

UNIT 4 Gas Exchange and Respiratory Function

Case Study

PROVIDING EVIDENCE-BASED CARE FOR A PATIENT WITH COVID-19



The medical unit where you work has just been designated to exclusively admit patients with coronavirus 2019 (COVID-19). A 35-year-old male admitted to the unit has a history of asthma and

hypertension that are both normally well controlled with medication. His temperature is 39°C (101.4°F), he has a cough and tests positive for COVID-19. The nurse manager asks you to develop an evidence-based plan of care that can be individualized for this patient and used as a template for other patients admitted to your unit with COVID-19.

QSEN Competency Focus: Evidence-Based Practice (EBP)

The complexities inherent in today's health care system challenge nurses to demonstrate integration of specific interdisciplinary core competencies. These competencies are aimed at ensuring the delivery of safe, quality patient care (Institute of Medicine, 2003). The Quality and Safety Education for Nurses project (Cronenwett, Sherwood, Barnsteiner, et al., 2007; QSEN, 2020) provides a framework for the knowledge, skills, and attitudes (KSAs) required for nurses to demonstrate competency in these key areas, which include ***patient-centered care, interdisciplinary teamwork and collaboration, evidence-based practice, quality improvement, safety, and informatics.***

Evidence-Based Practice Definition: Integrate best current evidence with clinical expertise and patient/family preferences and values for delivery of optimal health care.

SELECT PRE- LICENSURE KSAs	APPLICATION AND REFLECTION
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Knowledge

Differentiate clinical opinion from research and evidence summaries	Identify the pathophysiologic basis for why patients with asthma and hypertension are at higher risk for COVID-19. What is the strength of the evidence for an evidence-based plan of care for this patient?
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Skills

Locate evidence reports related to clinical practice topics and guidelines	What strategies would you use to search for and then identify appropriate evidence for developing an evidence-based plan of care for this patient? What resources might you mobilize for this patient so he can become educated on the best practices to prevent the spread of COVID-19 while he is in the hospital and upon discharge?
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Attitudes

Value the concept of EBP as integral to determining best clinical practice	Reflect on your attitudes toward using EBP for patients with COVID-19. Do you tend to think that infection is inevitable in patients with risk factors?
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Cronenwett, L., Sherwood, G., Barnsteiner, J., et al. (2007). Quality and safety education for nurses. *Nursing Outlook*, 55(3), 122–131; Institute of Medicine. (2003). *Health professions education: A bridge to quality*. Washington, DC: National Academies Press; QSEN Institute. (2020). *QSEN Competencies: Definitions and pre-licensure KSAs; Evidence based practice*. Retrieved on 8/15/2020 at: qsen.org/competencies/pre-licensure-ksas/#evidence-based_practice

17 Assessment of Respiratory Function

LEARNING OUTCOMES

On completion of this chapter, the learner will be able to:

1. Describe the structures and functions of the upper and lower respiratory tracts and concepts of ventilation, diffusion, perfusion, and ventilation–perfusion imbalances.
2. Explain and demonstrate proper techniques utilized to perform a comprehensive respiratory assessment.
3. Discriminate between normal and abnormal assessment findings of the respiratory system identified by inspection, palpation, percussion, and auscultation.
4. Recognize and evaluate the major symptoms of respiratory dysfunction by applying concepts from the patient’s health history and physical assessment findings.
5. Identify the diagnostic tests used to evaluate respiratory function and related nursing implications.

NURSING CONCEPTS

Assessment
Oxygenation
Perfusion

GLOSSARY

apnea: temporary cessation of breathing

bronchophony: abnormal increase in clarity of transmitted voice sounds heard when auscultating the lungs

bronchoscopy: direct examination of the larynx, trachea, and bronchi using an endoscope

cilia: short, fine hairs that provide a constant whipping motion that serves to propel mucus and foreign substances away from the lung toward the larynx

compliance: measure of the force required to expand or inflate the lungs

crackles: nonmusical, discontinuous popping sounds during inspiration caused by delayed reopening of the airways heard on chest auscultation

dyspnea: subjective experience that describes an uncomfortable or painful breathing sensation when either at rest or while walking or climbing stairs; also commonly referred to as shortness of breath

egophony: abnormal change in tone of voice that is heard when auscultating the lungs

fremitus: vibrations of speech felt as tremors of the chest wall during palpation

hemoptysis: expectoration of blood from the respiratory tract

hypoxemia: decrease in arterial oxygen tension in the blood

hypoxia: decrease in oxygen supply to the tissues and cells

obstructive sleep apnea: temporary absence of breathing during sleep secondary to transient upper airway obstruction

orthopnea: shortness of breath when lying flat; relieved by sitting or standing

oxygen saturation: percentage of hemoglobin that is bound to oxygen

physiologic dead space: portion of the tracheobronchial tree that does not participate in gas exchange

pulmonary diffusion: exchange of gas molecules (oxygen and carbon dioxide) from areas of high concentration to areas of low concentration

pulmonary perfusion: blood flow through the pulmonary vasculature

respiration: gas exchange between atmospheric air and the blood and between the blood and cells of the body

rhonchi: deep, low-pitched snoring sound associated with partial airway obstruction, heard on chest auscultation

stridor: continuous, high-pitched, musical sound heard on inspiration, best heard over the neck; may be heard without use of a stethoscope, secondary to upper airway obstruction

tachypnea: abnormally rapid respirations

tidal volume: volume of air inspired and expired with each breath during normal breathing

ventilation: movement of air in and out of the airways

wheezes: continuous musical sounds associated with airway narrowing or partial obstruction

whispered pectoriloquy: whispered sounds heard loudly and clearly upon thoracic auscultation

Disorders of the respiratory system are common and are encountered by nurses in every setting, from the community to the intensive care unit. Expert assessment skills must be developed and used to provide the best care for patients with acute and chronic respiratory problems. Alterations in respiratory status have been identified as important predictors of clinical deterioration in hospitalized patients (Institute for Healthcare Improvement [IHI], 2019). To differentiate between normal and abnormal assessment findings and recognize subtle changes that may negatively impact patient outcomes, nurses require an understanding of respiratory function and the significance of abnormal diagnostic test results.

Anatomic and Physiologic Overview

The respiratory system is composed of the upper and lower respiratory tracts. Together, the two tracts are responsible for **ventilation** (movement of air in and out of the airways). The upper respiratory tract, known as the upper airway, warms and filters inspired air so that the lower respiratory tract (the lungs) can accomplish gas exchange or diffusion. Gas exchange involves delivering oxygen to the tissues through the bloodstream and expelling waste gases, such as carbon dioxide, during expiration. The respiratory system depends on the cardiovascular system for perfusion, or blood flow through the pulmonary system (Norris, 2019).

Anatomy of the Respiratory System

Upper Respiratory Tract

Upper airway structures consist of the nose; paranasal sinuses; pharynx, tonsils, and adenoids; larynx; and trachea.

Nose

The nose serves as a passageway for air to pass to and from the lungs. It filters impurities and humidifies and warms the air as it is inhaled. The nose is

composed of an external and an internal portion. The external portion protrudes from the face and is supported by the nasal bones and cartilage. The anterior nares (nostrils) are the external openings of the nasal cavities.

The internal portion of the nose is a hollow cavity separated into the right and left nasal cavities by a narrow vertical divider, the septum. Each nasal cavity is divided into three passageways by the projection of the turbinates from the lateral walls. The turbinate bones are also called *conchae* (the name suggested by their shell-like appearance). Because of their curves, these bones increase the mucous membrane surface of the nasal passages and slightly obstruct the air flowing through them (Fig. 17-1).

Air entering the nostrils is deflected upward to the roof of the nose, and it follows a circuitous route before it reaches the nasopharynx. It comes into contact with a large surface of moist, warm, highly vascular, ciliated mucous membrane (called *nasal mucosa*) that traps practically all of the dust and organisms in the inhaled air. The air is moistened, warmed to body temperature, and brought into contact with sensitive nerves. Some of these nerves detect odors; others provoke sneezing to expel irritating dust. Mucus, secreted continuously by goblet cells, covers the surface of the nasal mucosa and is moved back to the nasopharynx by the action of the **cilia** (short, fine hairs).

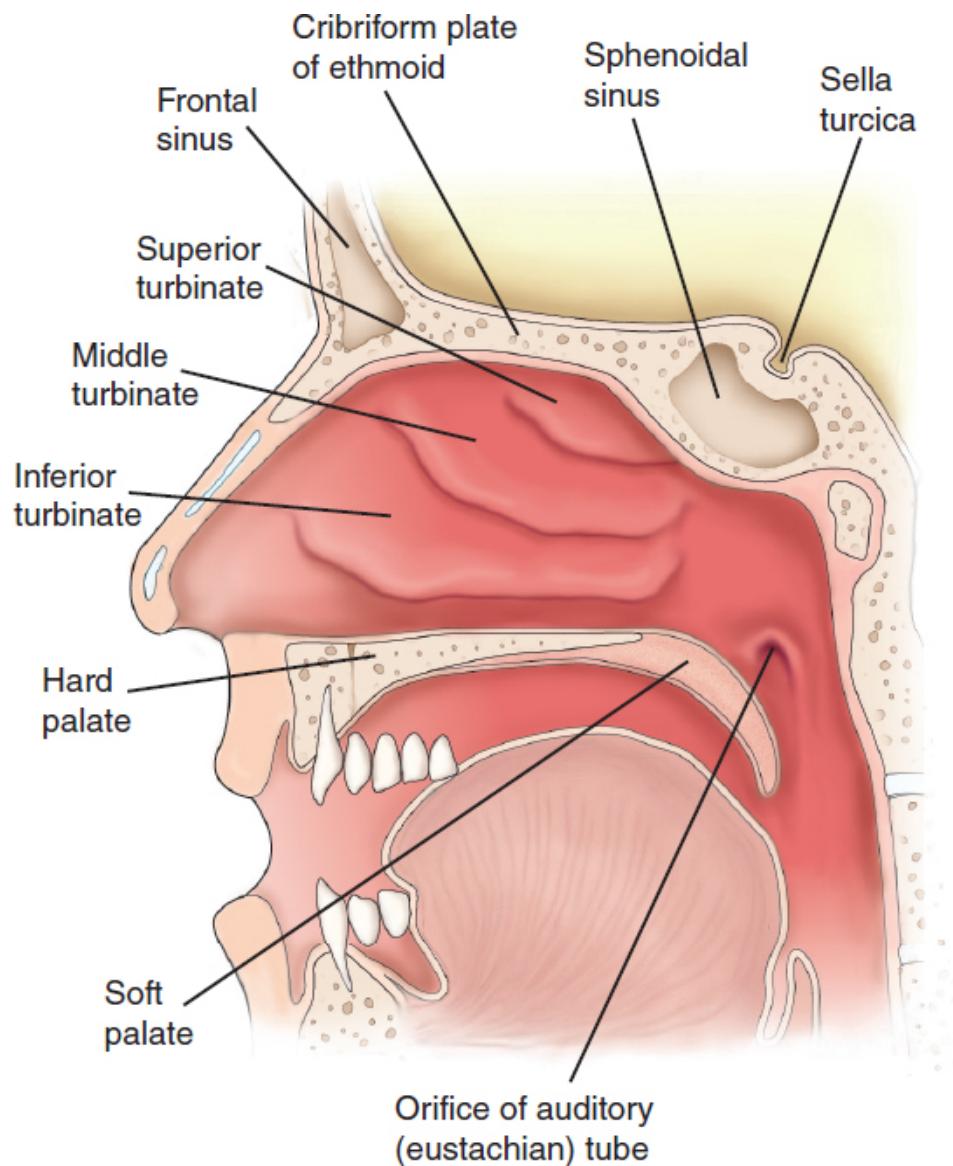


Figure 17-1 • Cross-section of nasal cavity.

Paranasal Sinuses

The paranasal sinuses include four pairs of bony cavities that are lined with nasal mucosa and ciliated pseudostratified columnar epithelium. These airspaces are connected by a series of ducts that drain into the nasal cavity. The sinuses are named by their location: frontal, ethmoid, sphenoid, and maxillary (Fig. 17-2). A prominent function of the sinuses is to serve as a resonating chamber in speech. The sinuses are a common site of infection.

Pharynx, Tonsils, and Adenoids

The pharynx, or throat, is a tubelike structure that connects the nasal and oral cavities to the larynx. It is divided into three regions: nasal, oral, and laryngeal.

The nasopharynx is located posterior to the nose and above the soft palate. The oropharynx houses the faecal, or palatine, tonsils. The laryngopharynx extends from the hyoid bone to the cricoid cartilage. The epiglottis forms the entrance to the larynx.

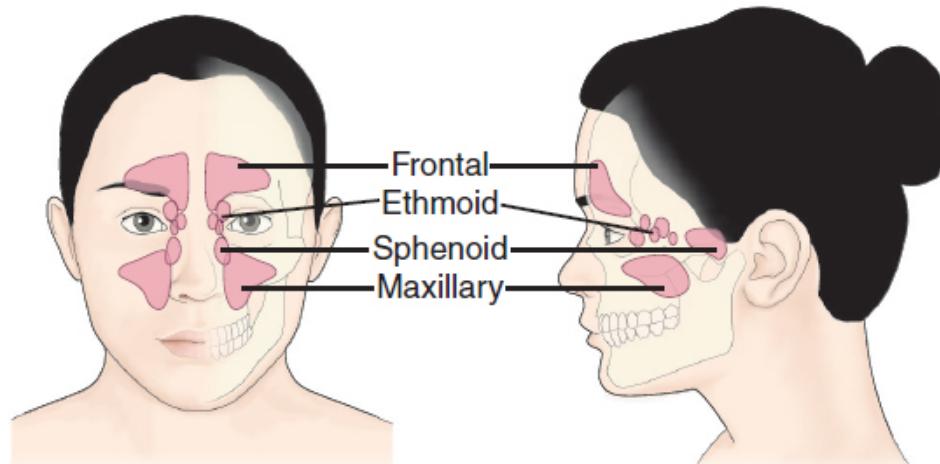


Figure 17-2 • The paranasal sinuses.

The adenoids, or pharyngeal tonsils, are located in the roof of the nasopharynx. The tonsils, the adenoids, and other lymphoid tissue encircle the throat. These structures are important links in the chain of lymph nodes guarding the body from invasion by organisms entering the nose and the throat. The pharynx functions as a passageway for the respiratory and digestive tracts.

Larynx

The larynx, or voice box, is a cartilaginous epithelium-lined organ that connects the pharynx and the trachea and consists of the following:

- *Epiglottis*: a valve flap of cartilage that covers the opening to the larynx during swallowing
- *Glottis*: the opening between the vocal cords in the larynx
- *Thyroid cartilage*: the largest of the cartilage structures; part of it forms the Adam's apple
- *Cricoid cartilage*: the only complete cartilaginous ring in the larynx (located below the thyroid cartilage)
- *Arytenoid cartilages*: used in vocal cord movement with the thyroid cartilage
- *Vocal cords*: ligaments controlled by muscular movements that produce sounds; located in the lumen of the larynx

Although the major function of the larynx is vocalization, it also protects the lower airway from foreign substances and facilitates coughing; it is, therefore, sometimes referred to as the “watchdog of the lungs” (Norris, 2019).

Trachea

The trachea, or windpipe, is composed of smooth muscle with C-shaped rings of cartilage at regular intervals. The cartilaginous rings are incomplete on the posterior surface and give firmness to the wall of the trachea, preventing it from collapsing. The trachea serves as the passage between the larynx and the right and left main stem bronchi, which enter the lungs through an opening called the *hilus*.

Lower Respiratory Tract

The lower respiratory tract consists of the lungs, which contain the bronchial and alveolar structures needed for gas exchange.

Lungs

The lungs are paired elastic structures enclosed in the thoracic cage, which is an airtight chamber with distensible walls (Fig. 17-3). Each lung is divided into lobes. The right lung has upper, middle, and lower lobes, whereas the left lung consists of upper and lower lobes (Fig. 17-4). Each lobe is further subdivided into two to five segments separated by fissures, which are extensions of the pleura.

Pleura

The lungs and wall of the thoracic cavity are lined with a serous membrane called the *pleura*. The visceral pleura covers the lungs; the parietal pleura lines the thoracic cavity, lateral wall of the mediastinum, diaphragm, and inner aspects of the ribs. The visceral and parietal pleura and the small amount of pleural fluid between these two membranes serve to lubricate the thorax and the lungs and permit smooth motion of the lungs within the thoracic cavity during inspiration and expiration.

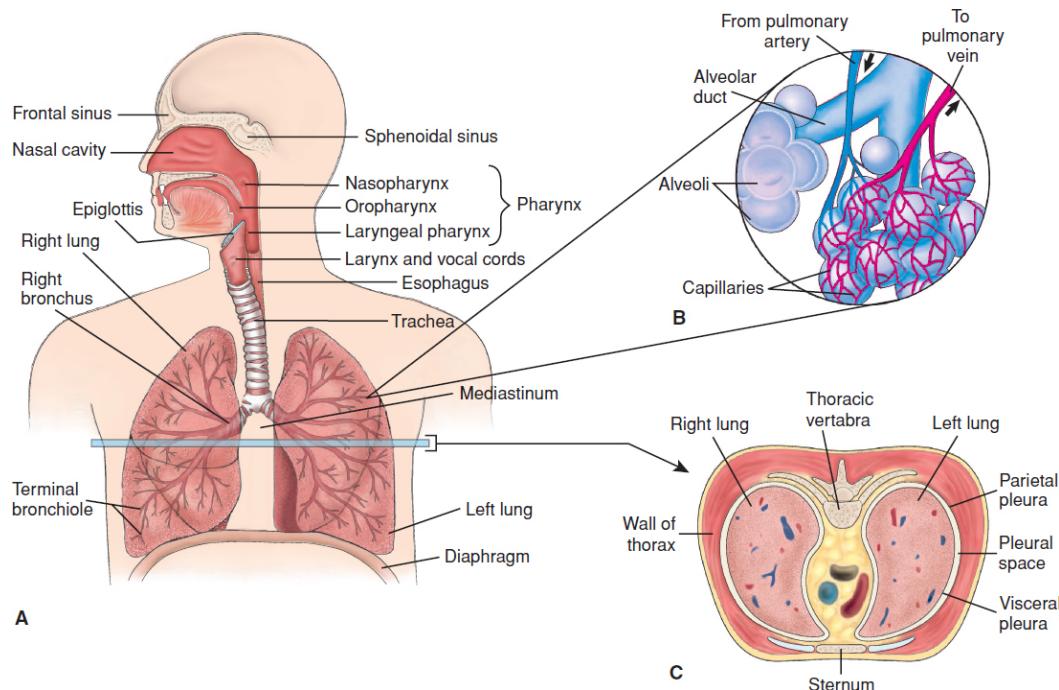


Figure 17-3 • The respiratory system. **A.** Upper respiratory structures and the structures of the thorax. **B.** Alveoli. **C.** A horizontal cross-section of the lungs.

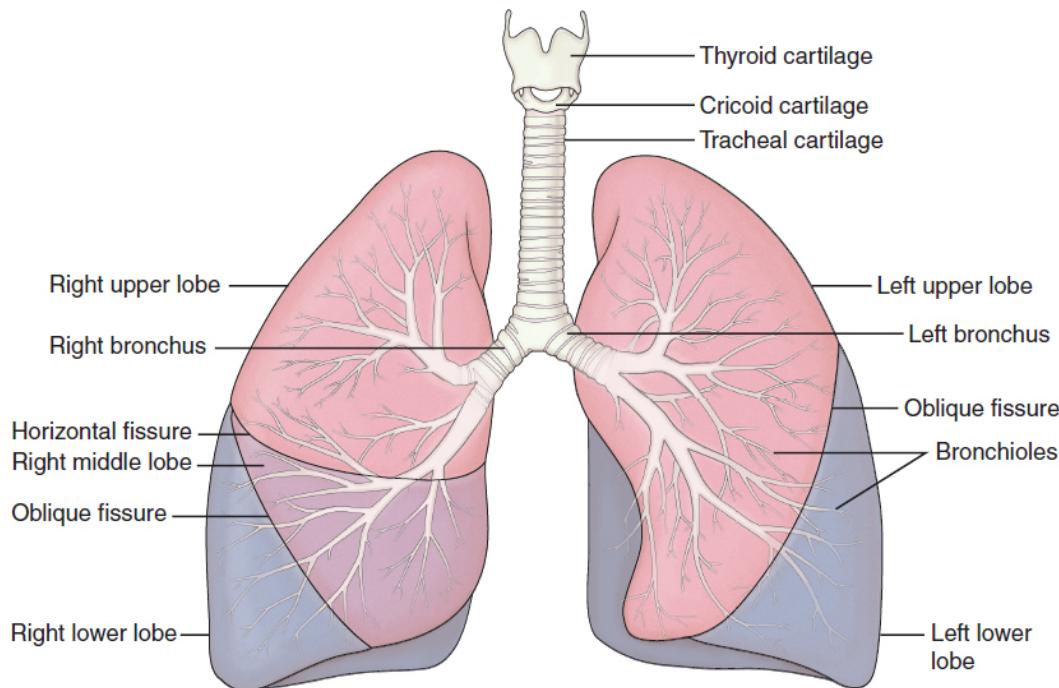


Figure 17-4 • Anterior view of the lungs. The lungs consist of five lobes. The right lung has three lobes (upper, middle, lower); the left has two (upper and lower). The lobes are further subdivided by fissures. The bronchial tree, another lung structure, inflates with air to fill the lobes.

Mediastinum

The mediastinum is in the middle of the thorax, between the pleural sacs that contain the two lungs. It extends from the sternum to the vertebral column and contains all of the thoracic tissue outside the lungs (heart, thymus, the aorta and vena cava, and esophagus).

Bronchi and Bronchioles

There are several divisions of the bronchi within each lobe of the lung. First are the lobar bronchi (three in the right lung and two in the left lung). Lobar bronchi divide into segmental bronchi (10 on the right and 8 on the left); these structures facilitate effective postural drainage in the patient. Segmental bronchi then divide into subsegmental bronchi. These bronchi are surrounded by connective tissue that contains arteries, lymphatics, and nerves.

