CHAPTER 45

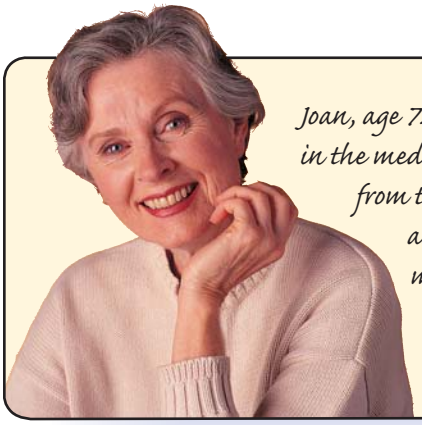
Oxygenation

Tyrone Jacobs

Tyrone, age 12, is brought to the emergency room gasping for breath. His parents are frantic. "It just seemed like he had a really bad cold," his mother says. An acute asthma attack is suspected, and measures are instituted immediately to protect the child's airway.

Yan Kim

Yan, age 57, developed respiratory failure from complications associated with pulmonary surgery. He is receiving oxygen therapy and mechanical ventilation via an endotracheal tube and undergoing continuous cardiac monitoring.



Joan McIntyre

Joan, age 72, has a tracheostomy and is receiving mechanical ventilation in the medical intensive care unit. Efforts are being made to wean her from the ventilator, but she has been unable to breathe on her own for any length of time. She has written notes asking the staff to "let me go" the next time she fails to be weaned.

Focusing on Blended Skills

The types of blended skills you'll need to respond to the case scenarios include:

Cognitive Skills

- Knowledge of the anatomy and physiology of the respiratory system and the factors that affect respiratory function
- Ability to incorporate knowledge of the nursing process to identify and care for patients with respiratory problems
- Knowledge of developmental variables affecting respiratory function
- Knowledge of normal and abnormal assessment findings such as breath sounds and respiratory parameters
- Knowledge of medications used to treat respiratory problems such as asthma
- Knowledge of measures used to treat problems involving oxygenation

Technical Skills

- Ability to use the equipment and protocols necessary to diagnose and treat respiratory problems
- Strong history and physical assessment techniques to identify problems associated with alterations in respiration and oxygenation
- Competence in particular skills, such as administration of inhaled medications, ventilatory assistance, oxygen therapy, and tracheostomy care
- Ability to ask for assistance when necessary when obtaining the nursing history or completing the physical examination or performing procedures to promote adequate oxygenation
- Ability to use measures to promote proper breathing and comfort
- Ability to adapt technical assistance related to oxygenation to meet the needs of patients at different developmental stages

Interpersonal Skills

- Strong people skills to establish trusting relationships with patients experiencing problems with respiratory functioning
- A good working relationship with colleagues to ensure competent multidisciplinary care
- Ability to communicate concern about patient, patient's complaints, and situation
- Demonstration of respect for patient's human dignity to promote patient's self-esteem
- Ability to use therapeutic communication effectively to meet the needs of patients at different developmental stages and with different abilities to communicate verbally
- Ability to interact with patients at different developmental stages, ensuring that care meets the developmental needs of each

Ethical and Legal Skills

- Strong sense of accountability for the health and well-being of patients experiencing respiratory problems and their families
- Ability to act as patient advocate to ensure competent care
- Knowledge of patients' and families' rights related to refusal of care
- Ability to consult with other members of the healthcare team to ensure the patient's safety
- Ability to practice in an ethically and legally defensible manner, maintaining the patient's rights, including the right to refuse care and the right to self-determination
- Ability to integrate ethical and legal principles into patient assessments, documentation, and communication

Learning Objectives

After completing the chapter, you will be able to accomplish the following:

1. Describe the principles of respiratory physiology.
2. Describe age-related differences that influence the care of patients with respiratory problems.
3. Identify factors that influence respiratory function.
4. Perform a comprehensive respiratory assessment using appropriate interview questions and physical assessment skills.
5. Develop nursing diagnoses that correctly identify problems that may be treated by independent nursing interventions.
6. Describe nursing strategies to promote adequate respiratory functioning and identify their rationale.
7. Plan, implement, and evaluate nursing care related to select nursing diagnoses involving respiratory problems.

Key Terms

adventitious
alveoli
atelectasis
bradypnea
bronchial
bronchodilator
bronchovesicular
cilia
crackles
diffusion
dry powder inhaler (DPI)
dyspnea
endotracheal tube
expiration
hemothorax
hyperventilation
hypoventilation
hypoxemia
hypoxia
inspiration
metered-dose inhaler (MDI)
nasal cannula
nebulizer
perfusion
pleural effusion
pleural friction rub
pneumothorax
pulmonary ventilation
pulse oximetry
respiration
spirometer
sputum
surfactant
tachypnea
thoracentesis
tracheostomy
vesicular
wheezes

Many people take respiratory function for granted, but an adequately functioning respiratory system is necessary for life. The respiratory system delivers oxygen to the cells and also removes carbon dioxide. The air passages must remain patent (open) for oxygen to enter the system. Any condition that interferes with normal functioning may cause pulmonary distress, which could lead to death. (See the accompanying Reflective Practice box for an example.)

This chapter describes the respiratory system's anatomy and physiology and general factors affecting respiratory functioning and oxygenation, the process of providing cells life-sustaining oxygen. Practical suggestions for performing a comprehensive respiratory assessment are presented, including sample interview questions for both a general and focused respiratory history, a description of the nursing examination, and laboratory and radiologic studies. After analyzing the data collected, nurses decide whether the respiratory data lead to a problem statement, indicate another problem, or are the possible cause of a problem. The chapter provides numerous examples of nursing diagnoses. Expected patient outcomes and specific nursing strategies for implementation are described. The concluding patient care study illustrates how, with knowledge of respiratory functioning and skilled nursing interventions, the nurse cares for a patient with respiratory problems.

ANATOMY AND PHYSIOLOGY OF RESPIRATION

The respiratory system performs its functions through pulmonary ventilation, respiration, and perfusion.

Normal functioning depends on essentially three factors:

- The integrity of the airway system to transport air to and from the lungs
- A properly functioning alveolar system in the lungs to oxygenate venous blood and to remove carbon dioxide from the blood
- A properly functioning cardiovascular and hematologic system to carry nutrients and wastes to and from body cells

Knowledge of the basic anatomy and physiology of the respiratory system provides a firm foundation for assessing this system and planning and implementing interventions to promote optimal respiratory function. This knowledge also helps nurses understand, interpret, and analyze assessment findings and provides the rationale for sound nursing interventions.

Understanding The Respiratory System

Structures

The airway, which begins at the nose and ends at the terminal bronchioles, is a pathway for the transport and exchange

Reflective Practice

Challenge to Technical Skills

Ventilators and telemetry have always intimidated me, so having a patient like Yan Kim was overwhelming. A 57-year-old man who had developed respiratory failure from complications secondary to pulmonary surgery, he was receiving oxygen therapy and mechanical ventilation via an endotracheal tube. Mr. Kim was also undergoing continuous cardiac monitoring. Providing care for him with all his equipment and so many alarms that could sound seemed insurmountable. The monitor had several different values on it and the continuous electrocardiogram (ECG) monitor always made me feel like the patient was on the verge of dying. We had not covered these skills yet in class, and I felt incompetent for the first 2 weeks of my critical care clinical experience. I could have voiced my concerns with these two machines, and I should have asked the first day what I should and shouldn't be worried about with critical care patients. But I didn't.

Thinking Outside the Box: Possible Course of Action

- Ask my instructor if there was any danger in having a patient who was receiving mechanical ventilation and being monitored by telemetry.
- Ask for someone to explain the ECG waveforms on the monitor and what to be concerned with when looking at them.
- Avoid caring for patients on ventilators and undergoing telemetry.

Evaluating a Good Outcome: How Do I Define Success?

- Patient is safe and receives care by a competent care provider promoting his health.
- I am confident in my technical skills and able to use technology to deliver the most helpful care.
- I continue to ask questions, challenge my practice, and learn to contribute to improved care, which will lead to enhanced nursing.

Personal Learning: Here's To the Future!

Fortunately our clinical rotations are planned so that we do not take care of critical care patients until we learn the necessary skills (telemetry and ventilation). This semester in my critical care clinical experiences, my fears have dissipated. I have learned that having patients that are being monitoring continuously via telemetry is quite reassuring: it serves as a constant monitor for me. Although I still assess the patient on my own, having continuous values to check is reassuring. As for the ventilator, I realized I knew a lot more than I thought. My instructor gave me a lesson on the ventilator during my clinical experience and connected the class lectures and book work with what I was seeing with my patient. I asked many questions and checked to see if I knew which settings would change with different scenarios. There are several settings and several values constantly being measured with the machine. Once I was able to see what all of these numbers meant and realized that I understood what each was for, I felt much more comfortable with patients on a ventilator. I realized my concerns and made sure that I provided unbiased care so that my concerns did not force me to neglect a patient.

Before, I would have been scared to get too close to the machine for fear of hitting the wrong button, fearing I would harm the patient. Now I am learning how the settings are specific to each patient. I feel comfortable reading the values and setting the controls. Still, I ask questions about the ventilator and telemetry readings because I want to know that I am interpreting them correctly. I feel it is my responsibility to obtain as much understanding and knowledge as I can so that I can provide the best care to these patients. This is very relieving and rewarding: now critical care patients don't seem so critical! My care for these patients is enhanced since I am more confident in my skills, and this enhances the care I deliver. Next time there is something new to me, I will voice my concern early on even if I am not "supposed to know" yet.

Overall, although I do not yet have much experience, I feel technically competent as a senior nursing student. I am confident because I challenge myself and I am self-motivated when it comes to searching for more information when needed.

Reflection

How would you respond in a similar situation? Why? What does this tell you about yourself and about the adequacy of your skills for professional practice? How did the nursing student apply the knowledge obtained through the lessons given by the instructor? How do you think the nursing student would have responded if the clinical experience was strictly observational? What information did the nursing student receive from the monitors? How did the nursing student use this information? What interventions did the nursing student implement to care for the patient's psychosocial status? Can you think of other ways to respond? What other skills (cognitive, interpersonal, technical, ethical/legal) would you need to respond well in this situation? Do you agree with the criteria to evaluate a successful outcome? Are there any other criteria that would be appropriate to use? Did the nursing student meet the criteria? Why or why not?

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of oxygen and carbon dioxide. The airway is divided into the upper and the lower airways.

The upper airway is composed of the nose, pharynx, larynx, and epiglottis. Its main function is to warm, filter, and humidify inspired air. The lower airway, known as the tracheobronchial tree, includes the trachea, right and left mainstem bronchi, segmental bronchi, and terminal bronchioles (Fig. 45-1). Its major functions are conduction of air, mucociliary clearance, and production of pulmonary surfactant.

The airways are lined with mucus, which traps cells, particles, and infectious debris. This mucus covering also helps to protect the underlying tissues from irritation and infection. **Cilia,** which are microscopic hair-like projections, propel trapped material and accompanying mucus toward the upper airway so they can be removed by coughing. Removal is facilitated when mucus is watery in consistency. An adequate fluid intake is necessary for the production of watery mucus normally present in the respiratory tract and for ciliary action.

The lungs, the main organs of respiration, are located within the thoracic cavity on the right and left sides (see Fig. 45-1). The lungs extend from the base at the level of the diaphragm to the apex (top), which is above the first rib. The heart lies between the right and left lung.

Each lung is divided into lobes. The right lung has three lobes; the left has two. Each lobe is subdivided into segments or lobules. The right lung has 10 bronchopulmonary segments; the left has 8. The main bronchus branches to each lung from the trachea. It immediately subdivides into secondary bronchi, one to each lobe. The bronchi subdivide again and again, becoming smaller and smaller as they branch through the lung. The smallest of these branches are the bronchioles, ending at the terminal bronchioles. The lungs are composed of elastic tissue that can stretch or recoil. Normally, the elastic fibers are partially stretched at all times, thus partially filling the thoracic cavity.

At the end of the terminal bronchioles there are clusters of **alveoli** (singular, alveolus), small air sacs. The alveoli are the site of gas exchange. The wall of each alveolus is made of a single-cell layer of squamous epithelium. (see Fig. 45-1). This thin wall allows for exchange of gases with the capillaries covering the alveoli. The average adult has more than 300 million alveoli. **Surfactant,** a detergent-like phospholipid, reduces the surface tension between the moist membranes of the alveoli, preventing their collapse. When surfactant production is reduced, the lung becomes stiff and the alveoli collapse.

The lungs and thoracic cavity are lined with a serous membrane called the pleura. The visceral pleura covers the lungs, and the parietal pleura lines the thoracic cavity. These two membranes are continuous with each other and form a closed sac. The pleural space lies between the two layers. Pleural fluid between the membranes acts as a lubricant and

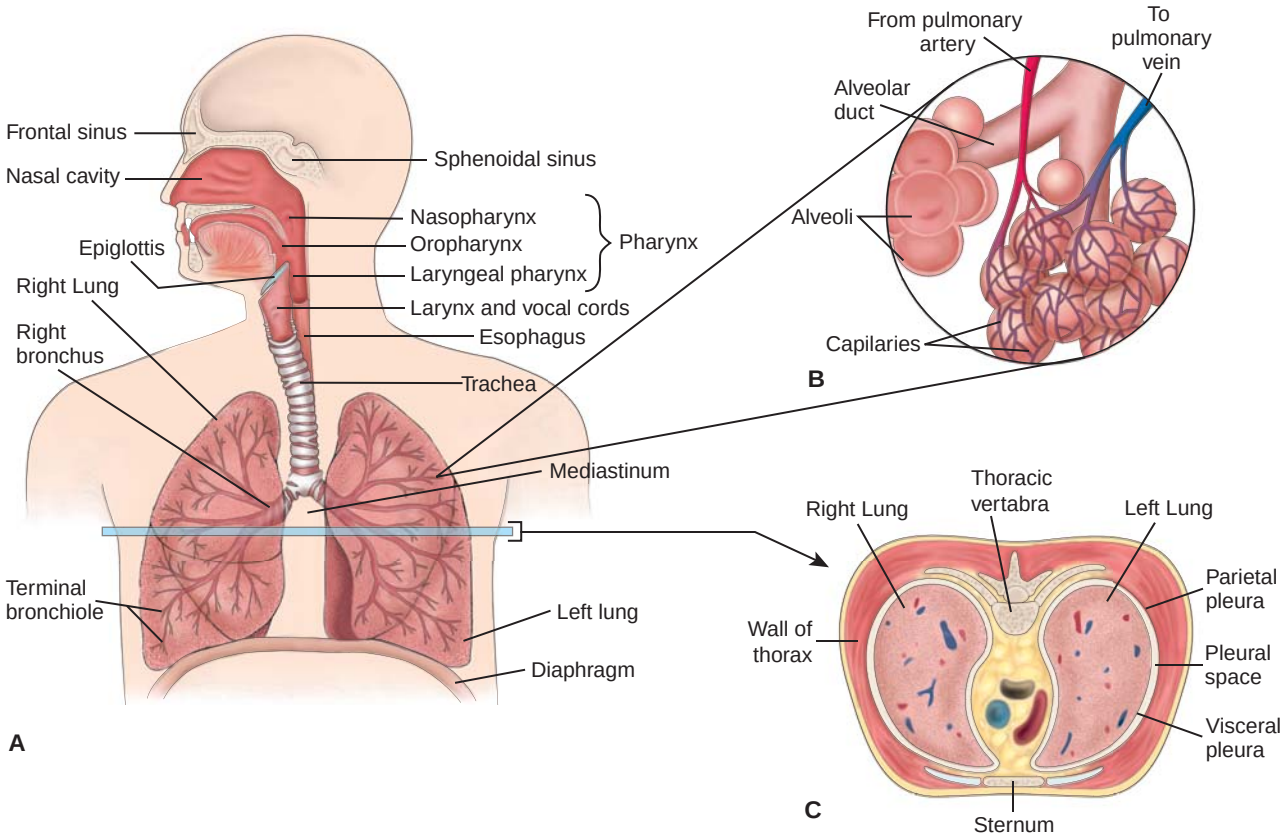


Figure 45-1. The organs of the respiratory tract. (**A**) Overview. (**B**) Alveoli (air sacs) of the lungs and the blood capillaries. (**C**) Transverse section through the lungs.

as an adhesive agent to hold the lungs in an expanded position. A few milliliters of fluid between the pleural surfaces allows the lungs to move easily along the chest wall as they expand and contract. Without this fluid, filling and emptying of the lungs are difficult.

Pressure within the pleural space (intrapleural pressure) is always subatmospheric (a negative pressure). This constant negative intrapleural pressure, along with the pleural fluid, holds the lungs in an expanded position.

Physiology of the Respiratory System

Living cells require oxygen and the removal of carbon dioxide, a byproduct of oxidation. Gas exchange, the intake of oxygen and the release of carbon dioxide, is made possible by pulmonary ventilation, respiration, and perfusion. **Pulmonary ventilation** refers to the movement of air into and out of the lungs. **Respiration** involves gas exchange between the atmospheric air in the alveoli and blood in the capillaries. **Perfusion** is the process by which oxygenated capillary blood passes through body tissues.

Pulmonary Ventilation

Pulmonary ventilation (breathing) is the movement of air into and out of the lungs. The process of ventilation has two phases: inspiration (inhalation) and expiration (exhalation). **Inspiration,** the active phase, involves movement of muscles and the thorax to bring air into the lungs. **Expiration,** the passive phase, is the movement of air out of the lungs.

Immediately before inspiration, the air pressure in the lungs is equal to that of the surrounding atmospheric pressure. According to Boyle's law, the volume of a gas at a constant temperature varies inversely with the pressure. This means that less pressure in the lungs facilitates the movement of more air into the lungs. The pressure within the lungs (intrapulmonic pressure) decreases as the volume of the lungs increases.

During inspiration, the following events occur: the diaphragm contracts and descends, lengthening the thoracic cavity; the external intercostal muscles contract, lifting the ribs upward and outward; and the sternum is pushed forward, enlarging the chest from front to back. This combination of an increased lung volume and decreased intrapulmonic pressure allows atmospheric air to move from an area of greater pressure (outside air) into an area of lesser pressure (within the lungs). The relaxation, or recoil, of these structures then results in expiration. The diaphragm relaxes and moves up, the ribs move down, and the sternum drops back into position. This causes a decreased volume in the lungs and an increase in intrapulmonic pressure. As a result, air in the lungs moves from an area of greater pressure to one of lesser pressure and is expired (Fig. 45-2).

Other physical factors contribute to air flow in and out of the lungs. These factors include the condition of the musculature, compliance of lung tissue, and airway resistance. The condition of the body's musculature can affect the process of respiration. The accessory muscles of the abdomen, neck, and back are used to maintain respiratory movements at times when breathing is difficult. These muscles are used to facilitate breathing; the movement is called retractions. The most common retractions involve the intercostal, scalene, sternocleidomastoid, trapezius, and pectoralis muscles.

Lung compliance refers to the ease with which the lungs can be inflated. The compliance of lung tissue affects lung volume. The ability of the lungs to adequately fill with air during inhalation is achieved by the normal elasticity of lung tissue, aided by the presence of surfactant. The varying changes in lung pressure and resulting lung compliance can be compared to differences in blowing up a new, noncompliant balloon versus one that was previously inflated. A stiff, noncompliant lung (like a new balloon) requires a greater inspiratory effort to inflate it. Emphysema, a chronic lung condition, and the normal changes associated with aging are examples of conditions that result in decreased elasticity of lung tissue, which, in turn, decreases compliance.

Airway resistance is the result of any impediment or obstruction that air meets as it moves through the airway. Any process that changes the bronchial diameter or width causes airway resistance. Obstruction in any part of the normal passageways impedes respiration. Obstruction can be caused by a foreign substance, such as a piece of food, a coin, or a toy, or by liquids, as in the case of a drowning victim. Obstruction can also result from secretions (eg, excessive or thickened secretions) or tissues (eg, tumors or edema of the respiratory tract). A decrease in the size of air passages resulting from constriction or poor neck positioning can also impede respiration. Bronchial constriction in asthma is an example of airway resistance related to a decrease in the size of air passages.

Consider Tyrone Jacobs, the 12-year-old boy with suspected asthma. An understanding of the underlying pathophysiologic processes involved with this disorder would provide the basis for the nurse's actions to protect the child's airway.

Respiration

Respiration, gas exchange, occurs at the terminal alveolar capillary system. Gases are exchanged between the air and blood via the dense network of capillaries in the respiratory portion of the lungs and the thin alveolar walls (see Fig. 45-1, Fig. 45-3). Gas exchange occurs via **diffusion.** Diffusion is the movement of gas or particles from areas of higher pressure or concentration to areas of lower pressure or concentration. In respiration, diffusion refers to the movement of oxygen and carbon dioxide between the air (in the alveoli) and the blood (in the capillaries). These gases move passively from an area of higher concentration to an area of lower concentration. The greater pressure of oxygen in the alveoli causes the oxygen to move from the alveoli into the capillaries containing the unoxygenated venous blood. Likewise, the carbon dioxide in the returning venous blood exerts a greater pressure than the carbon dioxide in the alveoli. Therefore, carbon dioxide diffuses across the capillary into the alveoli and ultimately is exhaled.

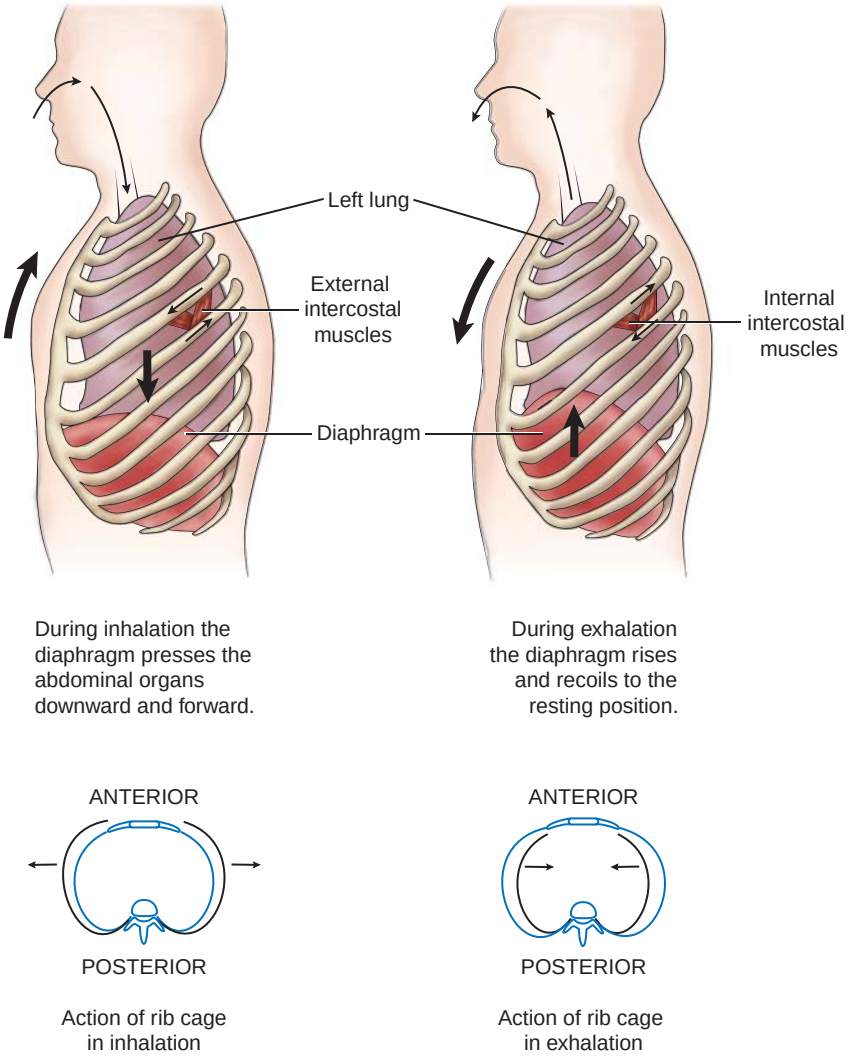


Figure 45-2. Pulmonary ventilation.

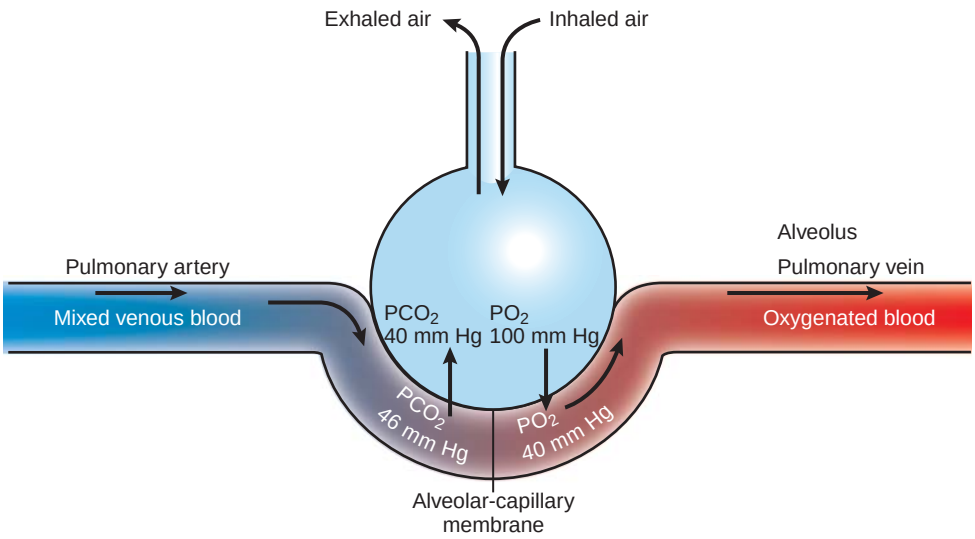


Figure 45-3. Gas exchange in the alveolus. The greater pressure of the oxygen in the air inhaled into the alveoli causes the oxygen to move into the capillaries, which contain unoxygenated blood. The carbon dioxide in the returning venous blood moves from the capillaries (area of greater concentration) into the alveoli (area of lesser concentration).

Diffusion of gases in the lung is influenced by four factors:

- Change in surface area available
- Thickening of alveolar–capillary membrane
- Partial pressure
- Solubility and molecular weight of the gas

Any change in the surface area available for diffusion hinders diffusion. For example, removal of a lung or the presence of a disease that destroys lung tissue can decrease the surface area available, ultimately affecting gas exchange. Incomplete lung expansion or the collapse of alveoli, known as **atelectasis,** prevents pressure changes and the exchange of gas by diffusion in the lungs. Atelectatic areas of the lung cannot fulfill the function of respiration. Examples of conditions that predispose a patient to atelectasis are obstructions of the airway by foreign bodies, mucus, airway constriction, external compression by tumors or enlarged blood vessels, and immobility. Any disease or condition that results in thickening of the alveolar–capillary membrane such as pneumonia or pulmonary edema makes diffusion more difficult.

The partial pressure, or pressure resulting from any gas in a mixture depending on its concentration, can also affect diffusion. If environmental oxygen is reduced, such as when a person is at higher altitudes or in the presence of toxic fumes, less oxygen is available for diffusion. When oxygen is administered, an increased amount of oxygen is available, resulting in greater diffusion across capillary membranes.

Finally, the solubility and molecular weight of the gas are factors in diffusion. Carbon dioxide has greater solubility in the respiratory membranes and diffuses more rapidly than oxygen. This allows for carbon dioxide to be released from the lungs with each exhalation.

Perfusion

Oxygenated capillary blood passes through the tissues of the body in the process called **perfusion.** The amount of blood flowing through the lungs is a factor in the amount of oxygen and other gases that are exchanged. The amount of blood present in any given area of lung tissue depends partially on whether the person is sitting, standing, or lying down. Perfusion is greater in dependent areas. The perfusion of lung tissue also depends on the person's activity level. Greater activity results in an increased need for cellular oxygen by the body's tissues and a subsequent increase in cardiac output and consequently in increased blood return to the lungs. In addition, perfusion to the body's tissues depends on an adequate blood supply and proper cardiovascular functioning to carry oxygen and carbon dioxide to and from the lungs. Cardiovascular function is discussed in relation to vital signs in Chapter 24 and in the following section.

