging noises are heard as the machine operates. Aneurysm clips, intraocular metal, heart valves made before 1964, and middle ear prostheses generally contraindicate MRI. Metal implants such as cardiac pacemakers and orthopedic implants may be affected by MRI but are not absolute contra-indications. Assess for and report claustrophobia. Patients who are anxious or restless may require sedation. Special equipment must be used for oxygen therapy or mechanical ventilation. Have patient remove metal watch and jewelry.	Safety precautions if sedated; otherwise, no special care is needed.
LABORATORY STUDIES **Arterial Blood Gas Analysis** Detects alkalosis or acidosis and alterations in oxygenation status.	Tell the patient a blood sample will be drawn from an artery (usually the radial). An Allen test *must* be done before an arterial puncture to ensure that the arteries to the hand are patent. (Arterial punctures require specialized training.)	Apply pressure to the puncture site for 5-10 min. Note on the laboratory slip the concentration of any oxygen therapy Transport the blood gas syringe containing the specimen to the laboratory in an ice bath within 15 min.
Sputum Analysis Examination Volume, consistency, odor, color provide clues to clinical disorders. ***Culture and Sensitivity (C&S)*** Reveals pathogens and effective antimicrobials. ***Cytology*** Detects malignant cells and inflammatory changes.	Collect the specimen early in the morning before breakfast. Provide a sterile container. Instruct patient to (1) brush teeth and rinse mouth; (2) cough deeply and expectorate directly into the container; (3) immediately cap the container; and (4) inform the nurse that the specimen is ready. *For cytology*, a special container and solution must be used for specimens. Send specimen to the laboratory promptly. Refrigerate if it will be more than an hour before delivery to the laboratory.	No special care.

NPO, Nothing by mouth.

remain as quiet and as motionless as possible during the procedure. No preparation is necessary, but patients should be warned that no metal may be worn inside the unit (with the exception of dental fillings). Patients with implanted devices such as pacemakers and orthopedic plates, pins, or screws may be ineligible for MRI scanning.

Pharmacology Capsule

Dyes used in computed tomography contain iodine that can produce fatal reactions in people with iodine allergies.

Positron Emission Tomography

Positron emission tomography (PET) scans of the lungs are used most often to distinguish malignant from benign cells and to evaluate the effectiveness of cancer treatment. PET scans use special radionuclides attached to a natural body compound, usually glucose. This substance is administered to the patient as an IV, and the radioactivity localizes in the appropriate areas

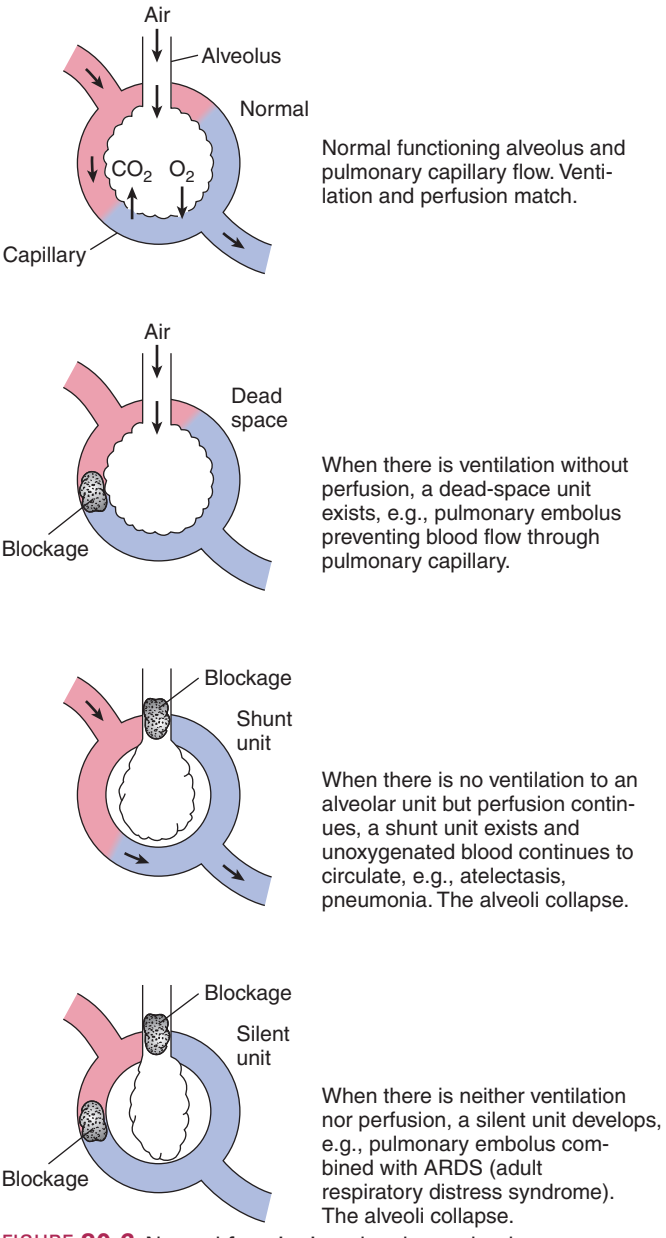

FIGURE **30-6** Normal functioning alveolus and pulmonary capillary blood flow. When both are normal, the ventilation and perfusion match.

of the body and is detected by the PET scanner. Cancerous tissue, which uses more glucose than normal tissue, will accumulate more of the substance and appear brighter than normal tissue on the PET images. The patient must remain quiet, avoiding movement or talking during the test. Because glucose is the substance most often tagged with the radionuclides, it is important to make sure that the patient has not eaten for at least 4 hours before the test.

PULMONARY FUNCTION TESTS

Pulmonary function tests are used to diagnose pulmonary disease, monitor disease progression, evaluate the extent of disability, and assess the effects of medication. The tests measure lung volumes and capacities including total lung capacity (TLC), forced respiratory volume (FEV), functional residual capacity (FRC), inspiratory capacity (IC), vital capacity (VC), forced vital capacity (FVC), minute volume (MV), and thoracic gas volume (TGV).

A clip is applied to the nose, and the patient breathes through a mouthpiece as directed while various measurements are taken to assess the mechanics of breathing (flow rates of gas in and out of the lungs) and to measure diffusion (the movement of the gas across the alveolar-capillary membrane).

Spirometry

A spirometer is an instrument that measures the ventilatory function of the lung. It measures the volume of air that the lung can hold, the rate of flow of air in and out of the lung, and the compliance (elasticity) of lung tissue. The test enables the physician to detect impaired pulmonary function, classify the pulmonary impairment, estimate the severity of the impairment, monitor the cause of pulmonary disease, evaluate treatment, give information helpful in planning care, and provide preoperative assessment.

The test involves inserting a mouthpiece, taking as deep a breath as possible, and blowing as hard, as fast, and as long as possible. Patients should be encouraged to continue blowing out until exhalation is complete.

Spirometry measures forced vital capacity and forced expiratory volume. These and other lung volumes and capacities are defined in Table 30-2.

People who are to undergo spirometry should be taught what to expect during the test and how to prepare. They may be anxious about taking a breathing test if they have respiratory problems, because they may fear increased dyspnea or exhaustion. They should be advised not to smoke or use bronchodilator medications for 4 to 6 hours before testing.

Pharmacology Capsule

Bronchodilators should not be given before pulmonary function testing because they can alter the results.

Arterial Blood Gas Analysis

Ventilation and diffusion also are measured by testing for concentrations of oxygen and carbon dioxide in the arterial blood to determine whether the exchange is adequate across the alveolar membrane. Blood gas analysis is useful in the care of patients with respiratory disorders, problems of circulation and distribution of blood, body fluid imbalances, and acid-base imbalances. *Drawing an arterial blood sample requires special training.* Samples are often obtained from the radial artery after first performing the Allen test to ensure adequate circulation to the hand from other arteries (Fig. 30-7). After the arterial puncture,

Table 30-2 ***Lung Volumes and Capacities***

VOLUME	DEFINITION	SIGNIFICANCE OF INCREASE	SIGNIFICANCE OF DECREASE
Total lung capacity (TLC)	Total lung volume when fully inflated	Overdistention of lung caused by obstructive lung disease	Restrictive lung disease
Forced expiratory volume (FEV)	Volume of air expired during specified time intervals (0.5, 1, 2, 3 sec)	Not significant	Restrictive or obstructive lung disease depending on measurements at time intervals
Functional residual capacity (FRC)	Volume of air remaining in the lungs after normal exhalation	Chronic obstructive pulmonary disease	Adult respiratory distress syndrome (ARDS)
Inspiratory capacity (IC)	Maximum volume of air that can be inhaled after a normal exhalation	Excessive use of positive end-expiratory pressure	Restrictive lung disease
Vital capacity (VC)	Total volume of air that can be exhaled after maximum inspiration	Not significant Increased or normal VC with normal flow rates: pulmonary edema	Decreased VC with normal or increased flow rates: impaired respiratory effort
Forced vital capacity (FVC)	Total volume of air exhaled rapidly and forcefully after maximum inhalation	Not significant	Obstructive or restrictive lung disease
Minute volume (MV)	Total amount of air breathed in 1 min	Not significant	Restrictive parenchymal lung disease; fatigue
Thoracic gas volume (TGV)	Total volume of air in the lungs, including ventilated and nonventilated areas	Obstructive lung disease with air trapping	Not significant

Data from Chernecky, C.C., & Berger, B.J. (2001). *Laboratory tests and diagnostic procedures.* (3rd ed.). Philadelphia: Saunders; Jaffe, M.S., & McVan, B.F. (1997). *Davis's laboratory and diagnostic test handbook.* Philadelphia: Saunders.

pressure must be applied for 5 to 10 minutes to ensure no bleeding. In the critical care setting, an arterial line, commonly called an *ART line,* may be placed by the physician. This line allows for frequent monitoring of arterial blood gases without repeated arterial punctures.

The arterial blood sample is analyzed for pH, $PaCO_2$, PaO_2, HCO_3, and O_2 saturation to detect alkalosis or acidosis and alterations in oxygenation status. Normal values for adults are pH: 7.35-7.45; $Paco_2$: 35-45 mm Hg; PaO_2: 80-100 mm Hg (some references give a lower limit of 75 mm Hg); HCO_3: 22-26 mEq/L; O_2 saturation: 96%-100%.

PULSE OXIMETRY

Pulse oximetry permits the noninvasive measurement of arterial oxygen saturation. A sensor is clipped to an earlobe or fingertip. A beam of light passes through the tissue, and the amount of light absorbed by oxygen-saturated hemoglobin is measured. The oxygen saturation is presented as a percentage and registered on a digital readout. Factors that interfere with accurate measurement of the oximeter are hypotension, hypothermia, vasoconstriction, and finger movement. Normal pulse oximetry is ≤95%. Notify your supervisor or the physician of readings <90%.

SPUTUM ANALYSIS

Sputum is material that originates in the bronchi. Sputum analysis may be performed when respiratory disease is suspected. The mucous membrane lining of the lower respiratory tract responds to acute inflammation by increasing the production of secretions, which may contain bacterial or malignant cells. These cells may be detected by examination of sputum. Sputum specimens are examined also for volume, consistency, color, and odor. Sputum that is thick, foul smelling, and yellow, green, or rust colored may indicate a bacterial infection. Instruct the patient to expectorate the specimen directly into a sterile container after coughing deeply. If the patient is unable to expectorate a specimen, sputum production may be induced with aerosol therapy or obtained by suctioning.

Culture and Sensitivity

Sputum culture and sensitivity tests are ordered to determine the presence of bacteria, identify the specific organisms, and identify appropriate antimicrobials. Collect specimens before antimicrobial therapy is begun to ensure that sufficient bacterial growth is present.

Acid-Fast Test

An acid-fast test on a sputum specimen is performed to determine the presence of acid-fast bacilli, which include the bacteria that cause tuberculosis. Specimens are usually collected on 3 consecutive days. Keep each sputum specimen covered and refrigerated or delivered to the laboratory within 1 hour. Use a new sterile container for each collection.

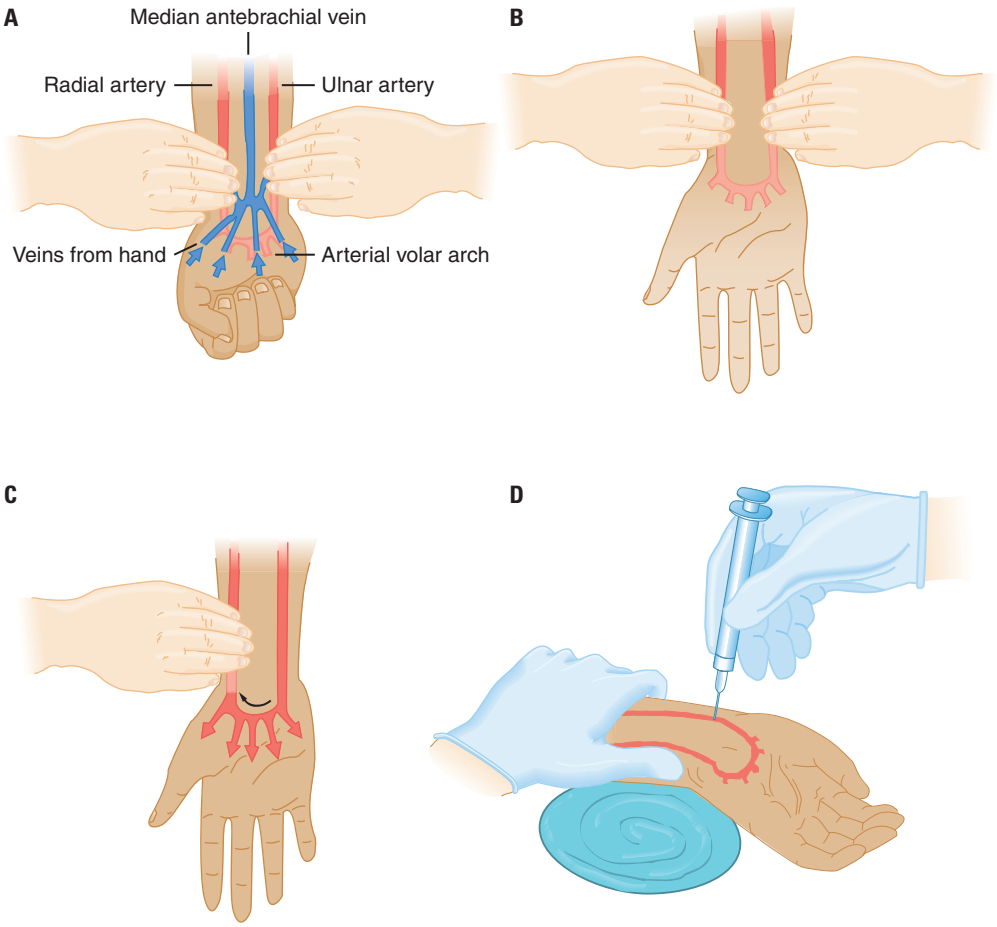

FIGURE 30-7 The Allen test should be done before each radial arterial puncture to ensure adequate collateral circulation. Because an arterial puncture may injure the radial artery, the adequacy of blood supply to the area by other arteries must be determined. A puncture is not done on an artery if the other blood supply is not adequate. To perform the Allen test, occlude the radial and ulnar arteries and have the patient make a fist (**A**). While maintaining pressure on the arteries, have the patient open the hand. The hand is pale if the arteries are occluded (**B**). Release the pressure on the ulnar artery. If collateral circulation is adequate, color will return to the hand. This is a positive Allen test result; the puncture can proceed on the radial artery. If color does not return, the Allen test result is negative and the radial artery should not be punctured (**C**). A blood sample is drawn from the radial artery after a positive Allen test result (**D**).

Cytologic Specimens

Sputum specimens are obtained for cytologic examination to determine the presence of lung carcinoma or infectious conditions. Because sputum contains cells from the tracheobronchial tree, malignant cells may be detected in the specimen. A special container with fixative solution may be used for this type of specimen collection. Consult the agency laboratory manual for directions.

FIBEROPTIC BRONCHOSCOPY

A bronchoscopic examination is performed by inserting a flexible fiberoptic scope through the nose or mouth into the bronchial tree after local anesthesia of the patient's throat. The scope allows for direct visualization of the bronchial tree structures for assessment, diagnosis, or removal of foreign bodies or mucus plugs. Lesions suggestive of malignancy may be located and a biopsy performed as well. Before the procedure, signed consent should be obtained. Have the patient remove dentures. Give sedatives as ordered. Afterward, monitor the patient's respiratory status and level of consciousness. The patient should take nothing by mouth until the gag reflex returns. Complications of bronchoscopy include bronchospasm, bacteremia, bronchial perforation, pneumonia, laryngospasm, hemorrhage, and pneumothorax.

Additional details about diagnostic tests and procedures are presented in the Diagnostic Tests and Procedures table on p. •••.