The subsegmental bronchi then branch into bronchioles, which have no cartilage in their walls. Their patency depends entirely on the elastic recoil of the surrounding smooth muscle and on the alveolar pressure. The bronchioles contain submucosal glands, which produce mucus that covers the inside lining of the airways. The bronchi and bronchioles are also lined with cells that have surfaces covered with cilia. These cilia create a constant whipping motion that propels mucus and foreign substances away from the lungs toward the larynx.

The bronchioles branch into terminal bronchioles, which do not have mucous glands or cilia. Terminal bronchioles become respiratory bronchioles, which are considered to be the transitional passageways between the conducting airways and the gas exchange airways. Up to this point, the conducting airways contain about 150 mL of air in the tracheobronchial tree that does not participate in gas exchange, known as **physiologic dead space**. The respiratory bronchioles then lead into alveolar ducts and sacs and then alveoli (see Fig. 17-3). Oxygen and carbon dioxide exchange takes place in the alveoli.

Alveoli

The lung is made up of about 300 million alveoli, constituting a total surface area between 50 and 100 m² (Norris, 2019). There are three types of alveolar cells. Type I and type II cells make up the alveolar epithelium. Type I cells account for 95% of the alveolar surface area and serve as a barrier between the air and the alveolar surface; type II cells account for only 5% of this area but are responsible for producing type I cells and surfactant. Surfactant reduces surface tension, thereby improving overall lung function. Alveolar macrophages, the third type of alveolar cells, are phagocytic cells that ingest foreign matter and, as a result, provide an important defense mechanism.

Function of the Respiratory System



The cells of the body derive the energy they need from the oxidation of carbohydrates, fats, and proteins. This process requires oxygen. Vital tissues, like the brain and the heart, cannot survive long without a continuous supply of oxygen. As a result of oxidation, carbon dioxide is produced and must be removed from the cells to prevent the buildup of acid waste products. The respiratory system performs this function by facilitating life-sustaining processes such as oxygen transport, respiration, ventilation, and gas exchange.

Oxygen Transport

Oxygen is supplied to, and carbon dioxide is removed from, cells by way of the circulating blood through the thin walls of the capillaries. Oxygen diffuses from the capillary through the capillary wall to the interstitial fluid. At this point, it diffuses through the membrane of tissue cells, where it is used by mitochondria for cellular respiration. The movement of carbon dioxide occurs by diffusion in the opposite direction—from cell to blood.

Respiration

After these tissue capillary exchanges, blood enters the systemic venous circulation and travels to the pulmonary circulation. The oxygen concentration

in blood within the capillaries of the lungs is lower than that in the lungs' alveoli. Because of this concentration gradient, oxygen diffuses from the alveoli to the blood. Carbon dioxide, which has a higher concentration in the blood than in the alveoli, diffuses from the blood into the alveoli. Movement of air in and out of the airways continually replenishes the oxygen and removes the carbon dioxide from the airways and the lungs. This whole process of gas exchange between the atmospheric air and the blood and between the blood and cells of the body is called **respiration**.

Ventilation

Ventilation requires movement of the walls of the thoracic cage and of its floor, the diaphragm. The effect of these movements is alternately to increase and decrease the capacity of the chest. When the capacity of the chest is increased, air enters through the trachea (inspiration) and moves into the bronchi, bronchioles, and alveoli, and inflates the lungs. When the chest wall and the diaphragm return to their previous positions (expiration), the lungs recoil and force the air out through the bronchi and the trachea. Inspiration occurs during the first third of the respiratory cycle; expiration occurs during the latter two thirds. The inspiratory phase of respiration normally requires energy; the expiratory phase is normally passive, requiring very little energy. Physical factors that govern airflow in and out of the lungs are collectively referred to as the mechanics of ventilation and include air pressure variances, resistance to airflow, and lung compliance.

Air Pressure Variances

Air flows from a region of higher pressure to a region of lower pressure. During inspiration, movements of the diaphragm and intercostal muscles enlarge the thoracic cavity and thereby lower the pressure inside the thorax to a level below that of atmospheric pressure. As a result, air is drawn through the trachea and the bronchi into the alveoli. During expiration, the diaphragm relaxes and the lungs recoil, resulting in a decrease in the size of the thoracic cavity. The alveolar pressure then exceeds atmospheric pressure, and air flows from the lungs into the atmosphere.

Airway Resistance

Resistance is determined by the radius, or size of the airway through which the air is flowing, as well as by lung volumes and airflow velocity. Any process that changes the bronchial diameter or width affects airway resistance and alters the rate of airflow for a given pressure gradient during respiration ([Chart 17-1](#)). With increased resistance, greater-than-normal respiratory effort is required to achieve normal levels of ventilation.

Compliance

Compliance is the elasticity and expandability of the lungs and thoracic structures. Compliance allows the lung volume to increase when the difference in pressure between the atmosphere and the thoracic cavity (pressure gradient) causes air to flow in. Factors that determine lung compliance are the surface tension of the alveoli, the connective tissue and water content of the lungs, and the compliance of the thoracic cavity.

Chart 17-1

Causes of Increased Airway Resistance

Common phenomena that may alter bronchial diameter, which affects airway resistance, include the following:

- Contraction of bronchial smooth muscle—as in asthma
- Thickening of bronchial mucosa—as in chronic bronchitis
- Obstruction of the airway—by mucus, a tumor, or a foreign body
- Loss of lung elasticity—as in emphysema, which is characterized by connective tissue encircling the airways, thereby keeping them open during both inspiration and expiration

Compliance is determined by examining the volume–pressure relationship in the lungs and the thorax. Compliance is normal (1 L/cm H₂O) if the lungs and the thorax easily stretch and distend when pressure is applied. Increased compliance occurs if the lungs have lost their elastic recoil and become overdistended (e.g., in emphysema). Decreased compliance occurs if the lungs and the thorax are “stiff.” Conditions associated with decreased compliance include severe obesity, pneumothorax, hemothorax, pleural effusion, pulmonary edema, atelectasis, pulmonary fibrosis, and acute respiratory distress syndrome (ARDS). Lungs with decreased compliance require greater-than-normal energy expenditure by the patient to achieve normal levels of ventilation.

Lung Volumes and Capacities

Lung function, which reflects the mechanics of ventilation, is viewed in terms of lung volumes and lung capacities. Lung volumes are categorized as tidal volume, inspiratory reserve volume, expiratory reserve volume, and residual volume. Lung capacity is evaluated in terms of vital capacity, inspiratory capacity, functional residual capacity, and total lung capacity. These terms are explained in [Table 17-1](#).

Pulmonary Diffusion and Perfusion

Pulmonary diffusion is the process by which oxygen and carbon dioxide are exchanged from areas of high concentration to areas of low concentration at the air–blood interface. The alveolar–capillary membrane is ideal for diffusion because of its thinness and large surface area. In the normal healthy adult, oxygen and carbon dioxide travel across the alveolar–capillary membrane without difficulty as a result of differences in gas concentrations in the alveoli and capillaries.

Pulmonary perfusion is the actual blood flow through the pulmonary vasculature. The blood is pumped into the lungs by the right ventricle through the pulmonary artery. The pulmonary artery divides into the right and left branches to supply both lungs. Normally, about 2% of the blood pumped by the right ventricle does not perfuse the alveolar capillaries. This shunted blood drains into the left side of the heart without participating in alveolar gas exchange. Bronchial arteries extending from the thoracic aorta also support perfusion but do not participate in gas exchange, further diluting oxygenated blood exiting through the pulmonary vein (Norris, 2019).

TABLE 17-1 Lung Volumes and Lung Capacities

Term	Symbol	Description	Normal Value ^a	Significance
Lung Volumes				
Tidal volume	VT or TV	The volume of air inhaled and exhaled with each breath	500 mL or 5–10 mL/kg	The tidal volume may not vary, even with severe disease.
Inspiratory reserve volume	IRV	The maximum volume of air that can be inhaled after a normal inhalation	3000 mL	
Expiratory reserve volume	ERV	The maximum volume of air that can be exhaled forcibly after a normal exhalation	1100 mL	Expiratory reserve volume is decreased with restrictive conditions, such as obesity, ascites, pregnancy.
Residual volume	RV	The volume of air remaining in the lungs after a maximum exhalation	1200 mL	Residual volume may be increased with obstructive disease.
Lung Capacities				
Vital capacity	VC	The maximum volume of air exhaled from the point of maximum inspiration: $VC = TV + IRV + ERV$	4600 mL	A decrease in vital capacity may be found in neuromuscular disease, generalized fatigue, atelectasis, pulmonary edema, COPD, and obesity.
Inspiratory capacity	IC	The maximum volume of air inhaled after normal expiration: $IC = TV + IRV$	3500 mL	A decrease in inspiratory capacity may indicate restrictive disease. It may also be decreased in obesity.
Functional residual capacity	FRC	The volume of air remaining in the lungs after a normal expiration: $FRC = ERV + RV$	2300 mL	Functional residual capacity may be increased with COPD and decreased in ARDS and obesity.
Total lung capacity	TLC	The volume of air in the lungs after a maximum inspiration $TLC = TV + IRV + ERV + RV$	5800 mL	Total lung capacity may be decreased with restrictive disease such as atelectasis and pneumonia and increased in COPD.

^aValues for healthy men; women are 20–25% less.

ARDS, acute respiratory distress syndrome; COPD, chronic obstructive pulmonary disease.

Adapted from West, J. B., & Luks, A. M. (2016). *West's respiratory physiology: The essentials* (10th ed.). Philadelphia, PA: Wolters Kluwer Health Lippincott Williams & Wilkins.

The pulmonary circulation is considered a low-pressure system because the systolic blood pressure in the pulmonary artery is 20 to 30 mm Hg and the diastolic pressure is 5 to 15 mm Hg. Because of these low pressures, the pulmonary vasculature normally can vary its capacity to accommodate the blood flow it receives. However, when a person is in an upright position, the pulmonary artery pressure is not great enough to supply blood to the apex of the lung against the force of gravity. Thus, when a person is upright, the lung may be considered to be divided into three sections: an upper part with poor blood supply, a lower part with maximal blood supply, and a section between

the two with an intermediate supply of blood. When a person who is lying down turns to one side, more blood passes to the dependent lung.

Perfusion is also influenced by alveolar pressure. The pulmonary capillaries are sandwiched between adjacent alveoli. If the alveolar pressure is sufficiently high, the capillaries are squeezed. Depending on the pressure, some capillaries completely collapse, whereas others narrow.

Pulmonary artery pressure, gravity, and alveolar pressure determine the patterns of perfusion. In lung disease, these factors vary, and the perfusion of the lung may become abnormal.

Ventilation and Perfusion Balance and Imbalance

Adequate gas exchange depends on an adequate ventilation-perfusion (V/Q.) ratio. In different areas of the lung, the V/Q. ratio varies. Airway blockages, local changes in compliance, and gravity may alter ventilation. Alterations in perfusion may occur with a change in the pulmonary artery pressure, alveolar pressure, or gravity.

V/Q. imbalance occurs as a result of inadequate ventilation, inadequate perfusion, or both. There are four possible V/Q. states in the lung: normal V/Q. ratio, low V/Q. ratio (shunt), high V/Q. ratio (dead space), and absence of ventilation and perfusion (silent unit) ([Chart 17-2](#)). V/Q. imbalance causes shunting of blood, resulting in **hypoxia** (low level of cellular oxygen). Shunting appears to be the main cause of hypoxia after thoracic or abdominal surgery and most types of respiratory failure. Severe hypoxia results when the amount of shunting exceeds 20%. Supplemental oxygen may eliminate hypoxia, depending on the type of V/Q. imbalance.

Gas Exchange

Partial Pressure of Gases

The air we breathe is a gaseous mixture consisting mainly of nitrogen (78%), oxygen (21%), argon (1%), and trace amounts of other gases including carbon dioxide, methane, and helium, among other gases. The atmospheric pressure at sea level is about 760 mm Hg. Partial pressure is the pressure exerted by each type of gas in a mixture of gases. The partial pressure of a gas is proportional to the concentration of that gas in the mixture. The total pressure exerted by the gaseous mixture, whether in the atmosphere or in the lungs, is equal to the sum of the partial pressures. The partial pressure of nitrogen is approximately 596 mm Hg, oxygen is 152 mm Hg, and argon is 7.6 mm Hg. [Chart 17-3](#) identifies and defines terms and abbreviations related to partial pressure of gases. However, the partial pressure of gases will be affected when the air is inhaled and humidified by the pulmonary tract. It is possible to calculate the partial pressure of gases, specifically oxygen, within the alveoli.

Chart 17-2

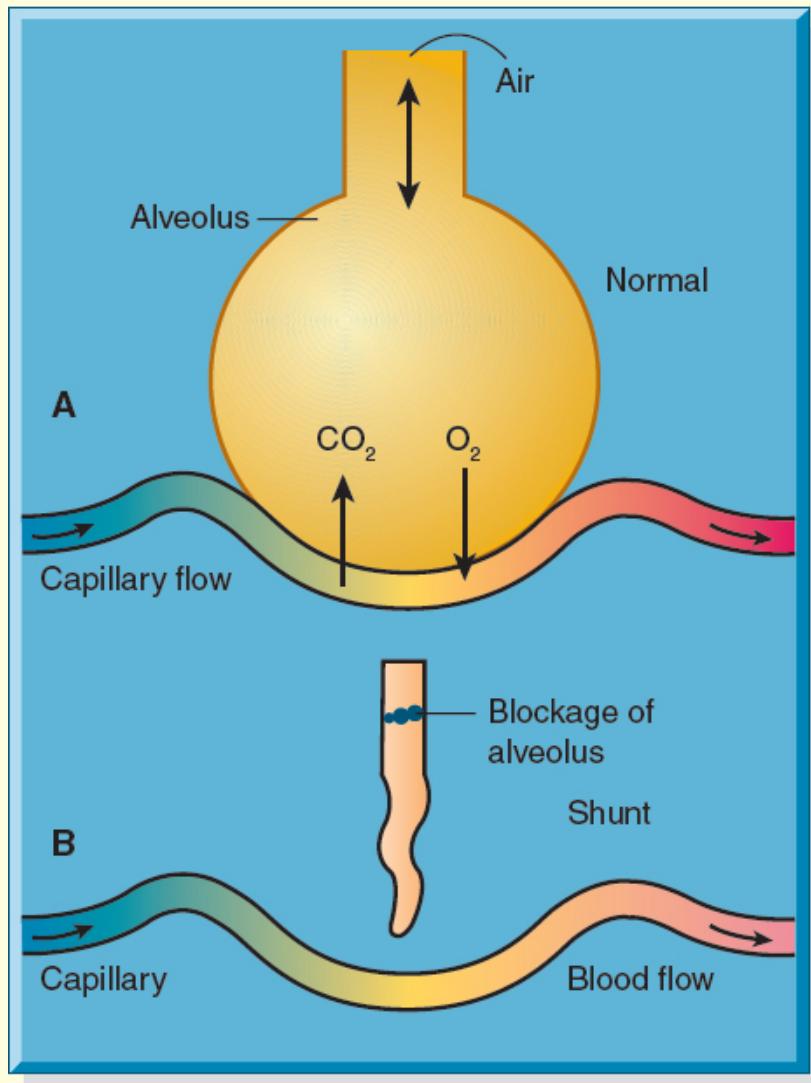
Ventilation–Perfusion Ratios

Normal Ratio (A)

In the healthy lung, a given amount of blood passes an alveolus and is matched with an equal amount of gas (**A**). The ratio is 1:1 (ventilation matches perfusion).

Low Ventilation–Perfusion Ratio: Shunts (B)

Low ventilation–perfusion states may be called *shunt-producing disorders*. When perfusion exceeds ventilation, a shunt exists (**B**). Blood bypasses the alveoli without gas exchange occurring. This is seen with obstruction of the distal airways, such as with pneumonia, atelectasis, tumor, or a mucus plug.

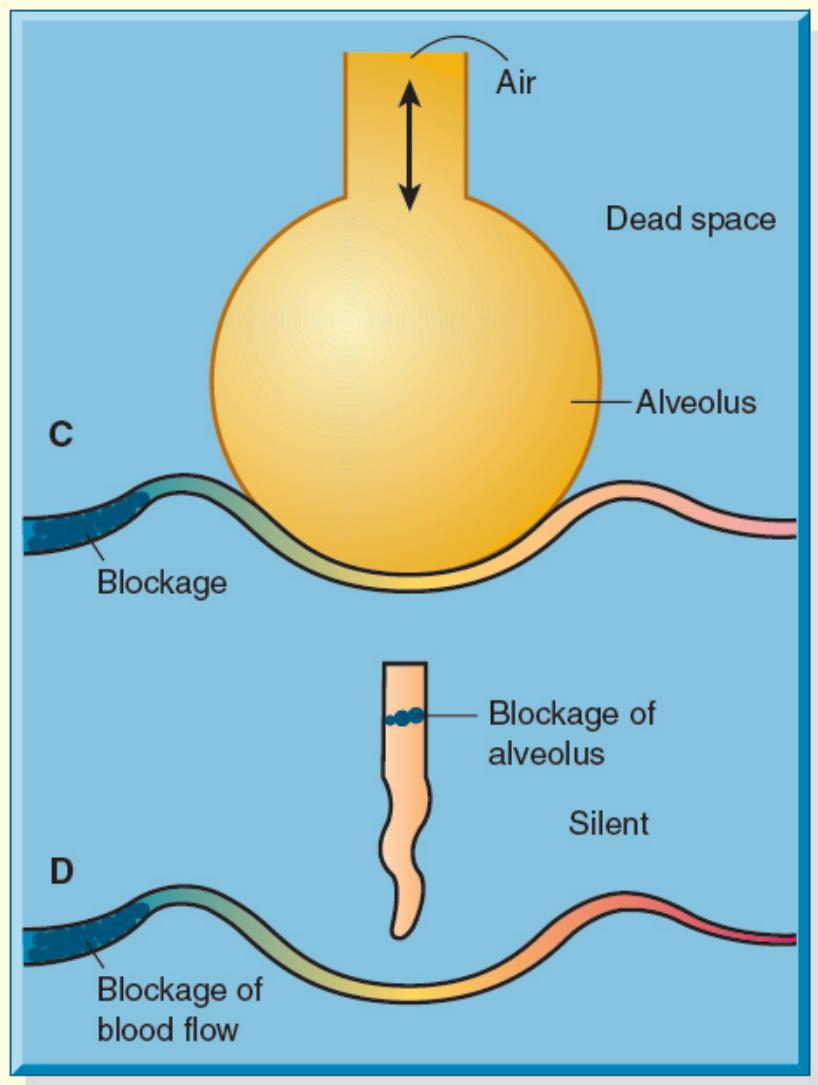


High Ventilation–Perfusion Ratio: Dead Space (C)

When ventilation exceeds perfusion, dead space results (**C**). The alveoli do not have an adequate blood supply for gas exchange to occur. This is characteristic of a variety of disorders, including pulmonary emboli, pulmonary infarction, and cardiogenic shock.

Silent Unit (**D**)

In the absence of both ventilation and perfusion or with limited ventilation and perfusion, a condition known as a silent unit occurs (**D**). This is seen with pneumothorax and severe acute respiratory distress syndrome.



Once the air enters the trachea, it becomes fully saturated with water vapor, which displaces some of the other gases. Water vapor exerts a pressure of 45 mm Hg when it fully saturates a mixture of gases at the body temperature of 37°C (98.6°F). Nitrogen and oxygen are responsible for almost all of the

remaining 715 mm Hg pressure. Once this mixture enters the alveoli, it is further diluted by carbon dioxide. In the alveoli, the water vapor continues to exert a pressure of 45 mm Hg. Under typical baseline conditions (i.e., without supplemental oxygen and at sea level), the partial pressure of alveolar oxygen (PAO_2) is approximately 100 mm Hg. This pressure ensures diffusion of oxygen across the alveolar–capillary membranes, and then eventually into the arterial blood and to red blood cells for transport to meet systemic oxygenation needs (Sharma, Hashmi, & Rawat, 2019).

Chart 17-3

Partial Pressure Abbreviations

P = Pressure

PO_2 = Partial pressure of oxygen

PCO_2 = Partial pressure of carbon dioxide

PAO_2 = Partial pressure of alveolar oxygen

PACO_2 = Partial pressure of alveolar carbon dioxide

PaO_2 = Partial pressure of arterial oxygen

PaCO_2 = Partial pressure of arterial carbon dioxide

Pv-O_2 = Partial pressure of venous oxygen

Pv-CO_2 = Partial pressure of venous carbon dioxide

P_{50} = Partial pressure of oxygen when the hemoglobin is 50% saturated

When a gas is exposed to a liquid, the gas dissolves in the liquid until equilibrium is reached. The dissolved gas also exerts a partial pressure. At equilibrium, the partial pressure of the gas in the liquid is the same as the partial pressure of the gas in the gaseous mixture. Oxygenation of venous blood in the lung illustrates this point. In the lung, venous blood and alveolar oxygen are separated by a very thin alveolar membrane. Oxygen diffuses across this membrane to dissolve in the blood until the partial pressure of oxygen in the blood is the same as that in the alveoli. However, because carbon dioxide is a by-product of oxidation in the cells, venous blood contains carbon dioxide at a higher partial pressure than that in the alveolar gas. In the lung, carbon dioxide diffuses out of venous blood into the alveolar gas. At equilibrium, the partial pressure of carbon dioxide in the blood and in alveolar gas is the same. The changes in partial pressure are shown in [Figure 17-5](#).