If a problem exists in ventilation, respiration, or perfusion, **hypoxia** may occur. Hypoxia is a condition in which an inadequate amount of oxygen is available to cells. The most common symptoms of hypoxia are **dyspnea** (difficulty breathing), an elevated blood pressure with a small pulse pressure, increased respiratory and pulse rates, pallor, and cyanosis. Anxiety, restlessness, confusion, and drowsiness also are common signs of hypoxia. Hypoxia is often caused by **hypoventilation** (decreased rate or depth of air movement into the lungs). Hypoxia can also be a chronic condition. The effects of chronic hypoxia can be detected in all body systems and are manifested as altered thought processes, headaches, chest pain, enlarged heart, clubbing of the fingers and toes, anorexia, constipation, decreased urinary output, decreased libido, weakness of extremity muscles, and muscle pain.

The Cardiovascular System and Transport of Respiratory Gases

Oxygen and carbon dioxide must move through the alveoli and be carried to and from body cells by the blood. Thus, an adequately functioning cardiovascular system is vital for exchange of gases. The cardiovascular system is composed of the heart and the blood vessels. The heart is a cone shaped, muscular pump, divided into four hollow chambers. The upper chambers, the atria (singular, atrium), receive blood from the veins. The lower chambers, the ventricles, force blood out of the heart through the arteries. The blood vessels form a closed circuit of tubes that carry blood between the heart and the body cells. Arteries and arterioles conduct blood away from the ventricles to the capillaries and the venules and veins and return blood from the capillaries to the atria. Capillaries function in the exchange of substances between the blood and the body cells.

Unoxygenated blood is carried from the heart to the lungs, where oxygen is picked up, then returned to the heart. This oxygenated blood is pumped out to all other parts of the body and back again. Oxygen is carried via plasma and red blood cells. It is dissolved in plasma, but because oxygen is insoluble in liquids, little oxygen is carried in this way. The majority of oxygen is carried by the red blood cells. The hemoglobin in red blood cells has a strong affinity for oxygen. Therefore, most oxygen (97%) is carried in the body by red blood cells as part of hemoglobin in the form of oxyhemoglobin. Hemoglobin also carries carbon dioxide easily in the form of carboxyhemoglobin.

Once the red blood cells reach the tissues, internal respiration must occur. Internal respiration is the exchange of oxygen and carbon dioxide between the circulating blood and the tissue cells. Any abnormality in the blood's constituents affects internal respiration. For example, hemorrhage or loss of blood can cause a decrease in cardiac output. A decrease in cardiac output causes a reduction in the amount of circulating blood that is available to deliver oxygen to the tissues. Anemia, a decrease in the amount of red blood cells or erythrocytes, results in insufficient hemoglobin available to transport oxygen. This may lead to an inadequate supply of oxygen to the tissues of the body. Alternately, exercise can improve the transport of oxygen. Regular exercise contributes to more effective pumping of the heart muscle, and cells are better able to use oxygen.

Neurologic Control of the Respiratory System

The medulla in the brainstem immediately above the spinal cord is the respiratory center. It is stimulated by an increased concentration of carbon dioxide and hydrogen ions and, to a lesser degree, by the decreased amount of oxygen in the arterial blood. In addition, chemoreceptors in the aortic arch and carotid bodies are sensitive to the same arterial blood gas levels and blood pressure and can activate the medulla. Proprioceptors in the muscles and joints respond to body movements such as exercise and cause an increase in ventilation.

Stimulation of the medulla increases the rate and depth of ventilation (both inspiration and expiration) to blow off carbon dioxide and hydrogen and increase oxygen levels (the patient is breathing faster and more deeply). The medulla sends an impulse down the spinal cord to the respiratory muscles to stimulate a contraction leading to inhalation. If a condition causes a chronic change in the oxygen and carbon dioxide levels, these chemoreceptors may become desensitized and not regulate ventilation adequately.

FACTORS AFFECTING RESPIRATORY FUNCTIONING

A variety of factors affect adequate respiratory functioning. Seven important factors are discussed in the following sections.

Levels of Health

Acute and chronic illnesses can dramatically affect a person's respiratory function. For example, people with renal or cardiac disorders often have compromised respiratory functioning because of fluid overload and impaired tissue perfusion. People with chronic illnesses often have muscle wasting and poor muscle tone. These problems affect all the muscles, including those of the respiratory system. Alterations in muscle function contribute to inadequate pulmonary ventilation and respiration. Anemia can result in impaired respiratory function. As discussed previously, anemia may lead to an inadequate supply of oxygen to the tissues of the body. Because hemoglobin also carries carbon dioxide to the lungs, anemia results in diminished carbon dioxide exchange. Myocardial infarction (heart attack) causes a lack of blood supply to heart muscle. Damage to the muscle interferes with effective contractions of the muscle, leading to decreased perfusion of tissues and decreased gas exchange. Physical changes such as scoliosis (curvature of the spine) influence breathing patterns and may cause air trapping. Research reveals a statistically significant correlation between obesity and chronic bronchitis. Moreover, people who are obese are often short of breath during activity, ultimately leading to less participation in exercise. As a result, the alveoli at the base of the lungs are rarely stimulated to expand fully.

Recall Yan Kim, the 57-year-old patient who developed respiratory failure from complications associated with pulmonary surgery. The acuity of the situation played a major role in the patient's current condition. The pulmonary surgery most likely reduced his respiratory function. The effects of anesthesia on his lungs and subsequently the development of complications compounded his situation.

Developmental Considerations

There are many age-related developmental considerations affecting respiratory function. Table 45-1 summarizes respiratory variations in the life cycle.

TABLE 45-1 Respiratory Variations in the Life Cycle

	Infant (Birth–1 year)	Early Childhood (1–5 years)	Late Childhood (6–12 years)	Aged Adult (65+ years)
Respiratory rate	30–60 breaths/min	20–40 breaths/min	15–25 breaths/min	16–20 breaths/min
Respiratory pattern	Abdominal breathing, irregular in rate and depth	Abdominal breathing, irregular	Thoracic breathing, regular	Thoracic, regular
Chest wall	Thin, little muscle, ribs and sternum easily seen	Same as infant's but with more subcutaneous fat	Further subcutaneous fat deposited, structures less prominent	Thin, structures prominent
Breath sounds	Loud, harsh crackles at end of deep inspiration	Loud, harsh expiration longer than inspiration	Clear inspiration is longer than expiration	Clear
Shape of thorax	Round	Elliptical	Elliptical	Barrel shaped or elliptical

Neonates and Infants

Birth necessitates many adaptations by a newborn. The most obvious changes occur in the lungs, which are transformed from fluid-filled structures to air-filled organs. The normal infant's chest is small, the airways are short, and aspiration is a potential problem. The respiratory rate is more rapid in infants than at any other age (see Table 45-1). As the alveoli increase in number and size, adequate oxygenation is accomplished at lower respiratory rates. Surfactant is formed in utero around 34 to 36 weeks. An infant born prior to 34 weeks may not have sufficient surfactant produced, leading to collapse of the alveoli and poor alveolar exchange. Synthetic surfactant can be give to the infant to help reopen the alveoli. Respiratory activity is primarily abdominal in infants.

Toddlers, Preschoolers, School-aged Children, and Adolescents

The preschool child's eustachian tubes, bronchi, and bronchioles are elongated and less angular. Thus, the average number of routine colds and infections decreases until the child enters day-care or school and is exposed more frequently to pathogens. Young children who are not placed in day-care usually have not had the opportunity to develop antibodies for the variety of viruses and bacteria they encounter. Good hand hygiene and tissue etiquette should be encouraged. Most children at this age have colds or upper respiratory infections, but some have more serious problems of otitis media, bronchitis, and pneumonia. By the end of late childhood and during adulthood, the immune system is prepared to protect the person from most infections.

Older Adults

Specific physical changes occur in older adults that are unrelated to any pathology (see Focus on the Older Adult box). The tissues and airways of the respiratory tract (including the alveoli) become less elastic. The power of the respiratory and abdominal muscles is reduced, and therefore the diaphragm moves less efficiently. The chest is unable to stretch as much,

Focus on the Older Adult

Nursing Strategies for Oxygen Problems Affecting Older Adults

Age-Related Changes	Nursing Strategies
Decreased Gas Exchange and Increased Work of Breathing	
• Decreased elastic recoil of the lungs • Expiration requiring use of accessory muscles • Fewer functional capillaries and more fibrous tissue in alveoli • Decreased skeletal muscle strength in thorax • Reduction in vital capacity and increase in residual volume	• Encourage rest periods as necessary. • Encourage cessation or moderation of smoking and second-hand smoke exposure. • Teach breathing exercises. • Remind about avoiding air pollutants. • Caution about effect of extreme weather conditions. • Instruct to avoid narcotics and sleeping pills. • Discuss home management with patient and family. • Teach avoidance of infection and preventive measures (ie, flu vaccination). • Use pillows as necessary to sleep.
Decreased Ventilation and Ineffective Cough	
• Less air exchange; more secretions remain in lungs • Drier mucous membranes • Altered pain sensation • Different norms for body temperature; fever may be atypical • Greater risk for aspiration due to slower gastric motility • Impaired mobility and inactivity, effects of medication	• Encourage increased fluid intake, especially water, as allowed. • Use cool-mist humidifier (teach proper cleaning technique). • Encourage attendance at pulmonary exercise rehabilitation program. • Discourage use of over-the-counter medications. • Teach how to splint thorax and cough effectively. • Instruct in use of supplemental oxygen. • Teach avoidance of milk products if they are troublesome.

resulting in a decline in maximum inspiration and expiration. Airways collapse more easily. These alterations increase the risk for disease, especially pneumonia and other chest infections.

Think back to Joan McIntyre, the 72-year-old woman who is having difficulty being weaned from the ventilator. The nurse needs to incorporate information about age-related changes when planning the patient's care. The nurse also needs to consider that some of these age-related changes may be making weaning more difficult for this patient.

Medications

Many medications affect the function of the respiratory system. Patients receiving drugs that affect the central nervous system need to be monitored carefully for respiratory complications. For example, opioids are chemical agents that depress the medullary respiratory center. As a result, the rate and depth of respirations decrease. The nurse must be alert for the possibility of respiratory depression or arrest when administering any narcotic or sedative.

Lifestyle

Activity levels and habits can dramatically affect a person's respiratory status. For example, sedentary activity patterns do not encourage the expansion of alveoli and the development of pulmonary exercise patterns (deep breathing). People who exercise (eg, aerobics, walking, swimming) three to six times per week can better respond to stressors to respiratory health.

Cigarette smoking (active or passive) is a major contributor to lung disease and respiratory distress. Cigarette smoking is the most important risk factor for chronic obstructive pulmonary disease (COPD; Boyle & Locke, 2004).

Nurses working with patients to initiate changes in health habits that affect respiration must also examine themselves as a factor in the success of the plan. See Promoting Health 45-1: Oxygenation.

Promoting Health 45-1

Oxygenation

Patients view nurses as role models for achieving healthy life-styles. Nurses dealing with stresses from professional and personal aspects of their own lives sometimes channel their energies into destructive behaviors. If the nurse wishes to encourage optimal respiratory functioning, he or she must demonstrate behaviors that support a healthy lifestyle.

Use the assessment checklist to determine how well you are meeting oxygenation needs. Then develop a prescription for self-care by choosing appropriate behaviors from the list of suggestions.

Assessment Checklist

almost always	sometimes	almost never	
☐	☐	☐	1. I breathe easily, without discomfort and without feeling short of breath.
☐	☐	☐	2. I exercise regularly.
☐	☐	☐	3. I maintain normal weight for my height and body frame.
☐	☐	☐	4. I live in an environment free of pollution.
☐	☐	☐	5. I avoid substances (tobacco, chemicals) that cause respiratory problems.
☐	☐	☐	6. I arrange to receive recommended immunizations.

Self-Care Behaviors

1. Follow a regular exercise program with 30 to 45 minutes of moderate activity three or four times a week.
2. Maintain normal body weight.
3. Obtain medical evaluation for chest pain, problems with breathing, chronic cough with sputum or blood.
4. Evaluate personal use of nicotine.
5. Incorporate a plan to reduce smoking and then stop smoking on a specific target date.
6. Avoid exposure to second-hand smoke when possible.
7. Arrange to have a tuberculin test (PPD) done annually.
8. Receive yearly influenza immunization.
9. Avoid chemical substances that cause respiratory depression.
10. Maintain a pollution-free environment (as much as possible).
11. Support federal and community efforts to keep the air free of pollution.

Information to promote lung health, such as information about air quality, smoking, tobacco use, allergies, and lung disease (including asthma, COPD, and lung cancer) is available on-line. Check out these sites: The American Lung Association at www.lungusa.org and the National Heart, Lung, and Blood Institute at www.nhlbi.nih.gov.

Environment

Although it is impossible to pinpoint all the effects of air pollution, researchers have demonstrated a high correlation between air pollution and cancer and lung diseases. For example, a person with adequate respiratory functioning who is exposed to air pollution may experience stinging of eyes and nasal passages, coughing, choking, headache, and dizziness. Occupational exposure to asbestos, silica, or coal dust, as well as environmental pollution, can lead to chronic pulmonary disease. Chronic exposure to radon, radiation, asbestos, and arsenic can lead to lung cancer. Additionally, people who have experienced an alteration in respiratory functioning in the past often have difficulty continuing to perform self-care activities in a polluted environment.

Psychological Health

Many psychological factors and conditions can affect the respiratory system. Individuals responding to stress may sigh excessively or exhibit **hyperventilation** (increased rate and depth of ventilation, above the body's normal metabolic requirements). Hyperventilation can lead to a lowered level of arterial carbon dioxide. Generalized anxiety has been shown to cause enough bronchospasm to produce an episode of bronchial asthma. In addition, patients with respiratory problems often develop some anxiety as a result of the hypoxia caused by the respiratory problem.

Think back to Tyrone Jacobs, the young boy described at the beginning of the chapter. The patient is gasping for breath, which is extremely frightening and anxiety producing. In addition, his parents are frantic; this would increase Tyrone's anxiety level, further limiting his ability to breathe. The nurse needs to incorporate an understanding of this situation and plan interventions that promote oxygenation while reducing anxiety.

THE NURSING PROCESS FOR OXYGENATION

Assessing

The patient's health history is an essential component for assessing respiratory functioning. Either the patient or a family member can provide this information. The nursing examination combined with laboratory findings can provide information to identify a patient's strengths, the nature of the problem, its course, related signs and symptoms, and its onset, frequency, and effects on activities of daily living. The nurse decides, based on these findings, what problems can be treated independently by nursing. Other problems are referred to a physician for decisions on treatment.

Nursing History

The nursing history, an important clinical tool in the early steps of the nursing process, always includes a respiratory component. The information gained provides data about why the patient needs nursing care and what kind of care is required to maintain a sufficient intake of air. Interview questions help identify current or potential health deviations, actions performed by the patient for meeting respiratory needs and the effects of such actions, contributing factors, the use of any aids to improve the intake of air, and effects on the patient's lifestyle and relationships with others.

Before starting the interview, ascertain that the patient is not in acute distress. If the patient is experiencing any respiratory distress, initiate appropriate actions immediately to help relieve symptoms. Enlist the aid of family members or others to help answer questions. When the patient is able, interview the patient to expand the initial database. If no emergency interventions are necessary for the patient's clinical condition, obtain a comprehensive history at this time.

When a health deviation is noted during the data collection, collect as much descriptive information as possible, including whether the problem evolved suddenly or slowly. The accompanying Focused Assessment Guide 45-1 provides some appropriate questions for health history assessment.

Physical Assessment

The basic examination of the lungs and respiratory status is discussed in Chapter 25. Always proceed in a well-organized manner through a sequence of inspection, palpation, percussion, and auscultation.

Recall Mr. Kim, the 57-year-old man who is receiving oxygen therapy and mechanical ventilation via an endotracheal tube. A complete assessment is necessary to identify specific problems related to oxygenation as well as to determine the effectiveness of current treatments.

Inspection

Inspect the chest contour and shape. Normally, the adult chest contour is slightly convex, with no sternal depression. The anteroposterior diameter should be less than the transverse diameter. The infant's chest wall is so thin and has so little musculature that the ribs, sternum, and xiphoid process are easily seen. Infants have a rounded chest wall in which the anteroposterior diameter (the measurement from the front to the back of the thorax) equals the transverse diameter. In preschool-aged and school-aged children, some subcutaneous fat is deposited on the chest wall, making landmarks less prominent than they were in infants. Muscular development is also more noticeable. The ratio of the transverse diameter to the anteroposterior diameter reaches the adult configuration of 1:2 by age 6 years. Bony landmarks are more prominent because of the loss of subcutaneous fat. Kyphosis (curvature of the spine) contributes to the older person's appearance of leaning forward. Barrel chest deformity (see Fig. 25-25 in Chap. 25) may result in an increased anteroposterior diameter.

Describe or sketch any abnormalities in thoracic structure (see Fig. 25-30 in Chap. 25 for structures). Note the contour of the intercostal spaces, which should be flat or depressed,

Focused Assessment Guide 45-1

Respiration and Oxygenation

Factors to Assess	Questions and Approaches
Usual patterns of respiration	How would you describe your breathing patterns? Do you have allergies? Do you smoke? Do you live with a smoker or are there smokers or other pollutants in your workplace?
Recent changes	Have you noticed any changes in your breathing pattern (out of breath, cough, pain)? Do you have chest pain?
Cough	How much and how often do you cough? Is the cough related to the time of day or any activity? What is it like (dry, bubbly, hoarse)? Do you have a history of allergies? Do you ever wheeze? Are you exposed to dust? Fumes? Where do you work? What kind of work? How are you treating the cough?
Sputum	Do you ever cough up and spit out mucus? How much do you spit out and do you associate it with anything (time of day, environment)? What color is it? Is it ever blood tinged? What is its odor?
Chest pain	On a scale of 0 to 5 (5 being very painful), how severe is the pain? Where is the pain? Is the pain worse with inspiration? Expiration? Cough? Does the pain radiate? What measures are you using to relieve the pain?
Dyspnea	Is it constant or remittent or related to any activity? How do different positions affect it? How does it affect your daily activities? Is any part of your body bluish during the breathing problem? What do you do during and after the breathing attack? Have you ever been told that you have asthma? Emphysema? Tuberculosis? Heart disease? Do you think the problem is getting worse or staying the same?
Fever	Have you had pneumonia recently? Do you have any contact with people who have tuberculosis? Do you have night sweats? Are others in your household well or ill? Have you traveled anywhere recently? What medications are you using?
Fatigue	Have you noticed you feel more tired lately? Are you getting your normal amount of sleep at night? Has your sleep at night been affected by any difficulty breathing? Do you become easily fatigued when you climb stairs? Has your pattern of daily activity changed lately? Can you sleep lying flat? How many pillows do you use?

and the movement of the chest, which should be symmetrical. Inspect the skin over the thorax for temperature and color. It should be warm and dry and even in color, with no cyanosis or pallor, which could indicate less than optimal oxygenation. Note any scars, recording the origin of such in the history under previous surgery or accidents.

Observe the respiratory rate and rhythm for 1 full minute. Normally, respirations are quiet and nonlabored. Note any flaring of the nostrils, muscular retractions, **tachypnea** (rapid breathing), or **bradypnea** (slow breathing), suggestive of a health deviation requiring further evaluation.

Always be alert for common clinical manifestations that may indicate an airway emergency. Specific disease processes and conditions leading to acute respiratory failure, and their associated clinical manifestations, are discussed in medical–surgical nursing textbooks.

Palpation

Palpate the trachea, which should lie equidistant from each clavicle. Skin temperature in this area is typically the same as the rest of the body.

Measure thoracic excursion by placing your hands on the patient's posterior thorax at the 10th rib, with both thumbs almost touching the vertebrae. Ask the patient to take a few deep breaths, and watch the movement of the hands. Usually the thumbs move 5 to 8 cm symmetrically at maximal inspiration (see Fig. 25-28 in Chap. 25).

Assess tactile fremitus (the capacity to feel sound on the chest wall) by placing your palm to the patient's chest wall, avoiding bony areas (eg, scapulae). Ask the patient to repeat some multi-syllable word (eg, "ninety-nine") and feel for the vibration. Normally the vibrations are equal bilaterally in different areas on the chest wall. The greatest intensity is noted at the anterior and posterior base of the neck and along the trachea and large bronchi. Increased fremitus occurs in patients with pneumonia because solid tissue conducts sound well. Conversely, patients with COPD have decreased fremitus because air does not conduct sound as well. Note the presence or absence of masses, edema, or tenderness on palpation.

Percussion

Perform percussion posteriorly as the patient pulls the shoulders forward. Continue with the examination proceeding down the patient's back, comparing one side to the other (see Chap. 25, Fig. 25-26). Percuss the anterior chest, starting at the apices, moving down the chest. Listen carefully to the intensity and quality of each sound as the chest wall and underlying structures are percussed:

- Resonance: a loud, hollow, low-pitched sound, heard over normal lungs
- Hyperresonance: a loud, low, booming sound typically heard over emphysematous lungs
- Flatness: a sound detected over bone or heavy muscle
- Dullness: a sound with medium pitch and intensity usually heard over the liver (fifth intercostal space at the right midclavicular line)
- Tympany: a high-pitched, loud, drum-like sound produced over the stomach

Dullness over the lung field occurs when fluid or solid tissue replaces normal lung tissue in the pleural space. This finding requires further investigation.

Auscultation

Using the diaphragm of a stethoscope, move from apex to base of the lungs, comparing one side with the other side while listening to a complete respiratory cycle: inspiration and expiration. Normal breath sounds include **vesicular** (low-pitched, soft sounds heard over peripheral lung fields), **bronchial** (loud, high-pitched sounds heard primarily over the trachea and larynx); and **bronchovesicular** (medium-pitched blowing sounds heard over the major bronchi) sounds (see Table 25-8 in Chap. 25). Auscultate as the patient breathes slowly through an open mouth. Breathing through the nose can produce falsely abnormal breath sounds. Breathing too quickly, such as with hyperventilation, may cause syncope and patient distress. If abnormal breath sounds are detected, instruct the patient to cough and auscultate again for at least two complete respiratory cycles. Record location, change in breath sounds after coughing, and the phase of respiration any abnormal sound is heard (eg, wheezing on expiration).

Adventitious breath sounds, or abnormal lung sounds, are categorized as either discontinuous or continuous sounds (see Table 25-9 in Chap. 25). **Crackles,** frequently heard on inspiration, are soft, high-pitched discontinuous (intermittent) popping sounds. They are produced by fluid in the airways or alveoli and delayed reopening of collapsed alveoli. They occur due to inflammation or congestion and are associated with pneumonia, congestive heart failure, bronchitis, and COPD. Crackles can be further classified as fine or coarse. Fine crackles are brief sounds, similar to the sound of hair rubbing together between the fingers. Coarse crackles are somewhat louder, moist, bubbling sounds (Smeltzer & Bare, 2008; Weber & Kelley, 2007). Occasional fine crackles at the end of deep inspiration heard on auscultation of the infant's thorax are normal.

Wheezes are continuous, musical sounds, produced as air passes through airways constricted by swelling, narrowing, secretions, or tumors. They can be further classified as sibilant wheezes or sonorous wheezes. Sibilant wheezes originate in smaller airways and are high pitched and whistling, whereas sonorous wheezes can be heard over larger airways and sound like a snore (Smeltzer et al., 2008; Weber & Kelley, 2007). They are often heard in patients with asthma, tumors, or a buildup of secretions.

When assessing Tyrone Jacobs, the child with asthma, auscultation of breath sounds is crucial. Auscultation of a child with asthma typically reveals wheezes.

A **pleural friction rub** is a continuous, dry grating sound. Pleural friction rub is caused by inflammation of pleural surfaces and loss of lubricating pleural fluid. It resembles the sound made by rubbing two leather surfaces together.

Common Diagnostic Tests

In addition to the nursing history and physical examination, the laboratory and radiologic tests described in Box 45-1 provide further assessment data that can aid in the formation of nursing diagnoses.

The nurse might anticipate diagnostic procedures such as radiography for Joan McIntyre, the older woman who is being weaned from the ventilator. This diagnostic test might provide clues to another problem that might be affecting the patient's ability to be weaned. In addition, arterial blood gases may be used to evaluate her response to weaning.

The tests described in the next sections are not distinctive for a particular disease but reflect how well the respiratory system is functioning.

Pulmonary Function Studies

Pulmonary function studies encompass a group of tests used to evaluate patients with respiratory disorders and are routinely performed to evaluate pulmonary status and detect abnormalities. They provide an evaluation of lung dysfunction, diagnosis disease, assess disease severity, assist in management of disease, and evaluate respiratory interventions. Most tests are administered by a respiratory therapist, technician, nurses with specialized training, or physicians. Several tests commonly encountered are described below. More specialized tests and their purposes include:

- Inert gas dilution, nitrogen washout, and body plethysmography measure lung volumes.
- Diffusion capacity estimates the patient's ability to absorb alveolar gases and determine if a gas exchange problem exists.
- Maximal respiratory pressures help evaluate neuromuscular causes of respiratory dysfunction.
- Exercise testing helps evaluate dyspnea during exertion.

Refer to Box 45-2 for Commonly Measured Values From Pulmonary Function Tests.

Spirometry

Spirometry measures the volume of air in liters exhaled or inhaled by a patient over time. It evaluates lung function and airway obstruction through respiratory mechanics. Spirometry can be used to measure the degree of airway obstruction and evaluates response to inhaled medications. The patient inhales deeply and exhales forcefully into a **spirometer,** an instrument that measures lung volumes and airflow.

Peak Expiratory Flow Rate

Peak expiratory flow rate (PEFR) refers to the point of highest flow during forced expiration. PEFR reflects changes in the size of pulmonary airways and is measured using a peak flow meter. It is routinely used for patients with moderate or severe asthma to measure the severity of the disease and degree of disease control. With the patient standing or sitting with the back positioned as straight as possible, the patient takes a deep breath and places the peak flowmeter in his or her mouth, closing the lips tightly around the mouthpiece. The patient forcibly exhales into the peak flowmeter, and an indicator on the meter rises to a number. The patient is asked to repeat this three times, and the highest number is recorded. This produces a measurement in liters indicating the maximum flow rate during a forced expiration. Normal values are established in regard to height, age, and gender, as well as individual baseline values for patients with disease. Patients commonly measure PEFR at home to monitor airflow. The results are used to track disease progression and regulate treatment by the patient and clinician.

Pulse Oximetry

Pulse oximetry is a noninvasive technique that measures the arterial oxyhemoglobin saturation (SaO_2 or SpO_2) of arterial blood. Pulse oximetry is useful for monitoring patients receiving oxygen therapy, titrating oxygen therapy, monitoring those at risk for hypoxia, and postoperative patients. Pulse oximetry does not replace arterial blood gas analysis. Desaturation indicates gas exchange abnormalities.

The nurse should know the patient's hemoglobin level before evaluating oxygen saturation because the test measures only the percentage of oxygen carried by the available hemoglobin. Thus, even a patient with a low hemoglobin could appear to have a normal SpO_2 because most of that hemoglobin is saturated. However, the patient may not have enough oxygen to meet body needs. A range of 95% to 100% is considered normal SpO_2; values less than 85% indicate that oxygenation to the tissues is inadequate.

Consider Tyrone Jacobs, the young boy with asthma described at the beginning of the chapter. The nurse would use pulse oximetry initially to obtain baseline information about the patient's oxygen saturation level and then as a means to evaluate the effectiveness of therapy.

Figure 45-4 shows a nurse using a pulse oximetry unit, and Skill 45-1 outlines nursing responsibilities when using a pulse oximetry unit.

Thoracentesis

Thoracentesis is the procedure of puncturing the chest wall and aspirating pleural fluid. The pleural cavity is a potential cavity because it is normally not distended with fluid or air. The physician usually performs thoracentesis at the bedside with the nurse assisting. The patient is required to sign a permit for this procedure. A thoracentesis may be performed to obtain a specimen for diagnostic purposes or to remove fluid that has accumulated in the pleural cavity and is causing respiratory difficulty and discomfort. Because the cavity being entered is sterile, surgical asepsis is required. Standard precautions also are used.