COMMON THERAPEUTIC MEASURES

THORACENTESIS

A thoracentesis is the insertion of a large-bore needle through the chest wall into the pleural space. The procedure is usually performed at the bedside by the

physician. Thoracentesis is done to remove pleural fluid, blood, or air or to instill medication. Pleural fluid may be removed to reduce respiratory distress caused by fluid accumulation in the pleural space. In addition, fluid obtained in the procedure may be studied to obtain blood cell counts or to measure protein, glucose, lactic dehydrogenase, fibrinogen, or amylase levels. The study of pleural fluids may aid in the diagnosis of infectious diseases and cancer.

The patient sits on the side of the bed and leans the upper torso over the bedside table with the head resting on folded arms or pillows (Fig. 30-8). If the patient is unable to sit up, a side-lying position with the head of the bed elevated 30 degrees may be used. The skin is cleansed thoroughly and a local anesthetic injected. The physician inserts a 20-gauge or larger needle between the ribs and through the parietal membrane Fluid or air is then aspirated, the thoracentesis needle is removed, and a sterile dressing is applied to the puncture site. The patient is positioned on the unaffected side. A chest radiograph may be ordered after the procedure to detect any pulmonary complications caused by accidental injury to the lung. Complications of thoracentesis include air embolism, hemothorax, pneumothorax, and pulmonary edema. Immediately report uneven chest movements, respiratory distress, or hemorrhage to the supervisor and the physician. Details of nursing responsibilities are included in Box 30-1.

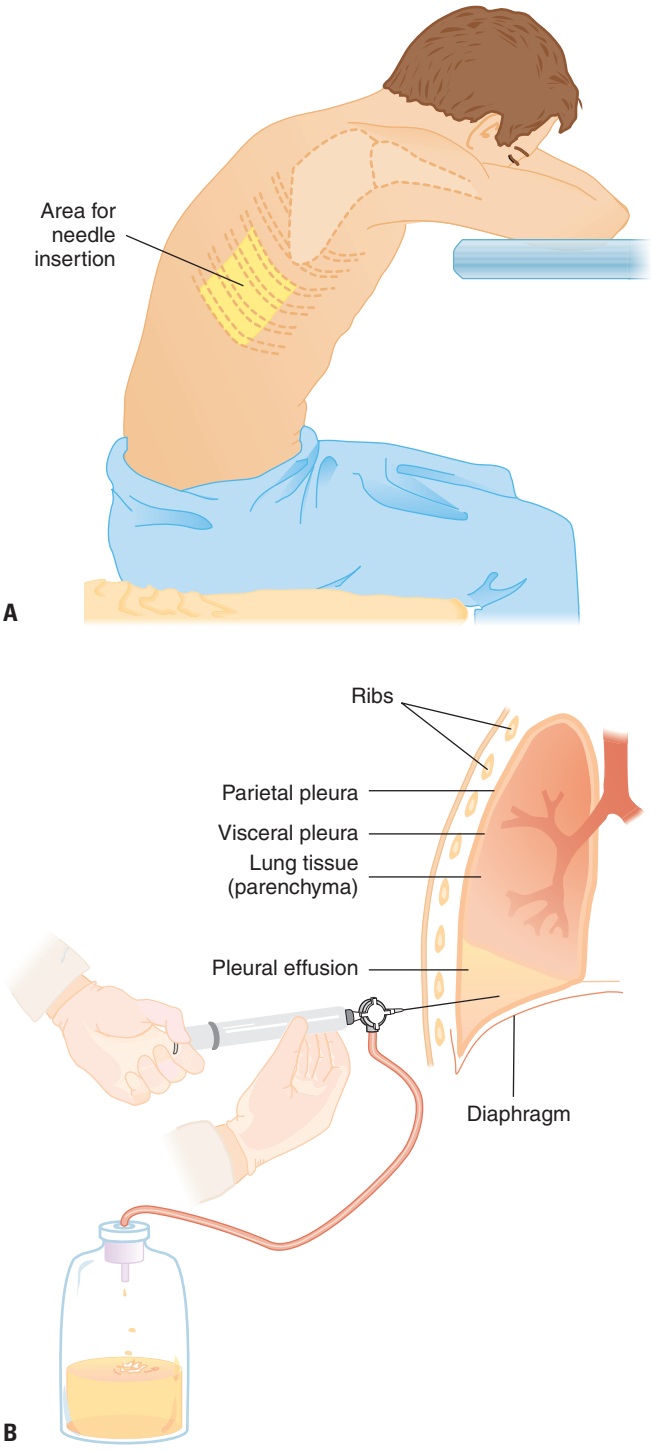

FIGURE 30-8 **A,** The patient is positioned for a thoracentesis. **B,** The needle is inserted into the pleural space, avoiding lung tissue and the diaphragm. The exact location of the puncture varies.

BREATHING EXERCISES

Deep-Breathing and Coughing Exercises

Deep-breathing and coughing exercises are performed to aid in lung expansion and expectoration of respiratory secretions. They are indicated when patients are immobilized or after general anesthesia. Instructions to the patient include the following:

1. Sit in a semi-Fowler's position for maximal lung expansion.
2. Place one hand on the abdomen to feel it rise and fall with breathing.
3. Inhale deeply through the nose, pause 1 to 3 seconds, and exhale slowly through the mouth.
4. After 4 to 6 deep breaths, cough deeply from the lungs to aid in the expectoration of sputum.
5. After thoracic or abdominal surgery, splint the incision with a pillow to minimize discomfort and support the incision.

Pursed-Lip Breathing

Another type of breathing exercise is pursed-lip breathing. It is used to inhibit airway collapse and to decrease dyspnea in patients with chronic lung disease. Instruct patients to pucker the lips as if to whistle, blow out a candle, or blow through a straw. They should then inhale through the nose and slowly exhale through pursed lips. Exhalation should last twice as long as inhalation.

Sustained Maximal Inspiration

Sustained maximal inspiration is used to ensure deep inspiration for maximal expansion and aeration of the lungs. An incentive spirometer is an instrument that frequently is used to encourage maximal inspiration. Spirometers basically consist of a cylinder that contains balls or disks and a tube through which the patient inhales. As the patient inhales through the tube,

FIGURE 30-9 Incentive spirometry encourages deep breathing by providing a visual cue to the patient about the efficiency of deep breathing.

the balls or disks rise (Fig. 30-9). Instruct the patient to inhale deeply to move the balls or disks in the cylinder upward. For maximum effect, the spirometer is kept upright because tilting the device reduces respiratory effort. Some spirometers provide a digital readout of the volume of air displaced. If the patient's maximal inspiration can be measured before surgery, that reading can be used as a target after surgery.

CHEST PHYSIOTHERAPY

Chest physiotherapy consists of percussion, vibration, and postural drainage. These mechanical techniques are used to facilitate the mobilization and expectoration of secretions in patients with large mucus-producing or chronic mucus-retaining respiratory disorders such as chronic bronchitis and cystic fibrosis. Although this therapy is usually performed in the acute care setting by a respiratory therapist, the nurse often does this in long-term and home care settings. Therefore you should be familiar with the procedures and be able to evaluate the patient's response. In an outpatient setting, you also may monitor the caregiver's technique in administering the treatment. Chest physiotherapy should be performed before meals to reduce the risk of regurgitation and aspiration of stomach contents.

Chest Percussion and Vibration

Chest percussion and vibration are performed to facilitate the movement of respiratory secretions so sputum can be expectorated. Percussion is clapping of the cupped palms against the chest wall to dislodge and mobilize respiratory secretions (Fig. 30-10, *A*). The procedure is performed with the hands cupped to create a pocket of air when striking the patient's chest—first with one hand and then with the other. Percussion is confined to areas protected by the rib cage and is never done over the sternum, kidney, liver, spleen, stomach, or spine. In general, percussion is done for 20 to 30 seconds, followed by vibration.

Vibration is performed by the therapist placing one hand on the top of the other, keeping the arms

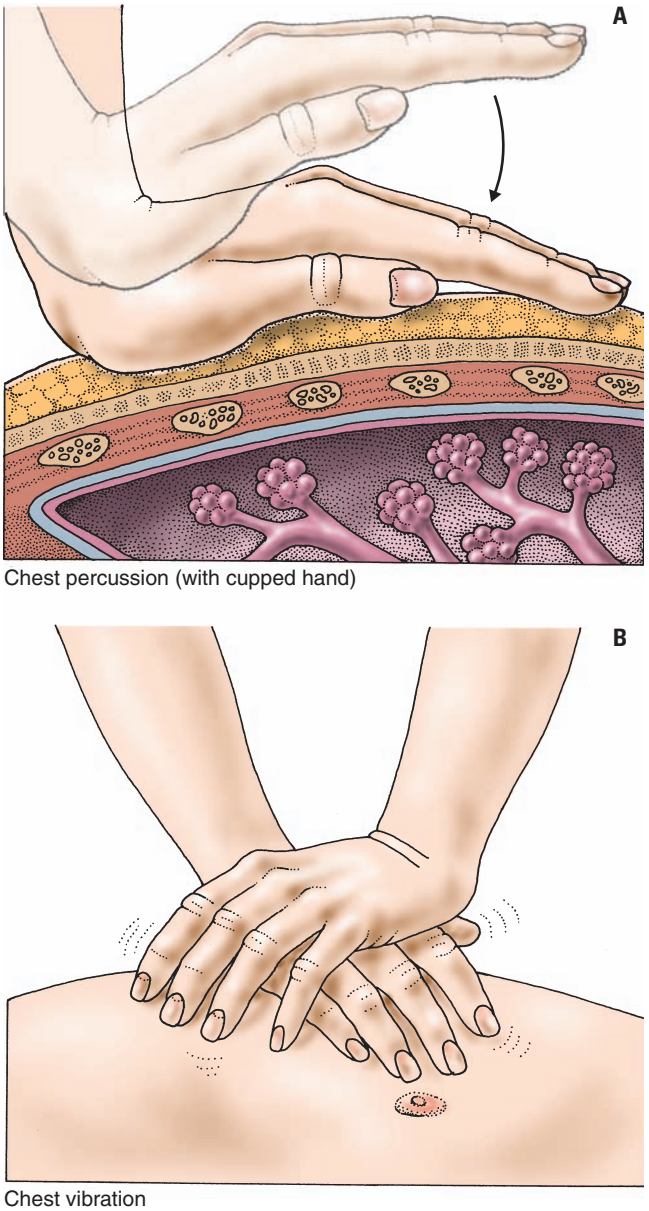

FIGURE 30-10 Chest physiotherapy. **A,** Percussion. **B,** Vibration.

straight, and pressing the hands flat against the patient's chest (see Fig. 30-10, *B*). As the patient exhales, the therapist creates a shaking (vibrating) movement with the palms. The therapist pauses during inhalation. The vibration is repeated over three or four breathing cycles.

Contraindications to percussion and vibration include lung cancer, bronchospasm, pain in the area being treated, hemorrhage, hemoptysis, increased intracranial pressure, chest trauma, pulmonary embolism, pulmonary edema, gastric reflux, pneumonectomy with open pericardium, extreme agitation or anxiety, and high risk for rib fractures.

Postural Drainage

Postural drainage is the technique of positioning the patient to facilitate gravitational movement of respiratory

secretions toward the bronchi and trachea for expectoration. Various positions are used to drain all 18 segments of the lungs. If a patient cannot tolerate a specific position, it should be omitted or modified. Instruct the patient to breathe slowly and deeply throughout the procedure. Drain the upper lobes first and the posterior basal segments of the lower lobes last. The patient should not sit up between position changes. Provide tissues and a disposal receptacle. Maintain each position for 5 to 15 minutes. Perform postural drainage before meals or tube feedings. It may be ordered after respiratory treatments with bronchodilators. The frequency is ordered by the physician. Discontinue the procedure and inform the physician if the patient experiences a heart rate over 120 beats per minute, dysrhythmias, hypertension, hypotension, dizziness, or signs of **hypoxemia.**

SUCTIONING

Suctioning may be required if excessive secretions accumulate in the oral or nasal airway and the patient cannot expectorate. The goal of suctioning is to improve oxygen and carbon dioxide exchange in the lungs by removing excessive mucus secretions with a suction catheter. Consult a procedure manual for details, but key points when suctioning a patient include the following:

1. Use strict aseptic technique.
2. Administer oxygen before inserting the suction catheter because the procedure temporarily interferes with the patient's airflow.
3. Moisten the catheter in sterile water, and insert the catheter through the nose or mouth before applying suction.
4. Apply suction as the catheter is withdrawn from the airway.
5. Maintain the pressure gauge between 80 and 100 mm Hg.
6. Limit each suction pass to 10 seconds.
7. Allow the patient to rest briefly, encourage deep breathing, and rinse the catheter with sterile solution between suction attempts.
8. Monitor the patient's response to suctioning.
9. If tachycardia or increased respiratory distress develops, stop the procedure and give the patient oxygen as ordered.
10. Document the amount, color, odor, and consistency of the patient's secretions as well as the patient's status before and after the procedure.

HUMIDIFICATION AND AEROSOL THERAPY

The upper respiratory system is designed to moisturize and warm the air that is inspired through the nose. Humidity is necessary in the respiratory tract to prevent secretions from becoming inspissated (thickened and dried). Inspissated secretions irritate the mucosa, making it more susceptible to bacterial infection.

Humidifiers

A humidifier creates water vapor to raise the relative humidity of inspired gas to 100%. There are several types of humidifying devices available for use. Room humidifiers deliver water vapor directly into the air. Medical oxygen is humidified as it bubbles through a container of water. Humidifiers that require heat to create water vapor pose a risk of heat injury. The fluid reservoir can become contaminated, making it a source of airborne infection. To prevent the spread of bacteria, sterile water should be used to fill the reservoir and the equipment must be cleaned between each use. Last, the equipment can present an electrical hazard.

Aerosol Therapy

Aerosol therapy is used to liquefy and mobilize respiratory secretions and to deliver medications. Aerosols are suspended liquid particles of bronchodilators or inactive fluids such as water or saline that are delivered by devices called *nebulizers.* Nebulizers deliver a humidified aerosol through large tubing, which may be connected to an oxygen mask or a handheld device. When handheld nebulizers are used, the patient should sit upright and slowly inhale the nebulizer aerosol deeply, hold the breath briefly, and exhale slowly. Once secretions are mobilized, the patient may require deep-breathing and coughing techniques, postural drainage, suctioning, or a combination of these to clear the secretions. Because aerosols can cause bronchospasm, bronchodilators may be ordered before administering some types of aerosol therapy. There is also a risk of fluid retention, infection, and drug toxicity.

OXYGEN THERAPY

Air in the atmosphere contains approximately 21% oxygen. Usually this is sufficient for oxygenation to maintain the tissue's ability to function appropriately. In the presence of cardiopulmonary disease or injury, it may be necessary to provide a patient with supplemental oxygen, that is, to enrich the atmospheric air with higher concentrations than the patient normally

Put on Your Thinking Cap!

Why is actual suctioning time limited to 10 seconds for each pass of the catheter?

Pharmacology Capsule

Oxygen should be thought of as a pharmacologic agent with risks of adverse effects.

breathes. Oxygen should be treated as a pharmacologic agent in that there may be serious side effects as well as benefits from its use.

Oxygen therapy requires a medical order that should be carried out like any drug order. If a patient is observed becoming lethargic or bradypneic (abnormally slow breathing), immediately notify a supervisor or physician because these are symptoms of adverse effects of oxygen therapy.

To administer oxygen to the patient, it is necessary to alter the gas from a compressed form such as a bulk oxygen supply or cylinder to a form with a usable, safe flow rate. Modern hospitals have bulk oxygen systems with wall adapters to which flowmeters can be attached. When patients with oxygen must be transported, a cylinder on wheels is necessary. A regulator with a flowmeter must be used. After a flowmeter has been attached to the oxygen source, it may be necessary to humidify the gas before delivering it to the patient. Humidification is usually unnecessary when using a low-flow cannula at a flow setting of 2 or fewer liters per minute or when using an air entrainment (Venturi) oxygen delivery system.

A tube is needed to connect the flowmeter to the specific oxygen delivery device being used. In some of the devices, the tube is incorporated as an integral component, but in others it is not. It is possible to use extension tubes for some devices, but increasing the length of the tube increases the resistance to gas flow, thus causing pressure to back up in the system, so the patient may not receive the desired oxygen flow.

Oxygen therapy is ordered in liters per minute, or FiO_2. FiO_2 means fraction of inspired oxygen. It is written, for example, as 0.30, which means 30% oxygen concentration. Various devices can deliver different amounts of oxygen (Fig. 30-11).