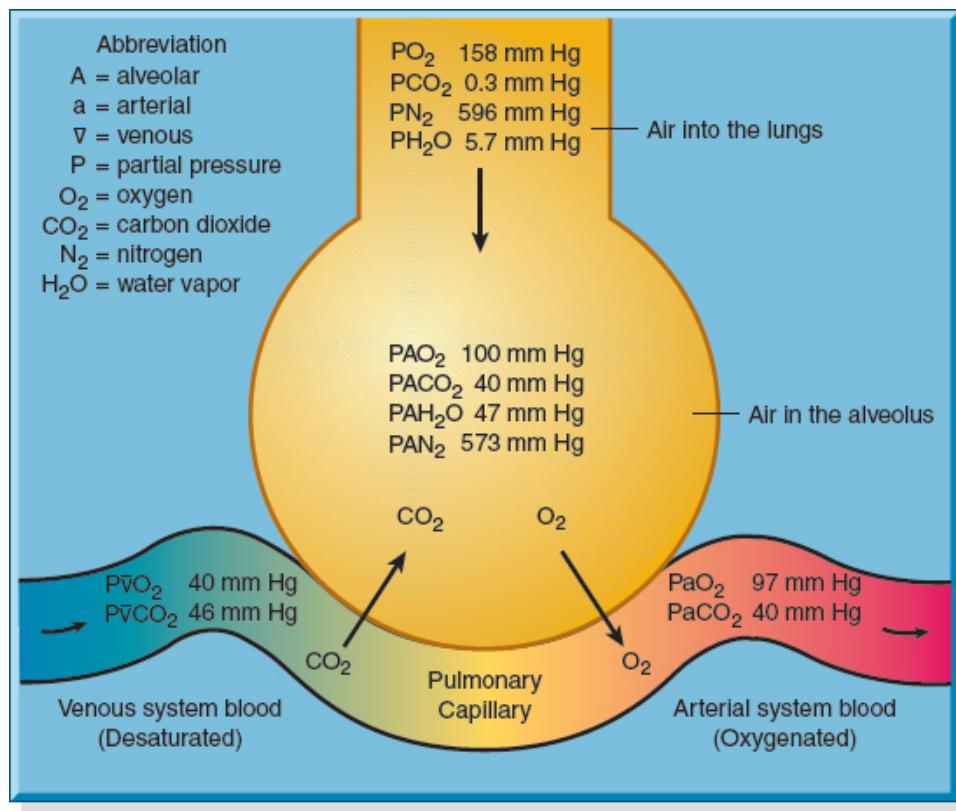
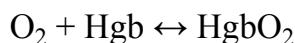


Figure 17-5 • Changes occur in the partial pressure of gases during respiration. These values vary as a result of the exchange of oxygen and carbon dioxide and the changes that occur in their partial pressures as venous blood flows through the lungs.

Effects of Pressure on Oxygen Transport



Oxygen and carbon dioxide are transported simultaneously, either dissolved in blood or combined with hemoglobin in red blood cells. Each 100 mL of normal arterial blood carries 0.3 mL of oxygen physically dissolved in the plasma and 20 mL of oxygen in combination with hemoglobin. Large amounts of oxygen can be transported in the blood because oxygen combines easily with hemoglobin to form oxyhemoglobin:



The volume of oxygen physically dissolved in the plasma is measured by the partial pressure of oxygen in the arteries (PaO₂). The higher the PaO₂, the greater the amount of oxygen dissolved. For example, at a PaO₂ of 10 mm Hg, 0.03 mL of oxygen is dissolved in 100 mL of plasma. At PaO₂ of 20 mm Hg, twice this amount is dissolved in plasma, and at PaO₂ of 100 mm Hg, 10 times this amount is dissolved. Therefore, the amount of dissolved oxygen is directly

proportional to the partial pressure, regardless of how high the oxygen pressure becomes.

The amount of oxygen that combines with hemoglobin depends on both the amount of hemoglobin in the blood and on PaO_2 , although only up to a PaO_2 of about 150 mm Hg. This is measured as **oxygen saturation** (SaO_2), the percentage of the O_2 that could be carried if all the hemoglobin held the maximum possible amount of O_2 . When the PaO_2 is 150 mm Hg, hemoglobin is 100% saturated and does not combine with any additional oxygen. When hemoglobin is 100% saturated, 1 g of hemoglobin combines with 1.34 mL of oxygen. Therefore, in a person with 14 g/dL of hemoglobin, each 100 mL of blood contains about 19 mL of oxygen associated with hemoglobin. If the PaO_2 is less than 150 mm Hg, the percentage of hemoglobin saturated with oxygen decreases. For example, at a PaO_2 of 100 mm Hg (normal value), saturation is 97%; at a PaO_2 of 40 mm Hg, saturation is 70%.

Oxyhemoglobin Dissociation Curve

The oxyhemoglobin dissociation curve (Chart 17-4) shows the relationship between the partial pressure of oxygen (PaO_2) and the percentage of saturation of oxygen (SaO_2). The percentage of saturation can be affected by carbon dioxide, hydrogen ion concentration, temperature, and 2,3-diphosphoglycerate. An increase in these factors shifts the curve to the right, thus less oxygen is picked up in the lungs, but more oxygen is released to the tissues, if PaO_2 is unchanged. A decrease in these factors causes the curve to shift to the left, making the bond between oxygen and hemoglobin stronger. If the PaO_2 is still unchanged, more oxygen is picked up in the lungs, but less oxygen is given up to the tissues. The unusual shape of the oxyhemoglobin dissociation curve is a distinct advantage to the patient for two reasons:

1. If the PaO_2 decreases from 100 to 80 mm Hg as a result of lung disease or heart disease, the hemoglobin of the arterial blood remains almost maximally saturated (94%), and the tissues do not suffer from hypoxia.

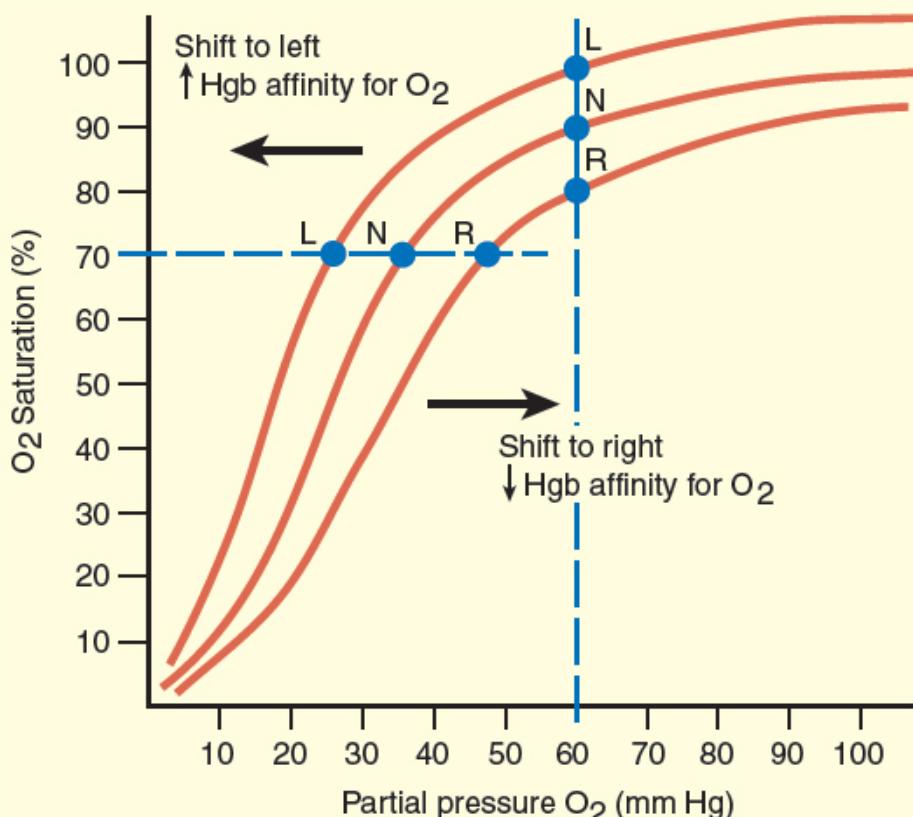
Chart 17-4

Oxyhemoglobin Dissociation Curve

The oxyhemoglobin dissociation curve is marked to show three oxygen levels:

1. Normal levels— $\text{PaO}_2 > 70 \text{ mm Hg}$
2. Relatively safe levels— $\text{PaO}_2 45\text{--}70 \text{ mm Hg}$
3. Dangerous levels— $\text{PaO}_2 < 40 \text{ mm Hg}$

The normal (middle) curve (N) shows that 75% saturation occurs at a PaO_2 of 40 mm Hg. If the curve shifts to the right (R), the same saturation (75%) occurs at the higher PaO_2 of 57 mm Hg. If the curve shifts to the left (L), 75% saturation occurs at a PaO_2 of 25 mm Hg.



2. When the arterial blood passes into tissue capillaries and is exposed to the tissue tension of oxygen (about 40 mm Hg), hemoglobin gives up large quantities of oxygen for use by the tissues.

With a normal value for PaO_2 (80 to 100 mm Hg) and SaO_2 (95% to 98%), there is a 15% margin of excess oxygen available to the tissues. With a normal hemoglobin level of 15 mg/dL and a PaO_2 level of 40 mm Hg (SaO_2 75%), there is adequate oxygen available for the tissues but no reserve for physiologic stresses that increase tissue oxygen demand. If a serious incident

occurs (e.g., bronchospasm, aspiration, hypotension, or cardiac arrhythmias) that reduces the intake of oxygen from the lungs, tissue hypoxia results.

An important consideration in the transport of oxygen is cardiac output, which determines the amount of oxygen delivered to the body and affects lung and tissue perfusion. If the cardiac output is normal (5 L/min), the amount of oxygen delivered to the body per minute is normal. Under normal conditions, only 250 mL of oxygen is used per minute, which is approximately 25% of available oxygen. The rest of the oxygen returns to the right side of the heart, and the PaO_2 of venous blood drops from 80 to 100 mm Hg to about 40 mm Hg. If cardiac output falls, however, the amount of oxygen delivered to the tissues also falls and may be inadequate to meet the body's needs.

Carbon Dioxide Transport

At the same time that oxygen diffuses from the blood into the tissues, carbon dioxide diffuses from tissue cells to blood and is transported to the lungs for excretion. The amount of carbon dioxide in transit is one of the major determinants of the acid–base balance of the body. Normally, only 6% of the venous carbon dioxide is removed in the lungs and enough remains in the arterial blood to exert a pressure of 40 mm Hg. Most of the carbon dioxide (90%) is carried by red blood cells; the small portion (5%) that remains dissolved in the plasma (partial pressure of carbon dioxide [PCO_2]) is the critical factor that determines carbon dioxide movement in or out of the blood.

Although the many processes involved in respiratory gas transport seem to occur in intermittent stages, the changes are rapid, simultaneous, and continuous.

Neurologic Control of Ventilation

Resting respiration is the result of cyclic excitation of the respiratory muscles by the phrenic nerve. The rhythm of breathing is controlled by respiratory centers in the brain. The inspiratory and expiratory centers in the medulla oblongata and pons control the rate and depth of ventilation to meet the body's metabolic demands.

The apneustic center in the lower pons stimulates the inspiratory medullary center to promote deep, prolonged inspirations. The pneumotaxic center in the upper pons is thought to control the pattern of respirations.

Several groups of receptor sites assist in the brain's control of respiratory function. The central chemoreceptors, located in the medulla, respond to chemical changes in the cerebrospinal fluid, which result from chemical changes in the blood. These receptors respond to an increase or decrease in the pH and convey a message to the lungs to change the depth and then the rate of ventilation to correct the imbalance. The peripheral chemoreceptors are located

in the aortic arch and the carotid arteries and respond first to changes in PaO₂, then to partial pressure of carbon dioxide (PaCO₂) and pH.

Mechanoreceptors in the lung include stretch, irritant, and juxtagapillary receptors, and respond to changes in resistance by altering breathing patterns to support optimal lung function. For example, the Hering–Breuer reflex is activated by stretch receptors in the alveoli. When the lungs are distended, inspiration is inhibited; as a result, the lungs do not become overdistended.

Proprioceptors in the muscles and chest wall respond to body movements, causing an increase in ventilation. Thus, range-of-motion exercises in a patient who is immobile stimulate breathing. Finally, baroreceptors, also located in the aortic and carotid bodies, respond to an increase or decrease in arterial blood pressure and cause reflex hypoventilation or hyperventilation.

Gerontologic Considerations

A gradual decline in respiratory function begins in early to middle adulthood and affects the structure and function of the respiratory system. The vital capacity of the lungs and the strength of the respiratory muscles peak between 20 and 25 years of age and decrease thereafter. With aging (40 years and older), changes occur in the alveoli that reduce the surface area available for the exchange of oxygen and carbon dioxide. At approximately 50 years of age, the alveoli begin to lose elasticity. A decrease in vital capacity occurs with the loss of chest wall mobility, which restricts the tidal flow of air. The amount of respiratory dead space increases with age. These changes result in a decreased diffusion capacity for oxygen with increasing age, producing lower oxygen levels in the arterial circulation. Older adults have a decreased ability to rapidly move air in and out of the lungs.

Gerontologic changes in the respiratory system are summarized in [Table 17-2](#). Despite these changes, in the absence of chronic pulmonary disease, older adults are able to carry out activities of daily living, but they may have decreased tolerance for, and require additional rest after, prolonged or vigorous activity.

Assessment

Health History

The health history initially focuses on the patient's presenting problem and associated symptoms. In conducting the history, the nurse should explore the onset, location, duration, character, aggravating and alleviating factors, radiation (if relevant), and timing of the presenting problem and associated

signs and symptoms. The nurse should also explore how these factors impact the patient's activities of daily living, usual work and family activities, and quality of life.

Common Symptoms

The major signs and symptoms of respiratory disease are dyspnea, cough, sputum production, chest pain, wheezing, and hemoptysis. During the health history, the nurse should also consider nonpulmonary diseases when evaluating symptoms, as these symptoms may occur with a variety of other illnesses.



Age-Related Changes in the Respiratory System

	Structural Changes	Functional Changes	History and Physical Findings
Defense Mechanisms (Respiratory and Nonrespiratory)	<p>↓ Number of cilia and ↓ mucus</p> <p>↓ Cough and gag reflex</p> <p>Loss of surface area of the capillary membrane</p> <p>Lack of a uniform or consistent ventilation and/or blood flow</p>	<p>↓ Protection against foreign particles</p> <p>↓ Protection against aspiration</p> <p>↓ Antibody response to antigens</p> <p>↓ Response to hypoxia and hypercapnia (chemoreceptors)</p>	<p>↓ Cough reflex and mucus</p> <p>↑ Infection rate</p> <p>History of respiratory infections, chronic obstructive pulmonary disease (COPD), pneumonia.</p> <p>Risk factors: smoking, environmental exposure, exposure to tuberculosis (TB)</p>
Lung	<p>↓ Size of airway</p> <p>↑ Diameter of alveolar ducts</p> <p>↑ Collagen of alveolar walls</p> <p>↑ Thickness of alveolar membranes</p> <p>↓ Elasticity of alveolar sacs</p>	<p>↑ Airway resistance</p> <p>↑ Pulmonary compliance</p> <p>↓ Expiratory flow rate</p> <p>↓ Oxygen diffusion capacity</p> <p>↑ Dead space</p> <p>Premature closure of airways</p> <p>↑ Air trapping</p> <p>↓ Expiratory flow rates</p> <p>Ventilation–perfusion mismatch</p> <p>↓ Exercise capacity</p> <p>↑ Anteroposterior (AP) diameter</p>	<p>Unchanged total lung capacity (TLC)</p> <p>↑ Residual volume (RV)</p> <p>↓ Inspiratory reserve volume (IRV)</p> <p>↓ Expiratory reserve volume (ERV)</p> <p>↓ Forced vital capacity (FVC) and vital capacity (VC)</p> <p>↑ Functional residual capacity (FRC)</p> <p>↓ PaO₂</p> <p>↑ CO₂</p>
Chest Wall and Muscles	<p>Calcification of intercostal cartilages</p> <p>Arthritis of costovertebral joints</p> <p>↓ Continuity of diaphragm</p> <p>Osteoporotic changes</p> <p>↓ Muscle mass</p> <p>Muscle atrophy</p>	<p>↑ Rigidity and stiffness of thoracic cage</p> <p>↓ Respiratory muscle strength</p> <p>↑ Work of breathing</p> <p>↓ Capacity for exercise</p> <p>↓ Peripheral chemosensitivity</p> <p>↑ Risk for inspiratory muscle fatigue</p>	<p>Kyphosis, barrel chest</p> <p>Skeletal changes</p> <p>↑ AP diameter</p> <p>Shortness of breath</p> <p>↑ Abdominal and diaphragmatic breathing</p> <p>↓ Maximum expiratory flow rates</p>

↓, decreased; ↑, increased.

Adapted from Ramly, E., Kaafarani, H. M. A., & Velmahos, G. C. (2015). The effect of aging on pulmonary function: Implications for monitoring and support of the surgical and trauma patient. *Surgical Clinics of North America*, 95(1), 53–69.

Dyspnea

The official American Thoracic Society Statement (2012) defines **dyspnea** as a subjective feeling of discomfort while breathing; its causes may include multiple physiologic, psychological, environmental, or social factors (Parshall, Schwartzstein, Adams, et al., 2012). In general, acute diseases of the lungs produce a more severe grade of dyspnea than do chronic diseases. Sudden dyspnea in a healthy person may indicate pneumothorax (air in the pleural cavity), acute respiratory obstruction, allergic reaction, or myocardial infarction. In patients who are immobilized, sudden dyspnea may denote pulmonary embolism (PE). Dyspnea and **tachypnea** (abnormally rapid respirations) accompanied by progressive **hypoxemia** (low blood oxygen level) in a person who has recently experienced lung trauma, shock, cardiopulmonary bypass, or multiple blood transfusions may signal ARDS. **Orthopnea** (shortness of breath when lying flat, relieved by sitting or standing) may be found in patients with heart disease and occasionally in patients with chronic obstructive pulmonary disease (COPD); dyspnea with an expiratory wheeze occurs with COPD. Dyspnea associated with noisy breathing may result from a narrowing of the airway or localized obstruction of a major bronchus by a tumor or foreign body. The high-pitched sound heard (usually on inspiration) when someone is breathing through a partially blocked upper airway is called **stridor**. To help determine the cause of dyspnea, the nurse should ask the following questions:

- Is the shortness of breath related to other symptoms? Is a cough present?
- Was the onset of shortness of breath sudden or gradual?
- At what time of day or night does the shortness of breath occur?
- Is the shortness of breath worse when lying flat?
- How much exertion triggers shortness of breath? Does it occur with exercise? Climbing stairs? At rest?
- How severe is the shortness of breath? On a scale of 0 to 10, if 0 is not at all breathless and 10 is very breathless, how hard is it to breathe?

Because patients use a variety of terms to describe breathlessness, the nurse must explore what these terms mean to each patient. The use of a standardized tool to assess dyspnea, as part of the routine nursing assessment, can be beneficial (Fig. 17-6). It is especially important to assess the patient's rating of the intensity or distress of breathlessness, what breathing feels like, and its impact on the patient's general health, function, and quality of life (Baker,

DeSanto-Madeya, & Banzett, 2017). See the Nursing Research Profile in Chart 17-5.

Cough

Cough is a reflex that protects the lungs from the accumulation of secretions or the inhalation of foreign bodies. Its presence or absence can be a diagnostic clue because some disorders cause coughing and others suppress it. The cough reflex may be impaired by weakness or paralysis of the respiratory muscles, prolonged inactivity, the presence of a nasogastric tube, or depressed function of the brain's medullary centers (e.g., anesthesia, brain disorders).

Cough results from irritation or inflammation of the mucous membranes anywhere in the respiratory tract and is associated with multiple pulmonary disorders. Mucus, pus, blood, or an airborne irritant, such as smoke or a gas, may stimulate the cough reflex. Common causes of cough include asthma, gastrointestinal reflux disease, infection, and side effects of medications, such as angiotensin-converting enzyme (ACE) inhibitors (Norris, 2019).

<p>Dyspnea: How to score the dyspnea assessment. Ask patient once per shift <u>and</u> any change in patient status.</p> <p>How much breathing discomfort (shortness of breath) do you have right now?</p> <table style="width: 100%; text-align: center;"> <tr> <td>0</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td><td>N/A</td></tr> <tr> <td>None</td><td>Mild</td><td>Moderate</td><td></td><td>Severe</td><td>Unbearable</td><td></td><td>Unable to respond</td><td></td><td></td><td></td><td></td></tr> </table>												0	1	2	3	4	5	6	7	8	9	10	N/A	None	Mild	Moderate		Severe	Unbearable		Unable to respond																
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<p>1. How much breathing discomfort (shortness of breath) do you have right now?</p> <table style="width: 100%; text-align: center;"> <tr> <td><input type="radio"/></td><td><input type="radio"/></td></tr> <tr> <td>0</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td><td>Unable to respond</td></tr> <tr> <td>None</td><td>Mild</td><td>Moderate</td><td></td><td>Severe</td><td>Unbearable</td><td></td><td></td><td></td><td></td><td></td><td></td></tr> </table>												<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	0	1	2	3	4	5	6	7	8	9	10	Unable to respond	None	Mild	Moderate		Severe	Unbearable						
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<p>2a. During the 24 hrs before you came to the hospital, what was the worst level of breathing discomfort (shortness of breath) you experienced?</p> <table style="width: 100%; text-align: center;"> <tr> <td><input type="radio"/></td><td><input type="radio"/></td></tr> <tr> <td>0</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td><td>Unable to respond</td></tr> <tr> <td>None</td><td>Mild</td><td>Moderate</td><td></td><td>Severe</td><td>Unbearable</td><td></td><td></td><td></td><td></td><td></td><td></td></tr> </table>												<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	0	1	2	3	4	5	6	7	8	9	10	Unable to respond	None	Mild	Moderate		Severe	Unbearable						
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<p><i>Note: If answer to 2a is 'None', questions 2b and 3 do not apply, and will not appear on the electronic form.</i></p> <p>2b. What were you doing when you experienced your worst breathing discomfort?</p> <table style="width: 100%; text-align: center;"> <tr> <td><input type="radio"/> Heavier activity</td><td>(e.g., mowing the lawn, raking leaves, walking uphill)</td> </tr> <tr> <td><input type="radio"/> Moderate activity</td><td>(e.g., walking, making the bed)</td> </tr> <tr> <td><input type="radio"/> Light activity</td><td>(e.g., eating, dressing, speaking, preparing lunch)</td> </tr> <tr> <td><input type="radio"/> Resting</td><td>(e.g., sitting in a chair or lying in bed)</td> </tr> </table> <p>3. Has your shortness of breath gotten worse in the last week (before coming to the hospital)?</p> <table style="width: 100%; text-align: center;"> <tr> <td><input type="radio"/></td><td><input type="radio"/></td><td><input type="radio"/></td></tr> <tr> <td>About the same</td><td>Worse</td><td>Much worse</td> </tr> </table>												<input type="radio"/> Heavier activity	(e.g., mowing the lawn, raking leaves, walking uphill)	<input type="radio"/> Moderate activity	(e.g., walking, making the bed)	<input type="radio"/> Light activity	(e.g., eating, dressing, speaking, preparing lunch)	<input type="radio"/> Resting	(e.g., sitting in a chair or lying in bed)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	About the same	Worse	Much worse																						
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Figure 17-6 • Dyspnea scale and patient's report of current and recent dyspnea. Reprinted from Baker, K. M., DeSanto-Madeya, S., & Banzett, R. B. (2017). Routine dyspnea assessment and documentation: Nurses experience yields wide acceptance. *BMC Nursing*, 16(3), 1–11. This article is distributed under the terms of the Creative Commons Attribution 4.0 International License (www.creativecommons.org/licenses/by/4.0), which permits unrestricted use, distribution, and reproduction in any medium.