Procedure

A thoracentesis is usually carried out with the patient sitting on a chair or the edge of the bed with the legs supported and

BOX 45-1 Common Diagnostic Procedures Used to Assess Respiratory Functioning

Arterial Blood Gas and pH Analysis

These examine arterial blood to determine the pressure exerted by oxygen and carbon dioxide in the blood and the blood pH. This test measures the adequacy of oxygenation, ventilation, and perfusion. Normal results are: pH (7.35–7.45), PCO_2 (35–45 mm Hg), PO_2 (80–100 mm Hg), HCO_3 (22–26 mEq/L), and base excess or deficit (–2 to +2 mmol/L).

Preparation

- Explain to the patient that this test requires an arterial puncture and collection of a blood specimen.
- The radial, brachial, or femoral arteries are usually the sites of choice.
- Perform Allen's test to ensure adequate ulnar blood flow when using radial artery.

Aftercare

- Record supplemental oxygen or respirator settings on laboratory slip.
- The arterial specimen is immediately placed on ice and taken to the laboratory.
- Apply pressure for 5 to 10 minutes and watch for evidence of bleeding. If patient is taking anticoagulants, pressure must be applied for a longer interval.

Cytologic Study

This involves a microscopic examination of sputum and the cells it contains. It is done primarily to detect cells that may be malignant, determine organisms causing infection, and identify blood or pus in the sputum.

Preparation

- Collect the specimen, if possible, in the morning before breakfast. The test usually involves 3 successive days of sputum collection. About 1 teaspoon of sputum is needed for a specimen.
- Instruct the patient that saliva is not a satisfactory specimen.
- Patient should take a deep breath and then expel the air with a deep cough.
- Expectorate the specimen into a sterile specimen container with the appropriate preservative, if indicated.
- Close the container with a tight-fitting lid.

Aftercare

- Advise the patient to inform the nurse when the specimen has been obtained.
- Label and package the specimen and send it to the laboratory as soon as possible.

Endoscopic Studies

These involve direct visualization of a body cavity. A bronchoscope is used to examine the larynx, bronchi, and trachea. Bronchoscopy is used to view lesions, obtain a biopsy, improve drainage, remove foreign substances, evaluate trauma, and drain abscesses.

Preparation

- Verify that an informed consent was obtained.
- The patient should be NPO for 6 to 8 hours before the test.
- An analgesic, sedative, and/or anticholinergic may be administered before the test.
- Local anesthetic is sprayed into the throat.

Aftercare

- Withhold food and fluids until the gag reflex returns.
- Check vital signs according to the protocol.
- Observe carefully for signs of respiratory impairment. Emergency resuscitation equipment should be available.
- Warm saline gargles may relieve throat irritation once the gag reflex has returned.

Skin Tests

These determine antigen–antibody reactions. In intradermal tests, antigens (to which the patient may have previously been exposed) are injected into the superficial layer of the skin with a needle and syringe to evaluate immune response.

Preparation

- Check patient's history for hypersensitivity to any of the test antigens. If positive, notify the physician before performing test.
- Cleanse the test area with alcohol and allow it to dry.

Aftercare

- Instruct the patient to have the test results read at the appropriate time.
- After reading the results, document the reaction, noting the amount of erythema or induration. Record the test, time, date, method, and site of administration on the patient record.

Radiography

Radiography is an x-ray examination of the lungs and the thoracic cavity. Radiographic examinations of the lungs are done to help diagnose pulmonary diseases and to determine the progress or development of disease.

(continued)

BOX 45-1 Common Diagnostic Procedures Used to Assess Respiratory Functioning *(continued)*

Preparation

- Instruct patient to remove clothing to the waist and put on gown. All metal jewelry should be removed.
- The patient will be required to take a deep breath and hold it during the radiograph.

Aftercare

- No special care is required after chest radiograph.

Lung Scan

Lung scan is the recording on a photographic plate of the emissions of radioactive waves from a substance injected into a vein as it circulates through the lung. A *perfusion scan* (Q scan) is done to measure integrity of pulmonary blood vessels and evaluate blood flow abnormalities (eg, pulmonary emboli). A *ventilation scan* (V scan) is done to detect ventilation abnormalities (especially in patients with emphysema). Both scans used together provide greater and more accurate diagnostic information than either test used solely.

Preparation

- Verify that an informed consent was obtained, if required by agency.
- Explain that no fasting is required.
- Patient should be told to remove jewelry from the chest area.

Aftercare

- No special care is required after the lung scan.
- Reassure patient that no radiation precautions are necessary.

Adapted from Fischbach, F., & Dunning, M. (2006). *Common laboratory and diagnostic tests.* (4th ed.). Philadelphia: Lippincott Williams & Wilkins; Pagana, K., & Pagana, T. (2002). *Manual of diagnostic and laboratory tests.* (2nd ed.). St. Louis: C. V. Mosby; and Corbett, J. (2004). *Laboratory tests and diagnostic procedures with nursing diagnoses* (6th ed.). Upper Saddle River, NJ: Pearson Prentice Hall.

the arms folded and resting on a pillow on the bedside table (Fig. 45-5). If unable to sit up, the patient may lie on the unaffected side with the hand of the affected side raised above the shoulder.

The location where the needle is inserted depends on where the fluid is present and where the physician can best aspirate it. Once this spot is identified by the physician, the skin is prepared over the area. A local anesthetic is administered and then the needle is inserted between the ribs through the intercostal muscles and fascia and into the pleura. After the procedure, the needle or plastic catheter is removed and a small sterile dressing is placed over the entry site.

During thoracentesis, fluid or air can be removed from the pleural cavity with a syringe. Another method for removing fluid is to drain the fluid into a bottle in which a partial vacuum has been created. With this technique, a small plastic catheter may be threaded through the needle, allowing the needle to be withdrawn. This catheter reduces the possibility of puncturing the lung. When this method is used, the tubing connecting the needle and the bottle must be sterile. Commonly, a calibrated bottle is used to collect the drainage,

BOX 45-2 Commonly Measured Values From Pulmonary Function Tests

- Vital Capacity (VC): The amount of air displaced by maximal exhalation
- Forced Expiratory Vital Capacity (FEVC): The amount of air expelled from a point of maximal inspiration to a point of maximal inspiration
- Forced Inspiratory Vial Capacity (FIVC): The amount of air inhaled from a point of maximal exhalation to a point of maximal expiration
- Forced Expiratory Volume (FEV): The forced expiratory volume that can be expressed in 1, 2, or 3 seconds in the first second of the FEVC maneuver
- Total Lung capacity (TLC): The amount of air contained within the lungs at maximum inspiration
- Residual Volume (RV): The amount of air left in the lungs at maximal expiration
- Peak Expiratory Flow Rate (PEFR): The maximum flow attained during the forced expiratory maneuver

Adapted from Fischbach, F., & Dunning, M. (2006) *Common laboratory and diagnostic tests.* (4th ed.). Philadelphia: Lippincott Williams & Wilkins; and Evans, S., & Scanlon, P. (2003). Current practice in pulmonary function testing. *Mayo Clinic Proceedings, 78*(6), 758–763.

Figure 45-4. Portable pulse oximetry unit, used to measure oxygen saturation (SpO_2) of arterial blood.

allowing the amount of fluid removed to be determined. The maximum amount of fluid removed is generally 1,000 mL.

Nursing Responsibilities

The nurse is responsible for collecting baseline data before the procedure and preparing the patient physically and emotionally for the procedure. Instruct the patient not to cough or breathe deeply during the procedure. Urge the patient to remain as still as possible to diminish the risk for accidental injury to the lung. Administer analgesics before the procedure as ordered.

During the procedure, observe the patient's reactions. Monitor the patient's color, pulse, and respiratory rates, reporting immediately to the physician any deviation from the patient's baseline. Fainting, nausea, and vomiting may occur.

Figure 45-5. Position of the patient for thoracentesis.

Ensure that specimens, if obtained, are taken to the laboratory immediately.

After the procedure, assess the patient for changes in vital signs, particularly respirations. If a large amount of fluid was removed, respirations usually become easier. If the lung was punctured, respiratory distress becomes acute. If blood appears in the sputum or the patient has severe coughing, notify the physician promptly. A chest radiograph is usually done after the procedure to verify the absence of complications.

Diagnosing

Each nursing diagnosis statement identifies an actual or potential patient problem and suggests expected patient outcomes. The etiology of the problem directs nursing interventions. In analyzing the assessment data, determine whether the alteration in respiratory function:

- Is the problem
- Is contributing to a different problem or a sign or symptom of a problem

Alterations in Respiratory Function as the Problem

After the assessment is completed and the data are examined, the nurse concludes either that there is no problem at this time or that there is an actual or potential respiratory problem that is amenable to independent or interdependent nursing actions. Nursing diagnoses indicating alterations in respiratory function are:

- Ineffective Airway Clearance
- Ineffective Breathing Pattern
- Impaired Gas Exchange
- Impaired Spontaneous Ventilation
- Dysfunctional Ventilatory Weaning

Common etiologies for these diagnoses include an inability to maintain proper position, pain or fear of pain, viscous secretions, fatigue, decreased level of consciousness, lack of knowledge, smoking, allergy, mechanical obstruction, medications, and decreased elasticity of the lungs. Examples of these diagnoses, etiologic factors, and defining characteristics appear in Examples of NANDA Nursing Diagnoses: Oxygenation.

Alterations in Respiratory Function as the Etiology

An alteration in respiratory functioning may affect other areas of human functioning. Nursing diagnoses resulting from alterations in respiratory functioning include:

- Activity Intolerance related to shortness of breath
- Anxiety related to feeling of suffocation
- Acute Pain related to pleural inflammation
- Acute Confusion related to impaired ventilation
- Impaired Verbal Communication related to endotracheal intubation

Examples of NANDA Nursing Diagnoses: *Oxygenation*

Nursing Diagnoses	Related Factors	Sample Defining Characteristics
Ineffective Airway Clearance	Thick yellow secretions, fever, fatigue, dehydration, poor nutrition	*"I never feel as though I am getting enough air."* Seventy-year-old man with a 20-year history of COPD, recent development of pneumonia. He is pale with circumoral cyanosis. His respiratory rate is 40 breaths/min and shallow. Coarse crackles are auscultated bilaterally. He does not sit quietly in chair or on bed. He cannot walk length of room without coughing episode, which produces little sputum.
Impaired Gas Exchange	Smokes one pack per day; works with asbestos in auto factory; has had a cold for 7 days	Cyanotic 50-year-old man. Using pursed-lip breathing while sitting on emergency room stretcher. Sitting hunched forward with overbed table supporting arms. Altered blood gases show respiratory acidosis. Admits to shortness of breath, nausea, and ankle edema for 1 week.
Ineffective Breathing Pattern	Anxious about results of cardiac catheterization and possible cardiac surgery	Hyperventilating, tachypneic (40 breaths/minute). *"I have a tingling feeling in my fingers."*

- Ineffective Coping related to frequent hospitalization resulting from acute symptoms of COPD
- Deficient Diversional Activity related to loss of ability to perform specific activities because of shortness of breath
- Fatigue related to impaired oxygen transport system
- Fear related to disabling respiratory illness
- Dysfunctional Grieving related to loss of normal respiratory functioning
- Ineffective Health Maintenance related to smoking
- Noncompliance (eg, with performance of daily respiratory exercises) related to side effects of therapy
- Imbalanced Nutrition: Less Than Body Requirements, related to difficulty breathing
- Impaired Oral Mucous Membrane related to presence of endotracheal tube
- Powerlessness related to inability for self-care because of COPD
- Chronic/Situational Low Self-Esteem related to loss of normal respiratory function
- Disturbed Sleep Pattern related to orthopnea and bronchodilators
- Social Isolation related to inability to walk to usual "people places"
- Risk for Suffocation related to child playing with a plastic bag
- Risk for Aspiration related to reduced level of consciousness
- Risk for Activity Intolerance related to COPD

Outcome Identification and Planning

When caring for patients with an alteration in respiratory function, nursing measures support the following general expected outcomes. The patient will:

- Demonstrate improved gas exchange in the lungs by an absence of cyanosis or chest pain and a pulse oximetry reading more than 95%
- Relate the causative factors, if known, and demonstrate a method of coping with these factors
- Preserve pulmonary function by maintaining an optimal level of activity
- Demonstrate self-care behaviors that provide relief from symptoms and prevent further pulmonary problems

When the patient's physical, psychosocial, and spiritual dimensions contribute to alterations in respiratory function, individualized expected outcomes are developed with the patient's input (eg, "By March 15, the patient will be able to walk up one flight of steps at home without dyspnea").

Implementing

Nursing interventions related to oxygenation aim to promote optimal functioning of the respiratory system.

Teaching About Pollution-Free Environments

A pollution-free environment is particularly important for individuals with respiratory problems. Teach the patient to

assess the environment and make adjustments, whenever possible, to factors that impair respiratory functioning or "triggers." The patient must actively plan to prevent exposure to pollutants and triggers. This might involve a job change, use of protective equipment, requesting enforcement of laws by government agencies, or subcontracting jobs. Dusting and vacuuming the office and home must be done at least twice per week. In some situations, the patient may be asked to wear a mask to prevent some symptoms of respiratory distress. Exposure to industrial or occupational hazards (eg, paint, varnish, gaseous fumes, and asbestos) must be restricted.

In the United States, fine pollutants, including carbon monoxide, sulfur dioxide, total suspended particulates, ozone, and nitrogen dioxide that pose a hazard to health, are monitored closely. On days when pollutant levels are significantly elevated, morbidity and mortality rates among people with preexisting pulmonary disease are greatly increased. Thus, on days when pollution alerts are announced, people with altered respiratory function should reduce their activities, stay indoors, and use an air conditioner, electronic air cleaner, or air filter. If pollen alters the patient's respiratory function, the same principles apply.

Cigarette smoking is the most important risk factor in pulmonary disease. The inhalation of cigarette smoke increases airway resistance, reduces ciliary action, increases mucus production, causes thickening of the alveolar–capillary membrane, and causes bronchial walls to thicken and lose their elasticity. These effects occur in both smokers and nonsmokers (children and adults) who live with smokers. Habitual smokers usually have great difficulty quitting or reducing their smoking and need much encouragement. The American Lung Association and the American Heart Association offer many free educational materials to aid and support patients who are trying to stop smoking. Their addresses and phone numbers are listed in local telephone directories. Nurses play a key role in presenting accurate information about the negative effects of smoking and encouraging the decision to stop smoking or to never start smoking.

Promoting Optimal Function

Most people with altered respiratory functioning experience anxiety as a result of their symptoms and the actual or potential loss of independence. Oxygen deficits, particularly in older people, impair all aspects of daily living. Going to get the mail or cleaning the house becomes a monumental task for people with oxygen deficits.

Reducing Anxiety

The nurse can create an environment that is likely to reduce anxiety. Help institute measures to alleviate discomfort immediately. Use effective listening skills and accurate observation to display a caring attitude. Attempt to understand the patient's life experiences and habits without judging them. Patients with harmful health habits often fear they will be judged, and this impedes the use of nursing interventions. Patients who believe nurses are genuinely concerned about them and their family are more willing to work toward achieving mutually desirable outcomes.

> *Think back to Joan McIntyre, the woman requesting to be "let go" the next time she fails to be weaned. The nurse needs to provide support to the patient, showing genuine concern for her welfare. In addition, the nurse needs to act ethically and legally to ensure the patient's rights.*

Maintaining Good Nutrition

People who work hard at breathing often do not have energy for eating. Many of the medications used for treatment can cause anorexia and nausea. However, maintaining an adequate nutritional intake is crucial. Assess nutritional status by measuring the patient's height, weight, upper arm circumference, serum protein levels, and nitrogen balance. Interventions should focus on ensuring an adequate intake of proteins, vitamins, and minerals. Consider the use of six small meals distributed over the course of the day instead of the usual three larger meals. Provide frequent oral hygiene and rest periods before eating to help improve the patient's intake. Meals should be eaten 1 to 2 hours after breathing treatments and exercises.

Patients who have COPD require a high protein/high calorie diet to counter malnutrition. Obese patient should be encouraged to loose weight using a calorie-controlled diet. Diets should be 40% to 55% carbohydrates, 30% to 40% fat, and 12% to 20% protein. A diet rich in antioxidants, vitamins A and C, and the B vitamins is important. If supplemental oxygen is used, reinforce the importance of wearing the cannula during and after meals. Eating and digestion require energy, which causes the body to use more oxygen (Stump, 2002).

Promoting Comfort

Positioning

Proper positioning is important to ease respirations. A proper position for breathing is a position that allows free movement of the diaphragm and expansion of the chest wall. Alternately, sitting in a slumped position permits the abdominal contents to push upward on the diaphragm, decreasing lung expansion during inspiration. People with dyspnea and orthopnea are most comfortable in a high Fowler's position because accessory muscles can easily be used to promote respiration. Research has demonstrated that, in patients with pulmonary disease who are acutely ill, turning to the prone position on a regular basis promotes oxygenation (Gattinoni, Tognoni, Pesenti, et al., 2001). In this position, the posterior dependent sections of the lungs are better ventilated and perfused. A partially prone position appears to be sufficient to achieve better ventilation while allowing access to invasive lines and the airway. See the accompanying Research in Nursing box.

Maintaining Adequate Fluid Intake

Patients can help keep their secretions thin by drinking 2 to 3 quarts (1.9 to 2.9 L) of clear fluids daily. Fluid intake should be increased to the maximum that the patient's health state can tolerate. Increased fluids are needed by patients who have

Research in Nursing: Bridging the Gap to Evidence-Based Practice

The Effect of Positioning in Premature Infants With Assisted Ventilation

Promotion of respiratory function is critical for premature infants. Adequate oxygenation is necessary for life. Appropriate interventions to optimize respiratory function are an important part of nursing care for these fragile patients.

Related Research

Yottiem, P., Tilokskulchai, F., Vichkhitsukon, K., et al. (2004). The effect of positioning in premature infants with assisted ventilation. *Asian Journal of Nursing Studies, 7*(3), 36–42.

This study assessed the effects of supine with flexion and side-lying positions on oxygen saturation and body temperature in premature infants with assisted ventilation. The infants were being treated in a neonatal intensive care unit in a large university hospital in Bangkok, Thailand. The infants were placed in a regular position for 1 hour. The infant's oxygen saturation and mean skin temperature were measured. Then, the infants were randomly assigned to be placed in a side-lying or supine with flexion position, with oxygen saturation and mean skin temperature remeasured after 1 hour. Positioning the infants in the side-lying or supine with flexion position resulted in higher mean oxygen saturation and mean skin temperature than in the regular position. The results of this study suggest that nurses should consider using these positions when working with premature infants on assisted ventilation to increase oxygen saturation and skin temperature, as long as it is not contraindicated for the infant.

Relevance to Nursing Practice

Nurses should consider positioning of premature infants and the effects on oxygenation and incorporate appropriate interventions in their care. Positioning premature infants in a side-lying or supine with flexion position is a noninvasive, easily implemented intervention. Promotion of respiratory function could be accomplished with this simple intervention. Also, additional studies should be considered to reproduce the finding and examine possible implications for all newborns.

For additional research, visit thePoint

an elevated temperature, who are breathing through the mouth, who are coughing, or who are losing excessive body fluids in other ways. In patients with right-sided heart failure, fluid intake should not exceed 1.5 quarts (1.4 L) daily.

Providing Humidified Air

Inspiring dry air removes the normal moisture in the respiratory passages that protects against irritation and infection. This is especially troublesome for patients who cannot breathe through their nose. When air humidity is low, it may be necessary to humidify the air with room humidifiers or vaporizers. Electric vaporizers that produce steam or cool mist are also useful, but neither device has been demonstrated to have greater therapeutic value than the other. Although a cool-mist vaporizer reduces the danger of burns because it does not generate heat or hot water, it can be a medium for pathogen growth if it is not adequately cleaned. A steam vaporizer does not present this risk for infection because the heat kills most pathogens.

Promoting Proper Breathing

Many people, both well and ill, have breathing habits that are not conducive to maximal respiratory functioning. Some people develop a pattern of shallow breathing or walk with a posture that makes the chest wall appear caved in, affecting chest expansion. Ill people may limit their respiratory efforts to compensate for disease symptoms or an illness. Breathing exercises are designed to help patients achieve more efficient and controlled ventilations, to decrease the work of breathing, and to correct respiratory deficits. Nursing interventions that maximize oxygen and carbon dioxide exchange in the lungs appear in Examples of Nursing Interventions Classification (NIC): Ventilation Assistance. Specific techniques are described below.

Deep Breathing

When hypoventilation occurs, a decreased amount of air enters and leaves the lungs. However, deep-breathing exercises can be used to overcome hypoventilation.

Instruct the patient to make each breath deep enough to move the bottom ribs. Unless the patient has a nasal condition that prohibits or prevents normal breathing, have the patient start slowly taking deep ventilations nasally and then expiring slowly through the mouth. Breathing through the nose warms, filters, and humidifies the air. The patient's respiratory status, motivation, and general clinical condition dictate the timing of this exercise, which should be done hourly while awake or four times daily.

Examples of Nursing Interventions Classification (NIC)
VENTILATION ASSISTANCE

- Maintain a patent airway
- Auscultate breath sounds, noting areas of decreased or absent ventilation, and presence of adventitious sounds
- Initiate and maintain supplemental oxygen, as prescribed
- Administer appropriate pain medication to prevent hypoventilation
- Ambulate three to four times per day, as appropriate
- Monitor respiratory and oxygenation status
- Administer medications (eg, bronchodilators and inhalers) that promote airway patency and gas exchange
- Teach pursed-lip breathing techniques, as appropriate
- Teach breathing techniques as appropriate
- Initiate a program of respiratory muscle strength and/or endurance training, as appropriate

Dochterman, J., & Bulechek, G. (Eds.) (2004). *Nursing interventions classification (NIC)* (4th ed.) (p. 767). St. Louis: Mosby.

Using Incentive Spirometry

Incentive spirometry provides visual reinforcement for deep breathing by the patient. An incentive spirometer assists the patient to breathe slowly and deeply and to sustain maximal inspiration. The gauge on the spirometer allows the patient to measure her own progress, providing immediate positive reinforcement. It encourages the patient to maximize lung inflation and prevent or reduce atelectasis. Optimal gas exchange is supported and secretions can be cleared and expectorated. Before using incentive spirometry equipment, the patient needs instructions on using the equipment properly. Validate the patient's correct use of this equipment in both healthcare and home environments. See Guidelines for Nursing Care 45-1, for teaching patients to use this device.

Pursed-Lip Breathing

Patients who experience dyspnea and feelings of panic can often reduce these symptoms by using pursed-lip breathing. Exhaling through pursed lips creates a smaller opening for air movement, effectively slowing and prolonging expiration. Prolonged expiration is thought to result in decreased airway narrowing during expiration and prevent the collapse of small airways. This results in improved air exchange and decreased dyspnea. Pursed-lip breathing also helps the patient to control the rate and depth of respiration, helping to reduce feelings of dyspnea. It also encourages relaxation, which aids the patient to gain control of dyspnea and reduce feelings of panic. Patients with COPD should be encouraged to try this breathing technique to help manage their daily activities (Dechman & Wilson, 2004; Smeltzer & Bare, 2008).

While sitting upright, the patient inhales through the nose while counting to three and then exhales slowly and evenly against pursed lips while tightening the abdominal muscles. During exhalation, the patient counts to seven. To purse the lips, the patient should position the lips as though he or she was sucking through a straw or whistling. When walking and using pursed lip breathing, the patient should inhale while taking two steps and then exhale through pursed lips while taking the next four steps, and then repeat the cycle. Before teaching these techniques, practice them alone and then with a partner.

Abdominal or Diaphragmatic Breathing

Many people with COPD breathe in a shallow, rapid, and exhausting pattern. This type of upper chest breathing can be altered to another form of breathing, diaphragmatic breathing. Diaphragmatic breathing reduces the respiratory rate, increases tidal volume, and reduces functional residual capacity.

To do this, the patient places one hand on the stomach and the other on the middle of the chest. He or she breathes in slowly through the nose, letting the abdomen protrude as far as it will go. Then the patient breathes out through pursed lips while contracting the abdominal muscles, with one hand pressing inward and upward on the abdomen. He or she repeats these steps for 1 minute, followed by a rest for 2 minutes. Encourage the patient to practice this breathing pattern several times during the day, so that eventually it becomes automatic.

Promoting and Controlling Coughing

A cough is a cleansing mechanism of the body. It is a means of helping to keep the airway clear of secretions and other debris. A cough that is dry is termed a nonproductive cough. A cough that produces respiratory secretions is termed a productive cough. The respiratory secretion expelled by coughing or clearing the throat is called **sputum.**

When the patient has excessive fluids or secretions in an organ or body tissue, the patient is said to be congested. Thus, a person with secretions or fluid in the lungs is said to have congested lungs. If the cough is dry, the patient is said to be congested with a nonproductive cough. If the cough produces sputum, the patient is said to be congested with a productive cough. Thick respiratory secretions are sometimes called phlegm. A patient who is coughing and does not have any congestion or secretions produced is said to be noncongested with a nonproductive cough.

A series of events produce a cough. The cough mechanism (Fig. 45-6) consists of an initial irritation; a deep inspi-

Guidelines for Nursing Care 45-1

Teaching Patients to Use an Incentive Spirometer

- Assist patient to upright position if possible.
- Remove dentures if they fit poorly.
- Medicate with ordered pain medication if needed.
- Demonstrate how to steady device with one hand and hold mouthpiece with other hand.
- Instruct the patient to exhale normally and then place lips securely around mouthpiece.
- Instruct patient not to breathe through his or her nose. Use a nose clip if necessary.
- Instruct the patient to inhale slowly and as deeply as possible through the mouthpiece.
- Tell patient to hold breath and count to three. Check position of gauge to determine progress and level attained.
- Instruct patient to remove lips from mouthpiece and exhale normally.
- Tell patient to complete breathing exercises about 10 times every hour if possible. Rest in between breaths as necessary.

ration; a quick, tight closure of the glottis together with a forceful contraction of the expiratory intercostal muscles; and an upward push of the diaphragm. This causes an explosive movement of air from the lower to the upper respiratory tract. To be effective, a cough should have enough muscle contraction to force air to be expelled and to propel a liquid or a solid on its way out of the respiratory tract. Coughing is most effective when the patient is sitting upright with feet flat on the floor. Coughing can be voluntary or involuntary.

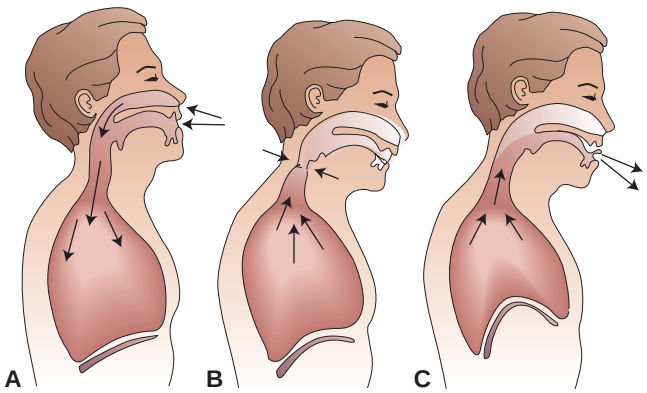


Figure 45-6. (**A**) A cough begins with a deep inspiration, distending the trachea and hyperinflating the lungs. (**B**) After inspiration, the glottis closes while intercostal and abdominal muscles contract forcibly. (**C**) When intrathoracic pressure reaches a high level, the glottis opens slightly, and the diaphragm is pushed up, producing an explosive movement of air.

Voluntary Coughing

When a cough does not occur as a result of reflex stimulation of the cough-sensitive areas, it can be induced voluntarily. Teaching the patient to cough voluntarily is an important aspect of preoperative and postoperative care. Coughing is more effective when combined with deep breathing. Although teaching a patient to cough and deep breathe is relatively easy, experience has shown that it is difficult to motivate patients to follow through and perform coughing on their own. Refer to Guidelines for Nursing Care 30-2 (Chap. 30), Effective Coughing, for detailed instructions for teaching this intervention. Frequently remind patients to perform effective coughing throughout the day. Develop a specific schedule for coughing on the patient's plan of care. Coughing early in the morning after rising removes secretions that have accumulated during the night. Coughing before meals improves the taste of food and oxygenation. At bedtime, coughing removes any buildup of secretions and improves sleep patterns. For a patient who is unable to cough voluntarily, manual stimulation over the trachea and prolonged exhalation can be helpful. If neither of these methods is successful, mechanical endotracheal suctioning with a catheter may be necessary.