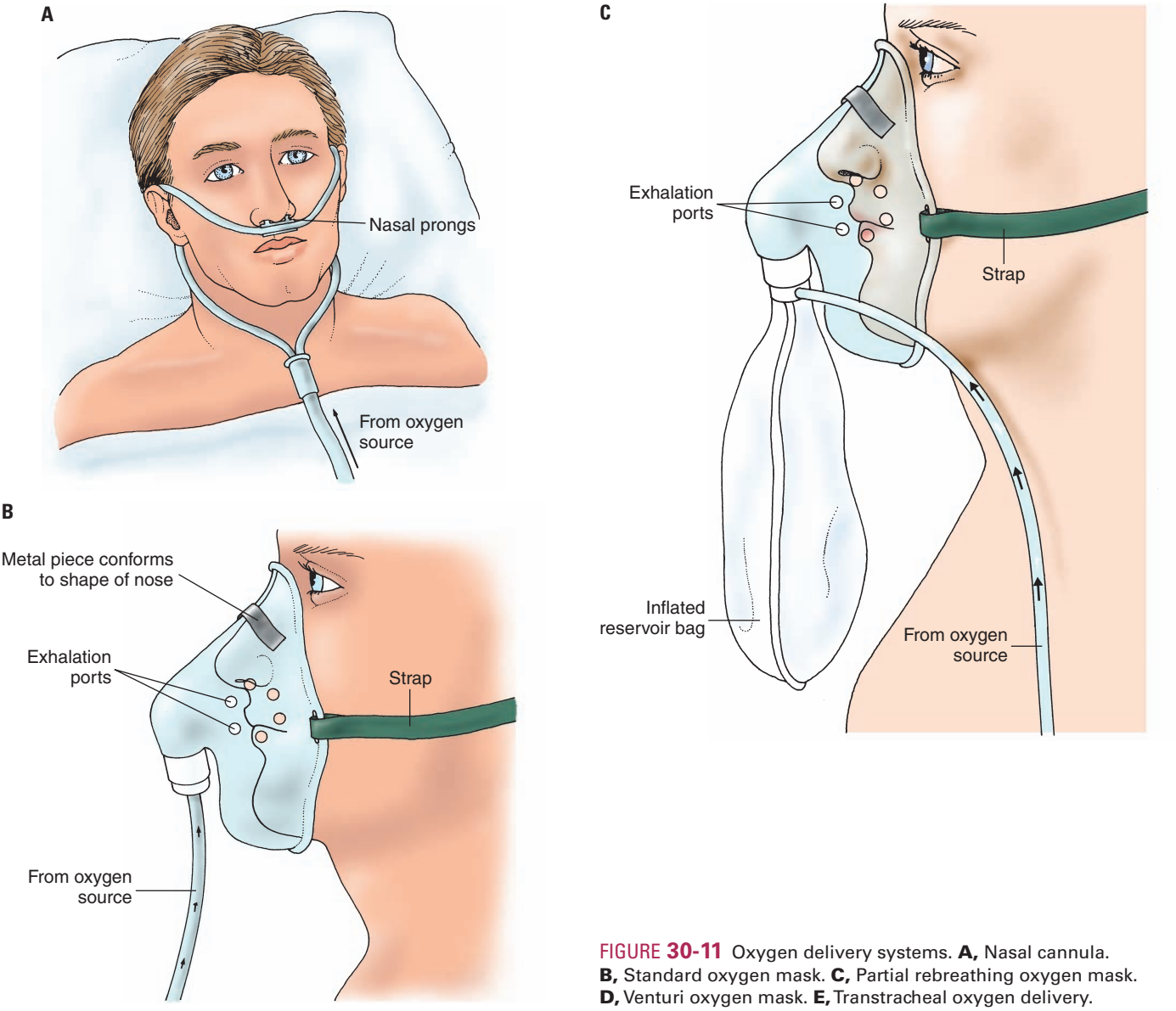

FIGURE 30-11 Oxygen delivery systems. **A,** Nasal cannula. **B,** Standard oxygen mask. **C,** Partial rebreathing oxygen mask. **D,** Venturi oxygen mask. **E,** Transtracheal oxygen delivery.

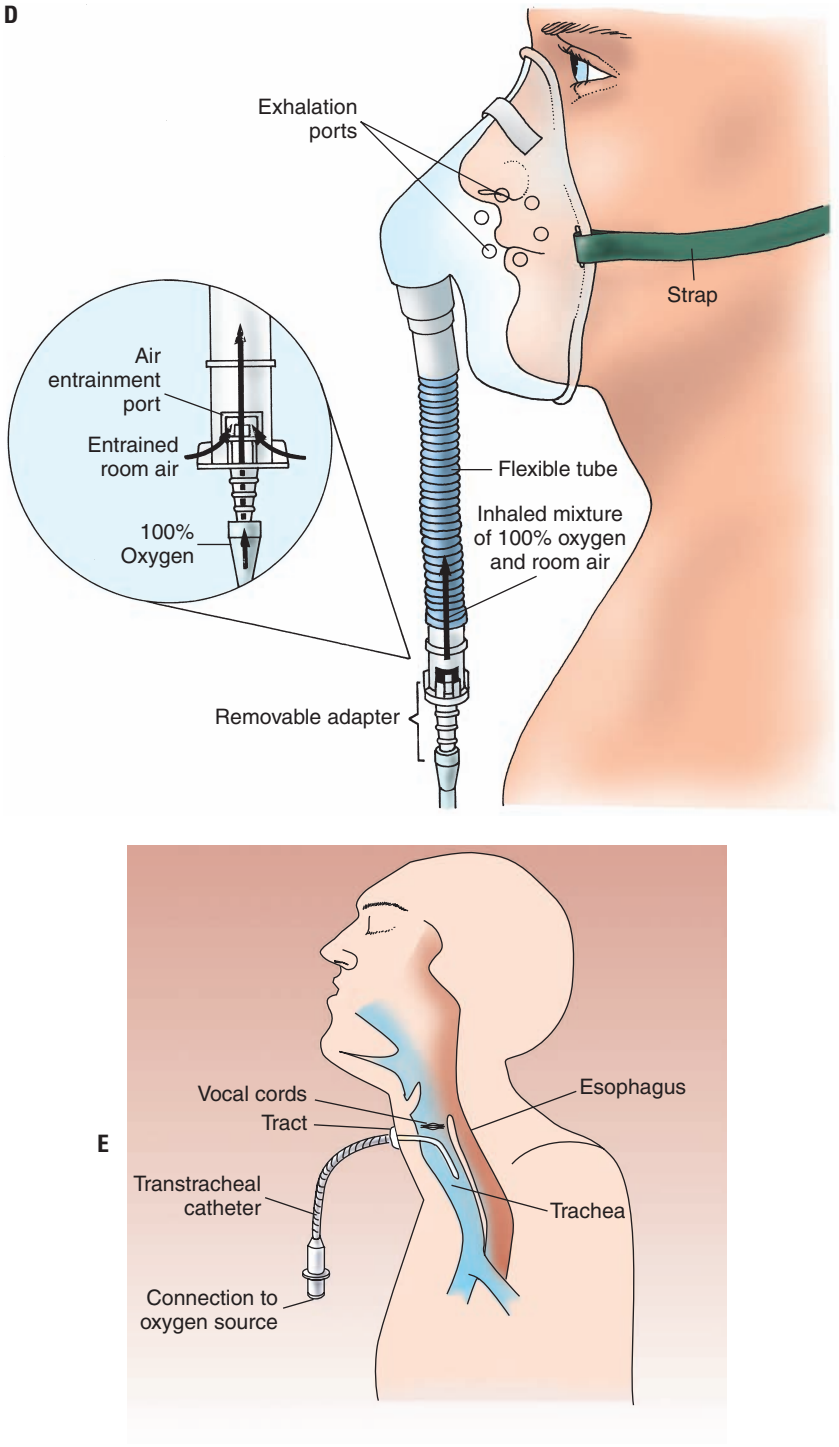

FIGURE **30-11** Cont'd

The most commonly used device is the nasal cannula, which fits around the face and directly into the nares by way of two prongs. It is designed to deliver a low flow of oxygen from 1 to 6 L/min with an approximate FiO_2 of 0.24 to 0.40 (24% to 40% oxygen). The nasal catheter is also a low-flow device that is inserted into one naris and then into the pharyngeal space approximately at the uvula. The FiO_2 and flow rates are the same as those for the cannula. This catheter is rarely used, except during short-term procedures.

Four types of masks are available: the simple oxygen mask, the partial rebreathing mask, the nonrebreathing mask, and the air entrainment (Venturi) mask. The simple oxygen mask is designed to deliver an FiO_2 ranging from 0.35 to 0.55 (35% to 55% oxygen). Flow rates from the flowmeter may be adjusted from 6 to 10 L/min. The minimum flow rate of 6 L/min is necessary to prevent any chance of carbon dioxide buildup from occurring. The partial rebreathing mask includes a reservoir bag to elevate the potential FiO_2. It is unique

because the patient actually rebreathes part of the exhaled gas in the system. However, it is designed so that the rebreathed gas contains almost no carbon dioxide from the patient's lungs—only enriched oxygen. The expected FiO_2 range is 0.35 to 0.60 (35% to 60%). The flowmeter setting must be from 6 to 10 L/min. The nonrebreathing mask is so named because none of the patient's exhaled gas is rebreathed. Like the previous mask, it also includes a reservoir bag to enhance the FiO_2, but it has a series of valves to direct the flow of oxygen in such a way that the patient receives a fresh supply of gas with each breath. The expected FiO_2 should be near 1.0 (100%). However, Scanlon and colleagues have shown experimentally that the highest FiO_2 is approximately 0.7 (70%). The air entrainment mask is designed to provide a specific FiO_2. This device has been called a *Venti mask* or a *Venturi mask* in the past and still may be referred to by these names. The manufacturers of these devices list a specific flowmeter setting for the desired FiO_2. It is also necessary either to adjust a setting on the device or to place a specific attachment on the mask to obtain the desired results. Read the literature accompanying the mask, and if there is confusion, consult a respiratory therapist.

Transtracheal oxygen therapy delivers oxygen through a small, flexible catheter that is inserted into the trachea through a small incision or with a special needle. This approach is sometimes used when long-term therapy is indicated.

There may be times when an oxygen mask must be removed, as for oral care or for eating or drinking. Ask the physician to write an order for the temporary use of a cannula during these times.

Advances in outpatient oxygen therapy have the potential to improve greatly the quality of life for patients with chronic pulmonary conditions. Whereas patients used to have to rent large cylinders for home use, they can now rent oxygen concentrators that process room air and deliver air with an increased percentage of oxygen. The concentrator is about the size of a canister vacuum cleaner and has a 50-foot tubing connected to a nasal cannula. This allows the patient considerable freedom of mobility in the home setting.

To leave the home, patients can use small tanks of compressed oxygen. The tanks weigh approximately 3 pounds and can deliver 2 L/min for approximately 3 hours. A device that can be used with the canister delivers oxygen only "on demand," when the patient inhales. This conserves the oxygen, making the canister last longer. Portable liquid oxygen canisters that can deliver a very high flow of oxygen are also available. These canisters can be refilled from a larger tank that can be kept in the patient's home. A weekend version of the tank fits in the back seat of a car and lasts several days. These devices allow considerable freedom for the patient.

The nurse must recognize the complications of oxygen therapy, including hypoventilation, toxicity, atelectasis, and ocular damage. Patients at greatest risk for oxygen-induced hypoventilation are those with chronic respiratory disorders. They may have become insensitive to high carbon dioxide levels in the blood, so that low oxygen levels in the blood serve as the stimulus for respirations ("hypoxic drive"). Oxygen administration raises the level of oxygen in the blood, and the patient who has hypoxic drive may hypoventilate or even have apnea. Oxygen toxicity can result from exposure to a high concentration of oxygen for a prolonged period of time. Toxicity progresses from tracheobronchitis to lung fibrosis and atelectasis and may be fatal. Atelectasis can result from the replacement of nitrogen normally in the alveoli with oxygen. Oxygen is readily absorbed, predisposing the alveoli to collapse. Exposure to 100% oxygen can cause retinal injury and visual impairment.

Key points when a patient is receiving oxygen therapy are the following:

1. Monitor the liter flow to be sure it is as prescribed.
2. Assess the patient's response to oxygen therapy; monitor reports of blood gas analyses.
3. Inspect the tubing for kinks, obstructions, loose connections; listen for a hissing sound in the oxygen mask; feel for adequate oxygen flow.
4. Maintain sterile water in the humidifier reservoir.
5. Clean and replace oxygen therapy equipment according to agency policy.
6. Post a "No Smoking" sign and advise the patient and visitors that smoking is not allowed because oxygen supports combustion.

INTERMITTENT POSITIVE-PRESSURE BREATHING TREATMENTS

Intermittent positive-pressure breathing (IPPB) treatments are used to achieve maximal lung expansion. The IPPB equipment delivers humidified gas with positive pressure, which forces air into the lungs with inhalation and allows passive exhalation. This facilitates maximal exchange of oxygen and carbon dioxide gases in the alveoli and promotes a productive cough. Aerosol medications, including mucolytics (agents that liquefy secretions) and bronchodilators, can be administered through IPPB treatments with a nebulizer device. Although most IPPB treatments are administered by respiratory therapists, they are done by nurses in some settings.

In the past, IPPB was used for a wide range of conditions. The American Association for Respiratory Care now recommends it only for specific conditions, including atelectasis, decreased lung compliance with kyphoscoliosis, and cardiogenic pulmonary edema. In addition to its limited usefulness, IPPB is losing favor because it may cause a tension pneumothorax in patients with chronic obstructive pulmonary disease. It also may cause respiratory alkalosis because of

hyperventilation. The desired effects of IPPB usually can be achieved by other, less expensive measures such as incentive spirometry and handheld nebulizers.

ARTIFICIAL AIRWAYS

Artificial airways are sometimes required to maintain a patent airway. Artificial airways include the oral airway, nasal airway, endotracheal tube, and tracheostomy tube.

Oral Airway

The oral airway is a curved tube used to maintain an airway temporarily. The oropharyngeal airway is inserted by tilting the head back, opening the mouth, and inserting the airway into the patient's mouth with the tip pointed toward the roof of the mouth. The tube is turned over while being advanced so that the end of the tube rests on the base of the patient's tongue.

Nasal Airway

A nasopharyngeal airway is a soft rubber tube that is inserted through the nose and extended to the base of the tongue. After ruling out a deviated septum, the nasal airway is coated with a water-soluble lubricant and inserted upward into the nose so that the distal end is located in the pharynx at the level of the base of the tongue. A nasal airway should be changed from one naris to the other every 8 hours.

Endotracheal Tube

An endotracheal tube is a long tube inserted through the mouth or nose into the trachea. These tubes have cuffs—inflatable balloons that seal the trachea to prevent aspiration of foreign material and to facilitate mechanical ventilation. Insertion of an endotracheal tube and care of the patient who is intubated require specialized training.

Tracheostomy

A tracheostomy is a surgically created opening through the neck into the trachea. There are a variety of tracheostomy tubes, and they may be used with or without cuffs. Care of the patient with a tracheostomy is covered in Chapter 53.

MECHANICAL VENTILATION

Mechanical ventilation is the process of providing respiratory support by means of a mechanical device called a *ventilator.* Ventilators are required most commonly for patients with acute respiratory failure who are unable to maintain adequate gas exchange in the lungs. This may be evidenced by **tachypnea** or bradypnea with an elevated or a stable arterial carbon dioxide tension ($Paco_2$), a low arterial oxygen tension (PaO_2), or a low pH. To ventilate a patient mechanically, a cuffed endotracheal or tracheostomy tube must be used to deliver the air. Once the tube is in place, the cuff must be inflated to create a closed system in the patient's airway. Otherwise, air being forced into the lungs could simply flow back out of the trachea.

A volume-limited ventilator is used most commonly for patients with acute respiratory failure. It inflates the lungs with a preset volume of oxygenated air that is delivered under pressure during the inspiratory cycle. The expiratory cycle may be conducted passively or with pressure as indicated.

There are three types of positive-pressure ventilators: volume cycled, pressure cycled, and time cycled. A volume-cycled ventilator, which delivers a constant preset amount of oxygenated air to the patient, is the most commonly used type. A pressure-cycled ventilator, which pushes air into the lungs until a preset pressure is reached, is not widely used for continuous mechanical ventilation. Time-cycled ventilators deliver oxygenated air over a preset length of time. This type is used most frequently in infants and children.

Depending on the patient's needs, ventilators may be programmed to control or assist the rate of ventilation. The most frequently used modes are intermittent mandatory ventilation and synchronized intermittent mandatory ventilation. These modes provide assistance with ventilation by allowing the patient to breathe spontaneously between a preset number of ventilator breaths. Ventilators deliver oxygen ranging in concentration from 21% oxygen (atmospheric air) to 100% oxygen. The oxygen concentration, or FiO_2, is adjusted for individual patient needs.

Tidal volume is the preset amount of oxygenated air delivered during each ventilator breath. This is usually 10 to 15 mL/kg of the patient's body weight.

The respiratory rate setting is the total number of breaths delivered per minute. The rate may be governed by the ventilator alone or by the ventilator and the patient's spontaneous respirations.

Positive end-expiratory pressure may be prescribed to keep the pressure in the lungs above the atmospheric pressure at the end of expiration. This reduces collapse of small airways and alveoli, thereby increasing the functional residual capacity and improving ventilation.

Other mechanical ventilation modalities include options such as pressure support, flow-by, continuous positive airway pressure, and high-frequency ventilation. These are mentioned only for completeness and not for discussion. If you encounter any of these modalities, specific training is needed that is beyond the scope of this text.

Like much other health care technology, mechanical ventilation can now be managed in the home. With proper training, these devices can be managed by a family member. A device that is used by people with sleep apnea is a continuous positive airway pressure (CPAP) unit. CPAP maintains positive pressure in the airway during sleep, thereby avoiding periods of apnea. CPAP units are small and have a nose mask that is worn during sleep.