To help determine the cause of the cough, the nurse inquires about the onset and time of coughing. Coughing at night may indicate the onset of left-sided heart failure or bronchial asthma. A cough in the morning with sputum production may indicate bronchitis. A cough that worsens when the patient is supine suggests postnasal drip (rhinosinusitis). Coughing after food intake may indicate aspiration of material into the tracheobronchial tree or reflux. A cough of recent onset is usually from an acute infection.

The nurse assesses the character of the cough and associated symptoms. A dry, irritative cough is characteristic of an upper respiratory tract infection of viral origin, or it may be a side effect of ACE inhibitor therapy. An irritative, high-pitched cough can be caused by laryngotracheitis. A brassy cough is the

result of a tracheal lesion, and a severe or changing cough may indicate bronchogenic carcinoma. Pleuritic chest pain that accompanies coughing may indicate pleural or chest wall (musculoskeletal) involvement. Violent coughing causes bronchial spasm, obstruction, and further irritation of the bronchi and may result in syncope (fainting).



Concept Mastery Alert

A nurse interviewing a patient who says he has a dry, irritating cough that is not "bringing anything up" should ask whether he is taking ACE inhibitors.

A persistent cough may affect a patient's quality of life and may produce embarrassment, exhaustion, inability to sleep, and pain. Therefore, the nurse should explore how a chronic cough impacts all aspects of the patient's life.

Chart 17-5



NURSING RESEARCH PROFILE

Dyspnea Assessment

Baker, K. M., DeSanto-Madeya, S., & Banzett, R. B. (2017). Routine dyspnea assessment and documentation: Nurses' experience yields wide acceptance. *BMC Nursing*, 16(3), 1–11.

Purpose

The study aims to explore nurses' approaches to dyspnea assessment, their perception of patient response, and their perception of the utility and burden of dyspnea measurement.

Design

This was a qualitative, descriptive study utilizing a three-part assessment of practice: a series of focus group interviews, a time-motion observation, and a randomized, anonymous online survey. A convenience sample of 63 nurses from six medical-surgical units participated in 12 half-hour focus group sessions. The focus group included questions about the process nurses used for assessment of dyspnea, views on the importance of dyspnea assessment and awareness, patients' abilities to rate and use a dyspnea scale, impact of routine assessment on workflow, and suggestions for improvement. Focus group sessions were conducted during regular work shifts and were recorded. Forty registered nurses representing 14 medical-surgical inpatient units were randomly selected for participation in the time-motion study. For this observation, a clinical nurse specialist recorded the time nurses spent assessing and documenting pain and dyspnea during routine morning nursing assessment of patients. The online survey addressed issues raised during the focus group sessions. Seventy registered nurses, from 14 inpatient medical-surgical units, were randomly selected to complete the anonymous, online survey.

Findings

Nursing assessment of dyspnea and pain took less than 1 min. Overwhelmingly, most of the nurses surveyed (94%) reported understanding the importance of assessing dyspnea. They described assessment of dyspnea as "easy" or "very easy" to complete and that the utilization of an assessment tool enhanced awareness of dyspnea, improved workflow, and standardized documentation.

Nursing Implications

Findings from this study support the use of a standardized tool to assess dyspnea as part of routine nursing assessment of patients.

Sputum Production

Sputum production is the reaction of the lungs to any constantly recurring irritant and often results from persistent coughing. It may also be associated

with a nasal discharge. The nature of the sputum is often indicative of its cause. A profuse amount of purulent sputum (thick and yellow, green, or rust colored) or a change in color of the sputum is a common sign of a bacterial infection. Thin, mucoid sputum frequently results from viral bronchitis. A gradual increase of sputum over time may occur with chronic bronchitis or bronchiectasis. Pink-tinged mucoid sputum suggests a lung tumor. Profuse, frothy, pink material, often welling up into the throat, may indicate pulmonary edema. Foul-smelling sputum and bad breath point to the presence of a lung abscess, bronchiectasis, or an infection caused by fusospirochetal or other anaerobic organisms.

Chest Pain

Chest pain or discomfort may be associated with pulmonary, cardiac, gastrointestinal, or musculoskeletal disease or anxiety. Chest pain associated with pulmonary conditions may be sharp, stabbing, and intermittent, or it may be dull, aching, and persistent. The pain usually is felt on the side where the pathologic process is located, although it may be referred elsewhere—for example, to the neck, back, or abdomen.

Chest pain may occur with pneumonia, pulmonary infarction, or pleurisy, or as a late symptom of bronchogenic carcinoma. In carcinoma, the pain may be dull and persistent because the cancer has invaded the chest wall, mediastinum, or spine.

Lung disease does not always cause thoracic pain because the lungs and the visceral pleura lack sensory nerves and are insensitive to pain stimuli. However, the parietal pleura have a rich supply of sensory nerves that are stimulated by inflammation and stretching of the membrane. Pleuritic pain from irritation of the parietal pleura is sharp and seems to “catch” on inspiration; patients often describe it as being “like the stabbing of a knife.” Patients are more comfortable when they lay on the affected side because this position splints the chest wall, limits expansion and contraction of the lung, and reduces the friction between the injured or diseased pleurae on that side. Pain associated with cough may be reduced manually by splinting the rib cage.

The nurse assesses the onset, quality, intensity, and radiation of pain and identifies and explores precipitating factors and their relationship to the patient’s position. In addition, the nurse must assess the relationship of pain to the inspiratory and expiratory phases of respiration (see [Chapter 9](#) for further discussion on assessment of pain).

Wheezing

Wheezing is a high-pitched, musical sound which is continuous, meaning it is heard on either expiration (asthma) or inspiration (bronchitis). It is often the major finding in a patient with bronchoconstriction or airway narrowing (see later discussion under Thoracic Auscultation).

Hemoptysis

Hemoptysis is the expectoration of blood from the respiratory tract. It can present as small to moderate blood-stained sputum to a large hemorrhage and always warrants further investigation. The onset of hemoptysis is usually sudden, and it may be intermittent or continuous. The most common causes are:

- Pulmonary infection
- Carcinoma of the lung
- Abnormalities of the heart or blood vessels
- Pulmonary artery or vein abnormalities
- PE or infarction

The nurse must determine the source of the bleeding, as the term *hemoptysis* is reserved for blood coming from the respiratory tract. Potential sources of bleeding include the gums, nasopharynx, lungs, or stomach. The nurse may be the only witness to the episode, and when evaluating the bleeding episode, the following points should be considered:

- Bloody sputum from the nose or the nasopharynx is usually preceded by considerable sniffing, with blood possibly appearing in the nose.
- Blood from the lung is usually bright red, frothy, and mixed with sputum. Initial symptoms include a tickling sensation in the throat, a salty taste, a burning or bubbling sensation in the chest, and perhaps chest pain, in which case, the patient tends to splint the bleeding side. This blood has an alkaline pH (greater than 7).
- Blood from the stomach is vomited rather than expectorated, may be mixed with food, and is usually much darker and often referred to as “coffee ground emesis.” This blood has an acid pH (less than 7).

Past Health, Social, and Family History

In addition to the presenting problem and associated symptoms, the history should also focus on the patient’s health, personal, and social history, and the family health history. Specific questions are asked about childhood illnesses, immunizations (including the most recent influenza and pneumonia vaccinations), medical conditions, injuries, hospitalizations, surgeries, allergies, and current medications (including over-the-counter medications and herbal remedies). Personal and social history addresses issues such as diet, exercise, sleep, recreational habits, and religion. Psychosocial factors that may affect the patient are also explored ([Chart 17-6](#)).

The nurse assesses for risk factors and genetic factors that may contribute to the patient’s lung condition ([Charts 17-7](#) and [17-8](#)). Many lung disorders are related to or exacerbated by tobacco smoke; therefore, smoking history (including exposure to secondhand smoke) is also obtained. Smoking history is

usually expressed in pack-years, which is the number of packs of cigarettes smoked per day times the number of years the patient has smoked. It is important to find out whether the patient is still smoking or when the patient quit smoking. The nurse should also ask patients whether they use electronic nicotine delivery systems (ENDS) including e-cigarettes, e-pens, e-pipes, e-hookah, and e-cigars, or any other smokeless tobacco products. In 2016, the U.S. Food and Drug Administration (FDA) finalized a rule that extended its regulatory authority to all tobacco products, including e-cigarettes, cigars, hookah, and pipe tobacco. The new rule mandates health warnings on products, bans free samples, and restricts youth (those under the age of 18) access to newly regulated tobacco products. The FDA has not found ENDS to be safe or effective in helping smokers curb the habit, as previously marketed by some manufacturers. The FDA has approved five forms of nicotine replacement therapy including nicotine gum, nicotine skin patches, nicotine lozenges, nicotine oral inhaled products, and nicotine nasal spray (American Lung Association, 2020). The American Lung Association views ENDS as a public health threat and calls for additional research regarding the risks and long-term effects to better understand potential risks (American Lung Association, 2019). In January 2018, The National Academies of Sciences, Engineering, and Medicine released a report on the public health consequences of e-cigarettes. The report presented 47 conclusions from a review of 800 studies and concluded that using e-cigarettes causes health risks. E-cigarettes contain and emit a number of potentially toxic substances such as propylene glycol, acetaldehyde, acrolein, and formaldehyde, among others. Acrolein, also used as a weed killer, is known to cause acute lung injury, COPD, asthma, and lung cancer. Additionally, e-cigarette use is associated with an increased risk for cough, wheeze, and asthma exacerbations in adolescents (The National Academies of Sciences, Engineering, and Medicine, 2018). Differences in socioeconomic factors, rooted in race and ethnicity, may predispose certain groups to greater burdens related to lung disease and should also be considered ([Chart 17-9](#)).

Chart 17-6 ASSESSMENT

Assessing Psychosocial Factors Related to Respiratory Function and Disease

- What strategies does the patient use to cope with the signs, symptoms, and challenges associated with pulmonary disease?
- What effect has the pulmonary disease had on the patient's quality of life, goals, role within the family, and occupation?
- What changes has the pulmonary disease had on the patient's family and relationships with family members?
- Does the patient exhibit depression, anxiety, anger, hostility, dependency, withdrawal, isolation, avoidance, nonadherence, acceptance, or denial?
- What support systems does the patient use to cope with the illness?
- Are resources (relatives, friends, or community groups) available? Do the patient and the family use them effectively?

Chart 17-7 RISK FACTORS

Respiratory Disease

- Atypical immune responses in disease (e.g., asthma)
- Exposure to indoor pollutants (e.g., tobacco smoke, radon gas)
- Exposure to outdoor pollutants (e.g., smog, vehicle exhaust emissions, pollen)
- Genetic makeup
- Infection (e.g., influenza, pneumonia)
- Obesity
- Personal or family history of lung disease
- Smoking (e.g., cigarettes, e-cigarettes)

Adapted from American Lung Association. (2019). Protecting your lungs: Tips to keep your lungs healthy. Retrieved on 12/22/2019 at: www.lung.org/lung-health-and-diseases/protecting-your-lungs

If the patient is experiencing severe dyspnea, the nurse may need to modify the questions asked and the timing of the health history to avoid increasing the patient's breathlessness and anxiety. Once the history is complete, the nurse conducts a comprehensive assessment. Data obtained from both the history and the assessment guide the development of a nursing care plan and patient education.

Chart 17-8



GENETICS IN NURSING PRACTICE

Respiratory Disorders

Various conditions that affect gas exchange and respiratory function are influenced by genetic factors. Some are known to have a direct inherited pathway while others have a strong familial association, but the exact inheritance pattern is not entirely clear. The following are examples of respiratory disorders with a known or associated familial component:

- Asthma
- Cystic fibrosis
- Chronic obstructive pulmonary disease
- Alpha₁-antitrypsin deficiency
- Primary ciliary dyskinesia
- Pulmonary fibrosis
- Pulmonary hypertension
- Tuberous sclerosis

Nursing Assessments

Refer to Chapter 4, Chart 4-2: Genetics in Nursing Practice: Genetic Aspects of Health Assessment

Family History Assessment Specific to Genetic Respiratory Disorders

- Assess family history for three generations for family members with histories of respiratory impairment.
- Assess family history for individuals with early-onset chronic pulmonary disease and family history of hepatic disease in infants (clinical symptoms of alpha₁-antitrypsin deficiency).
- Inquire about family history of cystic fibrosis, an autosomal recessive inherited respiratory disorder.

Patient Assessment Specific to Genetic Respiratory Disorders

- Assess for symptoms such as changes in respiratory status and triggers that precede changes in respiratory function
- Frequency of respiratory tract infections or sinus infections
- Determine exposure to environmental risks (e.g., radon, asbestos) or occupational exposures (e.g., coal miner, sandblaster, painter)
- Determine presence of secondary risk factors (e.g., smoking or exposure to secondhand smoke)
- Assess for:
 - Clubbing of fingers
 - Skin color in general or the presence of white patches on the skin
 - Presence of angiofibromas or ungual fibromas (seen with primary ciliary dyskinesia)
- Assess for presence and frequency of:
 - Wheezing or coughing

- Mucous production (frequency, amount, and characteristics of the mucous)
- Mucosal edema
- Assess for multisystem effects (gastrointestinal disorders, pancreatic insufficiency, liver or kidney disorders)

Genetic Resources

American Lung Association, www.lung.org

Cystic Fibrosis Foundation, www.cff.org

COPD Foundation, www.copdfoundation.org

Primary Ciliary Dyskinesia, www.pcdfoundation.org

- See also [Chapter 6, Chart 6-7: Components of Genetic Counseling](#)

Physical Assessment of the Respiratory System

General Appearance

The patient's general appearance may give clues to respiratory status. In particular, the nurse inspects for clubbing of the fingers and notes skin color.

Clubbing of the Fingers

Clubbing of the fingers is a change in the normal nail bed. It appears as sponginess of the nail bed and loss of the nail bed angle ([Fig. 17-7](#)). It is a sign of lung disease that is found in patients with chronic hypoxic conditions, chronic lung infections, or malignancies of the lung. Clubbing can also be seen in congenital heart disease and other chronic infections or inflammatory conditions, such as endocarditis or inflammatory bowel disease (Hogan-Quigley, Palm, & Bickley, 2017).

Cyanosis

Cyanosis, a bluish coloring of the skin, is a very late indicator of hypoxia. The presence or absence of cyanosis is determined by the amount of unoxygenated hemoglobin in the blood. Cyanosis appears when there is at least 5 g/dL of unoxygenated hemoglobin. A patient with a hemoglobin level of 15 g/dL does not demonstrate cyanosis until 5 g/dL of that hemoglobin becomes unoxygenated, reducing the effective circulating hemoglobin to two thirds of the normal level.

Chart 17-9

Disparities in Pulmonary Health Related to Socioeconomics, Race, and Ethnicity: A Snapshot

- Individuals living in rural areas are more likely to use tobacco and be exposed to secondhand smoke at work and at home, to start smoking at a younger age, and to use more than 15 cigarettes daily, yet have less access to smoking cessation programs.
- Individuals with lower income and lower levels of education are more likely to use tobacco products.
- Adults living below the poverty level are more likely to experience severe asthma exacerbations, hospitalizations, and death.
- More Hispanics live and work in areas with greater levels of pollution, have higher prevalence rates of asthma than Caucasians, and yet are less likely to be diagnosed with asthma than all other racial and ethnic groups. Hispanics are less likely than non-Hispanic Whites to receive health insurance as a benefit from an employer.
- African American men are 37% more likely to get lung cancer than Caucasian men even though smoking rates between these two groups are comparable.
- American Indians/Alaska Natives and African Americans are at a higher risk of complications resulting from influenza and pneumonia.
- Death rates for African Americans are 55 percent higher for asthma than among Caucasians.
- Older African Americans and older Hispanics are less likely than older Caucasians to receive influenza vaccines (28% and 24% less, respectively) and pneumonia vaccines (37% and 46%, respectively).

Adapted from American Lung Association. Disparities in lung health series.
Retrieved on 6/23/2019 at: www.lung.org/our-initiatives/research/lung-health-disparities

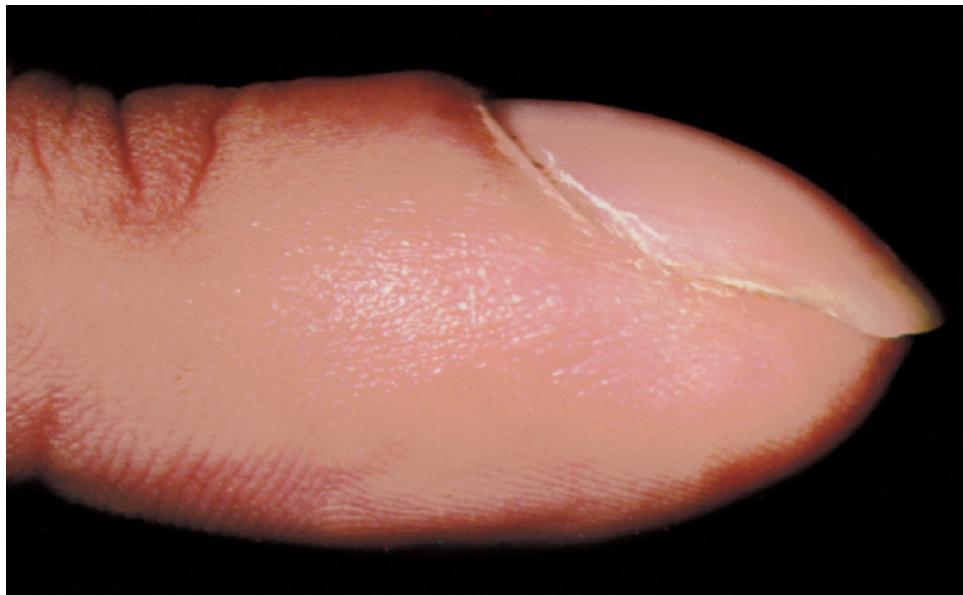


Figure 17-7 • Clubbed finger. In clubbing, the distal phalanx of each finger is rounded and bulbous. The nail plate is more convex, and the angle between the plate and the proximal nail fold increases to 180 degrees or more. The proximal nail fold, when palpated, feels spongy or floating. Among the many causes are chronic hypoxia and lung cancer.

A patient with anemia rarely manifests cyanosis, and a patient with polycythemia may appear cyanotic even if adequately oxygenated. Therefore, cyanosis is *not* a reliable sign of hypoxia.

Assessment of cyanosis is affected by room lighting, the patient's skin color, and the distance of the blood vessels from the surface of the skin. In the presence of a pulmonary condition, central cyanosis is assessed by observing the color of the tongue and lips. This indicates a decrease in oxygen tension in the blood. Peripheral cyanosis results from decreased blood flow to the body's periphery (fingers, toes, or earlobes), as in vasoconstriction from exposure to cold, and does not necessarily indicate a central systemic problem.

Upper Respiratory Structures

For a routine examination of the upper airway, only a simple light source, such as a penlight, is necessary. A more thorough examination requires the use of a nasal speculum.

Nose and Sinuses



The nurse inspects the external nose for lesions, asymmetry, or inflammation and then asks the patient to tilt the head backward. Gently pushing the tip of

the nose upward, the nurse examines the internal structures of the nose, inspecting the mucosa for color, swelling, exudate, or bleeding. The nasal mucosa is normally redder than the oral mucosa. It may appear swollen and hyperemic if the patient has a common cold; however, in allergic rhinitis, the mucosa appears pale and swollen.

Next, the nurse inspects the septum for deviation, perforation, or bleeding. Most people have a slight degree of septal deviation; such deviation usually causes no symptoms. However, actual displacement of the cartilage into either the right or left side of the nose may produce nasal obstruction.

While the head is still tilted back, the nurse inspects the inferior and middle turbinates. In chronic rhinitis, nasal polyps may develop between the inferior and middle turbinates; they are distinguished by their gray appearance. Unlike the turbinates, they are gelatinous and freely movable.