If the patient has a neuromuscular disorder and is unable to cough physically, an assisted cough may be used. For an

assisted cough, firm pressure is placed on the abdomen below the diaphragm in rhythm with exhalation. This pressure is similar to the Heimlich maneuver but with less force. This pressure is used to substitute for the weakened or paralyzed abdominal muscles.

Involuntary Coughing

Involuntary coughing often accompanies respiratory tract infections and irritations. Many times respiratory infections lead to the production of respiratory secretions. These secretions can trigger the cough mechanism. When the cough is productive, it helps clear the airway. However, when the cough is nonproductive, it can be fatiguing and irritating. Medications may control involuntary coughing. Refer to the section Cough Suppressants. Observation of the patient's breathing and coughing characteristics is necessary to determine the appropriate type of medication.

Using Cough Medications

Various medications can be used to promote coughing, aiding in the movement of mucus through the respiratory tract, and in controlling coughing to allow the patient to rest.

Cough Suppressants

Suppressants are drugs that depress a body function—in this case, the cough reflex. Codeine, which is present in many cough preparations, is generally considered the preferred cough suppressant ingredient. However, codeine can be addictive, and because of possible abuse, many states require a prescription for its use. Drowsiness (also common with antihistamines) is a side effect, so it may not be safe to use codeine when the person must remain alert, such as when driving a car. A suppressant that is not addictive is dextromethorphan, which can be found in many over-the-counter cold and cough remedies.

An irritating, nonproductive cough in people without congestion may be appropriately treated with suppressants. Suppression of the productive cough is usually not recommended unless the patient is trying to sleep. If a productive cough is suppressed, secretions can be retained, leading to a pulmonary infection.

Expectorants

Expectorants are drugs that facilitate the removal of respiratory tract secretions by reducing the viscosity of the secretions. Patients with extremely tenacious (thick) secretions may need the secretions liquefied for their cough to be effective. In that way, the nonproductive cough of a person with lung congestion can become productive. Use of an expectorant by a person without congestion is inappropriate. Guaifenesin is widely used as an expectorant in cold and cough medications (eg, Robitussin). Adequate fluid intake and air humidification are considered effective expectorants by some authorities.

Lozenges

Mild, nonproductive coughs in people without congestion can often be relieved by cough lozenges. A lozenge is a small, solid medication intended to be held in the mouth until it dissolves. Lozenges generally control coughs by the local anesthetic effect of benzocaine. The local anesthetic acts on sensory and motor nerves, controlling the primary irritation and inhibiting afferent and efferent impulses.

Teaching About Cough Medications

Cough medications are readily available, and people who purchase them are usually eager for relief. Often, consumers take excessive amounts of more than one type. Teach about the appropriate choice of expectorants and suppressants and about misuse of cough mixtures. For example, cough syrups with a high sugar or alcohol content can disturb the metabolic balance of patients with diabetes mellitus or can trigger a relapse for recovering alcoholics. Preparations containing antihistamines have an anticholinergic action, which can cause serious problems for people with glaucoma or cause urinary retention in men with prostate enlargement. Other cough preparations can be detrimental to people with hypertension or thyroid or cardiac diseases. In addition, prolonged use of self-prescribed cough preparations can conceal more serious health problems. If a cough lasts more than 7 days, urge the person to contact a physician. In addition, encourage the person to increase fluid intake if the secretions become too thick to expectorate.

Performing Chest Physiotherapy

Chest physiotherapy helps loosen and mobilize secretions. This is especially helpful for patients with large amounts of secretions or an ineffective cough. Chest physiotherapy includes percussion, vibration, and postural drainage.

Percussion

Percussion of lung areas involves the use of a cupped palm to loosen pulmonary secretions so that they can be expectorated with greater ease. With the hand held in a rigid, dome-shaped position (Fig. 45-7), the area over the lung lobes to be drained is struck in a rhythmic pattern. The patient is positioned in a lateral, supine, or prone position, based on the lobes to be treated and should not experience any pain. Percussion is never done on bare skin or performed over surgical incisions, below the ribs, or over the spine or breasts because of the danger of tissue damage. Typically, each area is percussed for 30 to 60 seconds several times a day. If the patient has tenacious secretions, the area may be percussed for up to 3 to 5 minutes several times per day. Patients may learn how to percuss the anterior surfaces of their own chest wall. In addition, family members can be taught how to percuss posterior surfaces. Mechanical devices as well as manual handheld cupping devices also are available for percussion on the chest wall.

Vibrating

Vibration uses manual compression and tremor on the patient's chest wall to help loosen respiratory secretions. Loosened secretions can be more easily expectorated. The practitioner uses rhythmic contraction and relaxation of arm and shoulder muscles while holding the hands flat on the

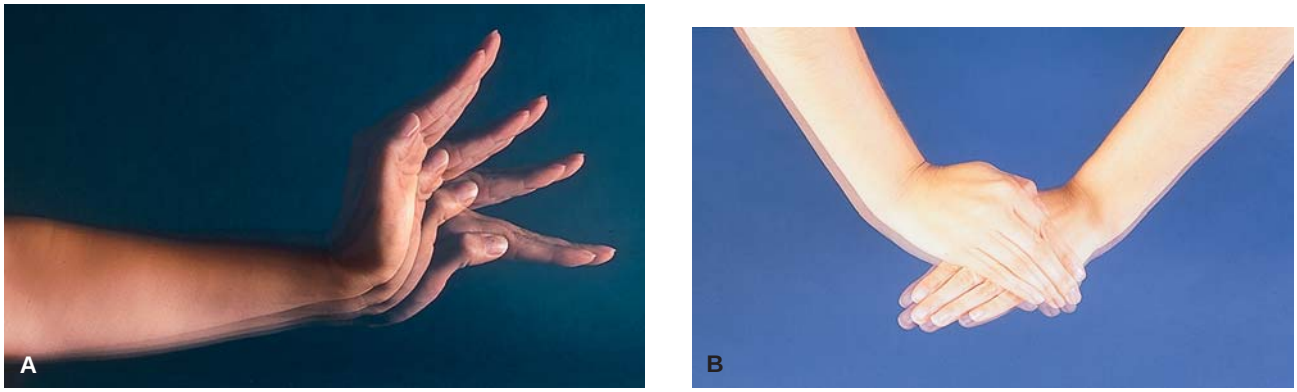


Figure 45-7. (**A**) The cupping position and action of the hand on manual percussion of the lung area. (**B**) The position and action of the hands necessary to use vibration to loosen respiratory secretions in the lungs. *(Photos © B. Proud.)*

patient's chest wall as the patient exhales. Vibration can be done for several minutes, several times a day. To avoid causing patient discomfort, vibration is never done over the patient's breasts, spine, sternum, and lower rib cage. Vibration (see Fig. 45-7) can also be taught to family members or accomplished using a mechanical device.

Providing Postural Drainage

Postural drainage makes use of gravity to drain secretions from the lungs. The patient is positioned in a way that promotes the drainage of secretions from smaller pulmonary branches into larger ones, where they can be removed by coughing (Fig. 45-8). Postural drainage is often preceded by vibration, percussion, or both.

When implementing postural drainage, have tissues and an emesis basin close at hand for the patient to use when coughing and expectorating secretions. Place the patient in an appropriate position to promote drainage from the lobes of the lungs. Postural drainage should be done two to four times a day for 20 to 30 minutes. Discontinue the drainage if the patient

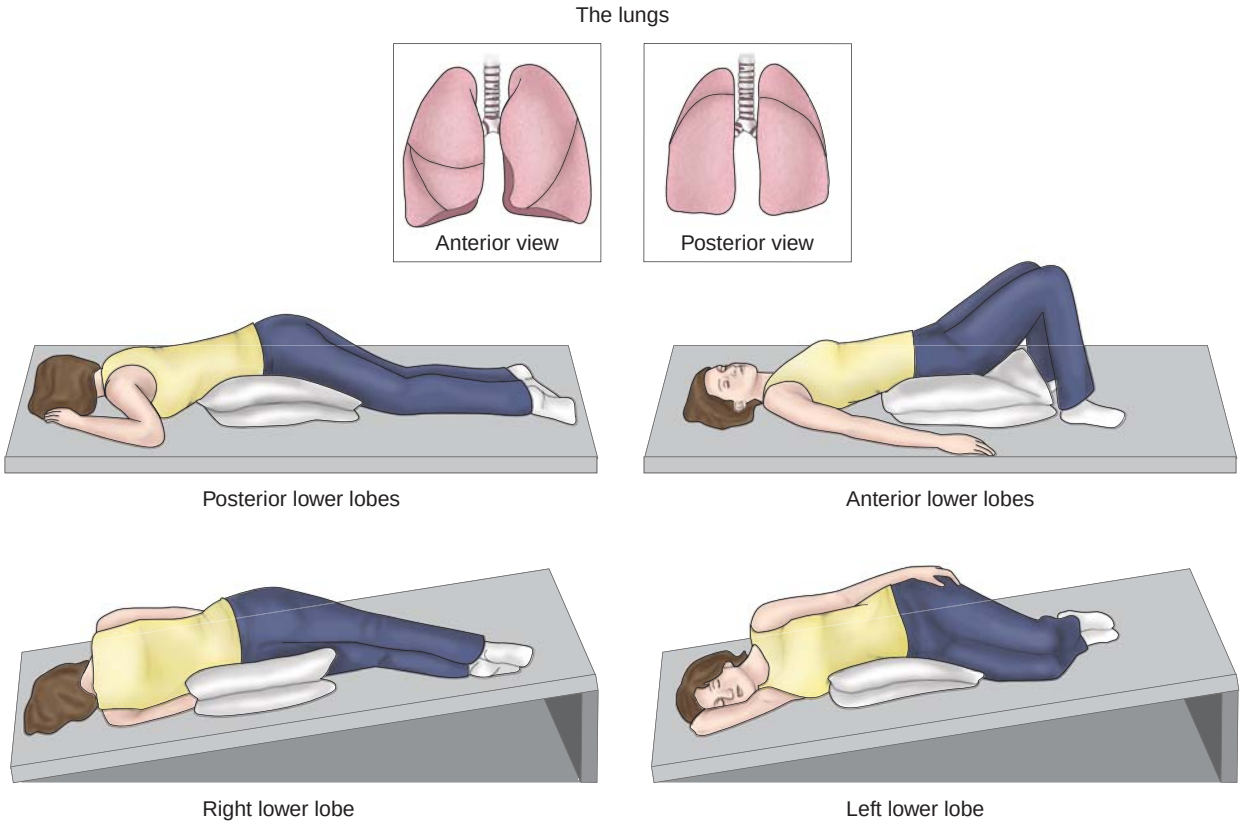


Figure 45-8. Postural drainage. Shown are four positions that use the force of gravity to assist the drainage of secretions from the smaller bronchial airways into the main bronchi and trachea so the patient is able to cough them up.

begins to feel weak or faint. Delay postural drainage for 1 to 2 hours after meals to avoid provoking vomiting. Appropriate positioning to achieve postural drainage is as follows:

- Use high Fowler's position to drain the apical sections of the upper lobes of the lungs.
- Place the patient in a lying position, half on the abdomen and half on the side, right and left, to drain the posterior sections of the upper lobes of the lungs.
- Place the patient lying on the left side with a pillow under the chest wall to drain the right lobe of the lung.

Place the patient in the Trendelenburg position to drain the lower lobes of the lungs.

Suctioning the Airway

If a patient is unable to remove secretions with coughing, secretions can be aspirated with a suctioning device. If the patient is able to raise secretions from the airways but unable to clear from the mouth, suctioning of the oropharynx or nasopharynx may be indicated, as demonstrated in Skill 45-2. If the patient is unable to raise secretions from the airways, tracheal suctioning may be indicated. Tracheal suctioning may be performed by passing a sterile catheter through the mouth (orotracheal) or through the nose (nasotracheal). It may also be passed through a tracheostomy or endotracheal tube (discussed later in the chapter). Suctioning to remove secretions is performed using the sterile technique as described in Chapter 27. The frequency of suctioning varies with the amount of secretions present but should be done often enough to keep ventilation effective and as effortless as possible. The suction catheter should be small enough not to occlude the airway being suctioned but large enough to remove secretions. Several sizes of catheters are available.

Suctioning irritates the mucosa and removes oxygen from the respiratory tract, possibly causing **hypoxemia** (insufficient oxygen in the blood). Thus, the patient must be hyperoxygenated before suctioning. This is easily accomplished by having the patient take several deep breaths before inserting the catheter.

When performed correctly, suctioning provides comfort by relieving respiratory distress. When performed incorrectly, it can increase anxiety and pain and cause respiratory arrest. It is normally painless; however, anticipate the administration of analgesic medication to a patient who has had surgery or experienced trauma before suctioning, because the cough reflex will be stimulated. Possible complications of suctioning include infection, cardiac arrhythmias, hypoxia, mucosal trauma, and death.

Wear gloves on both hands, goggles, and a mask, and a gown, if necessary, for protection from microorganisms. Continuously monitor the patient's color and heart rate and the color, amount, and consistency of secretions. If cyanosis, an excessively slow or rapid heart rate, or suddenly bloody secretions are noted, stop suctioning immediately, administer oxygen, and notify the physician. Cyanosis and a change in heart rate can indicate hypoxemia. Blood can indicate damage to the mucosa.

Meeting Respiratory Needs With Medications

Although treating patients with medications is a dependent nursing intervention, monitoring the patient's response and development of side effects to medications is an independent nursing action. Table 45-2 shows some common medications for improving respiratory functioning, their side effects, and nursing implications. Many of the drugs used to dilate bronchial airways interact with caffeine. Encourage patients to avoid caffeine, which may potentiate the side effects of bronchodilators.

Administering Inhaled Medications

Inhaled medications may be administered to open narrowed airways (**bronchodilators**), to liquefy or loosen thick secretions (mucolytic agents), or to reduce inflammation in airways (corticosteroids). These medications typically are administered via nebulizer, metered-dose inhaler, or dry powder inhaler.

Nebulizers disperse fine particles of liquid medication into the deeper passages of the respiratory tract, where absorption occurs. The treatment continues until all the medication in the nebulizer cup has been inhaled.

A **metered-dose inhaler (MDI)** delivers a controlled dose of medication with each compression of the canister. Common mistakes that patients make when using MDIs include the following:

- Failing to shake the canister
- Holding the inhaler upside down
- Inhaling through the nose rather than the mouth
- Inhaling too rapidly
- Stopping the inhalation when the cold propellant is felt in the throat
- Failing to hold their breath after inhalation
- Inhaling two sprays with one breath

To use an MDI, the patient must activate the device while continuing to inhale. For some patients, especially young children and older adults, a spacer or extender device may be necessary to aid delivery of medication by the inhalation route. The spacer acts as a reservoir. When the MDI is compressed, the medication is deposited in the reservoir, and the patient then inhales the medication from the spacer device. This makes administration less complicated and the dose more predictable.

Dry powder inhalers (DPI) are another type of delivery method for inhaled medications. DPIs are breath activated. A quick breath by the patient activates the flow of medication, eliminating the need to coordinate activating the inhaler (spraying the medicine) while inhaling the medicine at the same time. DPIs require less manual dexterity than does an MDI. DPIs are actuated by the patient's inspiration, so there is no need to coordinate the delivery of puffs with inhalation (Togger & Brenner, 2001). Many types of DPIs are available with distinctive operating instructions. Some have to be loaded with a dose of medication each time they are used. Some hold a preloaded number of doses. It is important to understand the particular instructions for the medication

TABLE 45-2 Selected Medications Used to Improve Respiratory Function

Medications	Activity	Route	Side Effects	Nursing Implications
Zafirlukast (Accolate) Montelukast (Singulair)	Bronchodilator Also inhibits leukotriene release as well as inflammatory reaction	PO	Headache, dizziness, nausea, vomiting	Not used to treat acute attacks. Do not give Accolate with meals. Singulair should be given before bedtime.
Albuterol	Bronchodilator	PO, inhalation	Tremors, anxiety, insomnia, headache, palpitations, hypertension, vomiting	Caution patient not to increase dosage without consulting physician. Be aware that children 2–6 years of age more frequently exhibit CNS stimulation.
Theophylline (Aminophylline)	Bronchodilator	PO, IV, rectally	Nausea, vomiting, tachycardia, diuresis, irritability, vertigo, convulsions, nevervousness	Monitor vital signs closely. Force fluids as clinical status allows. Monitor serum theophylline levels, especially if patient does not respond to drug or if severe side effects develop.
Corticosteroids (prednisone, dexamethasone, budesonide, triamcinolone acetonide)	Reduces inflammation	PO, IV, inhalation, intranasal	Fluid retention, hypertension, mood swings, weight gain, gastritis hyperglycemia, insomnia	Reduce sodium intake. Make patient and family aware of potential for labile emotions. Weigh daily in morning. Monitor blood pressure and blood sugar.
Diphenhydramine (Benadryl)	Antihistamine H_1-receptor antagonist	PO	Drowsiness, anorexia, dry mouth, constipation, blurred vision, urinary retention	Warn patient to use only with physician's advice in presence of bronchial asthma.
Cetrizine (Zyrtec)	Antihistamine H_1-receptor antagonist	PO	Headache with limited sedative effect, not associated with anticholinergic effects	Monitor effectiveness of drug. Contraindicated while breastfeeding.
Fexofenadine (Allegra)	Antihistamine H_1-receptor antagonist	PO	Headache, not associated with anticholinergic or sedative effects	
Cromolyn sodium (Intal)	Mast cell stabilizer Asthma prophylactic agent—no bronchodilator, antihistamine, or vasoconstrictor properties	Inhalation—MDI or nasal solution	Cough, nausea, nasal stinging and burning, throat irritation	Remind patient this is used to prevent asthma attacks, not to treat acute episodes. Inform patient that drug is effective only if taken routinely (2–4 times per week). Safety not established during pregnancy and breastfeeding.

CNS, central nervous system; PO, orally; IV, intravenously.

being used. One disadvantage of DPIs is that the medication in DPIs will clump if exposed to humidity.

Remember Tyrone, the 12-year-old boy with suspected asthma. During this acute attack, the nurse would anticipate administering bronchodilators via a nebulizer. The physician may order bronchodilators to be administered at home using a nebulizer or possibly an MDI with a spacer or dry powder inhaler.

A microchip-based inhaler has been developed that determines when the patient is breathing at an ideal rate to deliver a metered dose of asthma medication. This device (SmartMist) delivers a standard dose with a high degree of precision. Several companies are working on similar pulmonary drug-delivery systems.

Teaching Patients About Inhaled Medications

Patients need repeated instruction on how to use inhalers and nebulizers effectively and safely. Overuse may result in serious side effects and eventual ineffectiveness of the medication. Information about how to use MDIs, DPIs, and small-volume nebulizers properly, including patient teaching information, is provided in Chapter 29, Guidelines for Nursing Care 29-9. Package inserts with the medication also reinforce correct technique for using inhalers.

To ensure correct administration when a spacer is used, slow, deep inspirations are necessary. To prevent inhaling too quickly, some spacers are equipped with a whistle device that sounds if inhalation is too rapid. A spacer is also recommended for patients using corticosteroid inhaled agents because it reduces the risk for an oral fungal infection.

Providing Supplemental Oxygen

The amount of oxygen the patient uses for inspiration can be increased by providing a supplemental supply via oxygen therapy. Oxygen is considered a medication and must be ordered by a healthcare provider. Oxygen therapy can be intimidating or frighten patients, so provide clear explanations about the procedures and purpose to help reduce anxiety. Encourage patients to discuss concerns. If oxygen is given in an emergency, explanations concurrent with administration are appropriate.

Sources of Oxygen

Therapeutic oxygen is supplied from a wall outlet or a portable cylinder. A specially designed flowmeter is attached to the wall outlet (see Skill 45-3 for an illustration of a flowmeter). A valve regulates the oxygen flow in liters per minute. To release oxygen safely and at the desired rate from a cylinder or tank, a regulator is used. The regulator has two gauges. The one nearest the tank shows the pressure or amount of oxygen in the tank. The other gauge indicates the number of liters per minute of oxygen being released.

Oxygen concentrators are another way to provide oxygen. This oxygen delivery system concentrates room air to provide the appropriate concentration of oxygen to the patient. They are used frequently in home situations.

Oxygen Flow Rate

The flow rate of oxygen, measured in liters per minute, determines the amount of oxygen delivered to the patient. The rate varies depending on the condition of the patient and the route of administration of the oxygen. The flow rate does not necessarily reflect the oxygen concentration actually inspired by the patient because there is leaking and mixing with atmospheric air. If more precise doses are necessary, they are usually prescribed in terms of percentage of inspired oxygen. To regulate the oxygen percentage concentration accurately, samples of the air mixture the patient is actually inhaling should be analyzed every 4 hours. Several types of commercial oxygen analyzers are available.

The physician's written order prescribes the rate of oxygen administration. Closely monitor the flow rate for patients with chronic lung conditions, such as emphysema. Normally, excessive levels of carbon dioxide in the blood stimulate the patient to breathe. However, the chemoreceptors of patients with chronic lung disease become insensitive to carbon dioxide and respond to hypoxia to stimulate breathing. If excessive oxygen is given, the stimulus to breathe is removed; as a result, the patient may stop breathing completely. Most patients with chronic lung disease can tolerate oxygen administered at 2 L/min (usually by nasal cannula; see discussion below). However, arterial blood gas results should be monitored closely for changes. Many times, continuous pulse oximetry also is used to monitor the patient receiving oxygen.

Humidification

Most institutions do not require humidification with very-low-flow oxygen (2 L/min or less) delivered by nasal cannula (see oxygen delivery systems below) when administered to adults. However, because oxygen dries and dehydrates the respiratory mucous membranes, humidifying devices (supplying 20% to 40% humidity) are commonly used when oxygen is delivered at higher flow rates. Distilled or sterile water is commonly used to humidify oxygen. When moving patients receiving humidified oxygen, make sure that water from the humidifier does not enter the tubing through which the oxygen is flowing. Additional suggestions for transporting a patient with a portable oxygen tank are given in Guidelines for Nursing Care 45-2.

Precautions for Oxygen Administration

Oxygen, which constitutes 21% of normal air, is a tasteless, odorless, and colorless gas. It supports combustion. To prevent fires and injuries, take the following precautions:

- Avoid open flames in the patient's room.
- Place "no smoking" signs in conspicuous places in the patient's room or home. Instruct the patient and visitors about the hazard of smoking when oxygen is in use.
- Check to see that electrical equipment used in the room, such as electric bell cords, razors, radios, and suctioning equipment, is in good working order and emits no sparks.
- Avoid wearing and using synthetic fabrics that build up static electricity.

Guidelines for Nursing Care 45-2

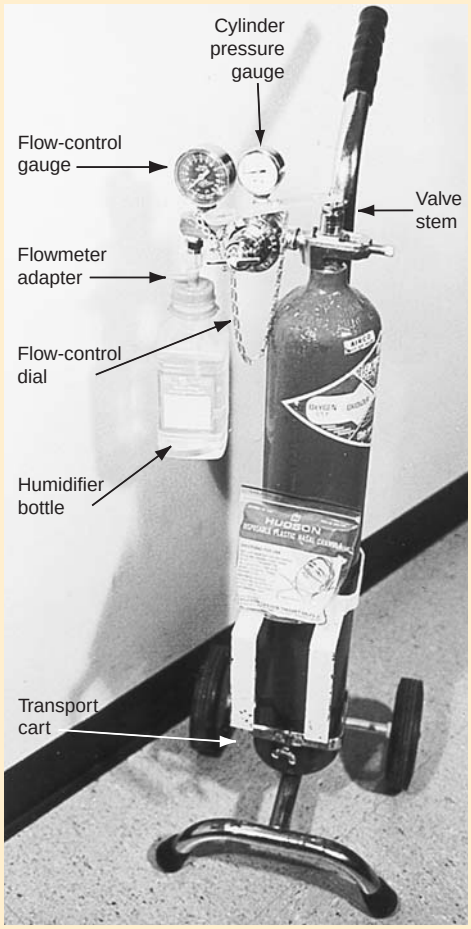
Transporting a Patient With a Portable Oxygen Cylinder

Before the Transfer:

- Check that additional oxygen source is available where patient is being transferred.
- Check amount of oxygen in cylinder (place cylinder key or wrench on valve stem and turn fully counterclockwise until needle on gauge indicates amount of available oxygen; turn the key back a half turn; use cylinder only if gauge indicates more than 500 psi).
- Connect oxygen tubing or humidifier bottle with tubing to the flowmeter adapter and adjust the flow-control dial to the prescribed setting.
- Attach patient's oxygen cannula to transport oxygen.
- Ensure that the cylinder is secured in holder before transporting patient (it is a dangerous practice to place the cylinder between the patient's legs or next to the patient during transfer because injury to the patient may result). If humidifier is used, ensure that cylinder remains upright.
- Place coiled tubing under pillow or attach to linen or patient's gown.

After the Transfer:

- Attach patient's oxygen cannula to wall oxygen.
- Turn off the oxygen flow from the cylinder by turning the cylinder key clockwise until it is tight.
- Remove any excess oxygen in the pressure gauge by "bleeding" it. Turn the flow-control dial back on until hissing sound stops and needle on gauge has fallen to zero. Turn flow-control dial off.



- Avoid using oils in the area. Oil can ignite spontaneously in the presence of oxygen.

Oxygen Delivery Systems

Oxygen can be administered by many different delivery systems: nasal cannula, nasal catheter, transtracheal catheter, simple mask, partial rebreather mask, nonrebreather mask, Venturi mask, and tent. Table 45-3 compares several oxygen delivery systems.

Nasal Cannula

A **nasal cannula,** also called nasal prongs, is the most commonly used oxygen delivery device. The cannula is a disposable plastic device with two protruding prongs that are inserted into the nostrils. The cannula is connected to an oxygen source with a flowmeter and, many times, a humidifier. The cannula does not impede eating or speaking and is easily used in the home. Disadvantages of this system are that it can easily be dislodged and can cause dryness of the nasal mucosa. Skill 45-3 describes oxygen administration by nasal cannula.

Nasal Catheter

A nasal, or oropharyngeal, catheter is another efficient means for administering oxygen, but it is infrequently used because it is uncomfortable for the patient and may cause trauma to respiratory mucous membranes. It is inserted into the nose through one nostril, with the end of the catheter resting in the oropharynx. The catheter must be changed to the other nostril every 8 hours. Gastric distention often occurs because the gas flow can be misdirected into the stomach.

TABLE 45-3 Oxygen Delivery Systems

Method	Amount Delivered FiO_2 (Fraction Inspired Oxygen)	Priority Nursing Interventions
Nasal cannula	*Low Flow* 1 L/min = 24% 2 L/min = 28% 3 L/min = 32% 4 L/min = 36% 5 L/min = 40% 6 L/min = 44%	Check frequently that both prongs are in patient's nares. Never deliver more than 2–3 L/min to patient with chronic lung disease.
Simple mask	*Low Flow* 6–10 L/min = 35%–60% (5 L/min is minimum setting)	Monitor patient frequently to check placement of the mask. Support patient if claustrophobia is a concern. Secure physician's order to replace mask with nasal cannula during meal time.
Partial rebreather mask	*Low Flow* 6–15 L/min = 70%–90%	Set flow rate so that mask remains two-thirds full during inspiration. Keep reservoir bag free of twists or kinks.
Nonrebreather mask	*Low Flow* 6–15 L/min = 60%–100%	Maintain flow rate so reservoir bag collapses only slightly during inspiration. Check that valves and rubber flaps are functioning properly (open during expiration and closed during inhalation). Monitor SaO_2 with pulse oximeter.
Venturi mask	*High Flow* 4–10 L/min = 24%–55%	Requires careful monitoring to verify FiO_2 at flow rate ordered. Check that air intake valves are not blocked.