Nursing care of patients on mechanical ventilation requires special training, but key aspects of care include the following:

1. Monitor settings to ensure they are set as prescribed.
2. Be sure high and low pressure alarm settings are turned on.
3. Have a manual resuscitator and oxygen source readily available.
4. Do not allow water to accumulate in the tubing.
5. Monitor the patient's vital signs and breath sounds; suction as necessary.
6. Establish an alternate method of communication because the patient cannot speak while intubated.

CHEST TUBES

Chest tubes are inserted to drain air or fluid from the pleural space of the lungs. This permits reexpansion of a collapsed lung in the patient with a hemothorax, pneumothorax, or pleural effusion. Chest tubes are inserted by the physician under sterile conditions in the operating room or at the bedside. Multiple tubes may be inserted. A small incision is made to insert one chest tube in the second to fourth intercostal space to remove air. A tube placed in the eighth or ninth intercostal space is for fluid removal. The tubes are sutured in place, and an airtight sterile dressing is applied. The distal ends of the plastic chest tubes are connected to sterile rubber tubing that leads to a pleural drainage device composed of three compartments: the collection chamber, the water-seal chamber, and the suction chamber (Fig. 30-12). Chest fluid and air drain into the collection chamber. Air is diverted to the water-seal chamber, where it can be seen bubbling up through the water. Suction pressure is controlled in the suction control chamber. The tubing in the suction chamber is partially submerged in water; the depth of the tube in the water regulates the amount of suction. After the tubes have been inserted, a chest radiograph is obtained to confirm placement.

Monitor the patient's vital signs, breath sounds, and oxygen status frequently. Assess the dressing to be sure a tight seal is maintained. Tape tubing connections, and inspect the connections frequently to detect air leaks. Coil extra tubing on the bed to avoid kinks, and keep the drainage system on the floor. Monitor the drainage for blood clots or lung tissue, which may have to be gently kneaded downward to keep the tube patent. Agency and physician preferences dictate whether chest tubes are stripped or milked (Fig. 30-13). Observe the chambers for bubbling. When the system is initially connected to the patient, bubbles are usually seen in the water-seal chamber. After a short time, bubbling in this chamber will stop until the lung has reexpanded or the tubing is occluded. If suction is prescribed, you will also see bubbling in the suction control chamber.

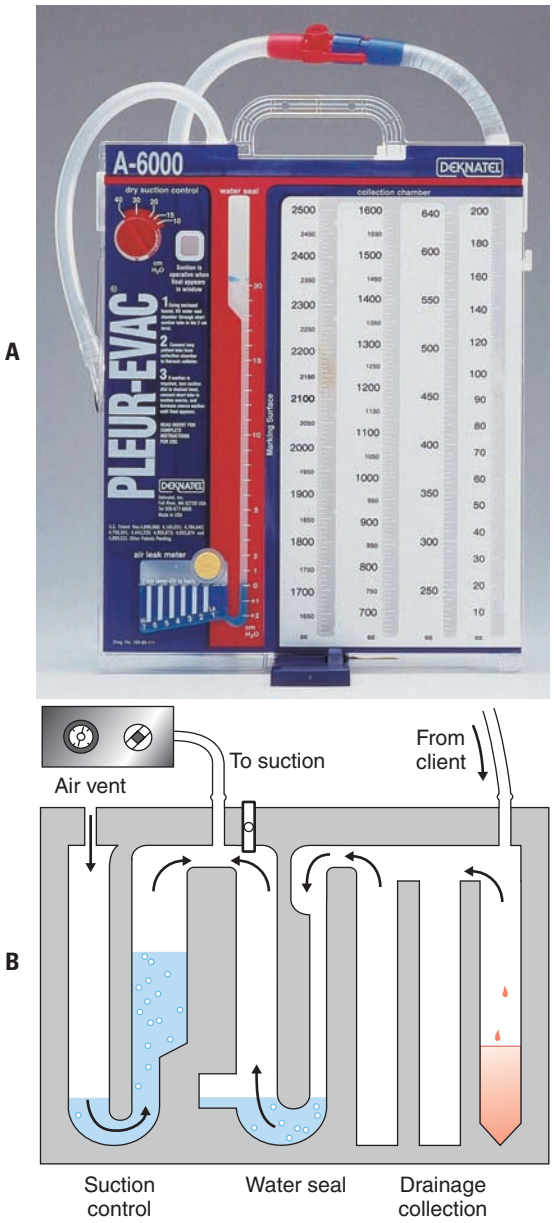

FIGURE 30-12 **A,** A commonly used disposable chest drainage system. **B,** Diagram of chambers of water-seal chest drainage.

The rate of drainage is monitored by marking the drainage level on the drainage receptacle. The middle water-seal chamber is observed for the expected rise in the fluid level with inspiration and the fall with expiration. This is called *tidaling.* Continuous bubbling in the water-seal chamber suggests an air leak. If an air leak is suspected, agency policy may permit the tubing to be clamped for a maximum of 10 seconds while locating the leak. The suction control chamber may be wet or dry. Wet chambers are regulated by maintaining the water level that is ordered by the physician. Gentle bubbling is expected in the wet suction chamber. Dry chambers are regulated by adjusting the dry suction until the float appears. The drainage receptacle is not usually changed unless the drainage chamber is full. Use sterile technique to change the receptacle. Know

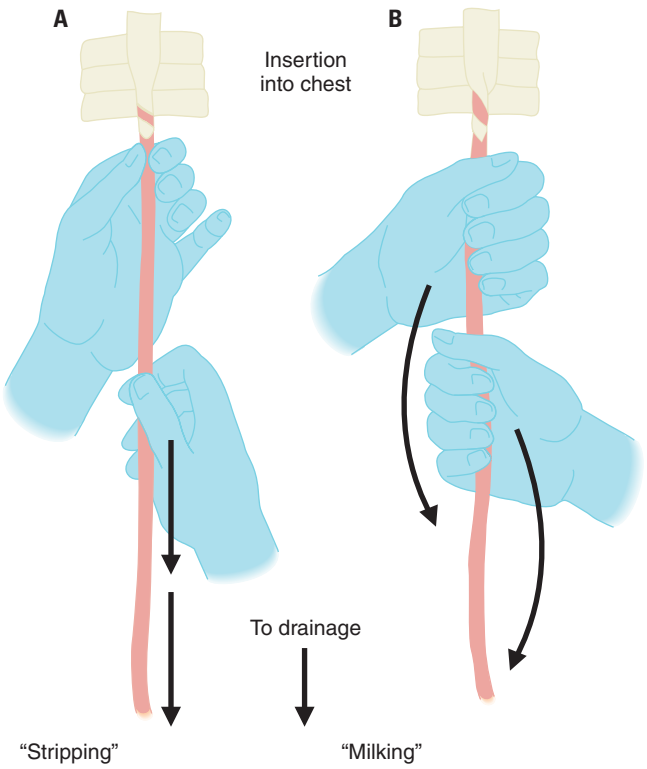

FIGURE **30-13** Two techniques for removing blood clots from chest tubes. **A,** Stripping. **B,** Milking. Both can create excessive negative pressure in the pleural space, but milking is safer than stripping. Follow agency policies and physician orders in relation to these procedures.

the agency policies and procedures for managing chest tubes.

An alternative to the large chest drainage systems is the Heimlich flutter valve. The valve is a disposable unit that is attached to the chest tube and to a sterile drainage receptacle. Air and fluid can flow into the receptacle but cannot flow backward into the chest. The patient who has a flutter valve can assume any position and can ambulate easily. A system with a flutter valve can be attached to chest suction if necessary.

THORACIC SURGERY

A thoracotomy is the surgical opening of the chest wall. Surgical procedures on the lung include pneumonectomy, lobectomy, segmental resection, and wedge resection. *Pneumonectomy* is the removal of an entire lung, whereas a *lobectomy* is removal of one lobe of a lung. The extensive dissection and removal of a section of the lung is called a *segmental resection.* A *wedge resection* is the removal of a small, triangular section of lung tissue. Other procedures that require a thoracotomy are *decortication* and *thoracoplasty.* Decortication is stripping of the membrane that covers the visceral pleura, and thoracoplasty is the removal of ribs. Among the most common purposes for thoracic surgery are evaluation of chest trauma, removal of tumors and cysts, and treatment of empyema.

PREOPERATIVE NURSING CARE *of the Patient with a Thoracotomy*

Preoperative nursing care is described in Chapter 17. Before thoracotomy, emphasize postoperative breathing exercises. If the insertion of a chest tube is anticipated, explain the procedure to the patient.

POSTOPERATIVE NURSING CARE *of the Patient with a Thoracotomy*

Assessment

After surgery, monitor vital signs, lung sounds, mental status, dressings, and chest tube function and drainage.

Nursing Diagnoses, Goals, and Outcome Criteria: Thoracotomy

General postoperative nursing diagnoses are presented in Chapter 16. Diagnoses and goals specific to the patient who has had a thoracotomy may also include the following:

Nursing Diagnoses	Goals and Outcome Criteria
Impaired Gas Exchange related to ventilation-perfusion mismatch	Improved gas exchange: vital signs consistent with patient's norms, arterial blood gases within normal limits
Ineffective Breathing Pattern related to preexisting respiratory disease or pain	Effective breathing pattern: regular respirations without cyanosis or dyspnea
Ineffective Airway Clearance related to dry secretions or ineffective cough	Improved airway clearance: breath sounds clear to auscultation

Interventions

Impaired Gas Exchange

After a thoracotomy, the patient is at risk for pneumonia and atelectasis because of the effects of anesthesia (which impairs ciliary motion), drugs that dry secretions, and immobility. To improve gas exchange, position the patient with the head of the bed elevated 20 to 40 degrees. In the immediate postoperative period, the patient is usually placed on the unaffected side. Thereafter, various positions are permitted depending on the specific surgical procedure. Avoid the operative side after wedge resection or segmentectomy to encourage expansion of remaining lung tissue on the affected side. After pneumonectomy, also avoid the complete side-lying position on the affected side because this may encourage mediastinal shift. Administer oxygen as ordered.

Ineffective Breathing Pattern

Splint the thoracic incision while assisting the patient to breathe deeply and cough. An incentive spirometer may be used to encourage full expansion of the lungs. Adequate pain control enables the patient to breathe more effectively. Chest physiotherapy and broncho-

dilators are indicated for some patients. When permitted, assist the patient to sit on the edge of the bed with the feet flat on the floor. An overbed table can be placed in front of the patient, who can lean on it with folded arms. This position fosters movement of the diaphragm and chest expansion.

Ineffective Airway Clearance

Good hydration thins secretions; therefore encourage fluids. If the patient cannot tolerate adequate oral fluids, intravenous fluids may be ordered. For management of chronic respiratory conditions, see Chapter 30.

VIDEO THORACOSCOPY

Many procedures that formerly required thoracic surgery now can be done with video thoracoscopy. Thoracoscopy is performed by inserting an endoscope through a small thoracic incision. Procedures that can be done with this instrument include resection of pulmonary and mediastinal lesions, biopsy, drainage of effusions, sympathectomy, vagotomy, and thymectomy. Potential complications of thoracoscopy include atelectasis, pneumonia, air leaks, and injury to thoracic organs. A chest tube is usually needed to promote full reexpansion of the lung on the operative side. Otherwise, patient care is much less complicated than it is after thoracotomy. Monitor the patient's respiratory status, including lung sounds. Immediately report sudden dyspnea or other signs of respiratory distress to the surgeon. Document the amount and appearance of chest tube drainage. Inspect the closed drainage system for proper functioning. Incentive spirometry may be used to encourage lung expansion. Give analgesics as ordered, although pain is usually not as severe as it is after thoracotomy. Patients are usually permitted out of bed 4 to 6 hours after surgery and can return to work in 1 week. Before discharge, instruct the patient to notify the physician of dyspnea or a temperature higher than 38.3° C (101° F).

DRUG THERAPY

Drugs used to treat respiratory disorders include decongestants, antitussives, antihistamines, expectorants, antimicrobials, bronchodilators, corticosteroids, mast cell stabilizers, leukotriene inhibitors, mucolytics, and thrombolytics, as described in the Drug Therapy table on p. •••.

Decongestants

Decongestants are sympathomimetic agents. They mimic the action of epinephrine and norepinephrine, causing constriction of nasal blood vessels and reducing the swelling of mucous membranes. Over-the-counter decongestants such as Sudafed are commonly used to treat the common cold. With oral decongestants, constriction of the blood vessels is not limited to the nasal passages, so that systemic vasoconstriction and elevated blood pressure may result. Systemic effects are less severe with topical drops and sprays. Nevertheless, people with hypertension, heart disease, diabetes mellitus, and hyperthyroidism are usually advised to avoid decongestant drugs except under medical supervision.

Pharmacology Capsule

People with hypertension, heart disease, and hyperthyroidism should not take over-the-counter cold remedies without consulting a pharmacist or a physician. Many cold remedies stimulate the heart and raise the blood pressure.

Antitussives

Antitussives suppress the cough reflex. Antitussive action is not always desirable because coughing removes secretions from the airways. However, when a cough is nonproductive, creates pain, interferes with sleep, or impairs wound healing, temporary cough suppression may be indicated. Codeine is an effective antitussive, but it is an opioid with many side effects and abuse potential. Therefore dextromethorphan, which is not an opioid, is more commonly used.

Pharmacology Capsule

Use antitussives cautiously. Cough is a protective mechanism that clears the airway.

Antihistamines

Antihistamines are also called *histamine-1 blockers* because they block the effects of histamine—one of the chemicals that causes allergic symptoms. Antihistamines include a variety of prescription and over-the-counter medications that are frequently used because of their action in drying nasal secretions. First-generation antihistamines such as diphenhydramine (Benadryl) provide short-term relief. However, they also can cause dizziness, dry mouth, constipation, blurred vision, urinary retention, tachycardia, drowsiness, and impaired judgment. Second-generation antihistamines such as loratadine (Claritin) are less likely to cause drowsiness. Antihistamines may worsen a cough by drying up bronchial secretions. These drugs are not usually recommended for people with asthma because dry secretions contribute to difficulty clearing the airway.

Expectorants

Expectorants thin respiratory secretions so they are more readily mobilized and cleared from the airways. Their value is in question, but they are commonly prescribed.

DRUG THERAPY *Drug Used to Treat Respiratory Disorders*

DRUG	USE/ACTION	SIDE EFFECTS	NURSING INTERVENTIONS
DECONGESTANTS			
Pseudoephedrine (Sudafed)	Vasoconstriction. Reduce swelling of mucous membranes. Used to treat nasal discharge, common cold.	Occasional mild CNS stimulation, especially in older adults. Toxicity: lightheadedness, tachycardia, palpitations, nausea, vomiting, hallucinations, seizures.	Monitor pulse and blood pressure, mental and emotional state. Contraindicated with severe hypertension, coronary artery disease, lactation. Tell patient to swallow extended-release tablets whole.
ANTITUSSIVES			
Codeine Hydrocodone bitartrate (Hycodan) Dextromethorphan	Suppression of cough reflex. Appropriate uses: control nonproductive cough or cough that interferes with rest or wound healing.	Codeine is an opioid; has abuse potential. Can cause sedation. Dextromethorphan does not have these effects.	Encourage fluids unless contraindicated to facilitate expectoration of secretions. Safety measures with codeine.
ANTIHISTAMINES			
Diphenhydramine (Benadryl)	Block allergic response. Dry respiratory secretions. Also antiemetic and sedative effects.	Drowsiness, dry mouth, blurred vision, photophobia, thickening of mucus secretions, decreased sweating, constipation, urinary retention, increased heart rate.	Safety precautions if drowsy. Monitor respiratory status. Not recommended for patients with asthma. Encourage fluids if not contraindicated. Monitor elimination. Oral hygiene.
EXPECTORANTS			
Guaifenesin (Robitussin)	Thin respiratory secretions for easier expectoration.	Nausea and vomiting with large doses.	Assess cough productivity. Do not crush sustained-release capsules.
ANTIMICROBIALS	Kill or inhibit the growth of bacteria, viruses, or fungi.	Side and adverse effects specific to each antimicrobial classification. Common side effects are nausea, vomiting, and diarrhea. Risk of superinfections such as yeast infections of mouth, genitourinary tract. Risk of severe allergic response.	Assess allergies before ad ministration. Be alert for allergic response: rash, dyspnea, loss of consciousness. Withhold drug if allergy suspected. Instruct patient to complete entire course of therapy. Monitor for improvement and for superinfections. Report continued symptoms.
BRONCHODILATORS	Relax smooth muscle in the bronchial tree to relieve bronchial constriction.		
1. Methylxanthines Theophylline Aminophylline	Methylxanthines also cause increased heart rate and force of cardiac contraction, central nervous system stimulation, and increased gastric acid secretion.	Anxiety, restlessness, tachypnea, tachycardia, dysrhythmias, GI distress. Rapid intravenous administration can cause hypotension, fatal dysrhythmias.	Monitor vital signs, mental state, serum drug levels. Measure intake and output. Give with milk or food to decrease GI distress. Do not administer before bedtime (may keep awake).
2. Sympathomimetics Epinephrine Isoproterenol hydrochloride (Isuprel) Ephedrine	Sympathomimetics also decrease mucus secretion, increase mucociliary clearance, and stabilize mast cells.	Restlessness, anxiety, tachycardia, headache, hypertension, disorientation, nausea, vomiting, diarrhea.	Do not exceed prescribed dosage. Teach patient to use inhaler. Rinse mouth after inhalation to decrease dryness and irritation. Avoid excessive caffeine. Monitor respiratory and cardiovascular status.