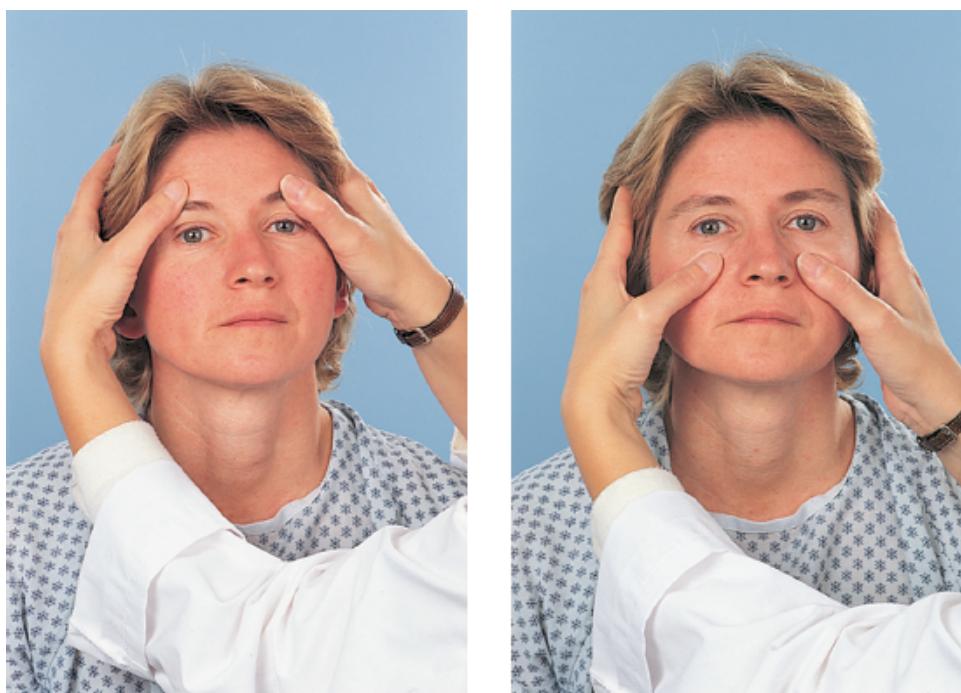


Figure 17-8 • Technique for palpating the frontal sinuses at left and the maxillary sinuses at right.

Next, the nurse may palpate the frontal and maxillary sinuses for tenderness (Fig. 17-8). Using the thumbs, the nurse applies gentle pressure in an upward fashion at the supraorbital ridges (frontal sinuses) and in the cheek area adjacent to the nose (maxillary sinuses). Tenderness in either area suggests inflammation. The frontal and maxillary sinuses can be inspected by transillumination (passing a strong light through a bony area, such as the sinuses, to inspect the cavity; see Fig. 17-9). If the light fails to penetrate, the cavity likely contains fluid or pus.

Mouth and Pharynx



After the nasal inspection, the nurse assesses the mouth and the pharynx, instructing the patient to open the mouth wide and take a deep breath. Usually, this flattens the posterior tongue and briefly allows a full view of the anterior and posterior pillars, tonsils, uvula, and posterior pharynx (see [Chapter 39](#), [Fig. 39-2](#)). The nurse inspects these structures for color, symmetry, and evidence of exudate, ulceration, or enlargement. If a tongue blade is needed to depress the tongue to visualize the pharynx, it is pressed firmly beyond the midpoint of the tongue to avoid a gagging response.



Figure 17-9 • At left, the nurse positions the light source for transillumination of the frontal sinus. At right, the nurse shields the patient's brow and shines the light. In normal conditions (a darkened room), the light should shine through the tissues and appear as a reddish glow (above the nurse's hand) over the sinus.

Trachea

Next, the position and mobility of the trachea are noted by direct palpation. This is performed by placing the thumb and the index finger of one hand on either side of the trachea just above the sternal notch. The trachea is highly sensitive and palpating too firmly may trigger a coughing or gagging response. The trachea is normally in the midline as it enters the thoracic inlet behind the sternum; however, it may be deviated by masses in the neck or the

mediastinum. Pulmonary disorders such as a pneumothorax or pleural effusion may also displace the trachea.

Lower Respiratory Structures and Breathing



Assessment of the lower respiratory structures includes inspection, palpation, percussion, and auscultation of the thorax. The patient should be positioned as necessary prior to the assessment.

Positioning

To assess the posterior thorax and the lungs, the patient should be in a sitting position with arms crossed in front of the chest and hands placed on the opposite shoulders (Hogan-Quigley et al., 2017). This position separates the scapulae widely and exposes more lung area for assessment. If the patient is unable to sit, with the patient supine, the nurse should roll the patient from side to side to complete the posterior examination. To assess the anterior thorax and lungs, the patient should be either supine or sitting. The supine position allows easier displacement of the patient's breast tissue, improving the nurse's ability to perform the chest examination.

Thoracic Inspection

Inspection of the thorax provides information about the respiratory system, the musculoskeletal structure, and the patient's nutritional status. The nurse observes the skin over the thorax for color and turgor and for evidence of loss of subcutaneous tissue. It is important to note asymmetry, if present. In documenting or reporting the findings, anatomic landmarks are used as points of reference ([Chart 17-10](#)).

Chest Configuration

Normally, the ratio of the anteroposterior diameter to the lateral diameter is 1:2. However, there are four main deformities of the chest associated with respiratory disease that alter this relationship: barrel chest, funnel chest (pectus excavatum), pigeon chest (pectus carinatum), and kyphoscoliosis.

Barrel Chest. Barrel chest occurs as a result of overinflation of the lungs, which increases the anteroposterior diameter of the thorax. It occurs with aging and is a hallmark sign of emphysema and COPD. In a patient with emphysema, the ribs are more widely spaced and the intercostal spaces tend to bulge on expiration. The appearance of the patient with advanced emphysema is thus quite characteristic, allowing the nurse to detect its presence easily, even from a distance.

Funnel Chest (Pectus Excavatum). Funnel chest occurs when there is a depression in the lower portion of the sternum. This may compress the heart

and great vessels, resulting in murmurs. Funnel chest may occur with rickets or Marfan syndrome.

Pigeon Chest (Pectus Carinatum). A pigeon chest occurs as a result of the anterior displacement of the sternum, which also increases the anteroposterior diameter. This may occur with rickets, Marfan syndrome, or severe kyphoscoliosis.

Kyphoscoliosis. Kyphoscoliosis is characterized by elevation of the scapula and a corresponding S-shaped spine. This deformity limits lung expansion within the thorax. It may occur with osteoporosis and other skeletal disorders that affect the thorax.

Breathing Patterns and Respiratory Rates

Observation of the rate, depth, and symmetry during respiration is a simple but important aspect of assessment. The normal adult who is at rest comfortably takes 12 to 20 breaths/min (Hogan-Quigley et al., 2017). Except for the occasional sigh, respirations are quiet with a regular rate, depth, and rhythm. The normal pattern associated with breathing is known as eupnea. Certain pathologic conditions may alter the rate and rhythm and are characteristic of certain disease states. For example, wheezing is commonly seen in the patient with asthma. Changes found during the act of breathing may be the first clinical sign that the patient's condition is deteriorating (IHI, 2019). The rate and depth of various patterns of respiration are presented in [Table 17-3](#).



Concept Mastery Alert

There are subtle differences between Cheyne–Stokes and Biot's respiration patterns. Between regularly cycled periods of apnea, Cheyne–Stokes respirations demonstrate a regular pattern with the rate and depth of breathing increasing and then decreasing. In Biot's respiration, irregularly cycled periods of apnea are interspersed with cycles of normal rate and depth.

Temporary pauses of breathing, or **apnea**, may be noted. When episodes of apnea occur repeatedly during sleep, secondary to transient upper airway blockage, the condition is called **obstructive sleep apnea**. In thin people, it is quite normal to note a slight retraction of the intercostal spaces during quiet breathing. Bulging of the intercostal spaces during expiration implies obstruction of expiratory airflow, as in emphysema. Marked retraction on inspiration, particularly if asymmetric, implies blockage of a branch of the respiratory tree. Asymmetric bulging of the intercostal spaces, on either side of the thorax, is created by an increase in pressure within the hemithorax. This may be a result of air trapped under pressure within the pleural cavity, where it is not normally present (pneumothorax), or the pressure of fluid within the pleural space (pleural effusion).

Use of Accessory Muscles

In addition to breathing patterns and respiratory rates, the nurse should observe for the use of accessory muscles, such as the sternocleidomastoid, scalene, and trapezius muscles during inspiration, and the abdominal and internal intercostal muscles during expiration. These muscles provide additional support to assist the breathing effort during times of exertion as seen in exercise or certain disease states (Hogan-Quigley et al., 2017).

Chart 17-10

Locating Thoracic Landmarks

With respect to the thorax, location is defined both horizontally and vertically. With respect to the lungs, location is defined by lobe.

Horizontal Reference Points

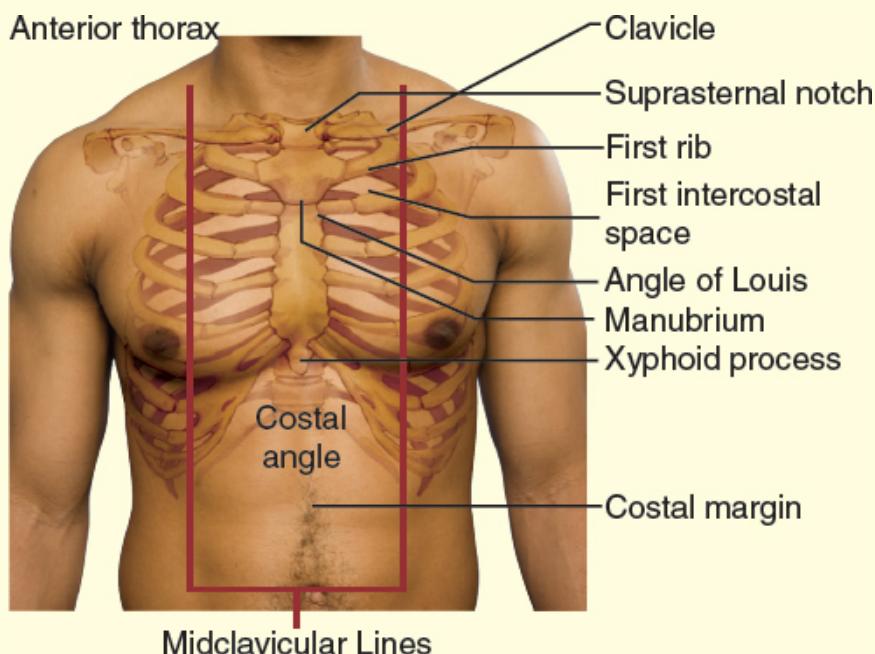
Horizontally, thoracic locations are identified according to their proximity to the rib or the intercostal space under the examiner's fingers. On the anterior surface, identification of a specific rib is facilitated by first locating the angle of Louis. This is where the manubrium joins the body of the sternum in the midline. The second rib joins the sternum at this prominent landmark.

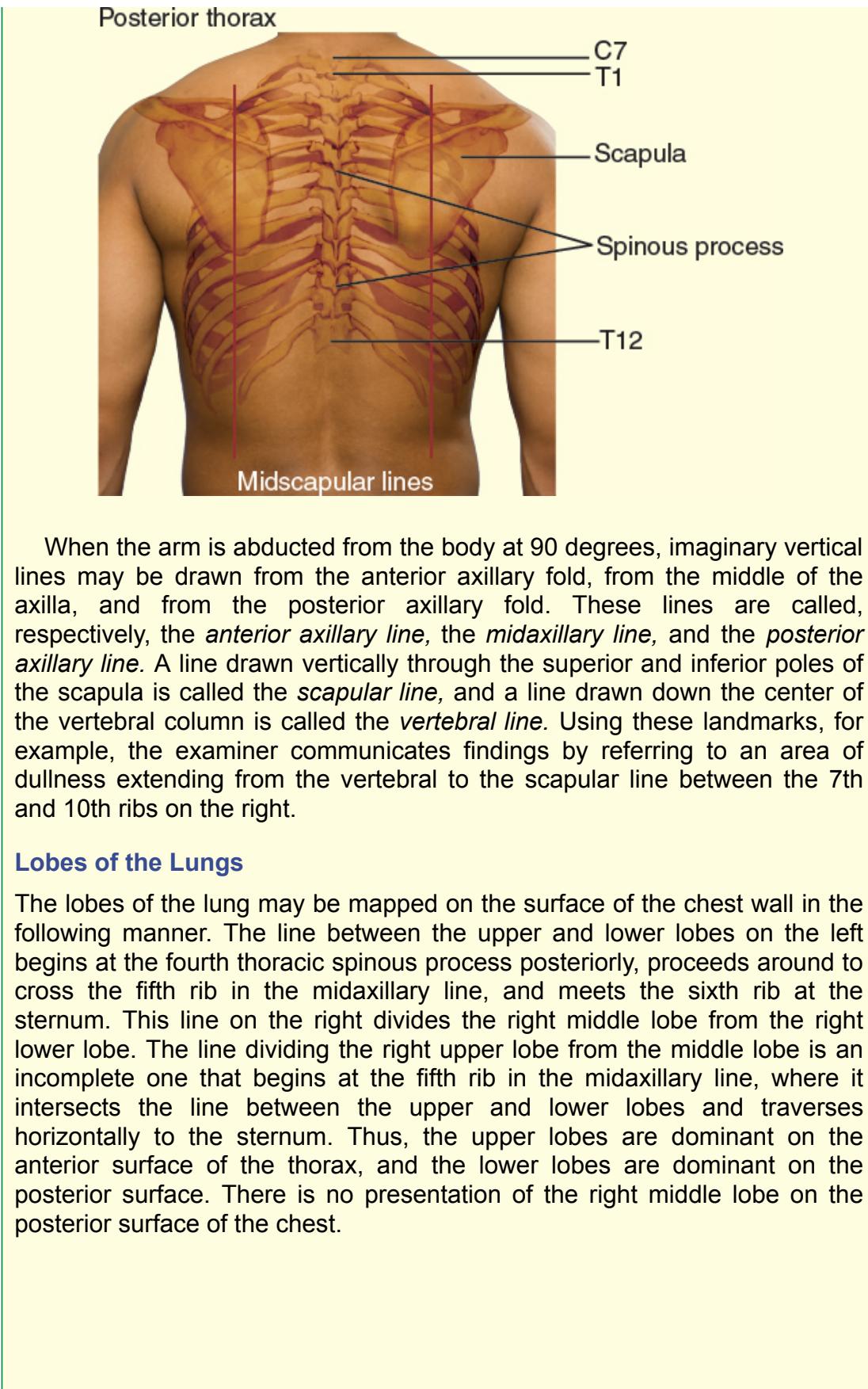
Other ribs may be identified by counting down from the second rib. The intercostal spaces are referred to in terms of the rib immediately above the intercostal space; for example, the fifth intercostal space is directly below the fifth rib.

Locating ribs on the posterior surface of the thorax is more difficult. The first step is to identify the spinous process. This is accomplished by finding the seventh cervical vertebra (*vertebra prominens*), which is the most prominent spinous process. When the neck is slightly flexed, the seventh cervical spinous process stands out. Other vertebrae are then identified by counting downward.

Vertical Reference Points

Several imaginary lines are used as vertical referents or landmarks to identify the location of thoracic findings. The *midsternal line* passes through the center of the sternum. The *midclavicular line* is an imaginary line that descends from the middle of the clavicle. The *point of maximal impulse* of the heart normally lies along this line on the left thorax.





Anterior view of lungs

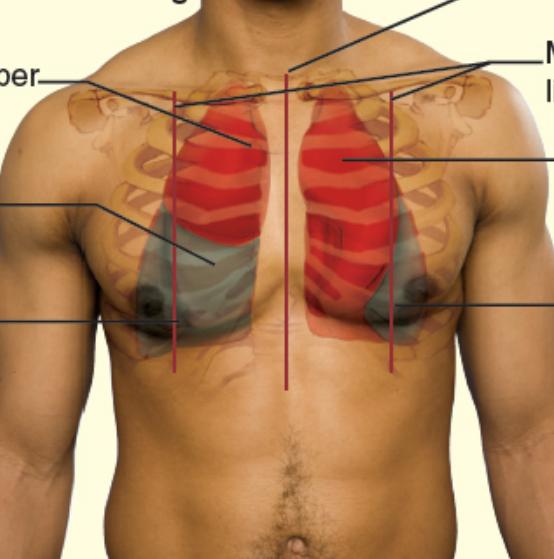


Diagram illustrating the anterior view of the lungs. The lungs are shown in red, with the right lung divided into three lobes: Right upper lobe, Right middle lobe, and Right lower lobe. The left lung is also divided into two lobes: Left upper lobe and Left lower lobe. Vertical red lines indicate anatomical landmarks: Midsternal line (at the sternum), Midclavicular line (at the clavicles), and a vertical line through the midline of the chest.

Right upper lobe
Right middle lobe
Right lower lobe
Midsternal line
Midclavicular line
Left upper lobe
Left lower lobe

Lateral view of lungs

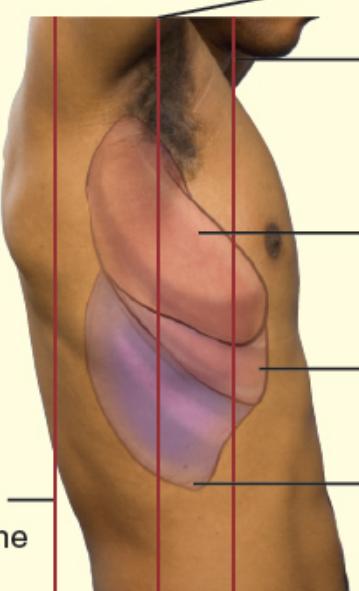
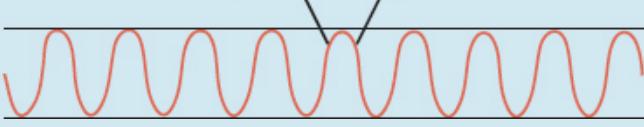
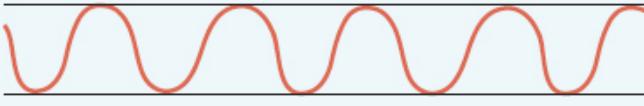
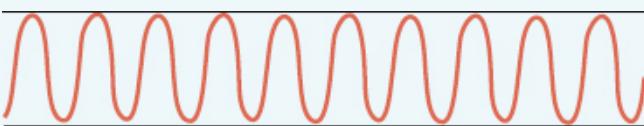
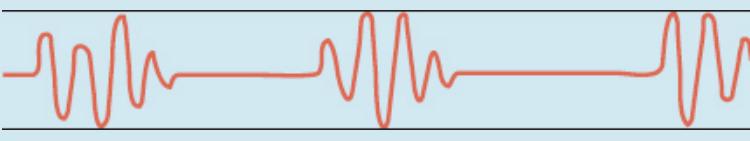
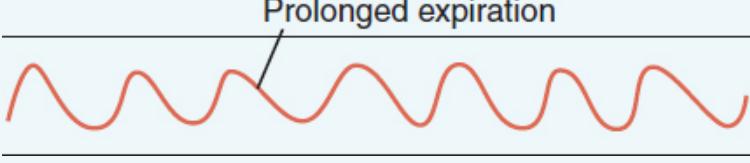


Diagram illustrating the lateral view of the lungs. The lungs are shown in pink and purple, with the right lung divided into three lobes: Right upper lobe, Right middle lobe, and Right lower lobe. Vertical red lines indicate anatomical landmarks: Midaxillary line (at the axilla), Anterior axillary line, and Posterior axillary line. The posterior axillary line is also labeled as the Posterior axillary line.

Midaxillary line
Anterior axillary line
Right upper lobe
Right middle lobe
Right lower lobe
Posterior axillary line

TABLE 17-3 Rates and Depths of Respiration

Type	Description
Eupnea	Normal, breathing at 12–20 breaths/min 
Bradypnea	Slower than normal rate (<10 breaths/min), with normal depth and regular rhythm Associated with increased intracranial pressure, brain injury, and drug overdose 
Tachypnea	Rapid, shallow breathing >24 breaths/min Associated with pneumonia, pulmonary edema, metabolic acidosis, septicemia, severe pain, or rib fracture 
Hypoventilation	Shallow, irregular breathing 
Hyperpnea	Increased depth of respirations, see also hyperventilation 
Hyperventilation	Increased rate and depth of breathing that results in decreased PaCO ₂ level Inspiration and expiration nearly equal in duration Associated with exertion, anxiety, and metabolic acidosis Called <i>Kussmaul's respiration</i> if associated with diabetic ketoacidosis or untreated kidney failure 
Apnea	Period of cessation of breathing; time duration varies; apnea may occur briefly during other

		breathing disorders, such as with sleep apnea; life-threatening if sustained
Cheyne-Stokes		Regular cycle where the rate and depth of breathing increase, then decrease until apnea (usually about 20 s) occurs Duration of apnea may vary and progressively lengthen; therefore, it is timed and reported. Associated with heart failure and damage to the respiratory center (drug induced, tumor, trauma)
Biot's respiration		Periods of normal breathing (3–4 breaths), followed by a varying period of apnea (usually 10–60 s) Also called <i>ataxic breathing</i> ; associated with complete irregularity Associated with respiratory depression resulting from drug overdose and brain injury, normally at the level of the medulla
Obstructive	 Prolonged expiration	Prolonged expiratory phase of respiration Associated with airway narrowing and seen in asthma, chronic obstructive pulmonary disease, and bronchitis

Adapted from Hogan-Quigley, B., Palm, M. L., & Bickley, L. (2017). *Bates' nursing guide to physical examination and history taking* (2nd ed.). Philadelphia, PA: Wolters Kluwer Health Lippincott Williams & Wilkins.

Thoracic Palpation

The nurse palpates the thorax for tenderness, masses, lesions, respiratory excursion, and vocal fremitus. If the patient has reported an area of pain or if

lesions are apparent, the nurse performs direct palpation with the fingertips (for skin lesions and subcutaneous masses) or with the ball of the hand (for deeper masses or generalized flank or rib discomfort).

Respiratory Excursion

Respiratory excursion is an estimation of thoracic expansion and may disclose significant information about thoracic movement during breathing. The nurse assesses the patient for range and symmetry of excursion. For anterior assessment, the nurse places the thumbs along the costal margin of the chest wall and instructs the patient to inhale deeply. The nurse observes movement of the thumbs during inspiration and expiration. This movement is normally symmetric (Hogan-Quigley et al., 2017).