Face Masks

Disposable and reusable face masks are available. The mask is fitted carefully to the patient's face to avoid leakage of oxygen and should be comfortably snug but not tight against the face. The most commonly used types of masks are the simple face mask, the partial rebreather mask, the nonrebreather mask, and the Venturi mask. Skill 45-4 describes the actions and rationales involved in using face masks.

The simple face mask is connected to oxygen tubing, a humidifier, and a flowmeter, just like the nasal cannula. This mask has vents on its sides that allow room air to leak in at many places, thereby diluting the source oxygen. The vents also allow exhaled carbon dioxide to escape. Often a simple mask is used when an increased delivery of oxygen is needed for short periods (eg, less than 12 hours). The mask should fit closely to the face to deliver this higher concentration of oxygen effectively. Patients may have difficulty keeping the mask in position over the nose and mouth, and because of this pressure and the presence of moisture, skin breakdown is a possibility. Eating or talking with the mask in place can be difficult. Because of the risk of retaining carbon dioxide, never apply the simple face mask with a delivery flow rate of less than 5 liters per minute.

The partial rebreather mask is similar to a simple face mask but is equipped with a reservoir bag for the collection of the first part of the patient's exhaled air. The remaining exhaled air exits through vents. The air in the reservoir is mixed with 100% oxygen for the next inhalation. Thus, the patient rebreathes about one third of the expired air from the reservoir bag. This type of mask permits the conservation of oxygen. An additional advantage is that the patient can inhale room air through openings in the mask if the oxygen supply is briefly interrupted. The disadvantages are those of any mask: eating and talking are difficult, a tight seal is required, and there is the potential for skin breakdown. Monitor the reservoir bag carefully. It should deflate slightly with inspiration; if it deflates completely, the flow rate should be increased until only a slight deflation is noted.

The nonrebreather mask delivers the highest concentration of oxygen via a mask to a spontaneously breathing patient. It is similar to the partial rebreather mask except two one-way valves prevent the patient from rebreathing exhaled air. The reservoir bag is filled with oxygen that enters the mask on inspiration. Exhaled air escapes through side vents. A malfunction of the bag could cause carbon dioxide buildup and suffocation. This mask can also be used to administer other gases, such as heliox.

The Venturi mask gets its name from the Venturi effect, which allows the mask to deliver the most precise concentrations of oxygen. This mask has a large tube with an oxygen

inlet. As the tube narrows, the pressure drops, causing air to be sucked in through side ports. These ports are adjusted according to the prescription for oxygen concentration. Be sure that the ports are always open. If these are occluded by linens, clothing, or a patient rolling on the mask, the oxygen delivered might be at an unsafe (too high or too low) concentration.

Oxygen Tent

Oxygen also can be administered by way of an oxygen tent. An oxygen tent is a light, portable structure made of clear plastic and attached to a motor-driven unit. The motor helps to circulate and cool the air in the tent. The cooling device functions like an electric refrigeration unit. A thermostat in the unit keeps the tent at the temperature considered most comfortable for the patient. The tent fits over the top part of the bed so that the patient's head and thorax are inside. It has side openings through which nursing care can be administered. Because the tent is highly humidified and covers most of the patient's gown and linens, check the patient frequently to prevent the patient from lying in a wet bed. Although an oxygen tent is commonly used with children who need a cool and highly humidified airflow (eg, children with pneumonia), the tent does not allow the maintenance of a satisfactory or precise oxygen concentration, so it is rarely used with other patients.

Oxygen Therapy in the Home

Liquid oxygen and oxygen concentrators, rather than cylinders, are used more commonly in the home setting. Liquid oxygen is kept inside a small thermal container that can be refilled from a larger storage tank kept in the home. An oxygen concentrator removes nitrogen from the room air and concentrates the oxygen left in the air. The oxygen concentrator needs a power source such as an electrical outlet or battery pack. Oxygen concentrators are portable, cost-effective, and easy to use but cannot deliver oxygen flow at greater than 4 L/min (fraction of inspired oxygen [FiO_2] of about 36%).

Patients using continuous supplemental oxygen therapy in the home have another alternative: transtracheal oxygen delivery (Fig. 45-9). With this type of delivery system, a small catheter is inserted into the trachea under local anesthesia, and then the catheter is attached to the oxygen source. A transtracheal catheter does not interfere with talking, eating, or drinking and delivers oxygen throughout the respiratory cycle rather than just at inspiration. The patient or family must assume responsibility for daily catheter care. Patients usually report improved mobility, comfort, and appearance and lower cost with this delivery system.

Patients using oxygen at home need instruction regarding safety precautions. See Teaching to Promote Health at Home 45-1 for information regarding the use of oxygen in the home setting.

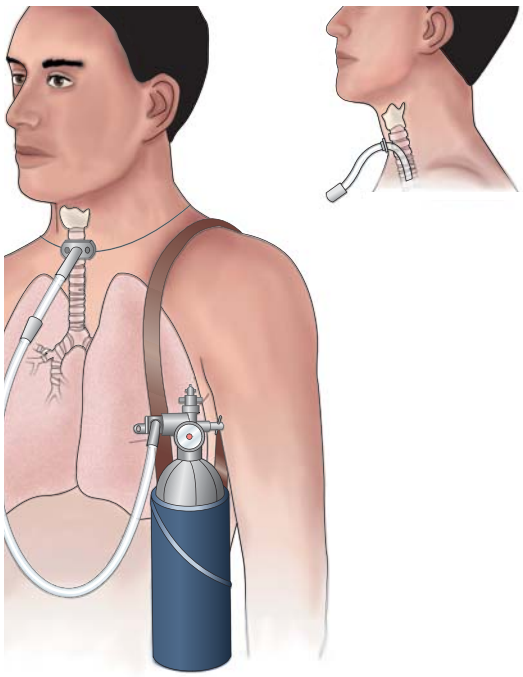


Figure 45-9. A transtracheal oxygen setup.

Managing Chest Tubes

Patients with fluid (**pleural effusion**), blood (**hemothorax**), or air (**pneumothorax**) in the pleural space require a chest tube to drain these substances and allow the compressed lung to reexpand. A chest tube is a firm plastic tube with drainage holes in the proximal end that is inserted in the pleural space. Once inserted, the tube is secured with a suture and tape, covered with an airtight dressing, and attached to a drainage system that may or may not be attached to suction. Other components of the system may include a closed water-seal drainage system that prevents air from reentering the chest once it has escaped and a suction control chamber that prevents excess suction pressure from being applied to the pleural cavity. The suction chamber may be a water-filled or a dry chamber. A water-filled suction chamber is regulated by the amount of water in the chamber, whereas dry suction is automatically regulated to changes in the patient's pleural pressure (Lazzara, 2002). Most healthcare agencies use a molded plastic, three-compartment disposable chest drainage unit for management of chest tubes (Fig. 45-10). There are also portable drainage systems that utilize gravity for drainage (Andrs, 2004).

The placement of the chest tube is determined by the type of drainage. When air is to be drained, the tube is placed higher in the chest. If fluid needs to be drained, the tube is inserted lower in the lung because fluids settle at the base of the lung.

Nursing responsibilities include assisting with insertion and removal of a chest tube. Once the tube is in place, the nurse monitors the patient's respiratory status and vital signs, checks the dressing, and maintains the patency and integrity of the drainage system. Guidelines for monitoring a patient with a chest tube are shown in Guidelines for Nursing Care 45-3.

Teaching to Promote Health at Home 45-1

Using Oxygen at Home

Health Topic	Teaching Tip	Why Is This Important?
Safety	• No smoking or open flames are allowed within 10 feet of the oxygen source. • Do not use electrical equipment near oxygen administration set (eg, space heaters, blow dryers). • Use caution with gas or electric appliances. • Ground oxygen concentrators. • Secure the oxygen tank in a holder and away from direct sunlight or heat. • Allow adequate airflow around the oxygen concentrator (avoid placing flush against the wall). • Notify local fire department of the oxygen in the home.	Oxygen is a combustible gas; a spark may ignite the oxygen.
Administration	• Follow the physician's prescription for the oxygen flow rate. • Have the physician's and nurse's phone number readily available. • Ensure enough available oxygen prior to leaving house for errands or trips. • Know how to reach the oxygen equipment vendor and the reasons for contacting the vendor. • Know signs and symptoms that indicate the need to call for emergency assistance.	Too much or too little oxygen may be detrimental to the patient.

Using Artificial Airways

Oropharyngeal and Nasopharyngeal Airways

An oropharyngeal or nasopharyngeal airway is a semicircular tube of plastic or rubber inserted into the back of the pharynx through the mouth (oro) or nose (naso) in a patient who is breathing spontaneously. The oropharyngeal airway is used to keep the tongue clear of the airway. It is often used for postoperative patients until they regain consciousness. Once the patient regains consciousness, the oropharyngeal airway is removed. Tape is not used to hold the airway in place because the patient should be able to expel the airway once he or she becomes alert.

A nasopharyngeal airway, commonly called a nasal trumpet, is inserted through the nare and protrudes into the back of the pharynx. The nasal trumpet allows for frequent nasotracheal suctioning without trauma to the nasal passageway. This airway may be left in place, without much discomfort, in the patient who is alert and conscious. Techniques to use when inserting an artificial airway are given in Guidelines for Nursing Care 45-4.

Endotracheal Tube

An **endotracheal tube** is a polyvinylchloride airway that is inserted through the nose or the mouth into the trachea, using

Figure 45-10. A chest drainage system attached to a patient. *(Photo by Rick Brady.)*

Guidelines for Nursing Care 45-3

Monitoring a Patient With a Chest Tube

- Assess the patient's respiratory status, vital signs, and breath sounds. Monitor for any indication of change in respiratory status.
- Observe the dressing around the chest tube insertion site and ensure that it is occlusive. All connections should also be securely taped.
- Check that the drainage tube has no dependent loops or kinks. The drainage collection device must be positioned below the tube insertion site to facilitate drainage.
- Keep drainage collection device secure so that it does not tip over.
- Check that two padded Kelly clamps are available and secured at the bedside. If the drainage unit requires changing, one clamp is positioned 1½ to 2½ inches from the insertion site, and the second clamp is placed 1 inch down from the first one until the unit has been switched. The physician may order a chest tube clamped before its removal to observe the patient's tolerance when it is discontinued or the chest tube may be clamped to assess for an air leak.
- Keep bottle of sterile saline or water at bedside. If chest tube disconnects from drainage unit, submerge end in water. This is done instead of clamping to prevent another pneumothorax. Air is still allowed to escape.
- Never clamp the tube if the patient leaves the unit for a test or moves away from the bed. Disconnect the suction tubing from the drainage system, allowing the unit to continue to collect drainage by gravity. Take bottle of sterile normal saline or water with patient.
- Avoid milking or stripping the tube to promote drainage. This creates excessive negative pressure that can damage delicate lung tissue.
- Assess the suction control chamber if suction is in use. If water suction is used, ensure that water is at the appropriate level (fluid can evaporate); water must be added to ensure that suction is adequate. Gentle bubbling in the suction chamber indicates that suction is being applied to assist drainage.
- Assist the patient to remain in high Fowler's position (if hemothorax is present) or semi-Fowler's position (for pneumothorax) for improved drainage or evacuation.
- Measure drainage output at the end of each shift by marking the level on the container or placing a small piece of tape at the drainage level to indicate date and time. Drainage is never emptied from the collection chamber. Document color and consistency of drainage. Drainage exceeding 100 mL/hr or a change in drainage to a bright red color that indicates fresh bleeding requires immediate notification of the physician.

a laryngoscope as a guide. It is used to administer oxygen by mechanical ventilator, to suction secretions easily, or to bypass upper airway obstructions (eg, tongue or tracheal edema). Although uncomfortable and easy to manipulate with the tongue, orotracheal insertion is often the method of choice, especially in an emergency, because insertion is easier and a larger tube can be used, making ventilation easier. Placement of the tube through the nasotracheal route, although tolerated better by patients, is more difficult and requires the use of a narrower tube. Most commonly, a cuffed endotracheal tube is used (Fig. 45-11). This type of tube prevents air leakage and bronchial aspiration of foreign material while allowing more precise control of oxygen and mechanical ventilation. However, careful monitoring of cuff pressure is necessary to decrease the risk for tracheal necrosis. The smallest amount of air that results in an airtight seal between the trachea and the tube is desirable and less likely to result in complications.

For a patient with an endotracheal tube who is receiving continuous mechanical ventilation, a closed airway suction system can be used to keep the airway patent and reduce the risk of hypoxemia or infection. The catheter (Fig. 45-12), encased in a plastic sleeve, remains connected to the patient's airway or ventilator tubing for up to 24 hours. This closed system is cost-effective because only one catheter is used daily, and the caregiver has additional protection from exposure to the patient's secretions. Some systems have an access valve, a safety feature that completely closes off access between the suction catheter and the endotracheal tube.

Consider Mr. Kim, the 57-year-old man receiving oxygen therapy and mechanical ventilation via an endotracheal tube. When developing the patient's plan of care, the nurse needs to assess the patient closely and frequently for signs and symptoms indicating an increase in secretions. If secretions increase, the nurse needs to suction the patient to maintain a patent airway and minimize his risk for hypoxemia and infection.

Tracheostomy

Tracheostomy Procedure and Tubes

A **tracheostomy** is an artificial opening made into the trachea, usually at the level of the second or third cartilaginous ring. A curved tube, called a tracheostomy tube, is inserted through the opening. A tracheostomy tube is inserted for a variety of reasons; for example, to replace an endotracheal tube, to provide a method for mechanical ventilation of the patient, to bypass an upper airway obstruction, or to remove tracheobronchial secretions. It is inserted in the operating room or intensive care unit under sterile conditions using local anesthesia. The tracheostomy can be temporary or permanent.

The tube is made of semiflexible plastic (polyurethane or silicone), rigid plastic, or metal and is available in different sizes with varied angles. The condition and needs of the patient determine the selection of either a metal or plastic tracheostomy tube. Although metal tubes are more cost-effective for long-term use, most do not have an adapter at the neckplate that permits connection to respiratory therapy equipment (eg, an oxygen delivery system, Ambu bag, or mechanical ventilator).

A tracheostomy tube consists of an outer cannula or main shaft, an inner cannula, and an obturator. An obturator, which guides the direction of the outer cannula, is inserted into the tube during placement and removed once the outer cannula of the tube is in place (Fig. 45-13). Many tubes also have inner cannulas that may or may not be disposable. The outer cannula remains in place in the trachea, and the inner cannula is removed for cleaning or replaced with a new one. Periodic cleaning or replacement of the inner cannula prevents airway obstruction from secretions that have accumulated on the tube's inner surface. A tube with an inner cannula is necessary when patients have excessive secretions or have difficulty clearing their secretions. It also may be recommended for a patient who will be discharged with a tracheostomy tube in place.

Tracheostomy tubes may be either cuffed or cuffless (see Fig. 45-13). The inflated cuff seals the opening around the tube to create a tight fit in the trachea. This prevents air leakage and aspiration, and permits mechanical ventilation. Newer tracheal cuffs are low pressure, do not require deflating for short intervals every few hours, and can be maintained at lower than tracheal capillary pressure. If a cuffed tube is used, always deflate it before oral feeding unless the patient is at high risk for aspiration. If left cuffed, the balloon can cause pressure that extends through the trachea and onto the esophagus, possibly impeding swallowing or causing erosion of the tissue.

A fenestrated tracheostomy tube has one large or several small openings or windows on its outer curve, has an inner cannula, and can be cuffed or cuffless. When the patient is being mechanically ventilated, the inner cannula is in place, blocking the small openings. After the patient is no longer connected to the ventilator, the inner cannula can be removed, the cuff deflated, and the tube plugged, allowing the patient to speak. Because the tube has these openings, it is not recommended for use in patients with a history of aspiration.

The tracheostomy tube is held in place by twill tapes or a Velcro strip fastened around the patient's neck. Usually a sterile, square gauze pad that has been precut by the manufacturer is placed between the skin and outer wings of the tube before the tube is tied. This tracheostomy dressing must be kept dry to prevent infection and skin irritation.

Regularly check cuff pressure, although some tubes have a pressure-release valve that prevents pressure from increasing to damaging levels. Also, because the tracheostomy tube bypasses the natural humidifying and heating mechanisms in the nose and mouth, administer heated, humidified oxygen to prevent secretions from becoming dry. Also, keep the tracheostomy tube free from foreign objects and nonsterile materials, such as cotton balls, loose threads from dressings, needles, and other small objects to reduce the risk of obstruction and infection. Artificial noses, small pieces that attach over the end of the tracheostomy tube, are available to filter and warm the air before it enters the trachea.

Preparation for emergency situations is an important part of nursing care for these patients. The tracheostomy is the patient's only airway, and measures to maintain its patency need to be readily available. Standard bedside equipment for emergency use should include the obturator from the current tube, suction equipment, oxygen, a spare tracheostomy tube of the same size and one a size smaller (Roman, 2005).

A patient who has a tracheostomy is unable to speak. Consider his or her impaired ability to communicate and keep communication tools (eg, writing board, letters, vocabulary cards) close at hand along with the call light or bell. To prevent anxiety, offer frequent reassurance and explanations and anticipate his or her needs.

Recall Joan McIntyre, the woman being weaned from the ventilator. Her plan of care needs to address her inability to communicate verbally. The nurse ensures that paper and pencil are readily available so that the patient can make her needs and wishes known.

Suctioning the Tracheostomy

Patients with tracheostomies frequently have an ineffective cough mechanism, and copious secretions, which necessitate tracheal suctioning to remove secretions. However, suctioning should be done only when clinically necessary because there are many potential risks related to suctioning. Close assessment of the patient before during and after the procedure are necessary to limit negative effects. Risks include hypoxia, infection, tracheal tissue damage, dysrhythmias, and atelectasis. Hyperoxygenate the patient before and after suctioning. Limit the application of suction to 10 to 20 seconds. These interventions help prevent hypoxia. Monitor the patient's pulse frequently to detect potential effects of

Guidelines for Nursing Care 45-4

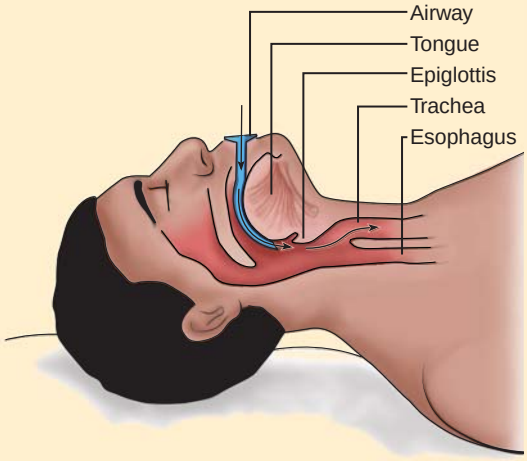
Inserting an Artificial Airway

Inserting an Oropharyngeal Airway

- Use an airway that is the correct size (size 90 mm is appropriate for the average adult). Airway should reach from opening of mouth to the back angle of the jaw.
- Explain what you are doing to the patient, even though the patient appears unconscious.
- Wash your hands and don gloves (if patient is coughing, wear mask and goggles or face shield).
- Remove dentures if they are present.
- Position patient on his or her back with neck hyperextended (unless this is inappropriate).
- Open patient's mouth by using your thumb and index finger to gently pry teeth apart.
- Insert the airway with the curved tip pointing up toward the roof of the mouth.
- Slide the airway across the tongue to the back of the mouth.
- Rotate the airway 180 degrees as it passes the uvula (a flashlight can confirm the position of the airway with the curve fitting over the tongue).
- Ensure adequate ventilation by auscultating breath sounds.
- Position patient on his or her side when airway is in place.
- Remove airway for a brief period every 4 hours. Provide mouth care and rinse airway before reinserting it.

Inserting a Nasopharyngeal Airway (Nasal Trumpet)

- Use an airway that is the correct size (size 28 French is an average adult size). Airway should reach from the tragus of the ear to the nostril plus one inch.
- Perform hand hygiene and don gloves (wear mask and goggles if patient is coughing).
- Explain the procedure to the patient.
- Lubricate the airway with the water-soluble lubricant.
- Position the patient on his or her back or in a side-lying position.
- Gently insert the airway into the naris. If resistance is met, stop and try inserting in the other naris.
- Remove the airway and place it in the other naris at least every 24 hours. Assess for any evidence of skin breakdown.
- Be aware that the airway may be used for suctioning to prevent trauma to the mucosa.



hypoxia and stimulation of the vagus nerve. Using an appropriate suction pressure (80–120 mm Hg) will help prevent atelectasis related to the use of high negative pressure (Roman, 2005). Research suggests that insertion of the suction catheter should be limited to a predetermined length (no further than 1 cm past the length of the tracheal or endotracheal tube) to avoid tracheal mucosal damage, including epithelial denudement, loss of cilia, edema, and fibrosis (Pate, 2004). Skill 45-5 describes suctioning a tracheostomy. For a patient with a tracheostomy tube who is receiving continuous mechanical ventilation, a closed airway suction system can be used to keep the airway patent and reduce the risk of hypoxemia or infection. See the previous description of this closed suction system (Endotracheal Tube).

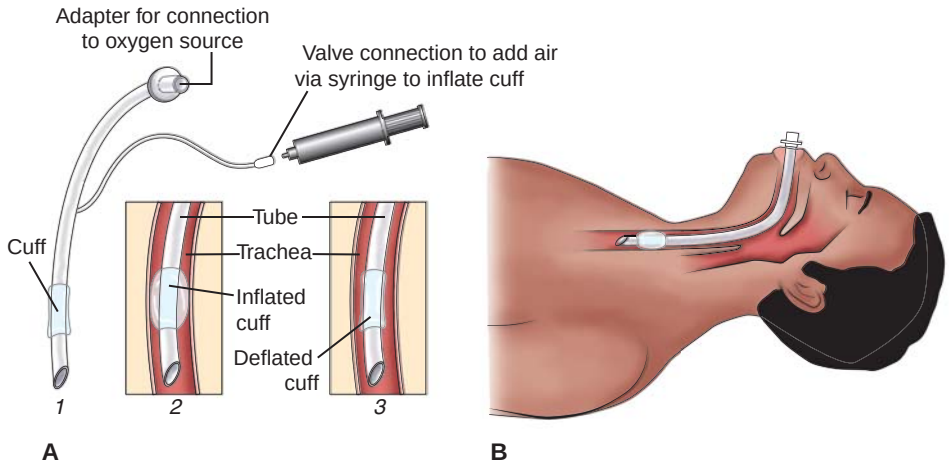


Figure 45-11. Endotracheal tube. (**A**) (*1*) Parts of a cuffed endotracheal tube; (*2*) tube in place with the cuff inflated; (*3*) tube in place with the cuff deflated. (**B**) Endotracheal tube in place.

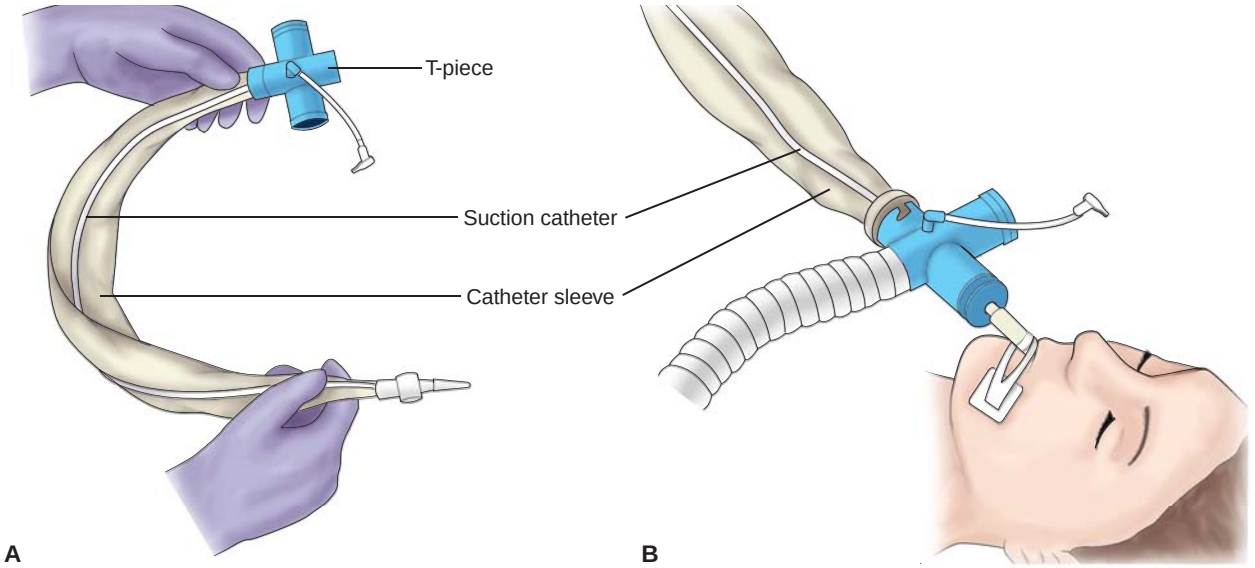


Figure 45-12. Closed airway suction system. (**A**) Closed tracheal suction system. (**B**) Closed system connected by a T-piece to the endotracheal tube and ventilator.

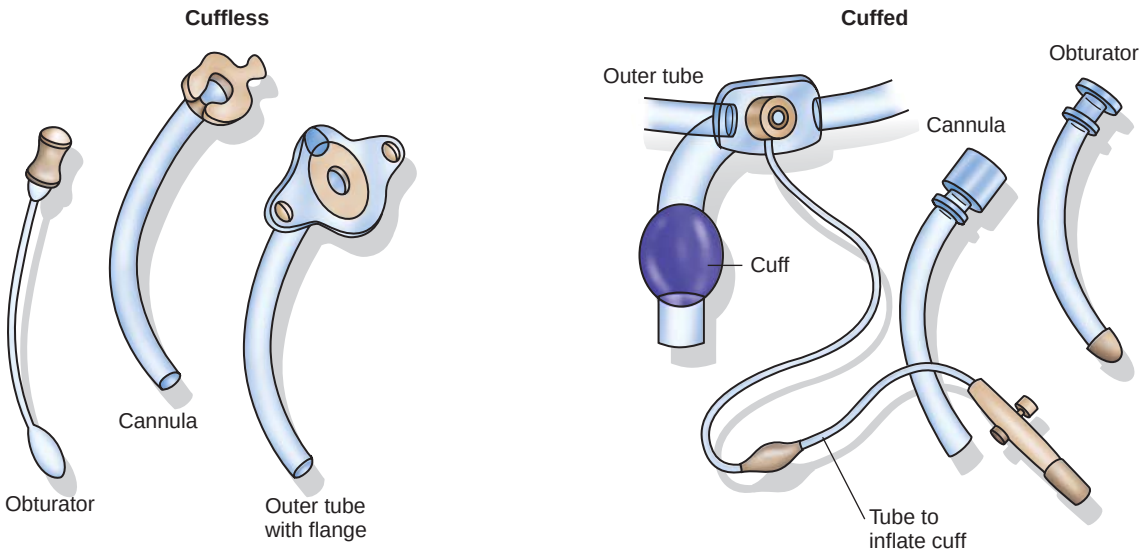


Figure 45-13. Two types of tracheostomy sets: cuffless and cuffed.

Providing Tracheostomy Care

In addition to suctioning the tracheostomy, the nurse is responsible for either cleaning a nondisposable inner cannula or replacing a disposable one. The inner cannula requires cleaning or replacement to prevent accumulation of secretions that can interfere with respiration and occlude the airway. Because soiled tracheostomy dressings place the patient at risk for the development of skin breakdown and infection, regularly change dressings and ties. Use gauze dressings that are not filled with cotton to prevent aspiration of foreign bodies (eg, lint or cotton fibers) into the trachea. Clean the skin around a tracheostomy to prevent buildup of dried secretions and skin breakdown. Exercise care when changing the tracheostomy ties to prevent accidental decannulation or expulsion of the tube. Have an assistant hold the tube in place during the change or keep the soiled tie in place until a clean one is securely attached. Agency policy and patient condition determine specific procedures and schedules, but a newly inserted tracheostomy may require attention every 1 to 2 hours. Skill 45-6 outlines tracheostomy care.