DRUG THERAPY *Drug Used to Treat Respiratory Disorders—cont'd*

DRUG	USE/ACTION	SIDE EFFECTS	NURSING INTERVENTIONS
BRONCHODILATORS—con't			
Selective beta$_2$ agonists: Albuterol sulfate (Proventil) Terbutaline sulfate (Brethine) Isoetharine hydrochloride (Bronkosol)		Less cardiac stimulation with beta$_2$ agonists.	
3. Inhaled muscarinics Ipratropium bromide (Atrovent)	Inhaled muscarinics act directly on the respiratory passages to cause bronchodilation. Not effective for acute asthma attacks.	Increased intraocular pressure with narrow-angle glaucoma. Rare: hypotension.	Monitor respiratory status. Evaluate for improvement. Tell patient not to use more than two inhalations at a time. Rinse mouth after inhaling to reduce dry mouth and throat. Avoid excessive caffeine intake.
CORTICOSTERIODS			
Inhalation: beclomethasone (Vanceril, Beclovent) Nasal: beclomethasone (Beconase)	Stabilize mast cells to reduce release of mediators that cause inflammation and edema. Restore bronchodilator response to sympathomimetics in treating acute bronchial constriction. Routes: oral, parenteral, inhalation.	Systemic therapy: water and sodium retention, potassium loss, abnormal fat distribution, hypertension, gastrointestinal distress. Masks signs of infection. Abrupt withdrawal can trigger adrenal insufficiency. Inhaled steroids: hoarseness, oral yeast infections, systemic effects possible with long-term use.	Monitor vital signs, weight, and electrolytes. Assess for subtle signs of infection. Rinse mouth after inhalation.
MAST CELL STABILIZER			
Cromolyn sodium (Intal) Nedocromil (Tilade)	Reduce the production of chemicals by the mast cells that cause bronchial constriction, edema, inflammation. Help reduce frequency/severity of asthma attacks. Do not *stop* asthma attack. Routes: inhalation, nasal.	Wheezing, sneezing, coughing. Occasional bronchoconstriction. Rare: allergies, headache, nausea, urinary frequency.	Instruct patient in self-medication. Advise that excessive use can actually cause bronchoconstriction. Rinsing mouth after use of inhaler reduces dry mouth effects. Monitor effects.
LEUKOTRIENE INHIBITORS			
Zafirlukast (Accolate)	Inhibit synthesis or receptors of substances that mediate allergic responses.	Zafirlukast: headache, nausea, diarrhea, infection.	Zafirlukast: take on empty stomach.
Zileuton (Zyflo)	Prevent acute asthma attacks.	Zileuton: elevated liver enzymes, pain, nausea, headache.	Zileuton: can take with or without food. Monitor liver function.
Montelukast (Singulair)		Montelukast well tolerated; does *not* seem to cause liver damage.	Montelukast: phenytoin can lower blood levels.
THROMBOLYTICS			
Streptokinase (Streptase) Urokinase (Abbokinase) Alteplase (Activase)	Dissolve clots; used to treat pulmonary emboli. An IV bolus dose is given, followed by an infusion.	Streptokinase: cerebral hemorrhage, hypotension, allergic reaction, bleeding. Alteplase: bleeding, dysrhythmias, rash, itching.	Assess for bleeding. Monitor fibrinogen levels, blood pressure, pulse. Watch for allergic reactions.

Antimicrobials

Antimicrobials kill or inhibit the growth of bacteria, viruses, or fungi. Antibacterials are used to treat only bacterial infections because they are not effective against viruses or fungi. A limited number of antiviral and antifungal drugs are available. Specific antimicrobials are best selected after culture and sensitivity tests are performed on a specimen of respiratory secretions. Antimicrobials can cause allergic responses and have many side effects. Instruct the patient in self-medication and stress the importance of completing the prescribed course of therapy to prevent reinfection and the development of resistant strains of pathogens.

Bronchodilators

Bronchodilators relax smooth muscle in the bronchial airways and blood vessels. They are used to treat airway obstruction from respiratory disorders such as asthma and chronic obstructive pulmonary disease. The primary drawback to many bronchodilators is their tendency to cause cardiac and central nervous system stimulation. Some bronchodilators act primarily to prevent bronchial constriction, whereas others relieve it.

Corticosteroids

Corticosteroids are anti-inflammatory drugs that may be administered parenterally, orally, and by inhalation. The drugs may be inhaled orally or nasally. They are important drugs in the treatment of asthma because they reduce inflammation and edema in the respiratory tract. These drugs are less commonly used to treat chronic obstructive pulmonary disease. Among the many systemic effects of steroids are fluid and electrolyte imbalances, hyperglycemia, hypertension, osteoporosis, reduced resistance to infection, and muscle wasting. Oral and parenteral steroids have more side effects than inhaled forms of the drug. Therefore parenteral use is generally confined to short-term, acute situations and oral use is usually limited to 2 weeks. Advise patients not to discontinue steroid therapy abruptly because that may lead to acute adrenal insufficiency.

Pharmacology Capsule

Inhaled corticosteroids can have systemic effects if used over a long period of time.

Mast Cell Stabilizers

Cromolyn sodium (Intal) and nedocromil (Tilade) reduce the production of chemicals by the mast cells that cause bronchoconstriction, edema, and inflammation. These drugs, *called mast cell stabilizers,* are used to prevent acute asthma attacks. They are not useful in stopping an attack after it starts.

Leukotriene Inhibitors

Leukotrienes are substances that mediate allergic responses, including bronchospasm. Drugs that inhibit leukotrienes are useful in the treatment of asthma because they inhibit the allergic response, thereby helping prevent acute asthmatic attacks. Examples are zafirlukast (Accolate), zileuton (Zyflo), and montelukast sodium (Singulair).

Mucolytics

Mucolytics reduce the viscosity (thickness) and elasticity of mucus. Acetylcysteine (Mucomyst) is used as an inhalant to thin the secretions in conditions such as acute and chronic bronchitis, asthma, and acute respiratory distress syndrome. It is important for the patient on mucolytics to be adequately hydrated.

Thrombolytics

Thrombolytics such as streptokinase (Streptase), urokinase (Abbokinase), and alteplase or tissue plasminogen activator (Activase) may be used to dissolve blood clots in the lungs (pulmonary emboli).

DISORDERS OF THE RESPIRATORY SYSTEM

ACUTE VIRAL RHINITIS (THE COMMON COLD)

Etiology and Risk Factors

Acute viral rhinitis, also called *coryza* or the *common cold,* is the most prevalent infectious disease. It is caused by viruses that invade the upper respiratory tract through airborne droplets. The droplets are spread by an infected person through breathing, sneezing, or coughing or by direct hand contact. Touching contaminated surfaces and then carrying the virus to the nasal membranes and eyes is the most important means of spreading a cold. Therefore careful attention to hand washing is one of the best preventive measures for avoiding a common cold.

Signs and Symptoms

Colds occur most frequently during the winter months when people tend to stay indoors and can more easily contaminate one another. A cold lasts 2 to 14 days, and people are most contagious during the first 3 days. Symptoms include a feeling of nasal dryness and stuffiness, sneezing, runny nose, headache, sore throat, lethargy, and fatigue. In severe cases, chills, fever, and marked prostration may be present.

Complications

Although most people with colds recover without incident, viral or bacterial pneumonitis develops in some patients.

Medical Diagnosis

The common cold is diagnosed on the basis of the patient history and physical examination.

Medical Treatment

The most common treatment for a cold is a combination of rest, fluids, proper diet, antipyretics, and analgesics. Antibiotics and currently available antiviral agents are usually not indicated because they are not effective against cold viruses (see the Health Promotion Considerations box on p. •••). Studies have been inconclusive about the value of using large doses of vitamin C for treating and preventing a cold. Other drugs that may be used to relieve the symptoms of the common cold by drying secretions are antihistamines and decongestants. Although many people believe that the herb *Echinacea* can prevent or reduce the duration of colds, research to date has not supported its value. Thorough hand washing can help prevent colds (see the Health Promotion Considerations box on p. •••).

NURSING CARE *of the Patient with Acute Viral Rhinitis*

Assessment

The complete assessment of the patient with a respiratory disorder is summarized in Box 30-1. The health history may be limited in focus and include a complete description of symptoms, past medical history, and drug history. The physical examination focuses on the nose, throat, ears, neck, and chest.

Health Promotion Considerations

Meeting *Healthy People 2010* Objectives for Reducing Antibiotic Use

Immunizations and Infectious Diseases *Healthy People 2010* objective: To reduce the number of courses of antibiotics prescribed for the sole diagnosis of the common cold

- Teach patients the difference between bacterial and viral infections
- Teach patients that the common cold from a viral cause does not require antimicrobial therapy
- Reinforce health promotion considerations such as good hand washing techniques, frequent hand washing, and covering mouth and nose when coughing or sneezing
- Teach patients the importance of adequate nutrition to reduce their susceptibility to infectious organisms

Health Promotion Considerations

The Importance of Frequent, Thorough Hand Washing

Teaching patients good hand-washing techniques, including washing with soap and warm water for at least 20 seconds, is a crucial "respiratory etiquette" health promotion intervention by the nurse.

Nursing Diagnosis, Goal, and Outcome Criteria: Common Cold

The primary diagnosis for the patient with a common cold is Ineffective Therapeutic Regimen Management related to lack of understanding of treatment, prevention, and signs and symptoms of complications. The goal of nursing care is effective patient management of the cold with full recovery and no complications. If the patient is at risk for secondary infection, the goal is absence of signs of worsening infection.

Criteria for assessing the effective patient management of the plan of care are the patient's verbalization of content presented and statement of intent to follow plan of care. Absence of infection is evidenced by normal vital signs, clear breath sounds, and clear sputum.

Interventions

The common cold is unlikely to require inpatient care unless a patient is immunocompromised. Therefore the primary nursing intervention is usually patient teaching. Advise the patient to rest and to maintain a daily fluid intake of 2 to 3 L, if not contraindicated. Good hydration is essential for keeping secretions thin for easier expectoration. A room humidifier may provide some comfort by keeping mucous membranes moist. Fever can be treated with antipyretics. If the physician has prescribed or recommended drugs, inform the patient of the proper use, dosages, and side effects. Many drugs used to treat symptoms of the common cold cause drowsiness, so advise the patient to avoid activities requiring mental alertness.

Pharmacology Capsule

Explain to patients that antibacterials are not usually prescribed for the common cold, because the common cold is caused by a virus and antibacterials are effective only against bacteria.

Infection control measures are needed to prevent spread of the cold and to protect the patient who has a cold from secondary bacterial infections. During the first 3 days, the patient is most contagious. The patient should avoid contact with others, especially those who are at increased risk for infection (young children, older adults, people who are immunosuppressed), to prevent the spread of the cold.

ACUTE BRONCHITIS

Etiology and Risk Factors

Acute bronchitis is a common condition that may follow a viral infection such as a cold or influenza. Bronchitis is usually viral in origin, but bacterial causes (*Streptococcus pneumoniae* or *Haemophilus influenzae*) also are common. Irritation and inflammation may

Patient Teaching Plan

Common Cold

To reduce the risk of spreading the cold or of acquiring secondary bacterial infection:

- Avoid close contact with other people who have bacterial infections.
- Avoid crowded places.
- Avoid sharing drinking glasses or eating utensils.
- Practice good hand washing with antibacterial soap.
- Cover the mouth when coughing or sneezing.
- Use disposable tissues for expectorated secretions; dispose of them promptly.
- If you develop purulent (greenish) sputum; chest pain; a temperature higher than 37.8° C (100° F); a red, sore throat; or lung congestion, contact the physician, because these signs and symptoms suggest a more severe respiratory condition that may require additional treatment.

occur throughout the upper respiratory tract, resulting in an increased production of mucus. Excess production of mucus leads to coughing and sputum production.

Signs and Symptoms

Symptoms of acute bronchitis include fever, cough, yellow or green sputum, rapid breathing, and occasionally chest pain.

Medical Diagnosis

Acute bronchitis is usually diagnosed on the basis of the health history and the physical findings.

Medical Treatment

Treatment consists of a broad-spectrum antibiotic (e.g., ampicillin, tetracycline, erythromycin) for 7 to 10 days; hospitalization is usually unnecessary.

NURSING CARE *of the Patient with Acute Bronchitis*

Nursing care with acute bronchitis is similar to that for the common cold. In addition, encourage patients who are taking antibiotics to take the full course of the medication.

INFLUENZA

The term *flu* is commonly used to describe a number of ailments involving various body systems. However, influenza is actually an acute viral respiratory infection that is accompanied by a fever. There are several strains of the influenza virus (A, B, C). A strain is further subtyped according to the place and year it was isolated. Influenza usually occurs in epidemics during the winter months. Those most susceptible to the influenza virus are very young children, older adults, people living in institutional situations, people with chronic diseases, and health care personnel.

Complications

The most common complications of influenza are bronchitis and viral or bacterial pneumonia. Other, less common complications are myocarditis, pericarditis, Reye's syndrome, confusion, seizures, Guillain-Barré syndrome, toxic shock syndrome, myositis, and renal failure.

Signs and Symptoms

Influenza is similar to the common cold in the way that it is spread, that is, through droplet infection; however, its symptoms differ from those of the common cold. People with colds experience nasal symptoms and malaise and usually are afebrile (without fever), whereas those with influenza typically have chills, fever, sore throat, muscular pain, headache, and dry, hacking cough.

Medical Diagnosis

A diagnosis of influenza is usually based on the patient's history and physical findings. Laboratory tests for confirming infections caused by the influenza virus are improving dramatically and can provide results in less than 48 hours. However, viral tests in general are expensive and may not be available in all facilities.

Medical Treatment

Treatment of influenza is similar to the treatment of the common cold: rest, fluids, proper diet, antipyretics, and analgesics. First-generation antiviral agents such as amantadine hydrochloride (Symmetrel) or rimantadine (Flumadine) can be used to treat type A influenza. Second-generation antivirals such as oseltamivir (Tamiflu) and zanamivir (Relenza) treat influenza types A and B. With either generation, therapy must be started within 24 to 48 hours after the onset of symptoms and continued for 10 days.

The best treatment is prevention through immunization, especially for older adults, people with chronic illnesses, health care personnel, and people living in crowded environments. The Department of Health and Human Services Centers for Disease Control and Prevention National Immunization Guidelines recommends an annual influenza vaccine. Two types of vaccine are available—an inactivated vaccine and a live vaccine. The live vaccine, known as FluMist(tm) is given intranasally. This vaccine is used only for healthy children, adolescents, and adults, ages 5 to 49 years. The inactivated influenza vaccine is recommended for all others, including health care workers. The immunizations are usually given in the fall of the year. The protection rate for influenza vaccines is approximately 70% in the general population but may be lower among older adults. Although the incidence of adverse reactions to influenza immunizations is small, some people report sore arm, headache, fever, muscle aches, nausea, and diarrhea. Reported intranasal vaccine reactions include runny nose, nasal congestion, or

cough. Acetaminophen 325 mg taken every 4 hours for the first 12 hours may reduce these symptoms. Other measures to reduce the risk of influenza are good nutrition and hygiene. An antiviral agent also may be prescribed for people who are at increased risk of acquiring viral infections.

Consider the Alternative

Echinacea is an herb taken orally to stimulate immune function, suppress inflammation, and treat viral infections such as the common cold and influenza. There is little evidence that it prevents colds, but it may decrease the duration and severity of a cold.

Pharmacology Capsule

Antiviral drugs must be administered soon after the onset of influenza symptoms to be effective.

NURSING CARE *of the Patient with Influenza*

Nursing care of the patient with influenza is similar to care of the patient with the common cold. Ongoing monitoring is particularly important with influenza because of the risk of serious complications, especially in older adults. In addition, encourage immunization against influenza for people at high risk: those with serious chronic cardiopulmonary disorders, residents of long-term care facilities, health care providers who have contact with high-risk patients, people older than 65 years, and those who have chronic metabolic disorders such as diabetes mellitus.

PNEUMONIA

Etiology and Risk Factors

The term *pneumonia* describes inflammation of certain parts of the lung such as the alveoli and bronchioles. Pneumonia may be caused by either infectious or noninfectious agents. Examples of infectious agents are bacteria, fungi, and nonspecific viruses. Noninfectious agents may include irritating fumes, dust, or chemicals that are inhaled or foreign matter that is aspirated. Nosocomial pneumonia is a hospital-acquired infection that may be attributed to inadequate hand washing, poor sterile technique with suctioning, contaminated equipment, and exposure to others who have infectious respiratory conditions.