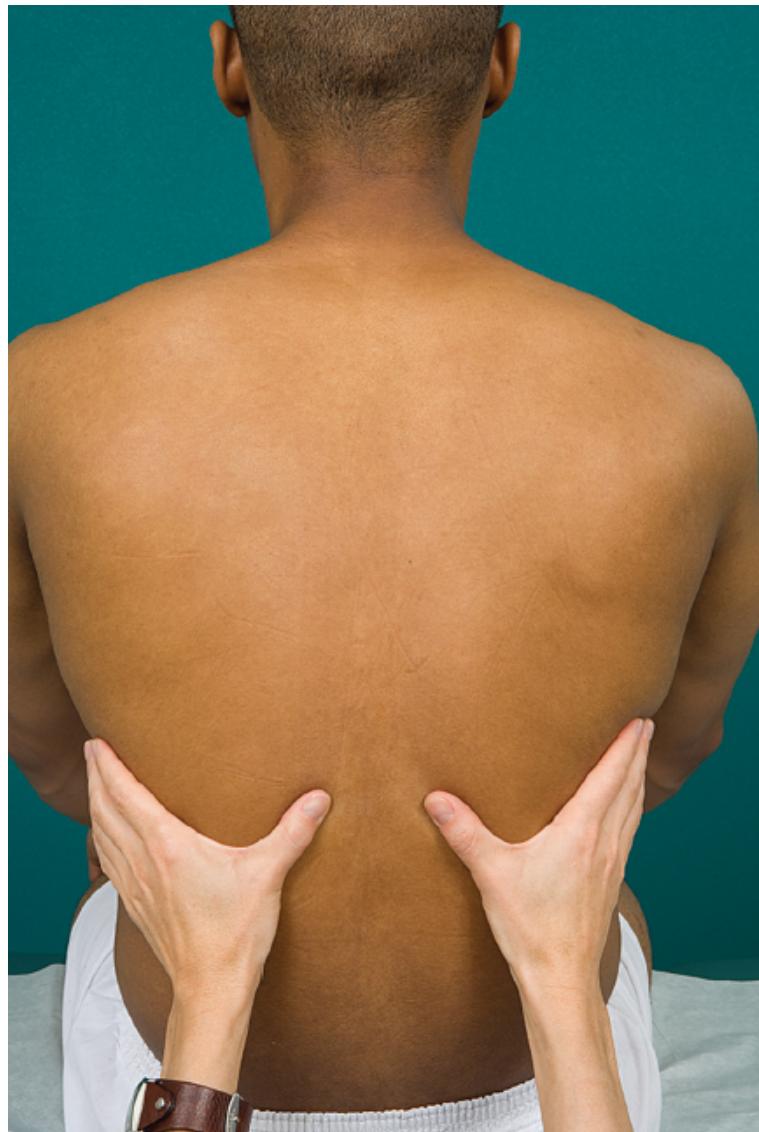


Figure 17-10 • Method for assessing posterior respiratory excursion. Place both hands posteriorly at the level of T9 or T10. Slide hands medially to pinch a small amount of skin between your thumbs. Observe for symmetry as the patient exhales fully following a deep inspiration.

Posterior assessment is performed by placing the thumbs adjacent to the spinal column at the level of the 10th rib (Fig. 17-10). The hands lightly grasp the lateral rib cage. Sliding the thumbs medially about 2.5 cm (1 inch) raises a small skin fold between the thumbs. The patient is instructed to take a full inspiration and to exhale fully. The nurse observes for normal flattening of the skin fold and feels the symmetric movement of the thorax.

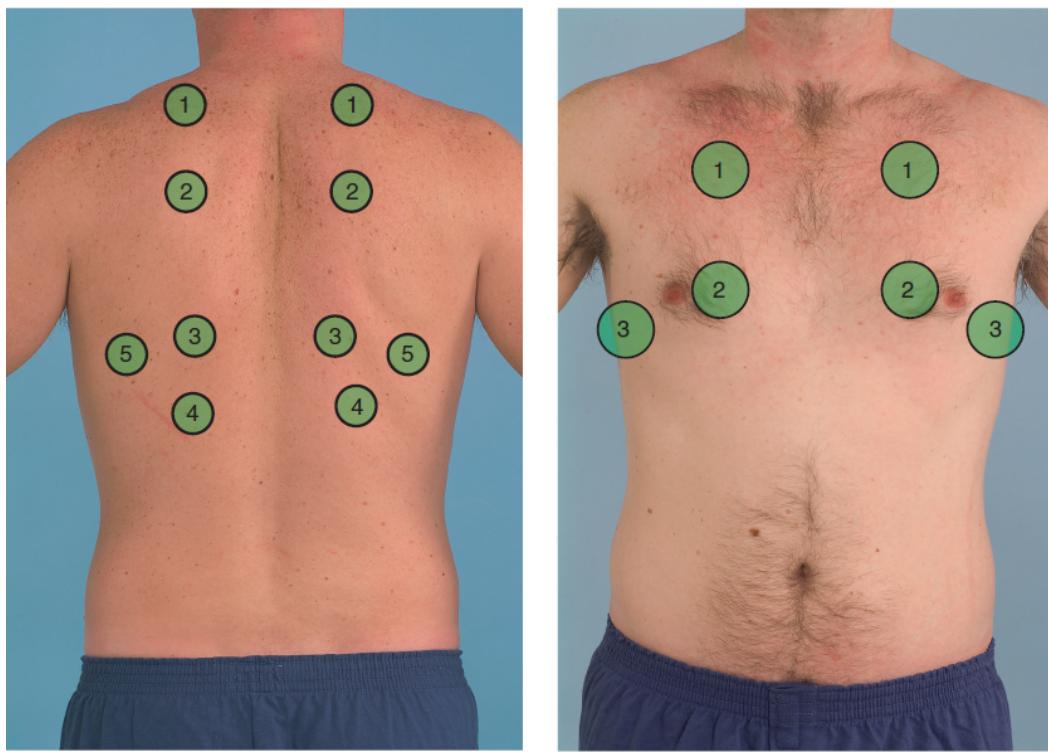


Figure 17-11 • Palpation sequence for tactile fremitus: posterior thorax (**left**) and anterior thorax (**right**).

Decreased chest excursion may be caused by chronic fibrotic disease. Asymmetric excursion may be due to splinting secondary to pleurisy, fractured ribs, trauma, or unilateral bronchial obstruction.

Tactile Fremitus

Tactile fremitus describes vibrations of the chest wall that result from speech detected on palpation. Normally, sounds generated by the larynx travel distally along the bronchial tree to set the chest wall in resonant motion. This is most pronounced with consonant sounds.

Normal fremitus varies on the basis of numerous factors. It is influenced by the thickness of the chest wall, especially muscle, and the subcutaneous tissue associated with obesity. It is also influenced by pitch; lower-pitched sounds travel better through the normal lung and produce greater vibration of the chest wall. Therefore, fremitus is more pronounced in men than in women because of the deeper male voice. Normally, fremitus is most pronounced where the large bronchi are closest to the chest wall, is more prominent on the right side, and is decreased or absent over the anterior chest wall which overlies the heart and great vessels (Hogan-Quigley et al., 2017).

The patient is asked to repeat “ninety-nine” or “one, one, one” as the nurse’s hands move down the patient’s thorax (Hogan-Quigley et al., 2017). The vibrations are detected with the palmar surfaces of the hands, or the ulnar

aspect of the extended hands, on the thorax. The hand or hands are moved in sequence down the thorax. Corresponding areas of the thorax are compared (Fig. 17-11). Bony areas are not assessed.

TABLE 17-4 Characteristics of Percussion Sounds

Sound	Relative Intensity	Relative Pitch	Relative Duration	Location Example	Examples
Flatness	Soft	High	Short	Thigh	Large pleural effusion
Dullness	Medium	Medium	Medium	Liver	Lobar pneumonia
Resonance	Loud	Low	Long	Normal lung	Simple chronic bronchitis
Hyperresonance	Very loud	Lower	Longer	None normally	Emphysema, pneumothorax
Tympany	Loud	High ^a	Medium	Gastric air bubble or puffed-out cheek	Large pneumothorax

^aDistinguished mainly by its musical timbre.

Adapted from Hogan-Quigley, B., Palm, M. L., & Bickley, L. (2017). *Bates' nursing guide to physical examination and history taking* (2nd ed.). Philadelphia, PA: Wolters Kluwer Health Lippincott Williams & Wilkins.

Air does not conduct sound well; however, a solid substance such as tissue does, provided that it has elasticity and is not compressed. Therefore, an increase in solid tissue per unit volume of lung enhances fremitus, and an increase in air per unit volume of lung impedes sound. Patients with emphysema exhibit almost no tactile fremitus. A patient with consolidation of a lobe of the lung from pneumonia has increased tactile fremitus over that lobe.

Thoracic Percussion

Percussion produces audible and tactile vibration and allows the nurse to determine whether underlying tissues are filled with air, fluid, or solid material. Healthy lung tissue is resonant. Dullness over the lung occurs when air-filled lung tissue is replaced by fluid or solid tissue. Table 17-4 reviews percussion sounds and their characteristics. Percussion is also used to estimate the size and location of certain structures within the thorax (e.g., diaphragm, heart, liver).

Percussion usually begins with the posterior thorax. The nurse percusses across each shoulder top, locating the 5-cm width of resonance overlying the lung apices (Fig. 17-12). Then the nurse proceeds down the posterior thorax, percussing symmetric areas at intervals of 5 to 6 cm (2 to 2.5 inches). To perform percussion, the middle finger of the nondominant hand is firmly placed against the area of the chest wall to be percussed. The distal interphalangeal joint of this finger is struck with the tip of the middle finger of the dominant hand. This finger is partially flexed, and percussion occurs in a smooth, dartlike fashion. Bony structures (scapulae or ribs) are not percussed.

To perform percussion over the anterior chest, the nurse begins in the supraclavicular area and proceeds downward, from one intercostal space to the next. Dullness noted to the left of the sternum between the third and fifth intercostal spaces is a normal finding, because that is the location of the heart.

Similarly, there is a normal span of liver dullness below the lung at the right costal margin (Hogan-Quigley et al., 2017).

Diaphragmatic Excursion

The normal resonance of the lung stops at the diaphragm. The position of the diaphragm is different during inspiration and expiration.

To assess the position and motion of the diaphragm, the nurse instructs the patient to take a deep breath and hold it while the maximal descent of the diaphragm is percussed. The point at which the percussion note at the midscapular line changes from resonance to dullness is marked with a pen. The patient is then instructed to exhale fully and hold it while the nurse again percusses downward to the dullness of the diaphragm. This point is also marked. The distance between the two markings indicates the range of motion of the diaphragm.

Maximal excursion of the diaphragm may be as much as 8 to 10 cm (3 to 4 inches) in healthy, tall young men, but for most people, it is usually 5 to 7 cm (2 to 2.75 inches). Normally, the diaphragm is about 2 cm (0.75 inch) higher on the right because of the location of the liver. Decreased diaphragmatic excursion may occur with pleural effusion. Atelectasis, diaphragmatic paralysis, or pregnancy may account for a diaphragm that is positioned high in the thorax (Hogan-Quigley et al., 2017).

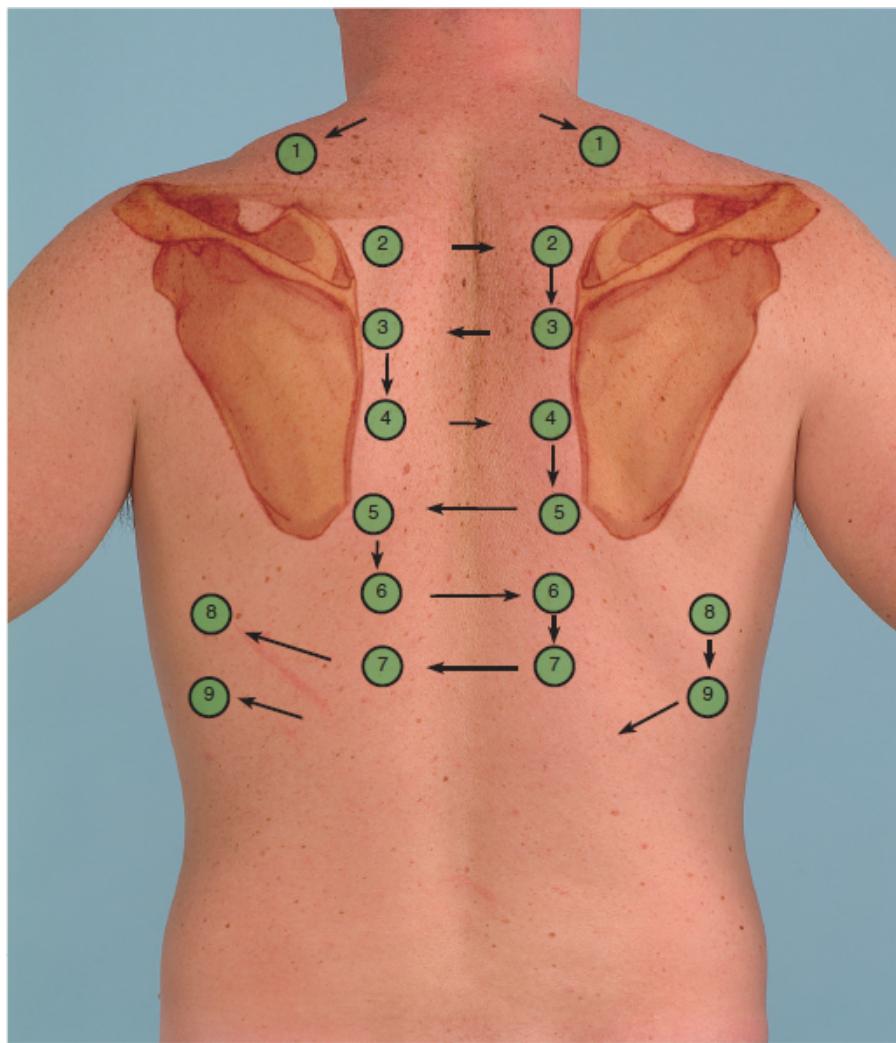


Figure 17-12 • Percussion of the posterior thorax. With the patient in a sitting position, symmetric areas of the lungs are percussed at 5-cm intervals. This progression starts at the apex of each lung and concludes with percussion of each lateral chest wall.

Thoracic Auscultation

Assessment concludes with auscultation of the anterior, posterior, and lateral thorax. Auscultation helps the nurse assess the flow of air through the bronchial tree and evaluate the presence of fluid or solid obstruction in the lung. The nurse auscultates for normal breath sounds, adventitious sounds, and voice sounds.

The nurse places the diaphragm of the stethoscope firmly against the bare skin of the chest wall as the patient breathes slowly and deeply through the mouth. Corresponding areas of the chest are auscultated in a systematic fashion from the apices to the bases and along midaxillary lines. The sequence of auscultation is similar to that used for percussion. The nurse may need to

listen to two full inspirations and expirations at each anatomic location for valid interpretation of the sound heard. Repeated deep breaths may result in symptoms of hyperventilation (e.g., lightheadedness); this is avoided by having the patient rest and breathe normally periodically during the examination.

Breath Sounds



Normal breath sounds are distinguished by their location over a specific area of the lung and are identified as vesicular, bronchovesicular, and bronchial (tubular) breath sounds ([Table 17-5](#)).

The location, quality, and intensity of breath sounds are determined during auscultation. When airflow is decreased by bronchial obstruction (atelectasis) or when fluid (pleural effusion) or tissue (obesity) separates the air passages from the stethoscope, breath sounds are diminished or absent. For example, the breath sounds of the patient with emphysema are faint or often completely inaudible. When they are heard, the expiratory phase is prolonged. In the patient with obesity, breath sounds may be inaudible. Bronchial and bronchovesicular sounds that are audible anywhere except over the main bronchus in the lungs signify pathology, usually indicating consolidation in the lung (e.g., pneumonia, heart failure). This finding requires further evaluation.

Adventitious Sounds

An abnormal condition that affects the bronchial tree and alveoli may produce adventitious (additional) sounds. Some adventitious sounds are divided into two categories: **crackles**, or nonmusical, discontinuous sounds; and **wheezes**, or continuous musical sounds ([Table 17-6](#)). **Rhonchi**, a type of wheezing, are lower-pitched continuous sounds heard over the lungs in partial airway obstruction. Depending on their location and severity, wheezes and rhonchi may be heard with or without a stethoscope. The duration of the sound is the important distinction to make in identifying the sound as discontinuous or continuous. Friction rubs may be either discontinuous or continuous. Stridor is a continuous, high-pitched musical sound which is heard over the neck. This sound is caused by an interruption of airflow and indicates a narrowing of the upper respiratory tract. Stridor warrants emergent attention.

Voice Sounds

The sound heard through the stethoscope as the patient speaks is known as vocal resonance. The nurse should assess voice sounds when abnormal breath sounds are auscultated. The vibrations produced in the larynx are transmitted to the chest wall as they pass through the bronchi and alveolar tissue. Voice sounds are evaluated by having the patient repeat “ninety-nine” or “eee” while the nurse listens with the stethoscope in corresponding areas of the chest from the apices to the bases. With normal physiology, the sounds are faint and indistinct. Pathology that increases lung density, such as pneumonia and

pulmonary edema, alters this normal physiologic response and may result in the following sounds:

- **Bronchophony** describes vocal resonance that is more intense and clearer than normal.
- **Egophony** describes voice sounds that are distorted. It is best appreciated by having the patient repeat the letter E. The distortion produced by consolidation transforms the sound into a clearly heard A rather than E.

TABLE 17-5 Breath Sounds

	Duration of Sounds	Intensity of Expiratory Sound	Pitch of Expiratory Sound	Locations Where Heard Normally
Vesicular ^a 	Inspiratory sounds last longer than expiratory ones.	Soft	Relatively low	Entire lung field except over the upper sternum and between the scapulae
Bronchovesicular 	Inspiratory and expiratory sounds are about equal.	Intermediate	Intermediate	Often in the first and second interspaces anteriorly and between the scapulae (over the main bronchus)
Bronchial 	Expiratory sounds last longer than inspiratory ones.	Loud	Relatively high	Over the manubrium, if heard at all
Tracheal 	Inspiratory and expiratory sounds are about equal.	Very loud	Relatively high	Over the trachea in the neck

^aThe thickness of the bars indicates intensity of breath sounds: The steeper their incline, the higher the pitch of the sounds.

Adapted from Hogan-Quigley, B., Palm, M. L., & Bickley, L. (2017). *Bates' nursing guide to physical examination and history taking* (2nd ed.). Philadelphia, PA: Wolters Kluwer Health Lippincott Williams & Wilkins.

TABLE 17-6 Abnormal (Adventitious) Breath Sounds

Breath Sound	Description	Etiology
Crackles		
Crackles in general	Nonmusical, discontinuous popping sounds that occur during inspiration (while usually heard on inspiration, they may also be heard on expiration); may or may not be cleared by coughing	Secondary to fluid in the airways or alveoli or to delayed opening of collapsed alveoli during inspiration Associated with heart failure and pulmonary fibrosis
Coarse crackles	Discontinuous popping sounds heard in early inspiration and throughout expiration; harsh, moist sound originating in the large bronchi; can be heard over any lung region; do not vary with body position	Associated with obstructive pulmonary disease
Fine crackles	Soft, high-pitched, discontinuous popping sounds heard in mid to late inspiration; sounds like hair rubbing together; originates in the alveoli, especially in dependent areas; may vary with body position	Associated with interstitial pneumonia, restrictive pulmonary disease (e.g., fibrosis); fine crackles in early inspiration are associated with bronchitis or pneumonia
Wheezes		
Wheezes in general	Continuous, musical, high-pitched, shrill sound usually heard on expiration but may be heard on inspiration depending on the cause	Associated with bronchial wall oscillation and narrowed airway diameter or partially obstructed airway Associated with chronic bronchitis or bronchiectasis
Rhonchi	Deep, lower-pitched rumbling sounds, snoring quality, heard primarily during expiration; may clear with coughing	Associated with secretions or tumor; variant of a wheeze; caused by air moving through narrowed tracheobronchial passages
Friction Rubs		
Pleural friction rub	Discontinuous, low-pitched, rubbing or grating sound, like two pieces of leather being rubbed together (sound imitated by rubbing thumb and finger together near the ear) Heard during inspiration and expiration May subside when patient holds breath; coughing will not clear sound Best heard in axillae and bases of lungs	Secondary to inflammation and loss of lubricating pleural fluid between the visceral and parietal pleurae
Other Breath Sounds		
Stridor	Continuous, high-pitched, musical sound, heard over the neck	Narrowing of the upper respiratory tract; immediate

Adapted from Hogan-Quigley, B., Palm, M. L., & Bickley, L. (2017). *Bates' nursing guide to physical examination and history taking* (2nd ed.). Philadelphia, PA: Wolters Kluwer Health Lippincott Williams & Wilkins.

- **Whispered pectoriloquy** describes the ability to clearly and distinctly hear whispered sounds that should not normally be heard.

Whenever an abnormality is detected on examination, it should be evident using more than one assessment method. A change in tactile fremitus is more subtle and can be missed, but bronchophony can be noted loudly and clearly.

Interpreting Findings

The physical findings for the most common respiratory diseases are summarized in [Table 17-7](#).



Assessment of Respiratory Function in the Patient Who Is Acutely or Critically Ill

Assessment of respiratory status is essential for the well-being of the patient who is acutely or critically ill. Often, such a patient is intubated and receiving mechanical ventilation. The nurse analyzes findings from the health history and assessment while considering laboratory and diagnostic test results. After checking the ventilator settings to make sure that they are set as prescribed and that alarms are always in the “on” position, the nurse must assess for patient–ventilator synchrony and for agitation, restlessness, and other signs of respiratory distress (nasal flaring, excessive use of intercostals and accessory muscles, uncoordinated movement of the chest and abdomen, and a report by the patient of shortness of breath). The nurse must note changes in the patient’s vital signs and evidence of hemodynamic instability and report them to the primary provider, because they may indicate that the mechanical ventilation is ineffective or that the patient’s status has deteriorated. It is important for the nurse to position the patient to promote adequate oxygenation and ventilation and to prevent potential complications. For example, the patient may need to be positioned with the head of bed elevated to prevent aspiration, especially if the patient is receiving enteral feedings. Alternatively, in patients with ARDS who are experiencing refractory hypoxemia, prone positioning is recommended (see [Chapter 19](#)). In addition, the patient’s mental status should be assessed and compared to previous status. Lethargy and somnolence may be signs of increasing carbon dioxide levels and should not be considered insignificant, even if the patient is receiving sedation or analgesic agents.