Assisting Ventilation

Mechanical ventilators are used to assist or completely control ventilation. These machines are used with patients who have endotracheal or tracheostomy tubes in place. Mechanical ventilation can be performed in acute care facilities, in extended care settings, and in the home. Mechanical ventilation improves oxygenation and ventilation and supports the patient's breathing function during emergency or acute care episodes as well as long-term situations.

Many types of ventilators are available. The nurse is responsible for addressing the physical and psychological concerns of the patient and family. In addition, key interventions include evaluating the patient's response to ventilation therapy, using safe practices and techniques, and monitoring the patient carefully for complications. (See specific clinical texts and literature that discuss the use of mechanical ventilators in greater detail.)

Another mechanical device used to assist ventilation is intermittent positive-pressure breathing (IPPB). This is a method of providing a specific amount of air, oxygen, and aerosolized medication under increased pressure to the respiratory tract. The patient receiving IPPB inhales the aerosol therapy through a mouthpiece or face mask. IPPB forces deeper inspiration by positive-pressure inhalation and then permits passive exhalation. The amount of pressure varies with each patient. It is now recognized as an alternative therapy when the patient is unable or unwilling to make the effort to ventilate his or her lungs. However, conservative methods must be attempted first, such as deep-breathing and coughing exercises, percussion, vibration, and postural drainage.

In emergency situations, the manual resuscitation bag (or Ambu bag) can be used to assist ventilation in patients whose respirations have ceased.

If Joan McIntyre stops breathing during the weaning process, the nurse could intervene by reconnecting her to the ventilator. Another alternative would be to use the manual resuscitation bag to assist with ventilation temporarily.

With the patient's head tilted back, jaw pulled forward, and airway cleared, the mask is held tightly over the patient's nose and mouth. The bag also fits easily over tracheostomy and endotracheal tubes. The operator's other hand compresses the bag at a rate that approximates normal respiratory rate (eg, 16 to 20 breaths/minute in adults). The one-way valve in the mask allows exhaled air to escape. Artificial ventilation can be sustained until spontaneous breathing starts, until other mechanical assistance is available, or until death is confirmed. The bag is self-inflating and may be attached to supplemental oxygen if needed.

Clearing an Obstructed Airway

Foreign-body obstruction of the airway often occurs during eating. In adults, meat is the most common food-related cause. In children, any variety of foods or objects can obstruct the upper airway. A patient who is semiconscious or unconscious develops airway obstruction as the tongue falls back, covering the pharynx. In fact, the tongue is the most common cause of airway obstruction.

Foreign bodies can cause a partial or complete airway obstruction. In partial airway obstruction with good air exchange, the patient can cough forcefully. Allow the person to cough, and encourage spontaneous breathing. Do not interfere with the patient's efforts to expel the object. With a partial airway obstruction, good air exchange can progress to poor air exchange. Poor air exchange may be indicated by a weak, ineffective cough, high-pitched noises while inhaling, increased breathing difficulties, and cyanosis. When this occurs, it is managed in the same way as complete airway obstruction.

With a complete airway obstruction, the victim is unable to speak or cough and may demonstrate the universal distress signal (clutching his or her throat with both hands). Immediate action is necessary, or the patient will become unconscious as the brain becomes hypoxic. After complete airway obstruction has been determined, perform the Heimlich maneuver (abdominal thrusts). Follow the American Heart Association protocols for cardiopulmonary resuscitation and obstructed airways. These protocols are continually being developed and updated.

Administering Cardiopulmonary Resuscitation

Cardiopulmonary resuscitation (CPR) is the combination of mouth-to-mouth breathing, which supplies oxygen to the lungs, and chest compressions, which circulate blood. It is often described in terms of the ABCDs of basic life support:

Airway: Tip the head and check for breathing. The respiratory tract must be opened so that air can enter.

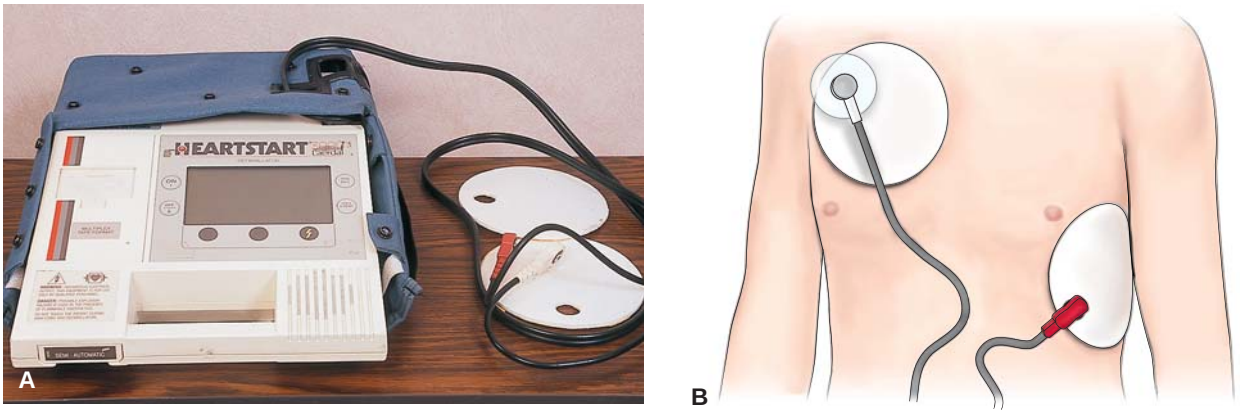


Figure 45-14. Placement of the automated external defibrillator (AED). (**A**) AED device. (**B**) Place the AED pad attached to the red cable connector to the left of the heart apex. To help remember where to place the pads, think "white right, red ribs." Placement of both electrode pads is the same as it is for manual defibrillation or cardioversion. *(Photograph © B. Proud)*

Breathing: If the victim does not start to breathe spontaneously after the airway is opened, give two breaths lasting 1.5 to 2 seconds.

Circulation: Check the pulse. If the victim has no pulse, chest compressions are initiated to provide artificial circulation.

Defibrillation: Apply the AED as soon as it is available.

Start CPR in any situation in which either breathing alone or breathing and the heartbeat are absent. The brain is sensitive to hypoxia and will sustain irreversible damage after 4 to 6 minutes of no oxygen. The faster CPR is initiated, the greater the chance of survival.

During CPR, standard precautions are followed even though contact with a patient's blood or body fluids does not always occur. Occupational Safety and Health Administra-

Research in Nursing: Bridging the Gap to Evidence-Based Practice

Use of Automated External Defibrillators by the Public

Early defibrillation in the event of a cardiac arrest has been shown to save lives. Cardiovascular disease is the most common cause of death in the United States. Many public buildings have automated external defibrillators (AEDs) available in an attempt to save lives in the future.

Related Research

Caffrey, S., Willoughby, P., Pepe, P., & Becker, L. (2002). Public use of automated external defibrillators. *New England Journal of Medicine, 347*(16), 1242–1247.

This observational study was designed to determine whether the general public would use AEDs in a public place, such as a major Midwest airport. Public service announcements were shown every half-hour including the following information: the purpose of the AED, the availability of the AED, and encouragement to use the AED if necessary. In a 2-year period, the AEDs were used a total of 18 times; in all but 2 of these instances the AED was initiated by a good Samaritan. Fifty-six percent of the survivors had a 1-year survival with a good neurologic outcome. This is compared to 5%, with the use of traditional cardiopulmonary resuscitation and emergency service response. The results of this study show the benefits of making AEDs available to the general public.

Relevance to Nursing Practice

Educating the general public is a major step taken to ensure the promotion of wellness. Nurses need to reassure and educate the general public regarding the use of AEDs and cardiopulmonary disease. In educating people in the use of AEDs, nurses are not only saving lives but also improving the quality of these lives.

For additional research, visit thePoint

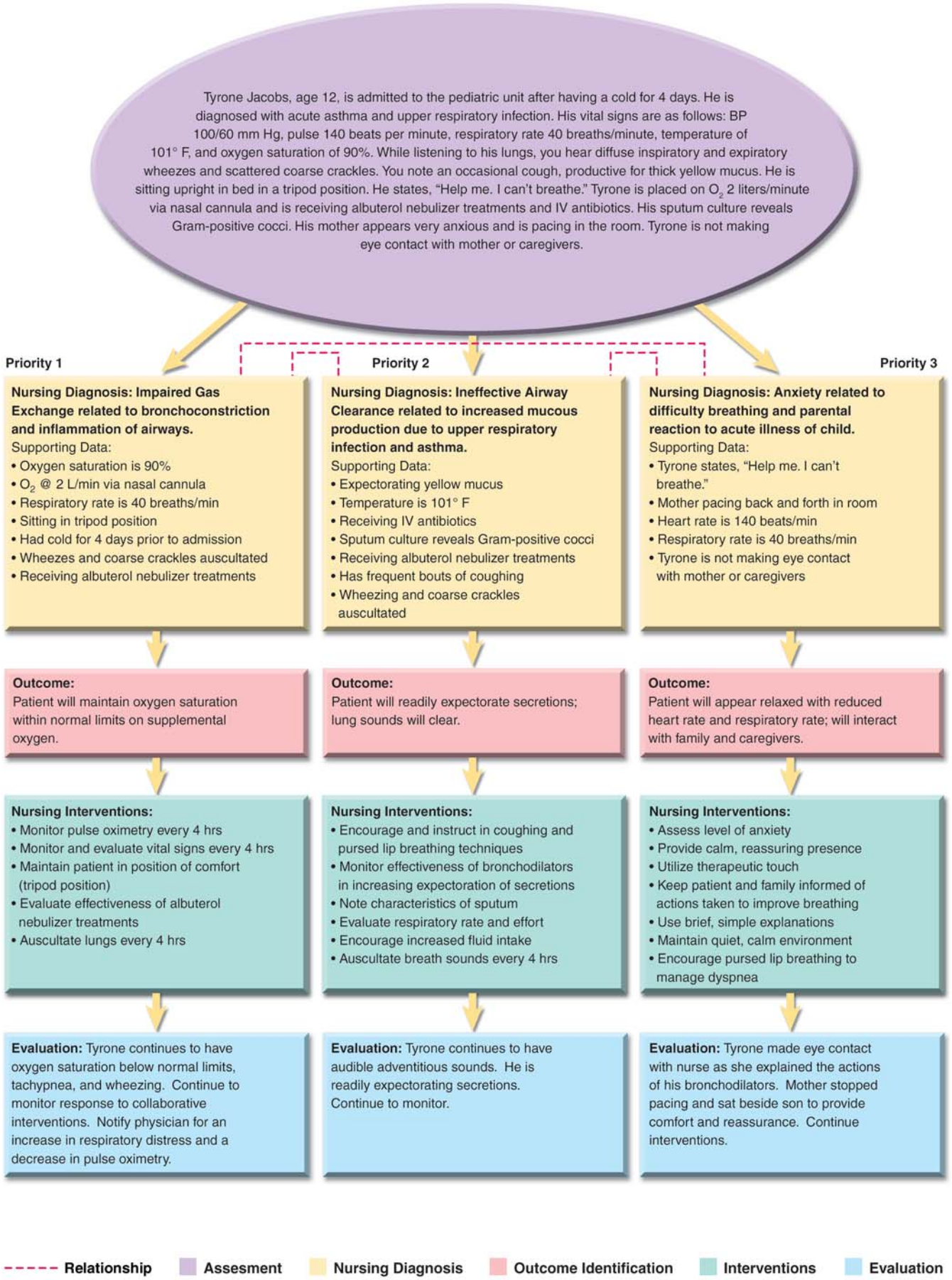
tion (OSHA) standards require healthcare facilities to provide an ample supply of ventilation masks along with other protective barriers for staff to use during resuscitation efforts.

Another device, the automated external defibrillator (AED), has also proved effective in reducing deaths attributed to cardiac arrest. This easy-to-use, computer-based device is designed to deliver a shock to the heart muscle quickly to interrupt ventricular fibrillation, the most common initial rhythm occurring in cardiac arrest. The AED has the ability to analyze the heart's rhythm, direct the operator to deliver a shock when appropriate or deliver one automatically, and then reanalyze the rhythm to determine whether it has returned to normal (Fig. 45-14). Using the AED is an integral part of resuscitation. See the accompanying Research in Nursing box that discusses use of AEDs by the public.

Most professional organizations recommend and support widespread efforts to teach CPR to lay people and all health professionals. Mannequins for practice can be obtained from the American Heart Association, the American Red Cross, and health agencies. The nurse is professionally responsible for maintaining proficiency in CPR skills. This necessitates periodic practice with mannequins (adult and infant). CPR must be administered quickly and accurately, without hesitation, when cardiac or pulmonary arrest occurs.

Evaluating

Evaluation is the final step of the nursing process; the accompanying concept map illustrates the nursing process for the care of Tyrone Jacobs. Evaluation is an ongoing and deliberate part of the nursing process that involves the nurse, patient, family, and other healthcare team members. It compares the patient's health status with previously defined expected outcomes and examines the patient's projected progress in meeting those outcomes. Everyone involved in the evaluation process needs to identify effective interventions and reasons for any failures in achieving the expected outcomes. Adjustments in the nursing plan of care are made accordingly. See Nursing Plan of Care 45-1 for Freddie Taft.



Concept map displaying the nursing process for Tyrone Jacobs.

Nursing Plan of Care 45-1

for Freddie Taft

Freddie Taft is a 1-year-old, alert, well-developed child who has been a patient on the pediatric unit for 3 days with status asthmaticus. He has had two other hospitalizations for acute asthma, during which he responded quickly to intravenous and inhalation bronchodilators. During this hospitalization, either his mother, a teacher, or his father, a psychologist, has stayed with him. Other relatives are caring for Freddie's 9-year-old sister and 5-year-old brother.

Freddie interacts happily with staff as long as a parent is within sight. Gross and fine motor coordination are appropriate for his age. His vocabulary consists of 25 words. The history is from his mother, who is a reliable source. He has had a clear nasal discharge with slight, intermittent, nonproductive cough for 3 days with no change in appetite or activity pattern.

On the day of admission, he attended the day-care center as usual. After being there for 3 hours, his cough became more frequent, and his respirations became more labored. The caregivers were not alarmed because he continued to eat, drink, nap, and play in his usual pattern. His mother states that when she arrived in the afternoon to pick up the boys, she discovered him to be using his intercostal and neck muscles excessively with every breath. His respirations were 50 breaths/min, labored, and accompanied by a grunt. By the time she arrived home, he was pale and fitful and was crying weakly. Respirations were 60 breaths/min, and peripheral cyanosis was noted. The pediatrician advised lung evaluation in the emergency department. While there, three subcutaneous injections of epinephrine were administered 5 minutes apart. The child did not respond satisfactorily, so he was admitted for intravenous aminophylline and steroid administration.

In addition to a history of asthma, Freddie is allergic to eggs and peanuts and has eczema on his face, arms, legs, and upper back. His current medications include albuterol every 8 hours; a topical steroid (Lidex Cream); and a multivitamin and mineral supplement (Poly-Vi-Sol drops). No one in the family smokes. The caregivers at the day-care center smoke outside the building. The day-care center is clean and had the rugs shampooed the night before this child's illness. This child had no sputum production or fever. Immunizations are current. A comprehensive assessment revealed the following findings:

Respiratory rate, 44 breaths/min

Irregular rhythm

Excessive use of accessory muscles

Nonproductive, frequent cough

Gurgles and expiratory wheezes noted

Pale, no cyanosis

Blood pressure, 100/60 mm Hg; heart rate, 120 beats/min

Restless child who naps for only 20 to 30 minutes at intervals day and night

Arterial blood gases: normal values

Chest radiograph: normal

Poor appetite, vomiting one or two times

Up early in morning

Sweat test: negative for cystic fibrosis

NURSING DIAGNOSIS

Ineffective Airway Clearance related to exposure to allergens, viral infection, bronchospasm, overproduction of mucus as manifested by: nonproductive frequent cough, presence of sonorous wheezes (rhonchi) and sibilant wheezes on expiration, restlessness, interrupted sleep.

EXPECTED OUTCOME

By 3/20/08, the patient will:

- Have rare episodes of coughing and no vomiting

Nursing Interventions	Rationale	Evaluative Statement
Hold meals until inhalation treatments are done.	Bronchodilators stimulate coughing and often cause vomiting if given after meals.	3/19/08 Outcome met. Freddie has not vomited in 2 days and has 2-hour intervals between coughing episodes. *M. Jones, RN*
Offer liquids every 3 hours in a bottle or cup.	Liquids help to liquefy secretions and prevent dehydration.	
Perform percussion during morning and evening bath.	Percussion loosens pulmonary secretions so that they are more easily expectorated.	

(continued)

Nursing Plan of Care 45-1

for Freddie Taft *(continued)*

EXPECTED OUTCOME

By 3/20/08, the patient's parents will:

- Remove dust-collecting toys

Nursing Interventions	Rationale	Evaluative Statement
Give parents allergy pamphlets from American Lung Association.	Adequate information reinforces instruction given by healthcare providers.	3/17/08 Outcome met. Parents removed furry toys from hospital room. *M. Jones, RN*
Review with both parents methods to reduce exposure to possible allergens at home.	Constant exposure to allergens (dust, mold, mildew, and so forth) and irritants (perfume, smog, cleaners, and so forth) produces bronchospasm and stimulates copious mucus production. Medications are most effective when allergens are removed.	
Encourage parents to examine day-care environment. Explore options with them.	Environment in day-care may contain allergens. The least irritating setting is desirable.	

SAMPLE DOCUMENTATION

3/17/08 Nursing

Family and staff conference to discuss Freddie's respiratory disturbance initiated by primary nurse's concern. Present were Freddie's mother; MJ (primary nurse); TK (clinical coordinator); TR (head of respiratory department); and MM and LQ (staff nurses). Primary nurse presented findings from assessment and nursing examination. Discussion centered on strategies to control airway edema and reduce wheezes, reduce coughing episodes and control vomiting, and prevent further bronchospasms and edema resulting from exposure to allergens in environment. See plan of care. Patient progress will be evaluated in 4 days during nursing grand rounds, 3/21/08.

M. Jones, RN

SKILL 45-1

Using a Pulse Oximeter

EQUIPMENT

Pulse oximeter with an appropriate sensor or probe

Alcohol wipe(s) or disposable cleansing cloth

Nail polish remover (if necessary)

IMPLEMENTATION

ACTION	RATIONALE
1. Identify the patient using at least two methods.	Positive identification of the patient is essential to ensure the intervention is administered to the correct patient.
2. Explain what you are going to do and why you are going to do it to the patient.	Explanation relieves anxiety and facilitates cooperation.
3. Perform hand hygiene.	Hand hygiene deters the spread of microorganisms.
4. Select an adequate site for application of the sensor.	Inadequate circulation can interfere with the oxygen saturation (SpO_2) reading.
a. Use the patient's index, middle, or ring finger (Figure 1).	a. Fingers are easily accessible.

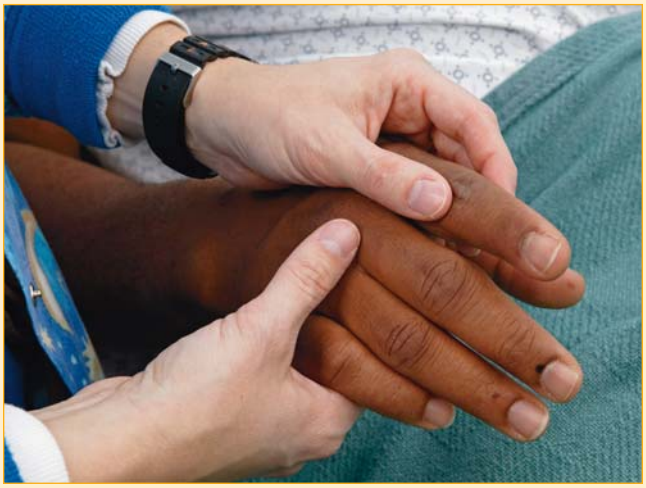


Figure 1. Selecting an appropriate finger.

b. Check the proximal pulse (Figure 2) and capillary refill (Figure 3) at the pulse closest to the site.	b. Brisk capillary refill and a strong pulse indicate that circulation to the site is adequate.

Figure 2. Assessing pulse.

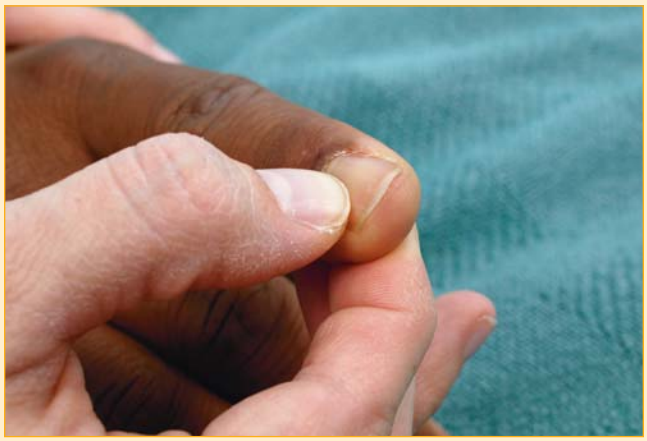


Figure 3. Assessing capillary refill.

(continued)

SKILL 45-1

Using a Pulse Oximeter *(continued)*

ACTION	RATIONALE
c. If circulation at site is inadequate, consider using the earlobe or bridge of nose.	c. These alternate sites are highly vascular alternatives.
d. Use a toe only if lower extremity circulation is not compromised.	d. Peripheral vascular disease is common in lower extremities.
5. Select proper equipment:	
a. If one finger is too large for the probe, use a smaller one. A pediatric probe may be used for a small adult.	a. Inaccurate readings can result if probe or sensor is not attached correctly.
b. Use probes appropriate for patient's age and size.	b. Probes come in adult, pediatric, and infant sizes.
c. Check if patient is allergic to adhesive. A nonadhesive finger clip or reflectance sensor is available.	c. A reaction may occur if patient is allergic to adhesive substance.
6. Prepare the monitoring site. Cleanse the selected area with the alcohol wipe or disposable cleansing cloth (Figure 4). Allow the area to dry. If necessary, remove nail polish and artificial nails after checking manufacturer's instructions.	Skin oils, dirt, or grime on the site, polish, and artificial nails can interfere with the passage of light waves.

Figure 4. Cleaning the area.

Figure 5. Attaching probe to patient's finger.

7. **Apply probe securely to skin** (Figure 5)**. Make sure that the light-emitting sensor and the light-receiving sensor are aligned opposite each other (not necessary to check if placed on forehead or bridge of nose).**	Secure attachment and proper alignment promote satisfactory operation of the equipment and accurate recording of the SpO_2.
8. Connect the sensor probe to the pulse oximeter (Figure 6), turn the oximeter on, and check operation of the equipment (audible beep, fluctuation of bar of light or waveform on face of oximeter).	Audible beep represents the arterial pulse, and fluctuating waveform or light bar indicates the strength of the pulse. A weak signal will produce an inaccurate recording of the SpO_2. Tone of beep reflects SpO_2 reading. If SpO_2 drops, tone becomes lower in pitch.
9. Set alarms on pulse oximeter. Check manufacturer's alarm limits for high and low pulse rate settings (Figure 7).	Alarm provides additional safeguard and signals when high or low limits have been surpassed.

(continued)

SKILL 45-1

Using a Pulse Oximeter *(continued)*

ACTION	RATIONALE
 **Figure 6.** Connecting sensor probe to unit.	 **Figure 7.** Checking alarms.
10. **Check oxygen saturation at regular intervals, as ordered by physician and signaled by alarms. Monitor hemoglobin level.**	Monitoring SpO_2 provides ongoing assessment of patient's condition. A low hemoglobin level may be satisfactorily saturated yet inadequate to meet a patient's oxygen needs.
11. Remove sensor on a regular basis and check for skin irritation or signs of pressure (every 2 hours for spring tension sensor or every 4 hours for adhesive finger or toe sensor).	Prolonged pressure may lead to tissue necrosis. Adhesive sensor may cause skin irritation.
12. Clean nondisposable sensors according to the manufacturer's directions. Perform hand hygiene.	Each deter the spread of microorganisms and contaminants.

Unexpected Situations and Associated Interventions

For absent or weak signal, check vital signs and patient condition. If satisfactory, check connections and circulation to site. Hypotension makes an accurate recording difficult. Equipment (restraint, blood pressure cuff) may compromise circulation to site and cause venous blood to pulsate, giving an inaccurate reading. If extremity is cold, cover with a warm blanket.

For inaccurate reading, check prescribed medications and history of circulatory disorders. Try device on a healthy person to see if problem is equipment-related or patient-related. Drugs that cause vasoconstriction interfere with accurate recording of oxygen saturation.

If bright light (sunlight or fluorescent light) is suspected of causing equipment malfunction, cover probe with a dry washcloth. Bright light can interfere with operation of light sensors and cause unreliable report.

General Considerations

Accuracy of readings can be influenced by conditions that decrease arterial blood flow, such as peripheral edema, hypotension, and peripheral vascular disease. Excess motion of sensor probe site can also interfere with obtaining an accurate reading.

Infant and Child Considerations

For infants, the oximeter probe may be placed on the toe or foot.

Older Adult Considerations

Careful attention to the patient's skin integrity and condition is necessary to prevent injury. Pressure or tension from the probe, as well as any adhesive used, can damage older, dry, thin skin.

Home Care Considerations

Portable units are available for use in the home or an outpatient setting.

SKILL 45-2

Suctioning the Nasopharyngeal and Oropharyngeal Airways

Watch & Learn

EQUIPMENT

Portable or wall suction unit with tubing

A commercially prepared suction kit with an appropriate size catheter or:

- Sterile suction catheter with Y-port in the appropriate size (Adult: 10–16 Fr)
- Sterile disposable container
- Sterile gloves

Sterile water or saline

Towel or waterproof pad

Goggles and mask or face shield

Disposable, clean gloves

Water soluble lubricant

IMPLEMENTATION

ACTION	RATIONALE
1. Identify the patient.	Positive identification of the patient is essential to ensure the intervention is administered to the correct patient.
2. Determine the need for suctioning. Verify the suction order in the patient's chart, if necessary. **For postoperative patient, administer pain medication before suctioning.**	To minimize trauma to airway mucosa, suctioning should be done only when secretions have accumulated or adventitious breath sounds are audible. Some facilities require an order for naso- and oropharyngeal suctioning. Suctioning stimulates coughing, which is painful for patients with surgical incisions.
3. Explain what you are going to do and the reason to the patient, even if the patient does not appear to be alert. Reassure patient you will interrupt procedure if he or she indicates respiratory difficulty.	Explanation alleviates fears. Even if patient appears unconscious, the nurse should explain what is happening. Any procedure that compromises respiration is frightening for the patient.
4. Perform hand hygiene.	Hand hygiene deters the spread of microorganisms.
5. Adjust bed to comfortable working position. Lower side rail closer to you. If patient is conscious, place him or her in a semi-Fowler's position. **If patient is unconscious, place him or her in the lateral position, facing you. Move the bed table close to your work area and raise to waist height.**	A sitting position helps the patient to cough and makes breathing easier. Gravity also facilitates catheter insertion. The lateral position prevents the airway from becoming obstructed and promotes drainage of secretions. The table provides a work surface and helps maintain sterility of objects on work surface.
6. Place towel or waterproof pad across patient's chest.	This protects bed linens.
7. Adjust suction to appropriate pressure (Figure 1). For a wall unit for an adult: 100 to 150 mm Hg; neonates: 60 to 80 mm Hg; infants: 80 to 100 mm Hg; children: 100 to 120 mm Hg For a portable unit for an adult: 10 to 15 cm Hg; neonates: 6 to 8 cm Hg; infants: 8 to 10 cm Hg; children: 10 to 12 cm Hg **Put on a disposable, nonsterile glove and occlude the end of the connecting tubing to check suction pressure. Place the connecting tubing in a convenient location.**	Higher pressures can cause excessive trauma, hypoxemia, and atelectasis.

Figure 1. Adjusting wall suction.