People who are most likely to contract pneumonia are smokers; those with altered consciousness from alcohol, seizures, anesthesia, or drug overdose; those who are immunosuppressed; chronically ill people who are malnourished or debilitated; and people on bed rest with prolonged immobility.

Patients at increased risk for aspiration pneumonia are those with impaired swallowing or cough reflexes, decreased gastrointestinal motility, esophageal abnormalities, tube feedings, tracheostomies, and endotracheal tubes.

Pathophysiology

Pneumonia may be classified according to the causative organism—usually bacteria or viruses. Gram-positive bacteria cause pneumococcal, staphylococcal, and streptococcal pneumonias, and gram-negative bacteria cause pseudomonal and influenza pneumonias and legionnaires' disease. Pneumococcal pneumonia (*S. pneumoniae*) is the most common cause of bacterial pneumonia. Viral pneumonias are caused by several different viruses, including the influenza virus.

The pathophysiology of pneumonia follows a predictable course. When pathogens invade the lungs, the inflammatory process causes fluid to accumulate in the affected alveoli. In a process called *hepatization*, capillaries dilate and neutrophils, red blood cells, and fibrin fill the alveoli, causing the lung to appear red and granular. Next, blood flow decreases and leukocytes (white blood cells) and fibrin infiltrate the area and consolidate (solidify). As the infection resolves, the consolidated material dissolves and is ingested and removed by macrophages.

Complications

Although most people recover from pneumonia, it remains among one of the leading causes of death, especially in older adults (CDC, 2002). Relatively common pulmonary complications of pneumonia include pleurisy, pleural effusion, and atelectasis. Pleurisy is inflammation of the pleura that causes pain with breathing. Pleural effusion is the accumulation of fluid between the pleura that encases the lungs and the pleura that lines the thoracic cavity. A large amount of fluid can lead to collapse of the lung. Atelectasis refers to collapsed alveoli. Other, less common pulmonary complications of pneumonia are lung abscesses, delayed resolution, and empyema. Empyema is the presence of purulent exudate in the pleural cavity. Potential systemic complications include pericarditis, arthritis, meningitis, and endocarditis.

Signs and Symptoms

Usual symptoms of pneumonia are fever, chills, sweats, chest pain, cough, sputum production, hemoptysis (coughing up blood), dyspnea (difficulty breathing), headache, and fatigue. Older adults, however, may present with confusion, anorexia, and weakness but no fever or cough. People with bacterial pneumonia may experience an abrupt, almost explosive onset: severe, shaking chills; sharp, stabbing lateral chest pain, especially with coughing and breathing; and intermittent cough with rusty sputum. Viral pneumonia is characterized by burning or searing chest pain in the sternal

area; a continuous, hacking, barking cough producing small amounts of sputum; and headache.

Medical Diagnosis

Diagnosis of pneumonia is based on the findings of the history and physical examination, sputum culture and Gram stain, chest radiograph, complete blood count, and blood culture.

Medical Treatment

Treatment usually consists of increased fluid intake (at least 3 L every 24 hours), limited activity or bed rest, antipyretics, analgesics, and, in some cases, oxygen and aerosol intermittent positive-pressure breathing therapy. Bacterial pneumonias are treated with appropriate antibacterials; however, antibacterials are not used with viral pneumonias because they do not kill viruses.

Vaccination with the pneumococcal conjugate vaccine is recommended for all children under 24 months of age; children ages 24 to 59 months who have sickle cell disease, HIV infection, chronic disease, or immunosuppression; and children ages 24 to 59 months who are African American, Alaskan native, or Native American.

Vaccination with an unconjugated pneumococcal vaccine (e.g., Pneumovax 23) may be recommended for adults with chronic illnesses, particularly cardiovascular and respiratory diseases and diabetes mellitus; people recovering from a severe illness; people age 65 years and older; and older adults living in nursing homes or other long-term care facilities. Vaccination with the unconjugated vaccine is not recommended for children younger than 2 years. A booster may be given to selected patients after 6 years.

Nursing Diagnoses, Goals, and Outcome Criteria: Pneumonia

Nursing Diagnoses	Goals and Outcome Criteria
Ineffective Airway Clearance related to increased sputum production, thick secretions, ineffective cough	Effective airway clearance: clear breath sounds without wheezes or crackles
Impaired Gas Exchange related to obstruction of airways by edema and secretions or atelectasis	Adequate oxygenation: normal arterial blood gases, heart rate, and respiratory rate
Activity Intolerance related to obstruction of airways by edema and secretions or atelectasis	Improved activity tolerance: performance of daily activities without fatigue or dyspnea
Imbalanced Nutrition: Less Than Body Requirements related to anorexia, dyspnea, fatigue	Optimal nutritional status: stable body weight
Risk for Deficient Fluid Volume related to inadequate fluid intake, fever, mouth breathing	Normal hydration: fluid intake equal to fluid output, moist mucous membranes, blood pressure consistent with patient norms
Acute Pain related to inflammation, cough, muscle aches	Pain relief: patient statement of pain relief, relaxed appearance

NURSING CARE *of the Patient with Pneumonia*

Assessment

Assessment of the patient with a respiratory disorder is summarized in Box 30-1 (see also Nursing Care Plan: The Patient with Pneumonia on p. •••).

Interventions

Ineffective Airway Clearance

Accumulated secretions in the respiratory tract impair gas exchange and may result in alveolar collapse. Therapeutic measures are taken to decrease the production and promote the expectoration of secretions. Administer antimicrobials, decongestants, and expectorants as ordered. A good cough is essential for removal of secretions, but antitussives may be given as ordered if the patient becomes exhausted because of constant coughing. Encourage or assist the patient to change positions at least every 2 hours to help mobilize secretions. Other measures used to mobilize secretions are deep-breathing and coughing exercises, chest physiotherapy, and aerosol therapy. The patient who has a very weak cough may require suctioning. Provide tissues and a receptacle for disposal of secretions. Note the amount, color, and consistency of secretions. Auscultate lung sounds frequently to assess the effects of interventions to clear the airways.

Impaired Gas Exchange

The edema and secretions present with pneumonia interfere with the exchange of gases in the lungs. The patient may have hypoxemia, meaning that the level of oxygen in the blood is low. At the same time, excess carbon dioxide may accumulate in the blood, a condition called **hypercapnia.** Because normal oxygenation is essential for all body tissues, efforts must be made to improve the patient's gas exchange.

To assess gas exchange, monitor vital signs, lung sounds, and skin color. Be alert for signs of hypoxemia: restlessness, tachycardia, and tachypnea. If arterial blood gases are being measured, report abnormal results to the physician. Hemoglobin may also be measured. A low hemoglobin is significant because it indicates the reduced oxygen-carrying capacity of red blood cells.

Measures that mobilize secretions, discussed earlier, are important in improving gas exchange. In addition, elevate the head of the bed. Some patients are more comfortable in a reclining chair that permits alterations in position. A semi-Fowler's position decreases the

NURSING CARE PLAN

The Patient with Pneumonia

ASSESSMENT

Health History: Alice Guthrie, 77 years old, is a retired schoolteacher who complains of chills and fever, cough, sore throat, and chest pain. The physician diagnosed viral pneumonia and recommended hospitalization. Ms. Guthrie states she had a cold for about a week and seemed to get progressively worse. She states she has "a little" shortness of breath and tires very easily. Her chest pain is aggravated by coughing. She has been taking over-the-counter cold remedies. She has a history of hypertension and congestive heart failure for which she takes verapamil hydrochloride (Calan SR), 240 mg daily, and digoxin, 0.25 mg daily. Ms. Guthrie lives alone in a one-story apartment. She has a close friend next door who visits frequently.

Physical Examination: Vital signs: temperature, 100.6° F orally; pulse, 92; respiration, 24; blood pressure, 160/94. Alert, slightly dyspneic. Skin color pale. Nail beds slightly dusky. Lung sounds clear to auscultation over right lung fields. Wheezes and crackles auscultated in left lung. Frequent cough producing greenish sputum. No retractions or use of accessory muscles of respiration. Abdomen soft.

Nursing Diagnosis	*Goals and Outcome Criteria*	*Interventions*
Ineffective Airway Clearance related to increased sputum production and thick secretions	The patient will have a patent airway, as evidenced by clear breath sounds without wheezes or crackles.	Administer decongestants and expectorants as ordered. Administer antitussives as ordered if cough interferes with rest. Suction only if necessary. Turn, deep breathe, and cough at least every 2 hours. Perform chest physiotherapy and provide aerosol therapy as ordered. Assess response. Monitor lung sounds, respiratory rate, and characteristics of secretions. Dispose of tissues in a sanitary manner.
Impaired Gas Exchange related to obstruction of airways by edema and secretions or atelectasis	The patient will have adequate oxygenation, as evidenced by normal arterial blood gases and vital signs.	Monitor vital signs, lung sounds, skin color, blood gas reports, and level of consciousness. Be alert for signs of hypoxemia: restlessness, tachycardia, tachypnea. Report abnormal findings to physician. Elevate head of bed. Administer oxygen therapy as ordered.
Activity Intolerance related to fatigue or hypoxia	The patient will perform activities of daily living as ordered without excessive fatigue or dyspnea.	Instruct in activity restrictions. Plan care to allow periods of uninterrupted rest. Assist with activities of daily living as needed. Gradually encourage increased activity while monitoring for dyspnea and fatigue. Keep interactions short, and limit visitors.
Imbalanced Nutrition: Less Than Body Requirements related to anorexia, dyspnea, or fatigue	The patient will maintain optimal nutritional status, as evidenced by stable body weight.	Monitor food intake and weight. If intake is poor, consult with dietitian about patient preferences. Suggest small, frequent meals. Provide pleasant environment for meals. Position for comfort. Use oxygen cannula during meals if permitted. Weigh daily.
Risk for Deficient Fluid Volume related to inadequate fluid intake, fever, or mouth breathing	The patient's hydration will remain normal, as evidenced by fluid intake equal to output, moist mucous membranes, and blood pressure consistent with patient's norms.	Monitor fluid status for signs of fluid volume deficit: decreased skin turgor, concentrated urine, decreased urine output, dry mucous membranes, elevated hemoglobin and hematocrit levels. Administer intravenous fluids as ordered. Encourage fluids by mouth up to 3 L/day as permitted. Record intake and output. Monitor temperature and treat fever as ordered. Keep dry and lightly covered. Administer tepid sponge baths as ordered for fever, but do not induce shivering. Use hypothermia blanket as ordered.
Acute Pain related to inflammation, cough, or muscle aches	The patient will report pain relief, as measured with a pain scale.	Use a pain scale to assess pain. Administer analgesics as ordered. Reposition for comfort. Splint painful areas during coughing and deep breathing. Use massage and relaxation techniques. Document effects of interventions.

? CRITICAL THINKING QUESTIONS

- What are the benefits of using a pain scale?
- What are the risks that occur when patients self-medicate?

pressure of the abdominal organs on the diaphragm so the patient breathes more easily. Maintain oxygen therapy as ordered.

Activity Intolerance

Activity is usually restricted for the patient with pneumonia and may range from complete bed rest to limited activities. Schedule nursing care to prevent overtiring and to allow for periods of uninterrupted rest. Provide assistance as needed until the patient is able to resume self-care. Keep conversations short, and encourage visitors not to tire the patient with long visits. When the patient begins to resume activities of daily living, evaluate the ability to tolerate daily activities.

Imbalanced Nutrition: Less Than Body Requirements

Good nutrition is essential to combat the infection and to promote healing (see the Nutrition Concepts box on p. •••). Assess the patient's usual dietary habits to provide baseline information so that the diet may be individualized. Monitor weight to determine the adequacy of nutrition. Weigh the patient before breakfast using the same scale each time. Monitor albumin and lymphocyte blood counts to detect low levels that are common with inadequate protein.

A typical diet for the patient with pneumonia is a high-protein, soft diet. Unfortunately, fatigue, dyspnea, and anorexia may interfere with adequate food intake. Provide the diet as ordered, assist the patient with the meal if needed, and document intake. To enhance the appetite, provide oral care before meals, elevate the head of the bed, and arrange the tray in an attractive and convenient manner. The diet should conform to the patient's preferences as much as possible. If oxygen is needed, a nasal cannula is recommended during meals. If the patient tires quickly, more frequent meals with smaller servings may be better received.

Nutrition Concepts

1. Adequate fluids are needed to mobilize pulmonary secretions for expectoration.
2. Approximately 40% of patients admitted to intensive care units with acute respiratory failure are malnourished.
3. Nutritional support for patients with respiratory failure should begin within the first 3 to 4 days of hospitalization.
4. Patients who receive nutritional support are more easily weaned from ventilators than those who receive only intravenous glucose support.
5. A diet for patients who have been in acute respiratory failure should be high in nutrients.
6. Lung disease can substantially increase energy needs.
7. The patient who is malnourished is at increased risk for respiratory infections because of impaired immunity and possible impairment of defense mechanisms.
8. When a patient has a fever, each degree Celsius of elevation increases the metabolic rate 10% to 13%. For each degree Fahrenheit, the metabolic rate rises 7.2%.
9. Excessive intake of vitamin K–rich foods (cabbage, broccoli, cauliflower, asparagus, onions, spinach, fish, liver) can interfere with anticoagulation therapy.

Risk for Deficient Fluid Volume

The patient with pneumonia may lose excess fluid because of fever and mouth breathing, and fluid intake may be inadequate because of fatigue and dyspnea. Dehydration causes respiratory secretions to be thicker and more difficult to mobilize. Signs and symptoms of deficient fluid volume include decreased skin turgor, concentrated urine, dry mucous membranes, and elevated hemoglobin and hematocrit levels. Therefore the patient should consume 3 L of fluid a day unless contraindicated. If the patient's oral intake is low, intravenous fluids may be ordered. Hard candy, if permitted, stimulates thirst and fluid intake. Intake and output records may be kept.

Monitor the patient's temperature every 2 to 4 hours to detect fever. Administer antipyretics as ordered. Keep the patient dry and lightly covered. Keep the room at a comfortable temperature that avoids chilling. Tepid sponge baths may be given for high fevers as ordered, but do not induce shivering. A hypothermia blanket may be needed to reduce body temperature.

Pain

Treat pain with ordered analgesics. Also use positioning, splinting painful areas during deep breathing and coughing, and massage to promote comfort. Other measures to manage pain are detailed in Chapter 14. Document the effects of comfort measures, and notify the physician if pain is unrelieved or worsens.

Prevention of Aspiration Pneumonia

Aspiration pneumonia may be prevented by measures to avoid aspiration or to treat it promptly. If a patient is at risk for aspiration, keep suction equipment on hand. Position patients with dysphagia (difficulty swallowing) upright with the neck in a neutral position or slightly bent forward during meals. Because semisol-

Patient Teaching Plan

Pneumonia

The teaching plan for the patient with pneumonia should include the following points:

- Gradually increase your activities as you recover because fatigue may persist for several weeks.
- Avoid people with colds or other infections.
- You need plenty of rest, good nutrition, and 3 L of fluids each day (unless contraindicated!).
- Complete any prescribed drugs after discharge.

ids are swallowed more easily than thin liquids, thickening agents may be added to liquids.

If a patient is receiving enteral feedings, elevate the head of the bed while the feeding is being delivered and for 30 minutes afterward. Check tube position per agency policy before each bolus feeding or at specified intervals. The aspirated fluid can be tested for acidity to ensure tube placement. Measure residual before each bolus feeding. If it is greater than 100 mL, withhold the feeding and notify the physician.

Stop continuous feedings for 20 to 30 minutes before lowering the patient's head. If a patient must be kept flat, the best position is on the right side. Check residual every 4 hours. If the residual is 20% more than the hourly rate, consult the physician about reducing the rate of feeding.

To reduce the risk of aspiration, position the unconscious patient on alternating sides with the head of the bed elevated unless contraindicated. Do not put fluids in the patient's mouth until the presence of a gag reflex has been established.

If aspiration is suspected, use suction to try to remove the foreign material. A side-lying or slight Trendelenburg position, if not contraindicated, may promote drainage from the airway. Stop the enteral feeding until it is ruled out as the source of the aspirated material. Monitor the patient closely and notify the physician. Administer oxygen as ordered.

PLEURISY (PLEURITIS)

Pleurisy is inflammation of the pleura. The most common causes are pneumonia, tuberculosis, injury to the chest wall, pulmonary infarction, and tumors. The most characteristic symptom of pleurisy is abrupt and severe pain. The pain almost always occurs on one side of the chest, and patients can usually point to the exact spot where the pain is occurring. Breathing and coughing aggravate the pain.

Treatment of pleurisy is aimed at the underlying disease and at pain relief. Analgesics, anti-inflammatory drugs, antitussives, antimicrobials, and local heat therapy may be ordered.

NURSING CARE *of the Patient with Pleurisy*

Assessment

Assessment of the patient with a respiratory disorder is summarized in Box 30-1.

Interventions

Acute Pain

When the patient reports pain, obtain a complete description including location, severity, precipitating factors, and alleviating factors. Use analgesics and splinting of the affected side to relieve pain. It is helpful also to splint the rib cage when coughing. If ordered, apply heat to the painful area and give antitussives to decrease painful coughing. If bed rest is prescribed, assist the patient with regular position changes. Administer nonsteroidal anti-inflammatory drugs (NSAIDs) as ordered to reduce pain and inflammation. Monitor patients on NSAIDs for gastrointestinal distress and bleeding.