Chest auscultation, percussion, and palpation are essential and routine parts of the evaluation of the patient who is critically ill, with or without mechanical

ventilation. A recumbent patient must be turned to assess all lung fields. Dependent areas must be assessed for normal breath sounds and adventitious sounds. Failure to examine the dependent areas of the lungs can result in missing the findings associated with disorders such as atelectasis or pleural effusion.

TABLE 17-7 Assessment Findings in Common Respiratory Disorders

This table lists the typical changes seen in respiratory disorders. The changes described vary with the extent and severity of the disorder. Use the table for the direction of typical changes, not for absolute distinctions.

Condition	Percussion Note	Trachea	Breath Sounds	Adventitious Sounds	Tactile Fremitus and Transmitted Voice Sounds
Normal The tracheobronchial tree and alveoli are open; pleurae are thin and close together; mobility of the chest wall is unimpaired.	Resonant	Midline	Vesicular, except perhaps bronchovesicular and bronchial sounds over the large bronchi and trachea, respectively	None, except perhaps a few transient inspiratory crackles at the bases of the lungs	Normal
Chronic Bronchitis The bronchi are chronically inflamed and a productive cough is present. Airway obstruction may develop.	Resonant	Midline	Vesicular (normal)	None; or scattered coarse crackles in early inspiration and perhaps expiration; or wheezes or rhonchi	Normal
Left-Sided Heart Failure (Early) Increased pressure in the pulmonary veins causes congestion and interstitial edema (around the alveoli); bronchial mucosa may become edematous.	Resonant	Midline	Vesicular	Late inspiratory crackles in the dependent portions of the lungs; possibly wheezes	Normal
Lobar Pneumonia Alveoli fill with fluid or blood cells, as in pneumonia, pulmonary edema, or pulmonary hemorrhage.	Dull over the airless area	Midline	Bronchial over the involved area	Late inspiratory crackles over the involved area	Increased over the involved area, with bronchophony, egophony, and whispered pectoriloquy
Partial Lobar Obstruction Atelectasis When a plug in a mainstem bronchus (as from mucus or a foreign object) obstructs bronchial air flow, affected alveoli collapse and become airless.	Dull over the airless area	May be shifted toward involved side	Usually absent when bronchial plug persists. Exceptions include right upper lobe atelectasis, where adjacent tracheal sounds may be transmitted	None	Usually absent when the bronchial plug persists. In exceptions (e.g., right upper lobe atelectasis) may be increased
Pleural Effusion Fluid accumulates in the pleural space and separates air-filled lung from the chest wall, blocking the transmission breath sounds.	Dull to flat over the fluid	Shifted toward the unaffected side in a large effusion	Decreased to absent, but bronchial breath sounds may be heard near top of large effusion	None, except a possible pleural rub	Decreased to absent, but may be increased toward the top of a large effusion
Pneumothorax When air leaks into the pleural space, usually unilaterally, the lung recoils away from the chest wall. Pleural air blocks transmission of sound.	Hyperresonant or tympanic over the pleural air	Shifted toward the unaffected side if tension pneumothorax	Decreased to absent over the pleural air	None, except a possible pleural rub	Decreased to absent over the pleural air
Chronic Obstructive Pulmonary Disease (COPD) Slowly progressive disorder in which the distal airspaces enlarge and lungs become hyperinflated. Chronic inflammation may precede or follow the development of COPD.	Diffusely hyperresonant	Midline	Decreased to absent with delayed expiration	None, or the crackles, wheezes, and rhonchi of associated chronic bronchitis	Decreased
Asthma Widespread usually reversible airflow obstruction with bronchial hyperresponsiveness and underlying inflammation. During attacks, as air flow decreases lungs hyperinflate.	Resonant to diffusely hyperresonant	Midline	Often obscured by wheezes	Wheezes, possibly crackles	Decreased

Reprinted with permission from Hogan-Quigley, B., Palm, M. L., & Bickley, L. (2017). *Bates' nursing guide to physical examination and history taking table* (2nd ed., Table 13-8). Philadelphia, PA: Wolters Kluwer.

Tests of the patient's respiratory status are easily performed at the bedside by measuring the respiratory rate, end-tidal carbon dioxide (ETCO_2), tidal volume, minute ventilation, vital capacity, inspiratory force, and compliance. These tests are particularly important for patients who are at risk for pulmonary complications, including those who have undergone chest or abdominal surgery, have had prolonged anesthesia, or have preexisting pulmonary disease, and those who are older or have obesity. These tests are also used routinely for patients who are mechanically ventilated. Although some of these tests are performed by respiratory therapists, it is useful for nurses to understand the significance of these test results.

The patient whose chest expansion is limited by external restrictions such as obesity or abdominal distention, or who cannot breathe deeply because of postoperative pain, sedation, or drug overdose will inhale and exhale a low volume of air (referred to as low tidal volumes). Prolonged hypoventilation at low tidal volumes can produce alveolar collapse (atelectasis). Consequently, when the forced residual capacity decreases, compliance is reduced, and the patient must breathe faster to maintain the same degree of tissue oxygenation. These events can be exaggerated in patients who have preexisting pulmonary diseases; in older adult patients whose airways are less compliant because the small airways may collapse during expiration; or in patients with obesity or who have relatively low tidal volumes even when healthy. (More details of the assessment of the patient with various lung disorders are described in subsequent chapters in this unit.)



Quality and Safety Nursing Alert

The nurse should not rely only on visual inspection of the rate and depth of a patient's respiratory excursions to determine the adequacy of ventilation. Respiratory excursions may appear normal or exaggerated due to an increased work of breathing, but the patient may actually be moving only enough air to ventilate the dead space. If there is any question regarding adequacy of ventilation, the nurse should use auscultation or pulse oximetry (or both) for additional assessment of respiratory status.

Tidal Volume

The volume of each breath is referred to as the **tidal volume** (see [Table 17-1](#) to review lung capacities and volumes). A spirometer is an instrument that can be used at the bedside to measure volumes. If the patient is breathing through an endotracheal (ET) tube or tracheostomy, the spirometer is directly attached to it and the exhaled volume is obtained from the reading on the gauge. In other

patients, the spirometer is attached to a facemask or a mouthpiece positioned so that it is airtight, and the exhaled volume is measured.

The tidal volume may vary from breath to breath. To ensure that the measurement is reliable, it is important to measure the volumes of several breaths and to note the range of tidal volumes, together with the average tidal volume.

Minute Ventilation

Because respiratory rates and tidal volumes vary widely from breath to breath, these data alone are unreliable indicators of adequate ventilation. However, the tidal volume multiplied by the respiratory rate provides what is called *minute ventilation* or *minute volume*, the volume of air exchanged per minute. This value is useful in detecting respiratory failure. In practice, the minute volume is not calculated but is measured directly using a spirometer. In a patient receiving mechanical ventilation, minute volume is often monitored by the ventilator and can be viewed on the monitoring screen.

Minute ventilation may be decreased by a variety of conditions that result in hypoventilation. When the minute ventilation falls, alveolar ventilation in the lungs also decreases and the PaCO₂ increases.

Vital Capacity

Vital capacity is measured by having the patient take in a maximal breath and exhale fully through a spirometer. The normal value depends on the patient's age, gender, body build, and weight.



Quality and Safety Nursing Alert

Most patients can generate a vital capacity twice the volume they normally breathe in and out (tidal volume). If the vital capacity is less than 10 mL/kg, the patient will be unable to sustain spontaneous ventilation and will require respiratory assistance.

When the vital capacity is exhaled at a maximal flow rate, the forced vital capacity (FVC) is measured. Most patients can exhale at least 80% of their vital capacity in 1 second (forced expiratory volume in 1 second, or FEV₁) and almost all of it in 3 seconds (FEV₃). A reduction in FEV₁ suggests abnormal pulmonary airflow. If the patient's FEV₁ and FVC are proportionately reduced, maximal lung expansion is restricted in some way. If the reduction in FEV₁ greatly exceeds the reduction in FVC (FEV₁/FVC less than 85%), the patient may have some degree of airway obstruction.

Inspiratory Force

Inspiratory force evaluates the effort the patient is making during inspiration. It does not require patient cooperation and, therefore, is a useful measurement in the patient who is unconscious. The equipment needed for this measurement includes a manometer that measures negative pressure and adapters that are connected to an anesthesia mask or a cuffed ET tube. The manometer is attached, and the airway is completely occluded for 10 to 20 seconds while the inspiratory efforts of the patient are registered on the manometer. The normal inspiratory pressure is about 100 cm H₂O. If the negative pressure registered after 15 seconds of occluding the airway is less than about 25 cm H₂O, mechanical ventilation is usually required because the patient lacks sufficient muscle strength for deep breathing or effective coughing.

Diagnostic Evaluation

A wide range of diagnostic studies may be performed in patients with respiratory conditions. The nurse should educate the patient on the purpose of the studies, what to expect, and any possible side effects related to these examinations prior to testing. The nurse should note trends in results because they provide information about disease progression as well as the patient's response to therapy.

Pulmonary Function Tests

Pulmonary function tests (PFTs) are routinely used in patients with chronic respiratory disorders to aid diagnosis. They are performed to assess respiratory function and to determine the extent of dysfunction, response to therapy, and as screening tests in potentially hazardous industries, such as coal mining and those that involve exposure to asbestos and other noxious irritants. PFTs are also used prior to surgery to screen patients who are scheduled for thoracic and upper abdominal surgical procedures, patients who are obese, and symptomatic patients with a history suggesting high risk. Such tests include measurements of lung volumes, ventilatory function, and the mechanics of breathing, diffusion, and gas exchange.

PFTs generally are performed by a respiratory therapist using a spirometer that has a volume-collecting device attached to a recorder that demonstrates volume and time simultaneously. Several tests are carried out because no single measurement provides a complete picture of pulmonary function. The most frequently used PFTs are described in [Table 17-8](#). Technology is available that allows for more complex assessment of pulmonary function. Methods include exercise tidal flow-volume loops, negative expiratory pressure, nitric oxide, forced oscillation, and diffusing capacity for helium or

carbon monoxide. These assessment methods allow for detailed evaluation of expiratory flow limitations and airway inflammation (Pagana, Pagana, & Pagana, 2017).

PFT results are interpreted on the basis of the degree of deviation from normal, taking into consideration the patient's height, weight, age, gender, and ethnicity. Because there is a wide range of normal values, PFTs may not detect early localized changes. The patient with respiratory symptoms usually undergoes a complete diagnostic evaluation, even if the results of PFTs are "normal." Patients with respiratory disorders may be taught how to measure their peak flow rate (which reflects maximal expiratory flow) at home using a spirometer. This allows them to monitor the progress of therapy, to alter medications and other interventions as needed on the basis of caregiver guidelines, and to notify the primary provider if there is inadequate response to their own interventions. (Instructions for home care education are described in [Chapter 20](#), which discusses asthma.)

TABLE 17-8 Pulmonary Function Tests

Term Used	Symbol	Description	Remarks
Forced vital capacity	FVC	Vital capacity performed with a maximally forced expiratory effort	Forced vital capacity is often reduced in chronic obstructive pulmonary disease because of air trapping
Forced expiratory volume (qualified by subscript indicating the time interval in seconds)	FEV _t (usually FEV ₁)	Volume of air exhaled in the specified time during the performance of forced vital capacity; FEV ₁ is volume exhaled in 1 s	A valuable clue to the severity of the expiratory airway obstruction
Ratio of timed forced expiratory volume to forced vital capacity	FEV _t /FVC%, usually FEV ₁ /FVC%	FEV _t expressed as a percentage of the forced vital capacity	Another way of expressing the presence or absence of airway obstruction
Forced expiratory flow	FEF _{200–1200}	Mean forced expiratory flow between 200 and 1200 mL of the FVC	An indicator of large airway obstruction
Forced midexpiratory flow	FEF _{25–75%}	Mean forced expiratory flow during the middle half of the FVC	Slowed in small airway obstruction
Forced end-expiratory flow	FEF _{75–85%}	Mean forced expiratory flow during the terminal portion of the FVC	Slowed in obstruction of smallest airways
Maximal voluntary ventilation	MVV	Volume of air expired in a specified period (12 s) during repetitive maximal effort	An important factor in exercise tolerance

Adapted from Fishbach, F. T., & Fishbach, M. A. (2018). *Fishbach's a manual of laboratory and diagnostic tests* (10th ed.). Philadelphia, PA: Wolters Kluwer.

Arterial Blood Gas Studies

Arterial blood gas (ABG) studies aid in assessing the ability of the lungs to provide adequate oxygen and remove carbon dioxide, which reflects ventilation, and the ability of the kidneys to reabsorb or excrete bicarbonate ions to maintain normal body pH, which reflects metabolic states. ABG levels are obtained through an arterial puncture at the radial, brachial, or femoral artery or through an indwelling arterial catheter. Pain (related to nerve injury or noxious stimulation), infection, hematoma, and hemorrhage are potential

complications that may be associated with obtaining ABGs (Pagana et al., 2017) (see [Chapter 10](#) for discussion of ABG analysis).

Venous Blood Gas Studies

Venous blood gas (VBG) studies provide additional data on oxygen delivery and consumption. VBG levels reflect the balance between the amount of oxygen used by tissues and organs and the amount of oxygen returning to the right side of the heart in the blood. VBG levels can be obtained by drawing blood from the venous circulation; this test is performed to provide an estimation of this balance when the ability to draw ABGs is not feasible. Mixed venous oxygen saturation ($S_{\text{v}}\text{O}_2$) levels, the most accurate indicator of this balance, can be obtained only from blood samples drawn from a pulmonary artery catheter. However, central venous oxygen saturation ($\text{Sc}_{\text{v}}\text{O}_2$) levels, which are measured using blood drawn from a central venous catheter placed in the superior vena cava, closely approximate $S_{\text{v}}\text{O}_2$ levels and are, therefore, useful as an alternative measure in patients without pulmonary artery catheters (Morton, Reck, & Headly, 2018).

Pulse Oximetry

Pulse oximetry, or SpO_2 , is a noninvasive method of continuously monitoring the oxygen saturation of hemoglobin (SaO_2). Although pulse oximetry does not replace blood gas analysis, it is an effective tool to monitor for changes in SaO_2 and can easily be used in the home and various health care settings.

A probe or sensor is attached to the fingertip ([Fig. 17-13](#)), forehead, earlobe, or bridge of the nose. The sensor detects changes in oxygen saturation levels by monitoring light signals generated by the oximeter and reflected by blood pulsing through the tissue at the probe. Normal SpO_2 values are more than 95%. Values less than 90% indicate that the tissues are not receiving enough oxygen, in which case further evaluation is needed. Advantages of pulse oximetry include the ability to obtain rapid results and continuous data using a noninvasive technique. Limitations of pulse oximetry include its inability to detect significant hyperoxemia (excess levels of oxygen), and to measure PaO_2 and ventilation. In order to ensure accurate readings, the nurse should verify correct placement of the probe and decrease or eliminate excess motion (e.g., from patient shivering or movement of the extremity). Readings are unreliable in settings of hypothermia, hemodynamic instability, or low perfusion states (e.g., shock, vasoconstriction, or decreased perfusion of the limb), and when a patient has dark skin or is wearing nail polish. In these situations, analysis of ABGs should be conducted, and when hyperoxemia is suspected, analysis of PaO_2 or PaCO_2 is required (Mechem, 2019).



A



B

Figure 17-13 • Measuring blood oxygenation with pulse oximetry reduces the need for invasive procedures, such as drawing blood for analysis of oxygen levels. **A.** Self-contained digital fingertip pulse oximeter, which incorporates the sensor and the display into one

unit. **B.** Tabletop model with sensor attached. Memory permits tracking heart rate and oxygen saturation over time.

End-Tidal Carbon Dioxide

End-tidal carbon dioxide (ETCO₂) monitoring is a noninvasive method of monitoring partial pressure of carbon dioxide (CO₂) at end exhalation. ETCO₂ monitoring is considered to be a reliable tool for detecting and monitoring life-threatening conditions because it provides immediate information about ventilation, perfusion, and metabolism by determining the concentration of CO₂. Changes in ETCO₂ and the concentration of CO₂ at the end of each breath can help to diagnose or indicate the severity of a disease or the outcome of a treatment. It is now part of the standard of care for all patients receiving general anesthesia, procedural sedation and/or analgesia, and is frequently part of routine monitoring in the prehospital and acute care settings (Krauss, Falk, & Ladde, 2018).

The application of ETCO₂ monitoring can indicate early respiratory depression and impaired airway function sooner than other devices, helping nurses to detect potential complications earlier (Aminiahidashti, Shafiee, Kiasari, et al., 2018). Data are reported as a number (capnometry) or as a number and a waveform (capnography). Capnography uses infrared technology to obtain results and monitors four phases of the respiratory cycle to depict the CO₂ concentrations of each phase.

A capnometry device, such as the colorimetric ETCO₂ detector, is a portable device which contains litmus paper that changes color when exposed to CO₂. An improper ET intubation, for instance with esophageal intubation, will not result in CO₂ exchange and thus the color of the litmus paper will not change (Krauss et al., 2018). ETCO₂ monitoring is the most reliable indicator that an ET tube is placed in the trachea during intubation (Krauss et al., 2018). Some additional indications for ETCO₂ monitoring include continuous monitoring of ET tube placement during patient transport, confirming return of spontaneous circulation with cardiopulmonary resuscitation, determining a prognosis in patients with trauma, and as an early indicator of respiratory compromise (Aminiahidashti et al., 2018; Krauss et al., 2018; Smallwood & Walsh, 2017). The clinician should use caution when interpreting results in patients who are mechanically ventilated with a bag or mask ventilation device, or who have received sodium bicarbonate, or who have ingested carbonated beverages or antacids, as any of these can result in false-positive results (Aminiahidashti et al., 2018).

Cultures

Throat, nasal, and nasopharyngeal cultures can identify pathogens responsible for respiratory infections, such as pharyngitis. Throat cultures are performed in adults with severe or ongoing sore throats accompanied by fever and lymph node enlargement and are most useful in detecting streptococcal infection. Rapid strep tests are now available that can provide results within 15 minutes, often replacing the need for throat cultures. Other sources of infection, such as *Staphylococcus aureus* or *Influenza*, are detected via nasal or nasopharyngeal cultures. Ideally, all cultures should be obtained prior to the initiation of antibiotic therapy. Results usually take between 48 and 72 hours, with preliminary reports available usually within 24 hours. Cultures may be repeated to assess a patient's response to therapy (Pagana et al., 2017).

Sputum Studies

Sputum is obtained for analysis to identify pathogenic organisms and to determine whether malignant cells are present. Periodic sputum examinations may be necessary for patients receiving antibiotics, corticosteroids, and immunosuppressive medications for prolonged periods because these agents are associated with opportunistic infections.

Sputum samples ideally are obtained early in the morning before the patient has had anything to eat or drink. The patient is instructed to clear the nose and the throat and rinse the mouth to decrease contamination of the sputum and not to simply spit saliva into the container. Rather, after taking a few deep breaths, the patient coughs deeply and expectorates sputum from the lungs into a sterile container.

If the patient cannot expel an adequate sputum sample following the above techniques, coughing can be induced by administering an aerosolized hypertonic solution via a nebulizer. Other methods of collecting sputum specimens include endotracheal or transtracheal aspiration or bronchoscopic removal. The nurse should label the specimen and send it to the laboratory as soon as possible to avoid contamination.

Imaging Studies

Imaging studies, including x-rays, computed tomography (CT), magnetic resonance imaging (MRI), and radioisotope or nuclear scanning may be part of any diagnostic workup, ranging from a determination of the extent of infection in sinusitis to tumor growth in cancer.

Chest X-Ray

Normal pulmonary tissue is radiolucent because it consists mostly of air and gases; therefore, densities produced by fluid, tumors, foreign bodies, and other pathologic conditions can be detected by x-ray examination. In the absence of

symptoms, a chest x-ray may reveal an extensive pathologic process in the lungs. The routine chest x-ray consists of two views: the posteroanterior projection and the lateral projection. Chest x-rays are usually obtained after full inspiration because the lungs are best visualized when they are well aerated. In addition, the diaphragm is at its lowest level and the largest expanse of lung is visible. Patients, therefore, need to be able to take a deep breath and hold it without discomfort. Chest x-rays are contraindicated in pregnant women.

Nursing Interventions

The nurse should notify the patient that chest x-rays do not require fasting, nor typically cause pain. However, in order to best visualize the lungs, the patient must be able to take a deep breath and hold it without discomfort, while the technician takes the images. The patient will be positioned in a standing, sitting, or recumbent position, in order to obtain the appropriate view of the chest (posterior–anterior, lateral, oblique, or decubitus position). The patient will be asked to wear a gown, remove metal objects from the chest, such as necklaces, and may be given a lead shield to minimize radiation exposure to the thyroid gland, ovaries, or testicles (Pagana et al., 2017).

Computed Tomography

A CT of the chest is an imaging method in which the lungs, mediastinum, and vascular structures within the chest are scanned in successive layers by a narrow-beam x-ray. The images produced provide a cross-sectional view of the chest. Whereas a chest x-ray shows major contrasts between body densities such as bone, soft tissue, and air, a CT scan can distinguish fine tissue density. A CT scan may be used to define pulmonary nodules and small tumors adjacent to pleural surfaces that are not visible on routine chest x-rays and to demonstrate mediastinal abnormalities and hilar adenopathy, which are difficult to visualize with other techniques. Contrast agents are useful when evaluating the mediastinum and its contents, particularly its vasculature. CT with contrast agent is not suitable for patients with compromised kidney function, or those with an allergy to iodine dye or shellfish, or who are pregnant, claustrophobic, or have severe obesity. Patients taking metformin should withhold the dose the day of the test in order to prevent lactic acidosis from developing (Pagana et al., 2017; Thompson & Kabrheil, 2018).

Advancements in CT scanning technology, referred to as multidetection, spiral, or helical CT, enable the chest to be scanned quickly while generating an extensive number of images that can generate a three-dimensional analysis (Pagana et al., 2017).