(continued)

SKILL 45-2

Suctioning the Nasopharyngeal and Oropharyngeal Airways *(continued)*

ACTION	RATIONALE
8. **Open sterile suction package using aseptic technique. The open wrapper or container becomes a sterile field to hold other supplies. Carefully remove the sterile container, touching only the outside surface. Set it up on the work surface and pour sterile saline into it.**	Sterile normal saline or water is used to lubricate the outside of the catheter, minimizing irritation of mucosa during introduction. It is also used to clear the catheter between suction attempts.
9. Place a small amount of water-soluble lubricant on the sterile field, taking care to avoid touching the sterile field with the lubricant package.	Lubricant facilitates passage of the catheter and reduces trauma to mucous membranes.
10. Increase the patient's supplemental oxygen level or apply supplemental oxygen per facility policy or physician order.	Suctioning removes air from the patient's airway and can cause hypoxemia. Hyperventilation can help prevent suction-induced hypoxemia.
11. Put on face shield or goggles and mask. Put on sterile gloves. **The dominant hand will manipulate the catheter and must remain sterile. The nondominant hand is considered clean rather than sterile and will control the suction valve (Y port) on the catheter.**	Handling the sterile catheter using a sterile glove helps prevent introducing organisms into the respiratory tract; the clean glove protects the nurse from microorganisms.
12. With dominant gloved hand, pick up sterile catheter. Pick up the connecting tubing with the nondominant hand and connect the tubing and suction catheter (Figure 2).	Sterility of the suction catheter is maintained.

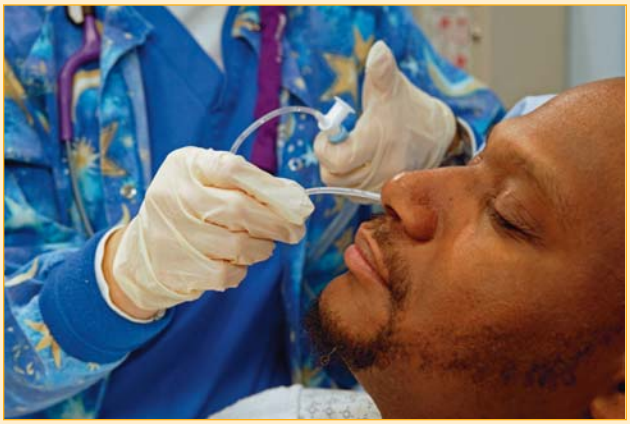
Figure 2. Connecting catheter to cubing.

13. Moisten the catheter by dipping it into the container of sterile saline (Figure 3). Occlude Y-tube to check suction.	Lubricating the inside of the catheter with saline helps move secretions in the catheter. Checking suction ensures equipment is working properly.

(continued)

SKILL 45-2

Suctioning the Nasopharyngeal and Oropharyngeal Airways *(continued)*

ACTION	RATIONALE
 **Figure 3.** Dipping catheter into sterile saline.	 **Figure 4.** Inserting catheter into naris.
14. Encourage the patient to take several deep breaths.	Suctioning removes air from the patient's airway and can cause hypoxemia. Hyperventilation can help prevent suction-induced hypoxemia.
15. Apply lubricant to the first 2 to 3 inches of the catheter, using the lubricant that was placed on the sterile field.	Lubricant facilitates passage of the catheter and reduces trauma to mucous membranes.
16. Remove the oxygen delivery device, if appropriate. Do not apply suction as the catheter is inserted. Hold the catheter between your thumb and forefinger. Insert catheter. For nasopharyngeal suctioning: **Gently insert catheter through the naris and along the floor of the nostril toward trachea** (Figure 4). Roll the catheter between your fingers to help advance it. Advance the catheter approximately 5 to 6 inches to reach the pharynx. For oropharyngeal suctioning: Insert catheter through the mouth, along the side of the mouth toward the trachea. Advance the catheter 3 to 4 inches to reach the pharynx.	Using suction while inserting the catheter can cause trauma to the mucosa and removes oxygen from the respiratory tract. Correct distance for insertion ensures proper placement of the catheter. The general guideline for determining insertion distance for nasopharyngeal suctioning for an individual patient is to estimate the distance from the patient's ear lobe to the nose.
17. Apply suction by intermittently occluding the Y port on the catheter with the thumb of your nondominant hand, and gently rotate the catheter as it is being withdrawn (Figure 5). **Do not suction for more than 10 to 15 seconds at a time.**	Turning the catheter as it is withdrawn minimizes trauma to the mucosa. Suctioning for longer than 10 to 15 seconds robs the respiratory tract of oxygen, which may result in hypoxemia. Suctioning too quickly may be ineffective at clearing all secretions.
 **Figure 5.** Suctioning nasopharynx.	 **Figure 6.** Rinsing catheter.

(continued)

SKILL 45-2

Suctioning the Nasopharyngeal and Oropharyngeal Airways *(continued)*

ACTION	RATIONALE
18. Replace the oxygen delivery device using your nondominant hand, if appropriate, and have the patient take several deep breaths.	Suctioning removes air from the patient's airway and can cause hypoxemia. Hyperventilation can help prevent suction induced hypoxemia.
19. Flush catheter with saline (Figure 6). Assess effectiveness of suctioning and repeat as needed and according to patient's tolerance.	Flushing clears catheter and lubricates it for next insertion. Reassessment determines need for additional suctioning.
Wrap the suction catheter around your dominant hand between attempts.	Wrapping prevents inadvertent contamination of catheter.
20. **Allow at least a 30-second to 1-minute interval if additional suctioning is needed. No more than three suction passes should be made per suctioning episode. Alternate the nares, unless contraindicated, if repeated suctioning is required. Do not force catheter through the nares. Encourage patient to cough and deep breathe between suctioning.** Suction the oropharynx after suctioning the nasopharynx.	The interval allows for reventilation and reoxygenation of airways. Excessive suction passes contribute to complications. Alternating nares reduces trauma. Suctioning the oropharynx after the nasopharynx clears the mouth of secretions. More microorganisms are usually present in the mouth, so it is suctioned last to prevent transmission of contaminants.
21. When suctioning is completed, remove gloves from dominant hand over the coiled catheter, pulling it off inside out. Remove glove from nondominant hand and dispose of gloves, catheter, and container with solution in the appropriate receptacle. Remove face shield or goggles and mask. Perform hand hygiene.	This technique reduces transmission of microorganisms. Hand hygiene prevents transmission of microorganisms.
22. Turn off suction. Remove supplemental oxygen placed for suctioning, if appropriate. Assist patient to a comfortable position. Raise bed rail.	Ensures patient comfort. Raising the bed rails helps maintain patient safety.
23. Offer oral hygiene after suctioning.	Respiratory secretions that are allowed to accumulate in the mouth are irritating to mucous membranes and unpleasant for the patient.
24. Reassess patient's respiratory status, including respiratory rate, effort, oxygen saturation, and lung sounds.	This assesses effectiveness of suctioning and the presence of complications.

Unexpected Situations and Associated Interventions

The catheter or sterile glove touches an unsterile surface: Stop the procedure. If the gloved hand is still sterile, call for assistance and have someone open another catheter, or remove the gloves and start the procedure over.

Patient vomits during suctioning: If the patient gags or becomes nauseated, the catheter must be removed. It has probably inadvertently entered the esophagus. If the patient needs to be suctioned again, change catheters, because it is probably contaminated. Turn patient to the side and elevate the head of the bed to prevent aspiration.

Secretions appear to be stomach contents: Ask the patient to extend the neck slightly. This helps to prevent the tube from passing into the esophagus.

Epistaxis is noted with continued suctioning: Notify physician and anticipate the need for a nasal trumpet. The nasal trumpet will protect the nasal mucosa from further trauma related to suctioning.

Infant and Child Considerations

For infants, use a 5 Fr to 6 Fr catheter.

For children, us a 6 Fr to 10 Fr catheter.

SKILL 45-3

Administering Oxygen by Nasal Cannula

Practice & Learn

EQUIPMENT

Flow meter connected to oxygen supply

Humidifier with sterile distilled water (optional for low-flow system)

Nasal cannula and tubing

Gauze to pad tubing over ears (optional)

IMPLEMENTATION

ACTION	RATIONALE
1. Identify the patient using at least two methods.	Positive identification of the patient is essential to ensure the intervention is administered to the correct patient.
2. Explain what you are going to do and the reason to the patient. Review safety precautions necessary when oxygen is in use. Place "no smoking" signs in appropriate areas.	Explanation relieves anxiety and facilitates cooperation. Oxygen supports combustion.
3. Perform hand hygiene.	Hand hygiene deters the spread of microorganisms.
4. **Connect nasal cannula to oxygen setup with humidification, if one is in use (Figure 1).** Adjust flow rate as ordered by physician (Figure 2). Check that oxygen is flowing out of prongs.	Oxygen forced through a water reservoir is humidified before it is delivered to the patient, thus preventing dehydration of the mucous membranes. Low-flow oxygen does not require humidification.

Figure 1. Connecting cannula to oxygen source.

Figure 2. Adjusting flow rate.

5. Place prongs in patient's nostrils (Figure 3). Place tubing over and behind each ear with adjuster comfortably under chin or around the patient's head, with adjuster at the back of the head or neck. Place gauze pads at ear beneath the tubing as necessary (Figure 4).	Correct placement of the prongs and fastener facilitates oxygen administration and patient comfort. Pads reduce irritation and pressure and protect the skin.

Figure 3. Applying cannula to nares.

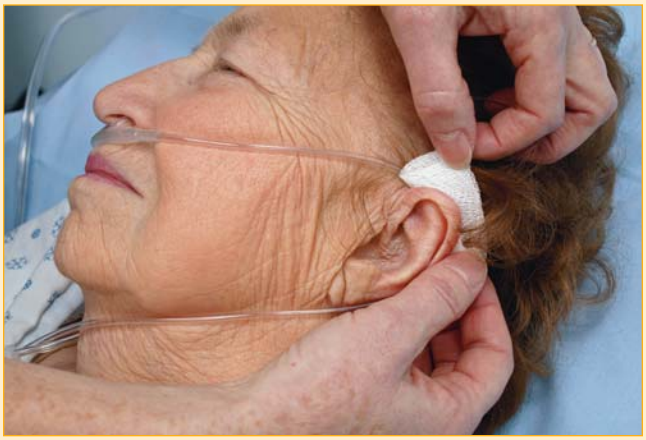


Figure 4. Placing gauze pad at ears.

(continued)

SKILL 45-3

Administering Oxygen by Nasal Cannula *(continued)*

ACTION	RATIONALE
6. Adjust the fit of the cannula as necessary (Figure 5). Tubing should be snug, but not tight against the skin.	Proper adjustment maintains the prongs in the patient's nose. Excessive pressure from tubing could cause irritation and pressure to the skin.

Figure 5. Adjusting cannula.

Figure 6. Cleaning cannula when indicated.

7. **Encourage patient to breathe through the nose, with mouth closed.**	Nose breathing provides for optimal delivery of oxygen to patient. The percentage of oxygen delivered can be reduced in patients who breathe through the mouth.
8. Reassess patient's respiratory status, including respiratory rate, effort, and lung sounds. Note any signs of respiratory distress, such as tachypnea, nasal flaring, use of accessory muscles, or dyspnea.	These assess the effectiveness of oxygen therapy.
9. Perform hand hygiene.	Hand hygiene deters the spread of microorganisms.
10. Put on clean gloves. Remove and clean the cannula and assess nares at least every 8 hours, or according to agency recommendations (Figure 6). Check nares for evidence of irritation or bleeding.	The continued presence of the cannula causes irritation and dryness of the mucous membranes.

Unexpected Situations and Associated Interventions

Patient was fine on oxygen delivered by nasal cannula but now is cyanotic, and the pulse oximeter reading is <93%: Check to see that the oxygen tubing is still connected to the flow meter and the flow meter is still on the previous setting. Someone may have stepped on the tubing, pulling it from the flow meter, or the oxygen may have accidentally been turned off. Assess lung sounds to note any changes.

Areas over ear or back of head are reddened: Ensure that areas are adequately padded and that tubing is not pulled too tight. If available, a skin care team may be able to offer some suggestions.

When dozing, patient begins to breathe through the mouth: Temporarily place the nasal cannula near the mouth. If this does not raise the pulse oximeter reading, you may need to obtain an order to switch the patient to a mask while sleeping.

Home Care Considerations

Oxygen administration may need to be continued in the home setting. Portable oxygen concentrators are used most frequently. Caregivers require instruction concerning safety precautions with oxygen use and need to understand the rationale for the specific liter flow of oxygen.

(continued)

SKILL 45-3

Administering Oxygen by Nasal Cannula *(continued)*

To prevent fires and injuries, take the following precautions:

Avoid open flames

Place "no smoking" signs in conspicuous places in the patient's home. Instruct the patient and visitors about the hazard of smoking when oxygen is in use.

Check to see that electrical equipment used in the room is in good working order and emits no sparks.

Avoid using oils in the area. Oil can ignite spontaneously in the presence of oxygen.

SKILL 45-4

Administering Oxygen by Mask

EQUIPMENT

Flow meter connected to oxygen supply

Face mask, specified by physician

Gauze to pad elastic band (optional)

Humidifier with sterile distilled water, if necessary for the type of mask prescribed

IMPLEMENTATION

ACTION	RATIONALE
1. Identify the patient.	Positive identification of the patient is essential to ensure the intervention is administered to the correct patient.
2. Explain what you are going to do and the reason to the patient. Review safety precautions necessary when oxygen is in use. Place "no smoking" signs in appropriate areas.	Explanation relieves anxiety and facilitates cooperation. Oxygen supports combustion.
3. Perform hand hygiene.	Hand hygiene deters the spread of microorganisms.
4. Attach face mask to oxygen source (with humidification, if appropriate for the specific mask) (Figure 1). Start the flow of oxygen at the specified rate. For a mask with a reservoir, be sure to allow oxygen to fill the bag (Figure 2) before proceeding to the next step.	Oxygen forced through a water reservoir is humidified before it is delivered to the patient, thus preventing dehydration of the mucous membranes. A reservoir bag must be inflated with oxygen because the bag is the source of oxygen supply for the patient.

Figure 1. Connecting face mask to oxygen source.

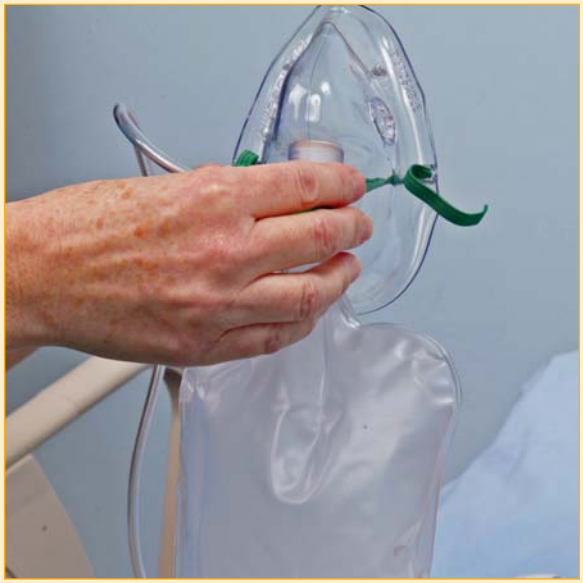


Figure 2. Allowing oxygen to fill the bag.

(continued)

SKILL 45-4

Administering Oxygen by Mask

ACTION

5. Position face mask over patient's nose and mouth (Figure 3). Adjust the elastic strap so that the mask fits snugly but comfortably on the face (Figure 4). Adjust the flow rate to the prescribed rate (Figure 5).

RATIONALE

A loose or poorly fitting mask will result in oxygen loss and decreased therapeutic value. Masks may cause a feeling of suffocation, and the patient needs frequent attention and reassurance.

Figure 3. Applying face mask over nose and mouth.

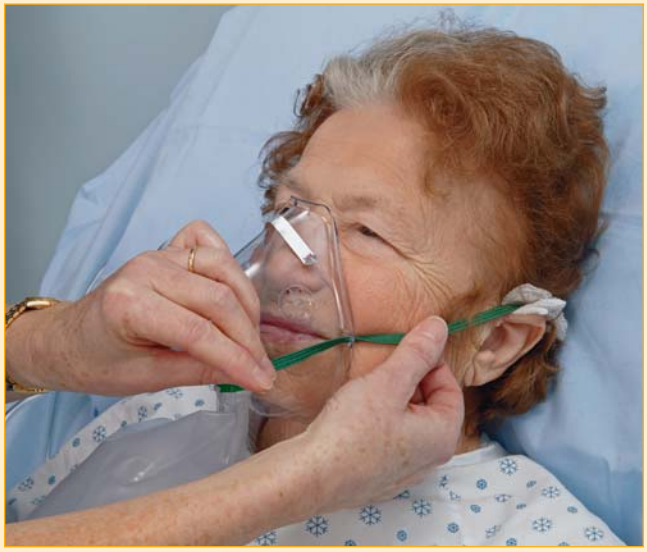


Figure 4. Adjusting elastic straps.

Figure 5. Adjusting flow rate.

(continued)

SKILL 45-4

Administering Oxygen by Mask *(continued)*

ACTION	RATIONALE
6. If the patient reports irritation or redness is noted, use gauze pads under the elastic strap at pressure points to reduce irritation to ears and scalp.	Pads reduce irritation and pressure and protect the skin.
7. Reassess patient's respiratory status, including respiratory rate, effort, and lung sounds. Note any signs of respiratory distress, such as tachypnea, nasal flaring, use of accessory muscles, or dyspnea.	This helps assess the effectiveness of oxygen therapy.
8. Perform hand hygiene.	Hand hygiene deters the spread of microorganisms.
9. **Remove the mask and dry the skin every 2 to 3 hours if the oxygen is running continuously. Do not use powder around the mask.**	The tight-fitting mask and moisture from condensation can irritate the skin on the face. There is a danger of inhaling powder if it is placed on the mask.

Unexpected Situations and Associated Interventions

Patient was previously fine but now is cyanotic, and the pulse oximeter reading is <93%: Check to see that the oxygen tubing is still connected to the flow meter and the flow meter is still on the previous setting. Someone may have stepped on the tubing, pulling it from the flow meter, or the oxygen may have accidentally been turned off. Assess lung sounds for any changes.

Areas over ear or back of head are reddened: Ensure that areas are adequately padded and that tubing is not pulled too tight. If available, a skin care team may be able to offer some suggestions.

General Considerations

Different types of face masks are available for use.

It's important to ensure the mask fits snugly around the patient's face. It it's loose, it will not effectively deliver the right amount of oxygen.

The mask must be removed for the patient to eat, drink, and take medications. Obtain an order for oxygen via nasal cannula for use during meal times and limit the amount of time the mask is removed to maintain adequate oxygenation.

SKILL 45-5

Suctioning the Tracheostomy: Open System

EQUIPMENT

Portable or wall suction unit with tubing

A commercially prepared suction kit with an appropriate size catheter (see General Considerations) or

- Sterile suction catheter with Y-port in the appropriate size
- Sterile disposable container
- Sterile gloves

Towel or waterproof pad

Goggles and mask or face shield

Disposable, clean gloves

Resuscitation bag connected to 100% oxygen

(continued)

SKILL 45-5

Suctioning the Tracheostomy: Open System *(continued)*

IMPLEMENTATION

ACTION	RATIONALE
1. Identify the patient.	Positive identification of the patient is essential to ensure the intervention is administered to the correct patient.
2. Determine the need for suctioning. Verify the suction order in the patient's chart. **For postoperative patient, administer pain medication as prescribed before suctioning.**	To minimize trauma to airway mucosa, suctioning should be done only when secretions have accumulated or adventitious breath sounds are audible. Suctioning stimulates coughing, which is painful for patients with surgical incisions.
3. Explain what you are going to do and the reason to the patient, even if the patient does not appear to be alert. Reassure patient you will interrupt procedure if he or she indicates respiratory difficulty.	Explanation alleviates fears. Even if patient appears unconscious, the nurse should explain what is happening. Any procedure that compromises respiration is frightening for the patient.
4. Perform hand hygiene.	Hand hygiene deters the spread of microorganisms.
5. Adjust bed to comfortable working position. Lower side rail closer to you. If patient is conscious, place him or her in a semi-Fowler's position (Figure 1). **If patient is unconscious, place him or her in the lateral position, facing you. Move the over the bed table close to your work area and raise to waist height.**	A sitting position helps the patient to cough and makes breathing easier. Gravity also facilitates catheter insertion. The lateral position prevents the airway from becoming obstructed and promotes drainage of secretions. The bed table provides a work surface and maintains sterility of objects on work surface.

Figure 1. Patient in semi-Fowler's position.

Figure 2. Turning suction device to the appropriate pressure.

6. Place towel or waterproof pad across patient's chest.	This protects bed linens and the patient.
7. **Turn suction to appropriate pressure (Figure 2):** For a wall unit for an adult: 100 to 150 mm Hg; neonates: 60 to 80 mm Hg; infants: 80 to 100 mm Hg; children: 100 to 120 mm Hg For a portable unit for an adult: 10 to 15 cm Hg; neonates: 6 to 8 cm Hg; infants: 8 to 10 cm Hg; children: 10 to 12 cm Hg **Put on a disposable, nonsterile glove and occlude the end of the connecting tubing to check suction pressure. Place the connecting tubing in a convenient location. If using it, place resuscitation bag connected to oxygen within convenient reach.**	Higher pressures can cause excessive trauma, hypoxemia, and atelectasis.

(continued)

SKILL 45-5

Suctioning the Tracheostomy: Open System *(continued)*

ACTION	RATIONALE
8. **Open sterile suction package using aseptic technique. The open wrapper or container becomes a sterile field to hold other supplies. Carefully remove the sterile container, touching only the outside surface. Set it up on the work surface and pour sterile saline into it.**	Sterile normal saline or water is used to lubricate the outside of the catheter, minimizing irritation of mucosa during introduction. It is also used to clear the catheter between suction attempts.
9. Put on face shield or goggles and mask (Figure 3). Put on sterile gloves. **The dominant hand will manipulate the catheter and must remain sterile. The nondominant hand is considered clean rather than sterile and will control the suction valve (Y port) on the catheter.**	Handling the sterile catheter using a sterile glove helps prevent introducing organisms into the respiratory tract; the clean glove protects the nurse from microorganisms.

Figure 3. Putting on goggles and mask.

Figure 4. Connecting suction catheter to the suction tubing.

10. With dominant gloved hand, pick up sterile catheter. Pick up the connecting tubing with the nondominant hand and connect the tubing and suction catheter (Figure 4).	Sterility of the suction catheter is maintained.
11. Moisten the catheter by dipping it into the container of sterile saline, unless it is a silicone catheter (Figure 5). Occlude Y-tube to check suction (Figure 6).	Lubricating the inside of the catheter with saline helps move secretions in the catheter. Silicone catheters do not require lubrication. Checking ensures equipment is working properly.

Figure 5. Moistening catheter in saline solution.

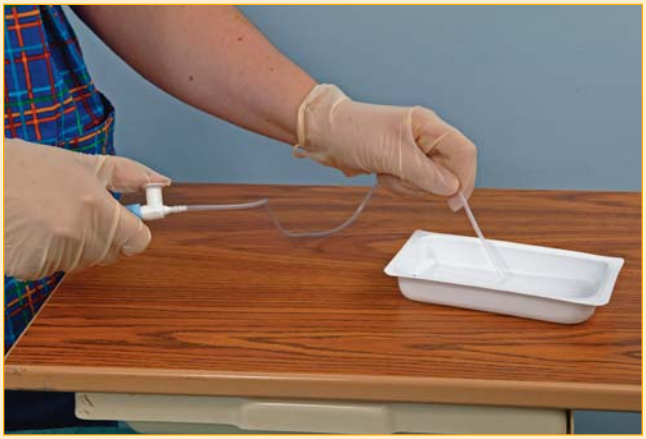


Figure 6. Occluding Y-port to check for proper suction.

(continued)

SKILL 45-5

Suctioning the Tracheostomy: Open System *(continued)*

ACTION	RATIONALE
12. Using your nondominant hand and a manual resuscitation bag, hyperventilate the patient delivering three to six breaths or use the sigh mechanism on a mechanical ventilator.	Hyperoxygenation aids in preventing hypoxemia during suctioning.
13. Open the adapter on the mechanical ventilator tubing or remove oxygen delivery setup with your nondominant hand.	This exposes tracheostomy tube without contaminating sterile gloved hand.
14. Using your dominant hand, gently and quickly insert catheter into trachea. **Advance the catheter to the predetermined length. Do not occlude Y-port when inserting catheter.**	Suctioning when inserting catheter increases the risk for trauma to airway mucosa and increases risk of hypoxemia. If resistance is met, the carina or tracheal mucosa has been hit. Withdraw the catheter at least ½ inch before applying suction.
15. Apply suction by intermittently occluding the Y port on the catheter with the thumb of your nondominant hand, and gently rotate the catheter as it is being withdrawn (Figure 7). **Do not suction for more than 10 to 15 seconds at a time.**	Turning the catheter as it is withdrawn minimizes trauma to the mucosa. Suctioning for longer than 10 to 15 seconds robs the respiratory tract of oxygen, which may result in hypoxemia. Suctioning too quickly may be ineffective at clearing all secretions.

Figure 7. Applying intermittent suction while withdrawing catheter.

16. Hyperventilate the patient using your nondominant hand and a manual resuscitation bag, delivering three to six breaths. Replace the oxygen delivery device, if applicable, using your nondominant hand and have the patient take several deep breaths. If the patient is mechanically ventilated, close the adapter on the mechanical ventilator tubing and use the sigh mechanism on a mechanical ventilator.	Suctioning removes air from the patient's airway and can cause hypoxemia. Hyperventilation can help prevent suction-induced hypoxemia.
17. Flush catheter with saline. Assess effectiveness of suctioning and repeat as needed and according to patient's tolerance. Wrap the suction catheter around your dominant hand between attempts.	Flushing clears catheter and lubricates it for next insertion. Reassessment determines need for additional suctioning. Prevents inadvertent contamination of catheter.
18. **Allow at least a 30-second to 1-minute interval if additional suctioning is needed. No more than three suction passes should be made per suctioning episode. Encourage patient to cough and deep breathe between suctionings.** Suction the oropharynx after suctioning the trachea. Do not reinsert in the tracheostomy after suctioning the mouth.	The interval allows for reventilation and reoxygenation of airways. Excessive suction passes contribute to complications. Alternating nares reduces trauma, and clears the mouth of secretions. More microorganisms are usually present in the mouth, so it is suctioned last to prevent transmission of contaminants.

(continued)

SKILL 45-5

Suctioning the Tracheostomy: Open System *(continued)*

ACTION	RATIONALE
19. When suctioning is completed, remove gloves from dominant hand over the coiled catheter, pulling it off inside out (Figure 8). Remove glove from nondominant hand and dispose of gloves, catheter, and container with solution in the appropriate receptacle. Remove face shield or goggles and mask. Perform hand hygiene.	All reduce transmission of microorganisms.

Figure 8. Removing gloves while keeping catheter inside.

20. Turn off suction. Assist patient to a comfortable position. Raise bed rail. Offer oral hygiene after suctioning.	Respiratory secretions that are allowed to accumulate in the mouth are irritating to mucous membranes and unpleasant for the patient.
21. Reassess patient's respiratory status, including respiratory rate, effort, oxygen saturation, and lung sounds.	This assesses effectiveness of suctioning and the presence of complications.

Unexpected Situations and Associated Interventions

Patient coughs hard enough to dislodge tracheostomy: Spare tracheostomy and obturator should be kept at bedside. Insert obturator into tracheostomy tube and reinsert tracheostomy into stoma. Remove obturator. Secure ties and auscultate lung sounds. Palpate for any subcutaneous emphysema.

Lung sounds do not improve greatly and oxygen saturation remains low after three suctionings: Allow patient time to recover from previous suctioning. If needed, hyperoxygenate again. Suction the patient again and assess whether the oxygen saturation increases, lung sounds improve, and secretion amount decreases.

General Considerations

The size catheter used is determined by the size of the tracheostomy. The external diameter of the suction catheter should not exceed ½ of the internal diameter of the tracheostomy. Larger catheters can contribute to trauma and hypoxemia.

Emergency equipment should be easily accessible at the bedside. Bag-valve mask, oxygen, and suction equipment should be kept at the bedside of a patient with a tracheostomy tube at all times.