Nursing Diagnoses, Goals, and Outcome Criteria: Pleurisy

The primary nursing diagnoses when a patient has pleurisy are listed here. There may be other diagnoses related to the underlying cause of pleurisy.

Nursing Diagnoses	Goals and Outcome Criteria
Acute Pain related to inflammation	Pain relief: patient statement of pain relief, relaxed expression
Ineffective Breathing Pattern related to splinting, pleural effusion	Effective breathing pattern: vital signs within patient norms, normal breath sounds

Ineffective Breathing Pattern

Monitor the patient's breathing pattern with attention to the symmetry of chest movement. Encourage the patient to turn, take deep breaths and cough, and ambulate if permitted to mobilize secretions and maximize ventilation. Elevate the head of the bed to improve lung expansion. If pleural effusion develops, the patient experiences progressive dyspnea, decreased or absent breath sounds in the affected area, and decreased chest wall movement on the affected side. A thoracentesis may be done to remove the accumulated fluid. If the procedure is done at the bedside, the nurse assists as described in the Common Therapeutic Measures section on p. •••.

CHEST TRAUMA

Traumatic chest injuries fall into two major categories: (1) nonpenetrating injuries and (2) penetrating injuries. Nonpenetrating or blunt injuries most commonly result from automobile accidents, falls, or blast injuries. In automobile accidents, 40% of the people killed have sustained blunt injuries from the steering wheel. The extent of the injury depends on the force and impact of the trauma. Common nonpenetrating injuries include rib fractures, pneumothorax, pulmonary contusion, and cardiac contusion. Penetrating injuries most commonly

Patient Teaching Plan

Pleurisy

- Take deep breaths every 1 to 2 hours while awake.
- Sitting upright will make breathing more comfortable.
- If being discharged on NSAIDs:
  - Avoid aspirin because it increases the risk of bleeding.
  - Take NSAIDs with food, milk, or antacids if gastrointestinal distress occurs.

result from gunshot or stab wounds to the chest. Common penetrating injuries include pneumothorax and life-threatening tears of the aorta, vena cava, or other major vessels.

Chest trauma can result in changes in normal pressure relationships between air inside and outside the body, interference with normal breathing patterns and protective mechanisms such as cough, disturbances in blood flow to the lungs, swelling, and pain. Patients are therefore at risk for air entering the pleural space, infection and increased secretions in the tracheobronchial tree, hemorrhage, and abnormal fluid collection in the lung.

Signs and Symptoms

Signs and symptoms of chest injury may include obvious trauma to the chest wall (e.g., bruising); chest pain; dyspnea; cough; asymmetric movement of the chest wall; marked cyanosis of the mouth, face, nail beds, and mucous membranes; rapid, weak pulse; decreased blood pressure; deviation of the trachea; distended neck veins; and bloodshot or bulging eyes.

Medical Treatment

Immediate care of a person with a chest injury is directed at stabilization and prevention of further injury. Remove clothing to assess injury sites and to observe

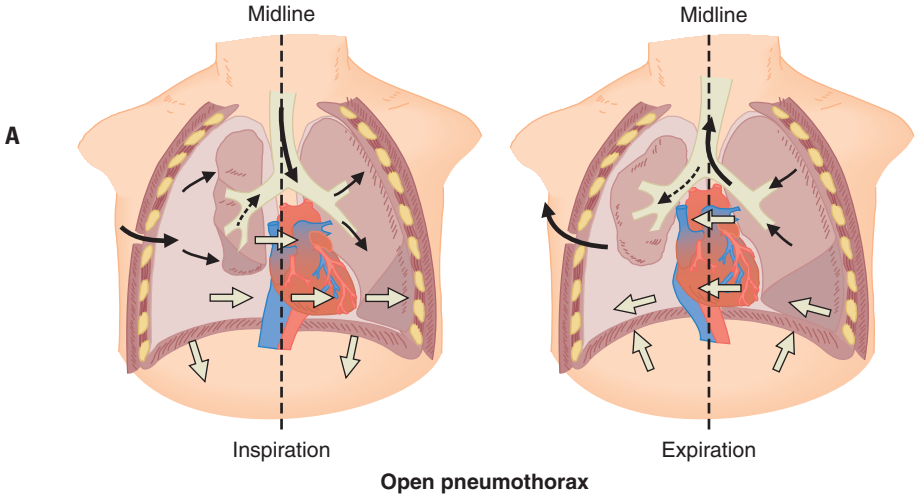

FIGURE **30-14** **A,** Open pneumothorax. *Solid and dashed arrows* = air movement; *open arrows* = structural movement. On inspiration, air is sucked into the pleural space through the open chest wound and the lung on the affected side collapses. The mediastinal contents shift toward the unaffected side. On expiration, air exits through the open wound and the mediastinal contents swing back toward the affected side (mediastinal flutter). **B,** An airtight dressing can cause a tension pneumothorax when air accumulates in the pleural space through a tear in the lung tissue. The air cannot exit if there is no open chest wound, and pressure builds, shifting the contents of the mediastinum toward the unaffected side and impairing circulatory and respiratory function (mediastinal shift).

for other injuries such as bleeding. Immediately treat bleeding. Cover any open chest wound with an airtight dressing taped on three sides. This is called a *vented dressing*; it permits air to escape through the chest wound but prevents additional air from entering the chest through the wound. If you were to completely seal an open chest wound, air could continue to leak from the lung into the pleural space. With no exit, the leaking air could accumulate in the pleural space and create a tension pneumothorax (discussed in the Pneumothorax section on p. •••).

If an airtight dressing has been applied, be alert for worsening respiratory status (increasing dyspnea, cyanosis, distended neck veins, trachea deviated from midline, decreased breath sounds on the affected side), which requires removal of the airtight dressing. Do not remove impaled objects but stabilize them with bulky dressings. Monitor vital signs and level of consciousness, keeping in mind the potential for shock. Oxygen may be administered by nasal cannula. To facilitate breathing, put the client in a semi-Fowler's position or on the injured side.

PNEUMOTHORAX

Chest injuries often cause pneumothorax, which is an accumulation of air in the pleural cavity that results in complete or partial collapse of a lung. Pneumothorax occurs in nearly half of the people who have chest injuries. Air enters the space between the chest wall and the lung either through a hole in the chest wall or through a tear in the bronchus, bronchioles, or alveoli (Fig. 30-14).

There are two types of pneumothorax: tension and open. With a tension pneumothorax, air repeatedly enters the pleural space with inspiration, causing the pressure to rise. Because air is not escaping from the wound, the accumulating pressure causes the affected lung to collapse. The heart, trachea, esophagus, and great blood vessels shift toward the unaffected side. This is called a *mediastinal shift*, a condition that interferes with blood return to the heart. This is a medical emergency because both the respiratory and circulatory systems are affected. If not corrected, cardiac output falls and the patient dies.

An open pneumothorax results from a chest wound that allows air to move in and out freely with inspiration and expiration. The lung on the affected side collapses. The heart, trachea, esophagus, and great blood vessels may shift back and forth toward the unaffected side with inspiration, then toward the affected side with expiration. This condition is called *mediastinal flutter.* Like mediastinal shift, it is potentially fatal.

Signs and Symptoms

Symptoms of pneumothorax are dyspnea, tachypnea, tachycardia, restlessness, pain, anxiety, decreased movement of the involved chest wall, asymmetric chest wall movement, diminished breath sounds on the injured side, and progressive cyanosis. In trauma cases, there may be a chest wound. If air can be heard or felt moving in and out of the wound, it is called a "sucking" chest wound.

Medical Treatment

The physician may insert an 18-gauge needle through the chest wall into the pleural space and aspirate accumulated air or fluid and then insert a chest tube. An alternative is to omit the needle aspiration and immediately insert the chest tube. If air is entering the pleural space from a tear in the lung or bronchus, surgery may be needed to repair the tear. A variety of materials are being studied for use in sealing persistent air leaks, including intrapleural tetracycline, autologous "blood patches," and fibrin glue.

NURSING CARE *of the Patient with Pneumothorax*

Assessment

The complete assessment of the patient with a respiratory disorder is outlined in Box 30-1. In addition, if the patient has a chest tube, monitor the insertion site as well as the amount and characteristics of any drainage from the tube. Care of patients with chest tubes is covered in the Chest Tubes section on p. •••.

Nursing Diagnoses, Goals, and Outcome Criteria: Pneumothorax

Nursing Diagnoses	Goals and Outcome Criteria
Ineffective Breathing Pattern related to decreased lung expansion	Effective breathing pattern: regular respirations, rate of 12 to 20/min, normal arterial blood gases, no dyspnea, normal skin color
Fear related to difficulty breathing	Decreased fear: calm demeanor, patient statement that fear is reduced
Decreased Cardiac Output related to mediastinal shift	Adequate cardiac output: pulse and blood pressure consistent with patient norms
Acute Pain related to trauma, altered pressure in chest cavity, chest tube	Pain relief: patient statement that pain is reduced/relieved, relaxed manner
Risk for Infection related to traumatic injury, chest tube insertion	Absence of infection: normal body temperature, normal white blood cell count

Interventions

Ineffective Breathing Pattern

Monitor the patient closely for increasing respiratory distress as indicated by tachycardia, dyspnea, cyanosis, restlessness, and anxiety. Inspect the trachea for deviation that may be caused by mediastinal shift. Check arterial blood gas results for hypoxemia (low blood oxygen) and hypercapnia (high blood carbon dioxide). Immediately report signs and symptoms of

deteriorating respiratory status to the physician. After the chest tube has been inserted, protect the tube and monitor its function as described on p. •••.

Position the patient for comfort in a Fowler's or semi-Fowler's position. Avoid the side-lying position until the affected lung has reexpanded, because this position could foster mediastinal shift. Support and encourage the patient to do deep-breathing and coughing exercises at least every 2 hours while awake. Administer oxygen as ordered.

Fear

A pneumothorax is frightening. Patients feel like they are suffocating and may fear they are dying. Speak to the patient calmly and explain what is happening. Tell the patient that the chest tube will allow the lung to reexpand and relieve the dyspnea. Also, tell the patient how to prevent dislodging the tube. Give the patient the opportunity to ask questions and express fears.

Decreased Cardiac Output

Monitor the patient's pulse and blood pressure. If cardiac output decreases because of mediastinal shift, the blood pressure falls and the pulse rate increases. Immediately notify the physician of signs of this potentially life-threatening change.

Acute Pain

Be alert for signs of pain, and document the characteristics of the patient's pain. Administer analgesics as ordered, and document the effects. In addition to drug therapy, use positioning, massage, distraction, and other measures described in Chapter 14. Notify the physician if pain is not relieved.

Risk for Infection

Monitor the patient for signs and symptoms of infection: fever, increased pulse and respirations, foul drainage from the tube insertion site, and elevated white blood cell count. Various possible sites of infection must be considered: traumatic wounds, chest tube insertion site, intravenous infusion sites, indwelling catheter, and lungs. Use sterile technique for invasive procedures and dressing changes, and administer prescribed antimicrobials. Encourage increased activity when permitted. Monitor hydration status and promote fluid intake of 2 to 3 L/day unless contraindicated. Before discharge, instruct the patient to keep the chest tube insertion site clean and dry and to notify the physician of signs of infection: fever or increasing redness, swelling, or drainage from the insertion site.

HEMOTHORAX

Hemothorax is an accumulation of blood between the chest wall and the lung that is often associated with pneumothorax. Hemothorax results from lacerated or torn blood vessels or lung tissues, lung malignancy, or pulmonary embolus. It may also be a complication of anticoagulant therapy. When air or blood collects in the pleural space, pressure around the lung increases, causing partial or complete collapse. Hemothorax is essentially treated like a pneumothorax, and the nursing care is similar. Surgical intervention may be needed to control the source of bleeding. In addition, the patient is at risk for decreased cardiac output due to hemorrhage.

RIB FRACTURES

Rib fractures are the most common chest injuries. The most common cause is a blunt injury, especially the impact of the steering wheel against the chest in an automobile accident. Ribs 5 through 10 are most frequently fractured because they are least protected by chest muscles. It takes approximately 6 weeks for rib fractures to heal.

Signs and Symptoms

Signs and symptoms of fractured ribs include pain at the site of injury (especially on inspiration), occasional bruising or surface markings, swelling, visible bone fragments at the site of the injury, and shallow breathing or holding the chest protectively to minimize painful chest movements.

Medical Treatment

Treatment is aimed at relief of pain so that the patient can have good chest expansion for adequate breathing. Intercostal nerve blocks with local anesthesia are most frequently used. Analgesics along with mild sedatives also may be given for pain relief. Strapping the chest with tape or binders was once common but is now avoided because this procedure constricts the expansion of the chest and restricts deep breathing, leading to complications such as pneumonia or atelectasis.

NURSING CARE *of the Patient with Rib Fractures*

Assessment

The nursing assessment of the patient with a respiratory disorder is outlined in Box 30-1. After rib fractures, the nurse is especially alert for signs of increasing respiratory distress that may indicate a pneumothorax caused by a bone fragment.

Nursing Diagnosis, Goal, and Outcome Criteria: Rib Fractures

The primary nursing diagnosis for the patient who has fractured ribs is Ineffective Breathing Pattern related to pain that occurs with ventilation. The goal of nursing care when a patient has fractured ribs is for the patient to have an effective breathing pattern. Outcome criteria include vital signs within normal range, absence of dyspnea, and breath sounds clear to auscultation.

Interventions

Breathing exercises are necessary to prevent pulmonary complications after rib fractures. Instruct the

patient in supporting the fractured ribs while deep breathing and coughing. The patient will perform these exercises better with adequate pain control. Assess the patient's pain every 2 hours, asking the patient to rank the pain from 0 (no pain) to 10 (worst pain imaginable). Encourage the patient to report pain, and offer reassurance that measures will be taken to provide relief. Because pain typically persists for 5 to 7 days, administer prescribed analgesics. After medications are given, provide a calm environment and encourage the patient to rest. Other nursing measures described in Chapter 14 (guided imagery, distraction, rhythmic breathing) may be used to manage pain as well. Evaluate the effects of pain management measures, and inform the physician if the patient's pain cannot be controlled.

FLAIL CHEST

The term *flail chest* refers to an injury in which two adjacent ribs on the same side of the chest are each broken into two or more segments. The affected section of the rib cage is, in a sense, detached from the rest of the rib cage. This permits it to move independently, so that the segment moves in with inspiration and moves out with expiration. The pattern of movement is exactly the opposite of the movement of an intact chest wall. Therefore it is called *paradoxical movement.* Ventilation is impaired, and the patient becomes hypoxemic. Also, contusion (bruising) of underlying lung tissue may cause fluid to accumulate in the alveoli. Fractured ribs may tear the pleura or the lung itself, resulting in a pneumothorax or a hemothorax. The loss of chest wall stability and collapse of a lung may permit the mediastinum to flutter, swinging back and forth with respirations. Progressive hypoxemia and hypercapnia may be fatal.

Signs and Symptoms

Signs and symptoms of flail chest include severe dyspnea, cyanosis, tachypnea, tachycardia, and paradoxical movement of the chest.

Medical Diagnosis

Diagnosis is based on the history, physical examination, and chest radiographs. Arterial blood gases may be measured to assess the adequacy of ventilation.

Medical Treatment

The treatment of flail chest varies depending on the severity of the condition. If the patient is able to maintain adequate oxygenation, treatment may consist of deep breathing and coughing, IPPB treatment, and pain management. The patient in respiratory distress usually requires intubation and mechanical ventilation. Radiographs and arterial blood gas tests are often repeated at intervals to monitor oxygenation and detect additional pulmonary complications such as pneumonia.

NURSING CARE *of the Patient with Flail Chest*

Assessment

The nursing assessment of the patient with a respiratory disorder is outlined in Box 30-1. When the patient has flail chest, defer the complete assessment until the patient's condition stabilizes. The initial assessment focuses on respiratory status, vital signs, other medical diagnoses, and a drug history.

Nursing Diagnoses, Goals, and Outcome Criteria: Flail Chest

Nursing Diagnoses	Goals and Outcome Criteria
Ineffective Breathing Pattern related to loss of rib cage integrity	Effective breathing pattern: normal pulse and respiratory rates, normal arterial blood gases, no dyspnea
Acute Pain related to fractures	Pain relief: patient statement of pain relief, relaxed manner
Anxiety related to lack of understanding of injury and treatment	Reduced anxiety: patient statement of reduced anxiety, calm manner

Interventions

Nursing interventions for patients with flail chest are similar to those for the patient with fractured ribs. Because flail chest is more serious and the patient may be acutely ill, anxiety may be very high. To reduce anxiety, respond promptly to the patient's needs, provide simple explanations, and acknowledge the patient's concerns. Anxiety may be especially high if mechanical ventilation is needed. The detailed care of patients who require mechanical ventilation is beyond the scope of this book. A general discussion of mechanical ventilation is included in the Common Therapeutic Measures section on p. •••.

PULMONARY EMBOLUS

An *embolus* is a foreign substance that is carried through the bloodstream. Emboli are usually blood clots but may be fat, air, tumors, bone marrow, amniotic fluid, or clumps of bacteria.

Etiology and Risk Factors

Risk factors for development of emboli include surgery of the pelvis or lower legs, immobility, obesity, estrogen therapy, and clotting abnormalities. Most pulmonary emboli originate in the deep veins of the thigh or pelvis. A thrombus that develops in the veins can break away and become an embolus. The embolus flows with the blood until it reaches a vessel too narrow to pass through. The embolus lodges and obstructs blood flow so that perfusion to the area is diminished. When a portion of a pulmonary blood vessel is occluded by an embolus, the patient is said to have a *pulmonary embolism* (PE). The effects depend on the extent of the lung tissue that is deprived of blood. Small emboli usually do not cause dramatic symptoms but disrupt perfusion nevertheless. The alveoli in the affected area

are ventilated, but without blood flow, gas exchange cannot occur. The result is a ventilation-perfusion mismatch that results in hypoxemia. If a large pulmonary vessel is obstructed, alveoli collapse, cardiac output falls, there is constriction of the bronchi and the pulmonary artery, and sudden death may ensue.

Signs and Symptoms

Classic signs and symptoms of PE include sudden chest pain that worsens with breathing, tachypnea, and dyspnea. A spontaneous onset of chest wall tenderness without a history of trauma should raise a red flag. The patient may be apprehensive and diaphoretic with a cough and hemoptysis. Crackles may be heard on auscultation of the lungs, and the patient may have fever and tachycardia.

Medical Diagnosis

A diagnosis of PE is suggested by the history and physical findings and is confirmed by arterial blood gas analysis, electrocardiogram, lung scan, and pulmonary angiogram.

Medical and Surgical Treatment

Anticoagulation therapy is the cornerstone of treatment for PE. Intravenous heparin is usually given to establish and maintain a partial thromboplastin time of 2.0 to 2.5 times the normal rate. Heparin prevents the development of new thrombi; it also prevents the extension of existing thrombi but does not dissolve them. The heparin is eventually discontinued, and the patient is maintained on an oral anticoagulant (warfarin sodium) for up to 6 months. Tissue plasminogen activator, a fibrinolytic, may be given intravenously to dissolve the clots.

Hypoxemia may be managed with oxygen therapy, endotracheal intubation, and mechanical ventilation. Intravenous fluids and drugs to improve cardiac function are indicated to treat hypotension. Intravenous morphine sulfate is commonly used to relieve chest pain and apprehension.

A number of surgical interventions have been used for PE, including embolectomy, vena cava interruption, and venous thrombectomy. Embolectomy, surgical removal of the embolus from the obstructed pulmonary arteries, is a risky procedure and is reserved for patients who are not candidates for fibrinolytic therapy. Vena cava interruption is most often done by placing a filter in the inferior vena cava to strain clots before they reach the pulmonary circulation (Fig. 30-15). Venous thrombectomy, removal of thrombi from veins, is not often done.

NURSING CARE *of the Patient with a Pulmonary Embolus*

Assessment

Assessment of the patient with a respiratory disorder is outlined in Box 30-1. When a patient has a PE, the nurse must monitor cardiopulmonary function but also must assess risk factors that may have led to the embolism. Homans' sign should be assessed in each leg. If this causes pain behind the knee or in the calf, the patient is said to have a positive Homans' sign, which is often associated with thrombophlebitis.

Nursing Diagnoses, Goals, and Outcome Criteria: Pulmonary Embolism

Nursing Diagnoses	Goals and Outcome Criteria
Ineffective Tissue Perfusion related to interruption of blood flow to the alveoli	Normal tissue perfusion: vital signs consistent with patient norms, no dyspnea, normal arterial blood gases

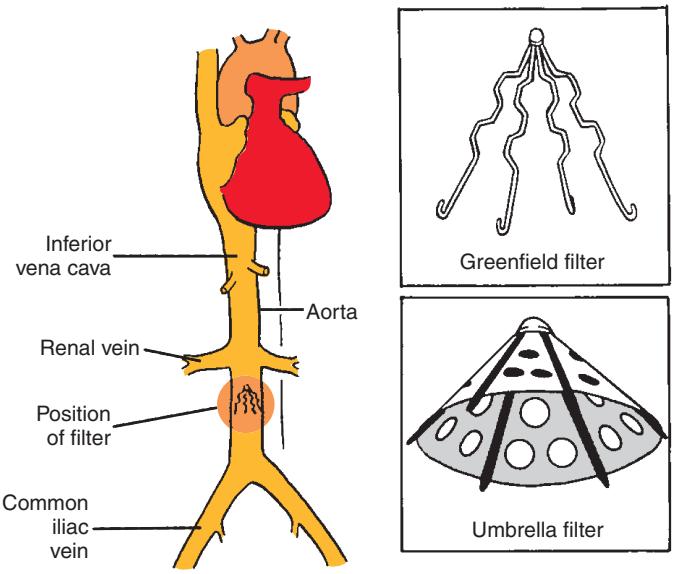

FIGURE **30-15** Greenfield and umbrella filters are examples of filters that may be placed in the inferior vena cava to prevent emboli traveling to the lung.

Anxiety related to dyspnea, fear of dying	Reduced anxiety: patient statement of less or no anxiety, calm manner
Risk for Injury related to anticoagulant therapy	Decreased risk of excessive bleeding: prothrombin time within therapeutic range, absence of excessive bruising or bleeding

Interventions

Ineffective Tissue Perfusion

Monitor the patient's respiratory rate and effort, breath sounds, skin color, pulse, and blood pressure. Note arterial blood gas results as a measure of **tissue perfusion,** and notify the physician if they are abnormal. Elevate the head of the patient's bed. Administer oxygen as ordered, usually by nasal cannula. Enforce strict bed rest or other prescribed activity limitations to decrease oxygen demands. Administer prescribed intravenous fluids and inotropic drugs. Measure and record fluid intake and output.

Interventions to decrease the risk of further emboli include active and passive range-of-motion exercises for immobilized patients, early ambulation after surgery, and antiembolism and pneumatic compression stockings. Do not place cushions and pillows under the legs where circulation might be impaired.

Put on Your Thinking Cap!

To prevent emboli, we recommend compression stockings and avoidance of pressure under the legs. This sounds like a contradiction! How can you explain the value of each intervention?

Anxiety

The patient in respiratory distress and pain is understandably anxious. Remain calm, and tell the patient what is being done. Explain equipment and procedures in terms the patient can understand. Encourage the patient to express concerns and ask questions. Permit a reassuring family member to remain with the patient.

Risk for Injury

Anticoagulant therapy poses a risk of uncontrolled bleeding. While the patient is hospitalized, assess for excessive bruising or bleeding. Symptoms that may be caused by internal bleeding include severe headache and abdominal or back pain. Inspect the urine for hematuria. Apply pressure to venipuncture sites to control bleeding.

To reduce the risk of bleeding, the patient's activated partial thromboplastin time is monitored every 1 to 2 days until stabilized at 1.5 to 2.5 times the normal rate. Patients with a PE are usually changed to warfarin sodium (Coumadin), an oral anticoagulant, after receiving heparin for a week or so. The effect of warfarin sodium is monitored by assessing the prothrombin time (PT), which should be 1.5 to 2.0 times the normal (control) rate, and the INR, which should be 2.0 to 3.0. The dosage is adjusted daily based on PT and INR.

Pharmacology Capsule

Monitor the patient's activated partial thromboplastin time when on heparin and monitor the prothrombin time and INR when on warfarin sodium to determine the extent of anticoagulation. Watch for bleeding.

Patient Teaching Plan

Pulmonary Embolism

Patients who have had a PE must be taught how to manage their anticoagulant therapy because they usually remain on these drugs for at least several months. The following are important points:

- Use soft toothbrush and electric razor to avoid trauma and bleeding.
- Report red or dark urine, which suggests urinary bleeding.
- Report vomited blood, nosebleed, and red or black stools, which suggest intestinal bleeding.
- Do not take any over-the-counter medications without consulting with the physician or pharmacist. Some drugs, especially aspirin, prolong the bleeding time, which could cause excessive bleeding.
- To reduce the risk of a future PE, avoid constricting clothing such as garters or tight girdles and avoid prolonged pressure on the back of the knee.

RESPIRATORY ARREST

Respiratory arrest, the cessation of breathing, is addressed in Chapter 15.

ACUTE RESPIRATORY DISTRESS SYNDROME

Etiology and Risk Factors

Acute respiratory distress syndrome (ARDS) is a progressive pulmonary disorder that follows some trauma to the lung. From 1 to 96 hours after the trauma, pulmonary infiltrates develop and lung compliance decreases. Fluid shifts into the interstitial spaces in the lungs and into the alveoli, causing pulmonary edema. Production of pulmonary surfactant decreases,

leading to atelectasis. Lung compliance decreases, and the patient rapidly becomes hypoxemic.

Some patients recover and heal completely, whereas lung fibrosis develops in others. The fibrosis may be mild or severe and sometimes occurs after the patient appears to be recovering. Progressive fibrosis may lead to death. Systemic complications of ARDS include cardiac dysrhythmias, renal failure, stress ulcers, thrombocytopenia, and disseminated intravascular coagulation. In addition, these patients are at risk for oxygen toxicity and sepsis.

Signs and Symptoms

The first sign of ARDS is usually increased respiratory rate. Auscultation of the lungs may reveal fine crackles. The patient may be restless, agitated, and confused. The pulse rate increases, and a cough may be present. These early signs are followed by progressively worsening dyspnea with retractions, cyanosis, and diaphoresis. Diffuse crackles and rhonchi may be heard on auscultation.

Medical Diagnosis

Acute respiratory distress syndrome is suspected on the basis of the patient's history and physical findings. Diagnostic studies include arterial blood gas analysis and chest radiographs. The blood pH rises and the $Paco_2$ falls at first because of hyperventilation. The PaO_2 falls below 70 mm Hg despite oxygen concentrations greater than 40% (FiO_2 0.4). Hypoxemia in spite of supplemental oxygen administration is a cardinal sign of ARDS. This hypoxemia causes respiratory acidosis, as evidenced by pH below 7.35.

Medical Treatment

Early detection and treatment are critical factors in treating ARDS successfully. The patient is usually intubated and placed on a mechanical ventilator with positive end-expiratory pressure. Patient anxiety and restlessness may require sedation or even pharmacologic paralysis. Specific drug therapy depends on the underlying cause of ARDS. For example, the patient with sepsis is treated with antimicrobials Corticosteroids are commonly used to reduce inflammation with ARDS, but there is some question about the value of this treatment.

NURSING CARE *of the Patient with Acute Respiratory Distress Syndrome*

The patient with ARDS is critically ill and should be treated in an intensive care setting. Critical care nursing is beyond the scope of this text. However, all nurses must be aware of the risk of ARDS and respond promptly when a patient exhibits progressive respiratory distress. The rapid progression of the condition is frightening to the patient and the family. Recognize their anxiety and fear and offer emotional support and simple explanations.

Key Points

- The function of the respiratory system is to supply oxygen for the metabolic needs of the cells and to eliminate carbon dioxide, one of the waste materials of cell metabolism.
- Age-related changes in the respiratory system include loss of lung elasticity, enlargement of bronchioles, decreased number of alveoli, thoracic rigidity, atrophy of chest muscles, and flattening of the diaphragm.
- A thoracentesis is the insertion of a needle through the chest wall into the pleural space to remove fluid, blood, or air or to instill medication.
- Chest physiotherapy, which consists of percussion, vibration, and postural drainage, mobilizes respiratory secretions for expectoration.
- Oxygen therapy is widely used and generally safe but must be used cautiously in chronic respiratory patients to avoid respiratory depression.
- Chest tubes drain fluid and air from the pleural space, permitting a collapsed lung to reexpand.
- Nursing diagnoses after thoracotomy may include Impaired Gas Exchange, Ineffective Breathing Pattern, and Ineffective Airway Clearance.
- Drugs commonly used for treatment of respiratory disorders include decongestants, antitussives, antihistamines, expectorants, antimicrobials, bronchodilators, corticosteroids, mast cell stabilizers, and leukotriene inhibitors.
- Acute viral rhinitis (the common cold), the most prevalent infectious disease, is treated symptomatically because available antimicrobials are not effective against the cold virus.
- Influenza is an acute viral respiratory infection that can lead to pneumonia, especially in debilitated people.
- Influenza immunizations do not protect everyone from influenza but do reduce the incidence of the infection and are recommended for people who have poor resistance to infection.
- Pneumonia may be caused by pathogenic organisms or by noninfectious agents such as inhaled irritants, including aspirated gastric contents.
- Nursing diagnoses for the patient with pneumonia may include Ineffective Airway Clearance, Impaired Gas Exchange, Activity Intolerance, Imbalanced Nutrition: Less Than Body Requirements, Risk For Deficient Fluid Volume, and Acute Pain.
- Pleurisy (pleuritis) is inflammation of the pleura that is treated with analgesics, anti-inflammatory drugs, antitussives, antimicrobials, and local heat therapy.
- Nursing diagnoses for the patient with pleurisy may include Acute Pain and Ineffective Breathing Pattern.
- Pneumothorax is the accumulation of air in the pleural space, which may cause the lung to collapse.
- The immediate treatment of an open chest wound is coverage with a vented dressing followed by careful monitoring to detect signs of a tension pneumothorax.
- With a tension pneumothorax, air accumulates in the affected side, collapsing the affected lung and causing the heart, trachea, esophagus, and great blood vessels to shift toward the unaffected side (mediastinal shift, a life-threatening condition).

- Nursing diagnoses when a patient has chest trauma may include Ineffective Breathing Pattern, Fear, Decreased Cardiac Output, Acute Pain, and Risk For Infection.
- Flail chest is the loss of thoracic integrity caused by fractures of two adjacent ribs into two or more segments on the same side of the chest.
- A pulmonary embolus is a foreign substance carried through the bloodstream into the lung, where it lodges and blocks blood flow.
- Nursing diagnoses for the patient who has a pulmonary embolism may include Ineffective Tissue Perfusion, Anxiety, and Risk for Injury.
- Adult respiratory distress syndrome, a progressive pulmonary disorder that may lead to fibrosis of lung tissue and death, is treated with mechanical ventilation and treatment of the underlying cause.

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REVIEW QUESTIONS *Choose the best answer.*

1. Where is the respiratory center located?
   1. Lungs
   2. Alveoli
   3. Brain
   4. Aorta

2. Age-related changes in the respiratory system include the following:
   1. Elevated diaphragm
   2. Atrophy of bronchioles
   3. Respiratory muscle hypertrophy
   4. Rib cage rigidity

3. Which of the following is the best example of documentation of the respiratory assessment?
   1. Patient expectorated moderate amount of tenacious, green sputum.
   2. Patient reports coughing up lots of mucus this shift.
   3. Physical activity seems to cause patient to have severe coughing spells.
   4. Patient is coughing up less sputum today than yesterday.

4. Your patient has a pulse oximeter. The current oxygen saturation is 96%. You should:
   1. Notify the registered nurse or physician immediately
   2. Document the reading and continue routine monitoring
   3. Increase the patient's oxygen to at least 5 L/min
   4. Request arterial blood gases to confirm the oximetry reading

5. Several days after thoracic surgery, your patient's respiratory status is normal. When checking the chest tube drainage system, you observe that there is no bubbling in the water-seal chamber. This could mean that:
   1. There is a leak in the drainage system
   2. The patient's affected lung has reexpanded
   3. It is time to change the drainage receptacle
   4. The patient's affected lung has collapsed

6. A community education project is designed to encourage older adults to have influenza immunizations. A participant asks about the difference between influenza and the common cold. What is the most appropriate reply?
   1. Influenza is actually just a very severe cold.
   2. Colds are caused by bacteria; influenza is caused by a virus.
   3. Influenza is more likely to cause fever and chills.
   4. They are equally likely to have serious complications.

7. A patient who has pneumonia has become restless; vital signs are: T = 100° F, P = 110, R = 28, BP = 130/72. You should suspect:
   1. Fluid volume excess
   2. Dehydration
   3. Excess potassium
   4. Hypoxemia

8. In the emergency care of a patient who has a sucking chest wound, why is a vented dressing preferred over a dressing that completely seals the wound?
   1. The vented dressing permits the drainage of blood from the pleural sac.
   2. Sealing the wound increases the risk of bacterial contamination.
   3. The vented dressing prevents air from escaping from the injured lung.
   4. Sealing the wound could lead to a tension pneumothorax.

9. A patient who comes into the ER after a traffic accident is in respiratory distress. You observe that a part of the rib cage moves inward with inspiration and outward with expiration. This pattern is described as:
   1. Paradoxical movement
   2. Tension pneumothorax
   3. Compensatory breathing
   4. Cheyne-Stokes respirations

10. Measures to prevent pulmonary embolism in postoperative patients include the following:
    1. Splinting extremities to limit movement
    2. Assisting with range-of-motion exercises
    3. Enforcing bed rest until wound healing is complete
    4. Supporting the legs with pillows to promote circulation