SKILL 45-6

Providing Tracheostomy Care

EQUIPMENT

Disposable gloves
Sterile gloves
Goggles and mask or face shield
Sterile tracheostomy cleaning kit (if available)
or
  Sterile basins (three)
  Sterile brush/pipe cleaners
  Sterile cotton-tipped applicators
  Sterile gauze sponges
Sterile cleaning solutions:
  Hydrogen peroxide
  Normal saline solution
  Sterile suction catheter and glove set
Commercially prepared tracheostomy or drain dressing
Tracheostomy ties (twill tape or Velcro)
Scissors
Plastic disposal bag

IMPLEMENTATION

ACTION	RATIONALE
1. Identify the patient.	Positive identification of the patient is essential to ensure the intervention is administered to the correct patient.
2. Determine the need for tracheostomy care. **Assess patient's pain and administer pain medication, if indicated.**	If tracheostomy is new, pain medication may be needed before performing tracheostomy care.
3. Explain what you are going to do and the reason to the patient, even if the patient does not appear to be alert. Reassure patient you will interrupt procedure if he or she indicates respiratory difficulty.	Explanation alleviates fears. Even if patient appears unconscious, the nurse should explain what is happening. Any procedure that compromises respiration is frightening for the patient.
4. Perform hand hygiene.	Hand hygiene deters the spread of microorganisms.
5. Adjust bed to comfortable working position. Lower side rail closer to you. If patient is conscious, place him or her in a semi-Fowler's position. **If patient is unconscious, place him or her in the lateral position, facing you. Move the bed table close to your work area and raise to waist height. Place a trash receptacle within easy reach of work area.**	A sitting position helps the patient to cough and makes breathing easier. Gravity also facilitates catheter insertion. The lateral position prevents the airway from becoming obstructed and promotes drainage of secretions. The bed table provides a work surface and maintains sterility of objects on work surface. A trash receptacle within reach prevents reaching over sterile field or turning back to field to dispose of trash.
6. Put on face shield or goggles and mask. Suction tracheostomy if necessary. If tracheostomy has just been suctioned, remove soiled site dressing and discard prior to removal of gloves used to perform suctioning.	Personnel protective equipment prevents contact with contaminants. Suctioning removes secretions to prevent occluding outer cannula while the inner cannula is removed.
CLEANING THE TRACHEOSTOMY (NONDISPOSABLE INNER CANNULA)	
7. Prepare supplies:	
a. Open tracheostomy care kit and separate basins, touching only the edges. If kit is not available, open three sterile basins.	Basins are sterile receptacles for cleaning solutions.
b. Fill one basin 0.5″ deep with hydrogen peroxide or ½ hydrogen peroxide and ½ saline, based on facility policy (Figure 1).	Hydrogen peroxide helps remove dry, encrusted secretions.
c. Fill other two basins 0.5″ deep with saline.	Saline rinses and removes hydrogen peroxide and lubricates the outer surface of the inner cannula for easier reinsertion.
d. Open sterile brush or pipe cleaners if they are not already available in a cleaning kit. Open additional sterile gauze pad.	Sterile brush or pipe cleaner provides friction to clean inner surface of cannula.

(continued)

SKILL 45-6

Providing Tracheostomy Care *(continued)*

ACTION

Figure 1. Preparing supplies.

8. Put on disposable gloves.
9. Remove the oxygen source if one is present (Figure 2). If not already removed, remove site dressing and dispose of in the trash (Figure 3). Stabilize the outer cannula and faceplate of the tracheostomy with one hand. Rotate the lock on the inner cannula in a counterclockwise motion with your other hand to release it (Figure 4).

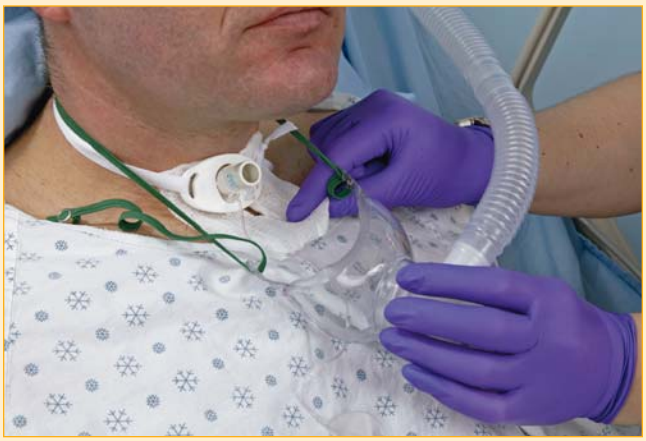


Figure 3. Removing soiled dressing.

RATIONALE

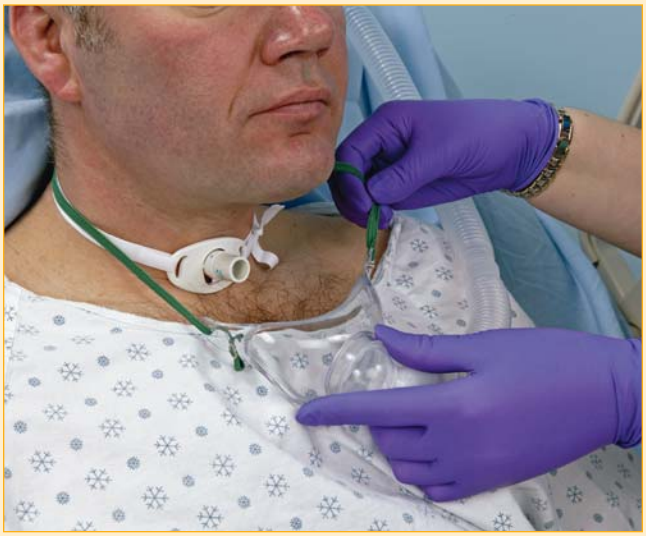


Figure 2. Removing oxygen source.

Gloves protect against exposure to blood and body fluids.

Stabilizing base plate prevents trauma to and pain from stoma. Releasing the lock permits removal of the inner cannula.

Figure 4. Rotating inner cannula while stabilizing outer cannula.

(continued)

SKILL 45-6

Providing Tracheostomy Care *(continued)*

ACTION	RATIONALE
10. Continue to hold the faceplate. Gently remove the inner cannula (Figure 5) and carefully drop it in the basin with hydrogen peroxide. Replace the oxygen source over the outer cannula. Remove gloves and discard (Figure 6).	Soaking in hydrogen peroxide loosens dry, hardened secretions. Replacing the source maintains oxygen supply to the patient.

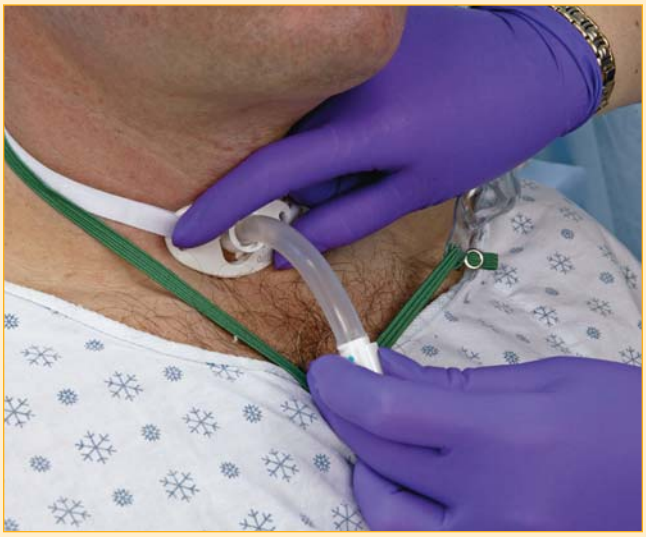


Figure 5. Removing inner cannula for cleaning.

Figure 6. Removing gloves.

11. Clean the inner cannula as follows:	
a. Put on sterile gloves.	Sterile gloves maintain surgical asepsis.
b. Remove inner cannula from soaking solution. Moisten brush or pipe cleaners in saline and insert into tube, using back-and-forth motion (Figure 7).	Movement of brush creates friction and helps remove accumulated secretions.
c. Agitate cannula in saline solution (Figure 8). Remove and tap against inner surface of basin (Figure 9).	Saline rinses inner cannula. Tapping tube against basin removes excess saline in inner tube.
d. Place on sterile gauze pad.	Placing on sterile gauze maintains sterility and frees both hands for suctioning.

Figure 7. Using brush to clean inner cannula.

Figure 8. Rinsing cannula using an agitating motion.

(continued)

SKILL 45-6

Providing Tracheostomy Care *(continued)*

ACTION	RATIONALE

Figure 9. Tapping cannula to remove excessive moisture.

12. **Suction outer cannula using sterile technique if necessary.** — Suctioning removes any remaining secretions.
13. Stabilize the outer cannula and faceplate with one hand. Replace inner cannula into outer cannula (Figure 10). Turn lock clockwise and check that inner cannula is secure. Reapply oxygen source if needed (Figure 11). — Clockwise motion secures inner cannula in place. Maintains oxygen supply to the patient.

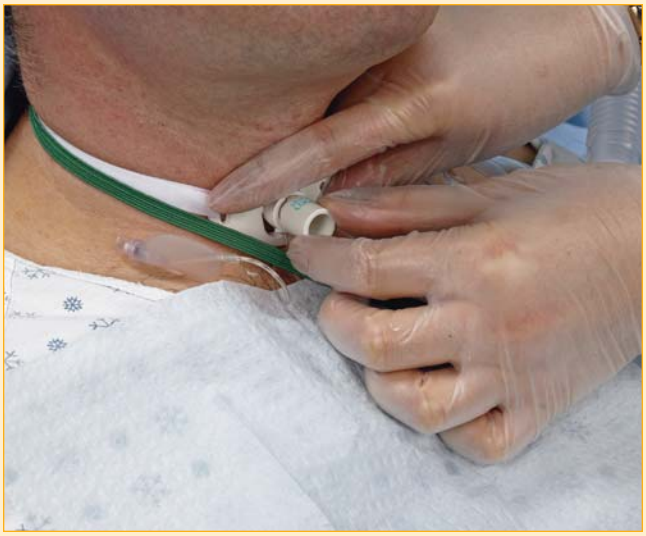


Figure 10. Replacing inner cannula.

Figure 11. Reapplying oxygen source.

(continued)

SKILL 45-6

Providing Tracheostomy Care *(continued)*

ACTION	RATIONALE
APPLYING CLEAN DRESSING AND TIES/TAPE	
14. Remove oxygen source. Dip cotton-tipped applicator or gauze sponge in second basin with sterile saline and clean stoma under faceplate. **Use each applicator or sponge only once, moving from stoma site outward (Figure 12).**	Saline is nonirritating to tissue. Cleansing from stoma outward and using each applicator only once promotes aseptic technique

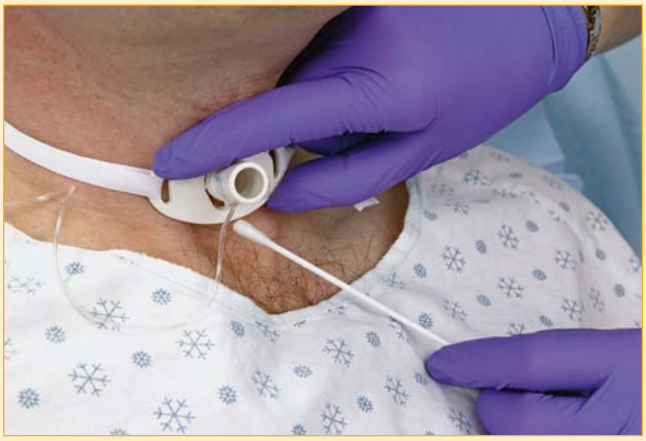


Figure 12. Cleaning with cotton-tipped applicators under faceplate.

15. Pat skin gently with dry 4″ × 4″ gauze sponge (Figure 13).	Gauze removes excess moisture.

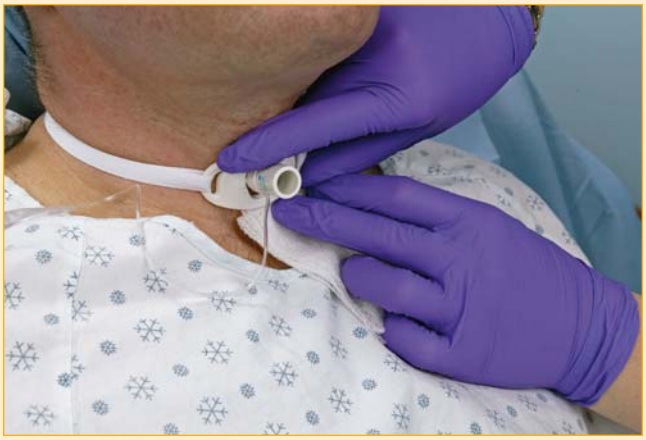


Figure 13. Patting skin around stoma gently.

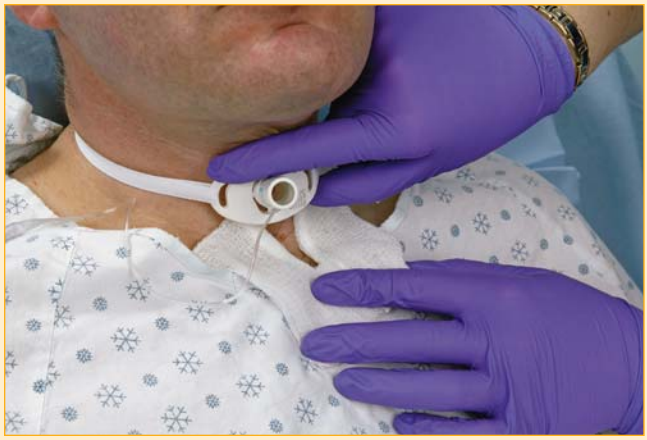


Figure 14. Sliding new tracheostomy dressing under faceplate.

16. Slide commercially prepared tracheostomy dressing or pre-folded non-cotton-filled 4″ × 4″ dressing under faceplate (Figure 14).	Lint or fiber from a cut cotton-filled gauze pad can be aspirated into the trachea, causing respiratory distress, or embed in stoma and cause irritation or infection.

(continued)

SKILL 45-6

Providing Tracheostomy Care *(continued)*

ACTION	RATIONALE
17. Change the tracheostomy tape:	
a. **Leave soiled tape in place until new one is applied.**	Leaving tape in place ensures that tracheostomy will not inadvertently be expelled if patient coughs or moves.
b. Cut piece of tape the length of twice the neck circumference plus 4″. Trim ends of tape on the diagonal (Figure 15).	This action provides for secure attachment with knot in front at neckplate. Diagonal cut facilitates insertion of tape into openings on faceplate.
c. Insert one end of tape through faceplate opening alongside old tape. Pull through until both ends are even length (Figure 16).	Doing so provides attachment for one side of faceplate.
d. Slide both ends of the tape under patient's neck and insert one end through remaining opening on other side of faceplate. Pull snugly and tie ends in double square knot (Figure 17). You should be able to fit one finger between the neck and the ties. Check to make sure that the patient can flex neck comfortably.	A secure tape prevents accidental expulsion of the tracheostomy tube. Allowing one finger breadth under tape permits neck flexion that is comfortable and ensures that tape will not compromise circulation to the area.
e. Carefully remove old tape (Figure 18). Reapply oxygen source if necessary.	Removing old tape after application of new prevents accidental expulsion of the tracheostomy tube. Maintains oxygen supply to the patient.

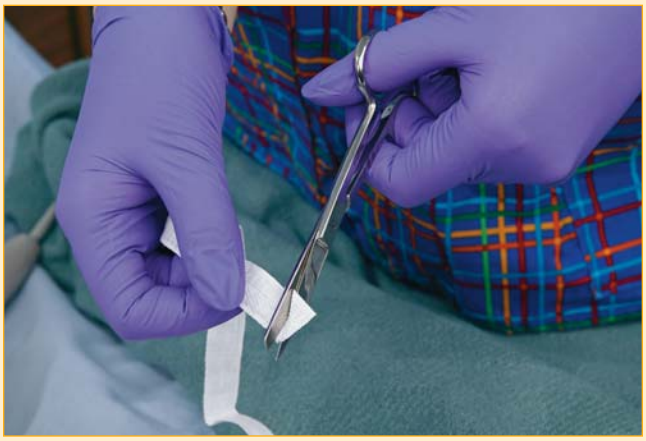


Figure 15. Cutting twill tape.

Figure 16. Pulling tape through alongside old tape.

Figure 17. Tying ends with a double square knot.

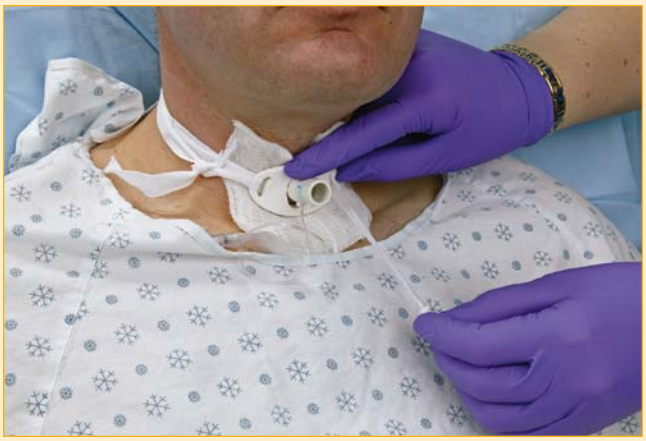


Figure 18. Removing old ties.

(continued)

SKILL 45-6

Providing Tracheostomy Care *(continued)*

ACTION	RATIONALE
18. Remove face shield or mask and goggles. Remove gloves and discard. Perform hand hygiene. Reassess patient's respiratory status, including respiratory rate, effort, oxygen saturation, and lung sounds.	Hand hygiene prevents spread of microorganisms. Assessments determine the effectiveness of interventions and the presence of complications.

Unexpected Situations and Associated Interventions

Patient coughs hard enough to dislodge tracheostomy: A spare tracheostomy and obturator should be kept at bedside. Insert obturator into the new tracheostomy and insert tracheostomy into stoma. Remove obturator. Secure ties and auscultate lung sounds. Palpate for any subcutaneous emphysema.

On palpating around insertion site, you note a moderate amount of subcutaneous emphysema in tissue: Assess for dislodgement of the tracheostomy tube. If the tube becomes displaced, a buildup of air in the subcutaneous portion of the skin is likely. Notify physician if the subcutaneous emphysema is a change in the status of the tracheostomy.

General Considerations

One nurse working alone should always place new tracheostomy ties in place before removing old ties to prevent accidental extubation of tracheostomy. If it is necessary to remove old ties first, obtain the assistance of a second person to hold the tracheostomy tube in place while the old tie is removed and the new tie is replaced.

Emergency equipment should be easily accessible at the bedside. Bag-valve mask, oxygen, the obturator from the current tracheostomy, spare tracheostomy of the same size, spare tracheostomy one size smaller, and suction equipment should be kept at the bedside of a patient with an endotracheal tube at all times.

If the patient is currently using a tracheostomy without a cuff, a spare tracheostomy of the same size with a cuff should be kept at the bedside for emergency use.

Home Care Considerations

The patient and home caregiver should be instructed on how to perform tracheostomy care. The nurse should observe a return demonstration and provide feedback.

Clean, rather than sterile, technique can be used in the home setting.

Sterile saline can be made by mixing 1 teaspoon of table salt in 1 quart of water and boiling for 15 minutes. The solution is cooled and stored in a clean, dry container. Saline is discarded at the end of each day to prevent growth of bacteria.

The patient who is performing self-care should use a mirror to view the steps in the procedure.

The Taylor Suite offers these additional resources to enhance learning and facilitate understanding of this chapter.

- thePoint online resource, http://thepoint.lww.com/Taylor6E
- Student CD-ROM included with the book
- Study Guide to Accompany Taylor's Fundamentals of Nursing

Developing Critical Thinking Skills

1. Using the Focused Assessment Guide in this chapter, work with a partner to assess the respiratory functioning of the following patients. Discuss ways in which you would modify your assessment to meet the specific needs of individual patients:
   - A 6-year-old who presents with asthma and is experiencing difficulty breathing
   - A 12-year-old who is brought to emergency room after illicit use of inhalants ("huffing")
   - An adult dying of cancer who is receiving increasing doses of narcotics, which depress respiratory functioning
   - A hospitalized young adult with a 24-pack/year history of smoking who is noted to have a persistent, hacking cough
2. A postoperative patient who is at high risk for pulmonary complications because of a long history of smoking refuses to use the incentive spirometer or to cooperate with instructions to deep breathe. How would you respond to this patient? Discuss with other students what nursing response is most likely to secure his cooperation in necessary self-care measures.

Practicing for NCLEX

1. A patient has a fractured rib and is breathing less often and with less depth because of the pain. The nurse would document this finding using which term?
   a. Fremitus
   b. Hyperventilation
   c. Pleural friction rub
   d. Hypoventilation
2. When auscultating Mr. Chang's breath sounds, the nurse detects a continuous, musical sound heard on expiration. The nurse identifies this sound as:
   a. Crackles
   b. Wheezes
   c. Bronchial sounds
   d. Pleural friction rub
3. Air that develops in the pleural space is referred to as:
   a. Pneumothorax
   b. Pleural effusion
   c. Hemothorax
   d. Atelectasis
4. When planning care for a patient with chronic lung disease who is receiving oxygen through a nasal cannula, the nurse expects that:
   a. The oxygen must be humidified.
   b. The rate will be 2 L/min or less.
   c. Arterial blood gases will be drawn every 4 hours to assess flow rate.
   d. The rate will be 6 L/min or more.
5. Which oxygen delivery device would the nurse expect to use to provide the highest concentration of oxygen to a patient who is breathing spontaneously?
   a. Partial rebreather mask
   b. Nonrebreather mask
   c. Simple mask
   d. Venturi mask
6. When teaching a patient about pulse oximetry, which statement would the nurse most likely include in the discussion?
   a. A range of 95% to 100% is considered normal oxygen saturation.
   b. Oximetry measures the oxygen saturation of venous blood.
   c. Fasting is required for 12 hours before the test.
   d. Pulse oximetry is a replacement for arterial blood gas analysis.
7. Which action would the nurse include when performing oropharyngeal suctioning on a patient?
   a. Use clean technique.
   b. Apply suction as the catheter is introduced.
   c. Flush the catheter with saline between catheter insertions.
   d. Limit suctioning to 25- to 30-second intervals at one time.
8. Effective use of a metered-dose inhaler requires that the patient accomplish which action?
   a. Breathe in through the nose.
   b. Inhale two sprays with one breath.
   c. Hold the breath for 5 to 10 seconds after inspiration.
   d. Exhale quickly through an open mouth.
9. Mr. Parks has chronic obstructive pulmonary disease. The nurse has taught him that pursed-lip breathing helps him by:
   a. Increasing carbon dioxide, which stimulates breathing
   b. Prolonging inspiration and shortening expiration
   c. Liquefying his secretions
   d. Decreasing the amount of air trapping and resistance
10. A patient develops sudden cardiac arrest. What is the critical time that the nurse must keep in mind before irreversible brain damage occurs?
    a. 1 to 3 minutes
    b. 2 to 4 minutes
    c. 4 to 6 minutes
    d. 8 to 10 minutes
11. David White is in the hospital with a medical diagnosis of viral pneumonia. He is receiving oxygen through a simple face mask. The nurse ensures that the mask fits snugly over the patient's face for which reason?
    a. To prevent mask movement and consequent skin breakdown
    b. To help the patient feel secure
    c. To maintain carbon dioxide retention
    d. To aid in maintaining expected oxygen delivery
12. When suctioning a patient through a tracheostomy tube, the nurse was careful not to occlude the Y port when inserting the suction catheter because this would:
    a. Prevent suctioning from occurring
    b. Cause trauma to the tracheal mucosa
    c. Break the sterile technique
    d. Suction out all the carbon dioxide
13. The nurse follows safe technique when using a portable oxygen cylinder by:
    a. Checking the amount of oxygen in the cylinder before using it
    b. Using a cylinder for a patient transfer that indicates available oxygen is 500 psi
    c. Placing the oxygen cylinder on the stretcher next to the patient
    d. Discontinuing oxygen flow by turning cylinder key counterclockwise until tight
14. Which blood gas values would the nurse identify as within the normal range?
    a. pH, 7.25 to 7.35; $PaCO_2$, 25 to 35 mm Hg; PaO_2, 50 to 100 mm Hg
    b. pH, 7.35 to 7.45; $PaCO_2$, 45 to 50 mm Hg; PaO_2, 90 to 100 mm Hg
    c. pH, 7.35 to 7.45; $PaCO_2$, 35 to 45 mm Hg; PaO_2, 80 to 100 mm Hg
    d. pH, 7.30 to 7.40; $PaCO_2$, 30 to 45 mm Hg; PaO_2, 70 to 100 mm Hg
15. Abdominal breathing at 30 to 60 breaths/minute with an irregular pattern of rate and depth would closely describe the breathing patterns of what age group?
    a. Aged adult
    b. Infant
    c. Early childhood
    d. Late childhood

Answers With Rationale

1. The correct answer is *d*. Hypoventilation is a decreased rate or depth of air movement into the lungs. Hyperven-

tilation is an increased rate and depth of ventilation. Fremitus is the vibration of the chest wall that can be palpated. A pleural friction rub is a dry grating sound caused by inflammation of pleural surfaces.

2. The correct answer is *b.* Wheezes are a continuous sound heard on expiration. Crackles are not described as squeaky. The pleural friction rub is a dry, grating sound. Bronchial breath sounds are normal sounds heard over the trachea.
3. The correct answer is *a.* Air in the pleural space is termed pneumothorax. Fluid in the pleural space is referred to as a pleural effusion. Blood collection in the pleural space is referred to as a hemothorax. Atelectasis refers to an incomplete expansion or collapse of the alveoli.
4. The correct answer is *b.* A rate higher than 2 L/min may destroy the hypoxic drive that stimulates respirations in the medulla in a patient with chronic lung disease. Oxygen delivered at low rates does not necessarily have to be humidified, and arterial blood gases are not required at regular intervals to determine the flow rate.
5. The correct answer is *b.* The nonrebreather mask provides the highest concentration of oxygen to a spontaneously breathing patient. None of the other devices would provide this.
6. The correct answer is *a.* Pulse oximetry measures oxygen saturation levels of arterial blood, which normally range from 95% to 98%. Fasting is not required before the test. Pulse oximetry is an adjunct therapy, not a replacement for arterial blood gas analysis.
7. The correct answer is *c.* Flushing the catheter with saline between insertions is important to clear the catheter of secretions. The nurse should use sterile technique and should not apply suction as the catheter is being introduced; suctioning should be limited to 10- to 15-second intervals to avoid causing hypoxia.
8. The correct answer is *c.* Holding one's breath for 5 to 10 seconds after inspiration of the medication allows the drug to reach the alveoli. Correct technique for using an MDI includes breathing in through the mouth so that all the medication is properly delivered to the lungs, using one spray of medication for each breath to receive the correct dose, and exhaling slowly through pursed lips to minimize airway trapping and resistance.
9. The correct answer is *d.* Doing pursed-lip breathing correctly diminishes carbon dioxide retention. It also prolongs expiration, increases airway pressure, and lessens the amount of airway trapping and resistance.
10. The correct answer is *c.* After 4 to 6 minutes without oxygen, irreversible brain damage can occur.
11. The correct answer is *d.* A snug-fitting mask is necessary to deliver the expected rate of oxygen. A simple face mask does not trap carbon dioxide or cause retention. Patients often complain that an oxygen mask is uncomfortable. A snug fit may limit but not prevent movement of the mask.
12. The correct answer is *b.* Occluding the Y port causes suction and may traumatize the tracheal mucosa if applied when the catheter is inserted. Occluding the Y port does not prevent suction.
13. The correct answer is *a.* The cylinder must always be checked before use to ensure that enough oxygen is available for the patient. It is unsafe to use a cylinder that reads 500 psi or less because not enough oxygen remains for a patient transfer. A cylinder that is not secured properly may result in injury to the patient. Oxygen flow is discontinued by turning the valve clockwise until it is tight.
14. The correct answer is *c.* These are the normal arterial blood gas ranges for pH, carbon dioxide, and oxygen.
15. The correct answer is *b.* Respirations in the infant are more rapid and have not stabilized. As alveoli increase in number and size, the respiratory rate decreases.

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