Nursing Interventions

The nurse should inform patients preparing for CT scans that they will be required to remain supine and still for a short period, typically less than 30 minutes, while a body scanner surrounds them and takes multiple images. Patients typically do not experience claustrophobia during CT scanning but can be given antianxiety medications preprocedure if this is a concern. If contrast agent is required, patients will need to stay *nil per os* (NPO) for 4 hours prior to the examination. In this case, the nurse should also assess for allergies to iodine or shellfish (Pagana et al., 2017). Vital signs should be monitored and documented before, during, and after the scan especially if sedation or analgesia is administered.

Pulmonary Angiography

Pulmonary angiography is used to investigate congenital abnormalities of the pulmonary vascular tree, and less frequently PE, when less invasive tests are inconclusive. This study has primarily been replaced by CT scan of the chest. To visualize the pulmonary vessels, a radiopaque agent is injected through a catheter, which has been initially inserted into a vein (e.g., jugular, subclavian, brachial, or femoral vein) and then threaded into the pulmonary artery. Contraindications include allergy to the radiopaque agent, pregnancy, and bleeding abnormalities, whereas potential complications include acute kidney injury, acidosis, cardiac arrhythmias, and bleeding (Pagana et al., 2017).

CT pulmonary angiography (CTPA) combines pulmonary angiography and CT scan imaging. CTPA images the pulmonary arteries and is used primarily if treatment is required for a PE. This procedure typically takes no longer than 30 minutes to complete (Pagana et al., 2017). The patient lies in a supine position on an x-ray table. A catheter is placed in the femoral vein, advanced into the inferior vena cava and into the pulmonary artery. Contrast agent and fluoroscopy are utilized for visualization of the pulmonary vasculature when CTPA is performed. The same contraindications for CT with contrast agent apply to CTPA (Pagana et al., 2017; Thompson & Kabrhel, 2018).

Nursing Interventions

Prior to the angiography, the nurse should verify that informed consent has been obtained; assess for known allergies that may suggest allergies to radiopaque agent (e.g., iodine and shellfish); assess anticoagulation status and renal function; ensure that the patient has not eaten or had anything to drink preprocedurally as prescribed (normally for 4 hours); and administer preprocedure medications that may include antianxiety medications, secretion-reducing agents, and antihistamines (Pagana et al., 2017). The nurse should instruct patients that they may experience a warm flushing sensation or chest pain during the injection of the dye. If an arterial puncture is necessary, the affected extremity will need to be immobilized for a certain amount of time depending on the size of the sheath used and the type of arterial closure device

employed. Introduction of the catheter into the right ventricle may trigger ventricular irritability. Therefore, during and after the procedure, the patient should be monitored for cardiac arrhythmias such as premature ventricular contractions (PVCs). Following the procedure, the nurse should closely monitor vital signs, level of consciousness, oxygen saturation, and the vascular access site for bleeding or hematoma, and perform frequent assessment of neurovascular status. It may be indicated to apply cold compresses to the puncture site to decrease swelling (Pagana et al., 2017).

Magnetic Resonance Imaging

MRI is similar to a CT scan except that magnetic fields and radiofrequency signals are used instead of radiation. MRI is able to better distinguish between normal and abnormal tissues than CT and, therefore, yields a much more detailed diagnostic image. MRI is used to characterize pulmonary nodules; to help stage bronchogenic carcinoma (assessment of chest wall invasion); and to evaluate inflammatory activity in interstitial lung disease, acute PE, and chronic thromboembolic pulmonary hypertension. Contraindications for MRI include severe obesity, claustrophobia, confusion and agitation, and having implanted metal or metal support devices that are considered unsafe (Pagana et al., 2017). Various labels and icons are used to indicate whether a medical device is safe or unsafe for use during MRI. Recent improvements in technology have contributed to the design of certain medical devices, such as infusion pumps and ventilators, deemed safe for the MRI room. The nurse should consult with specially trained MRI personnel to clarify the safety of various devices (Wells & Murphy, 2014). Gadolinium-based contrast agents used during MRI may potentially lead to nephrogenic systemic fibrosis in patients with reduced kidney function. Therefore, additional kidney function testing may be necessary, especially in adults older than 60 years of age (Pagana et al., 2017).

Nursing Interventions

Patients scheduled for MRI should be instructed to remove all metal items such as hearing aids, hair clips, and medication patches with metallic foil components (e.g., nicotine patches). Prior to the MRI, the nurse should assess for the presence of implanted metal devices, such as aneurysm clips or a cardiac implantable electronic device. Patients with any type of cardiac implantable electronic device need to be screened to determine if they can safely undergo MRI (Indik, Gimbel, Abe, et al., 2017).

The nurse should inform patients preparing for MRI that they will need to lie flat and remain still for between 30 and 90 minutes, while the table that they are on moves into a large tubular magnet. Patients should be notified that they will hear a loud humming or thumping noise. Earplugs are typically offered to patients to minimize this noise. Patients will be able to communicate

with the MRI staff via a microphone and earphones. The nurse should clarify with the primary provider or the technologist if the prescribed test requires the use of a contrast agent or if the patient should remain NPO pre-examination. Patients who experience claustrophobia should be offered antianxiety medications preprocedure or be scheduled at a facility that uses an open MRI system (Pagana et al., 2017).

Fluoroscopic Studies

Fluoroscopy, which allows live x-ray images to be generated via a camera to a video screen, is used to assist with invasive procedures, such as a chest needle biopsy or transbronchial biopsy, that are performed to identify lesions. It also may be used to study the movement of the chest wall, mediastinum, heart, and diaphragm; to detect diaphragm paralysis; and to locate lung masses. The specific procedure performed under fluoroscopy will guide those respective nursing interventions (e.g., see nursing interventions described in the Lung Biopsy Procedures section).

Radioisotope Diagnostic Procedures (Lung Scans)

Several types of lung scans—V/Q scan, gallium scan, and positron emission tomography (PET)—are performed to assess normal lung functioning, pulmonary vascular supply, and gas exchange. Pregnancy is a contraindication for these scans.

A V/Q lung scan is performed by injecting a radioactive agent into a peripheral vein and then obtaining a scan of the chest to detect radiation. The isotope particles pass through the right side of the heart and are distributed into the lungs in proportion to the regional blood flow, making it possible to trace and measure blood perfusion through the lung. This procedure is used clinically to measure the integrity of the pulmonary vessels relative to blood flow and to evaluate blood flow abnormalities, as seen in PE. The imaging time is 20 to 40 minutes, during which the patient lies under the camera with a mask fitted over the nose and the mouth. This is followed by the ventilation component of the scan. The patient takes a deep breath of a mixture of oxygen and radioactive gas, which diffuses throughout the lungs. A scan is performed to detect ventilation abnormalities in patients who have regional differences in ventilation. It may be helpful in the diagnosis of bronchitis, asthma, inflammatory fibrosis, pneumonia, emphysema, and lung cancer. Ventilation without perfusion is seen with PE.

A gallium scan is a radioisotope lung scan used to detect inflammatory conditions, abscesses, adhesions, and the presence, location, and size of tumors. It is used to stage bronchogenic cancer and to document tumor regression after chemotherapy or radiation. Gallium is injected intravenously,

and scans are obtained at intervals (e.g., 6, 24, and 48 hours) to evaluate gallium uptake by the pulmonary tissues.

PET is a radioisotope study with advanced diagnostic capabilities that is used to evaluate lung nodules for malignancy. PET can detect and display metabolic changes in tissue, distinguish normal tissue from diseased tissue (such as in cancer), differentiate viable from dead or dying tissue, and show regional blood flow. PET is more accurate in detecting malignancies than CT and has equivalent accuracy in detecting malignant nodules when compared with invasive procedures such as thoracoscopy. Images from PET scans are now being superimposed on CT and MRI images to enhance the accuracy of diagnosis (Pagana et al., 2017).

Nursing Interventions

For each of these nuclear scans, the nurse should educate the patient on what to expect. Intravenous access is required. Chest x-ray should be performed prior to a V/Q scan. Patients should be told that V/Q and gallium scans require only a small amount of radioisotopes; therefore, radiation safety measures are not indicated. Normally, the patient may eat or drink prior to V/Q or gallium scans. Multiple factors can hinder the uptake of radioactive agents used for a PET scan. The nurse should instruct the patient to avoid caffeine, alcohol, and tobacco for 24 hours prior to the PET scan and abstain from food and fluids for 4 hours prior to the scan. Accurate results depend on an empty bladder; thus, a Foley catheter may be indicated. The nurse should encourage fluid intake postprocedure to facilitate the elimination of radioisotopes in the urine (Pagana et al., 2017).

Endoscopic Procedures

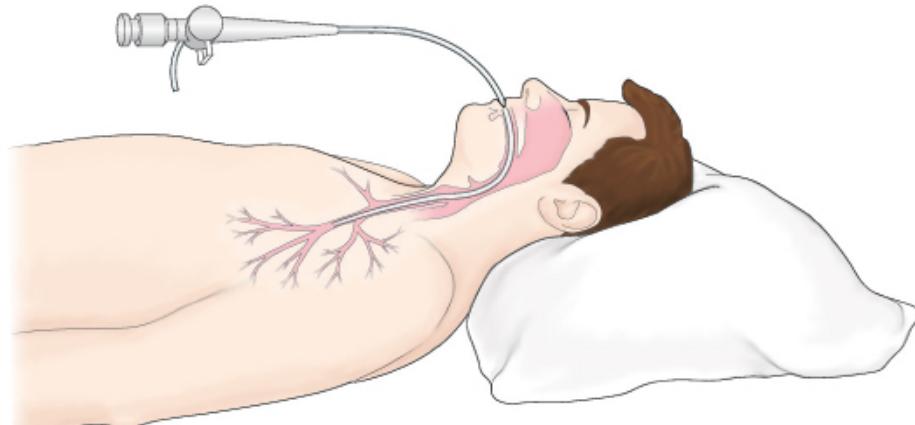
Endoscopic procedures include bronchoscopy, thoracoscopy, and thoracentesis.

Bronchoscopy

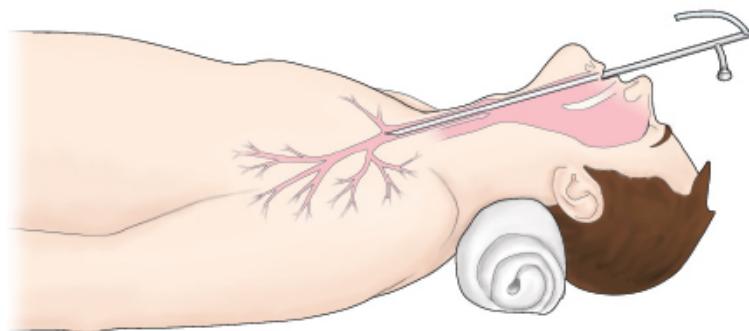
Bronchoscopy is the direct inspection and examination of the larynx, trachea, and bronchi through either a flexible fiberoptic bronchoscope or a rigid bronchoscope (Fig. 17-14). The fiberoptic scope is used more frequently in current practice.

Procedure

The purposes of diagnostic bronchoscopy are (1) to visualize tissues and determine the nature, location, and extent of the pathologic process; (2) to collect secretions for analysis and to obtain a tissue sample for diagnosis; (3) to determine whether a tumor can be resected surgically; and (4) to diagnose sources of hemoptysis.



Fiberoptic bronchoscopy



Rigid bronchoscopy

Figure 17-14 • Endoscopic bronchoscopy permits visualization of bronchial structures. The bronchoscope is advanced into bronchial structures orally. Bronchoscopy permits the clinician to not only diagnose but also treat various lung problems.

Therapeutic bronchoscopy is used to (1) remove foreign bodies or secretions from the tracheobronchial tree, (2) control bleeding, (3) treat postoperative atelectasis, (4) destroy and excise lesions, and (5) provide brachytherapy (endobronchial radiation therapy). It has also been used to insert stents to relieve airway obstruction that is caused by tumors or miscellaneous benign conditions or that occurs as a complication of lung transplantation.

The fiberoptic bronchoscope is a thin, flexible bronchoscope that can be directed into the segmental bronchi. Because of its small size, its flexibility, and its excellent optical system, it allows increased visualization of the peripheral airways and is ideal for diagnosing pulmonary lesions. Fiberoptic bronchoscopy allows biopsy of previously inaccessible tumors and can be performed at the bedside. It also can be performed through ET or tracheostomy tubes of patients on ventilators. Cytologic examinations can be performed without surgical intervention.

The rigid bronchoscope is a hollow metal tube with a light at its end. It is used mainly for removing foreign substances, investigating the source of massive hemoptysis, or performing endobronchial surgical procedures. Rigid bronchoscopy is performed in the operating room, not at the bedside.

Possible complications of bronchoscopy include a reaction to the local anesthetic, oversedation, prolonged fever, infection, aspiration, vasovagal response, laryngospasm, bronchospasm, hypoxemia, pneumothorax, and bleeding (Pagana et al., 2017).

Nursing Interventions

Before the procedure, the nurse should verify that informed consent has been obtained. Food and fluids are withheld for 4 to 8 hours before the test to reduce the risk of aspiration when the cough reflex is blocked by anesthesia. The patient must remove dentures and other oral prostheses. The nurse explains the procedure to the patient to reduce fear and decrease anxiety and then administers preoperative medications (usually atropine and a sedative or opioid) as prescribed to inhibit vagal stimulation (thereby guarding against bradycardia, arrhythmias, and hypotension), suppress the cough reflex, sedate the patient, and relieve anxiety.



Quality and Safety Nursing Alert

Sedation given to patients with respiratory insufficiency may precipitate respiratory arrest.

The examination is usually performed under local anesthesia or moderate sedation; however, general anesthesia may be used for rigid bronchoscopy. A topical anesthetic such as lidocaine is normally sprayed on the pharynx or dropped on the epiglottis and vocal cords and into the trachea to suppress the cough reflex and minimize discomfort.

After the procedure, the patient must take nothing by mouth until the cough reflex returns, because the preoperative sedation and local anesthesia impair the protective laryngeal reflex and swallowing. Once the patient demonstrates a cough reflex, the nurse may offer ice chips and eventually fluids. In the older adult patient, the nurse assesses for confusion and lethargy, which may be owing to the large doses of lidocaine given during the procedure. The nurse also monitors the patient's respiratory status and observes for hypoxia, hypotension, tachycardia, arrhythmias, hemoptysis, and dyspnea. Any abnormality is reported promptly. A small amount of blood-tinged sputum and fever may be expected within the first 24 hours (Pagana et al., 2017). The patient is not discharged from the postanesthesia care unit (PACU) until adequate cough reflex and respiratory status are present. The nurse instructs

the patient and caregivers to report any shortness of breath or bleeding immediately.

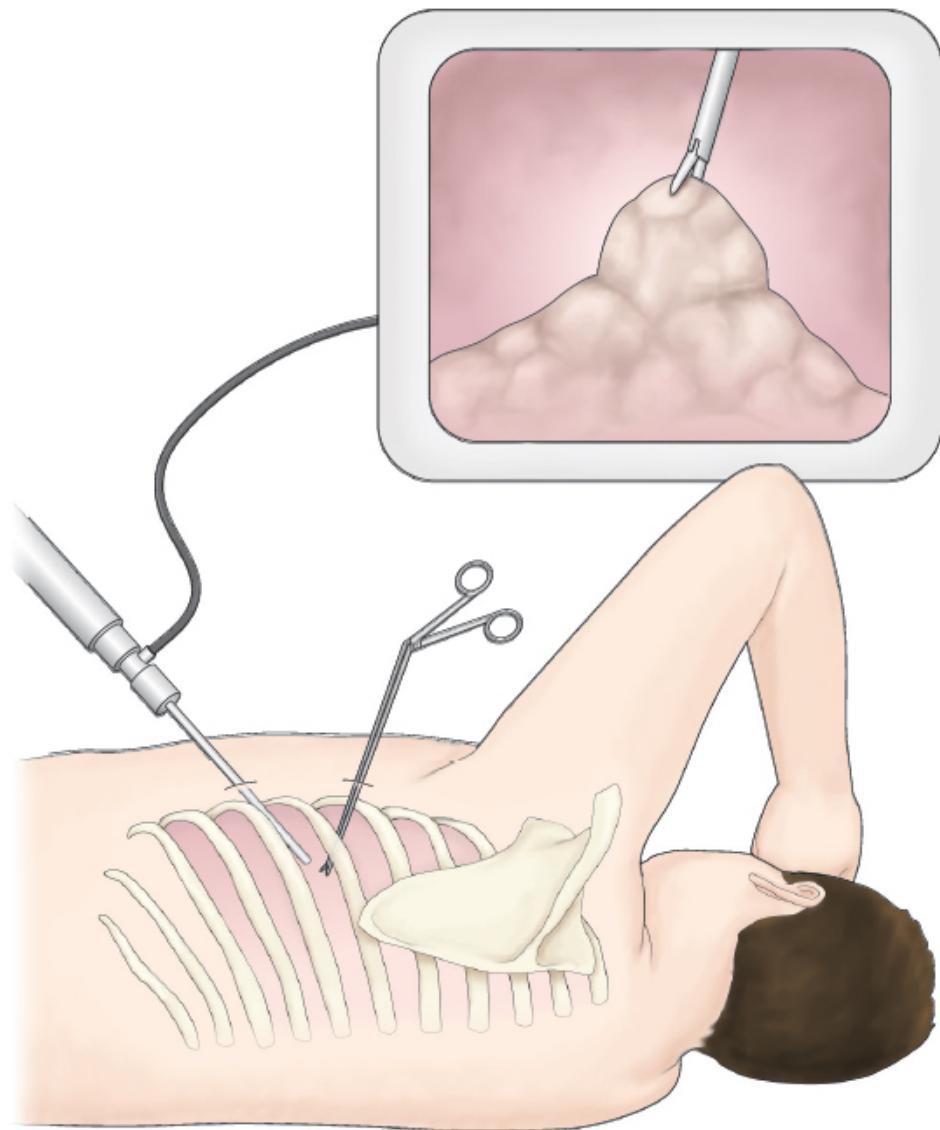


Figure 17-15 • Endoscopic thoracoscopy. Like bronchoscopy, thoracoscopy uses fiberoptic instruments and video cameras for visualizing thoracic structures. Unlike bronchoscopy, thoracoscopy usually requires the surgeon to make a small incision before inserting the endoscope. A combined diagnostic–treatment procedure, thoracoscopy includes excising tissue for biopsy.

Thoracoscopy

Thoracoscopy is a diagnostic procedure in which the pleural cavity is examined with an endoscope and fluid and tissues can be obtained for analysis (Fig. 17-15).

Procedure

This procedure is performed in the operating room, normally under anesthesia. Small incisions are made into the pleural cavity in an intercostal space at the location indicated by clinical and diagnostic findings. The fiberoptic mediastinoscope is inserted into the pleural cavity, any fluid present is aspirated, and the pleural cavity is inspected through the instrument. After the procedure, a chest tube may be inserted to facilitate re-expansion of the lung.

Thoracoscopy is primarily indicated in the diagnostic evaluation and treatment of pleural effusions, pleural disease, and tumor staging. Biopsies of the lesions and resection of tissues can be performed under visualization for diagnosis.

Thoracoscopic procedures have expanded with the availability of video monitoring, which permits improved visualization of the lung. Video-assisted thoracoscopy (VATS) may be used in the diagnosis and treatment of empyema, pleural effusion, pulmonary and pleural masses, and pneumothorax. Although VATS does not replace the need for thoracotomy in the treatment of some lung cancers, its use continues to grow, because it is less invasive than open surgical procedures, and hospitalization and recovery are shorter.

Nursing Interventions

The nurse should follow routine preoperative practices, such as ensuring that informed consent is obtained and that the patient remains NPO prior to the procedure. Postoperatively, the nurse should monitor vital signs, pain level, and respiratory status, and should look for signs of bleeding and infection at the incisional site. Shortness of breath may indicate a pneumothorax and should be reported immediately. If a chest tube was inserted during the procedure, monitoring of the chest drainage system and chest tube insertion site is essential (see [Chapter 19](#)).

Thoracentesis

In some respiratory disorders, pleural fluid may accumulate. Thoracentesis (aspiration of fluid and air from the pleural space) is performed for diagnostic or therapeutic reasons. Purposes of the procedure include removal of fluid and, very rarely, air from the pleural cavity; aspiration of pleural fluid for analysis; pleural biopsy; and instillation of medication into the pleural space. Studies of pleural fluid include Gram stain culture and sensitivity, acid-fast staining and culture, differential cell count, cytology, pH, total protein, lactic dehydrogenase, glucose, amylase, triglycerides, and cancer markers such as carcinoembryonic antigen.



For the procedural guidelines for assisting with a thoracentesis,
go to thepoint.lww.com/Brunner15e.

Biopsy

Biopsy—the excision of a small amount of tissue—may be performed to permit examination of cells from the upper and lower respiratory structures and adjacent lymph nodes. Local, topical, or moderate sedation, or general anesthesia, may be given, depending on the site and the procedure.

Pleural Biopsy

Pleural biopsy is accomplished by needle biopsy of the pleura, thoracoscopy, or pleuroscopy, a visual exploration through a fiberoptic pleuroscope inserted into the pleural space or through a thoracotomy. Pleural biopsy is performed when there is pleural exudate of undetermined origin or when there is a need to culture or stain the tissue to identify tuberculosis or fungi.

Lung Biopsy Procedures

Lung biopsy is performed to obtain tissue for examination when other diagnostic testing indicates potential interstitial lung disease, such as cancer, infection, or sarcoidosis. Several nonsurgical lung biopsy techniques are used because they yield accurate information with low morbidity: transbronchial brushing or needle aspiration, transbronchial lung biopsy, and percutaneous (through-the-skin) needle biopsy. Possible complications for all methods include pneumothorax, pulmonary hemorrhage, and empyema (Pagana et al., 2017).

Procedure

In transbronchial brushing, a fiberoptic bronchoscope is introduced into the bronchus under fluoroscopy. A small brush attached to the end of a flexible wire is inserted through the bronchoscope. Under direct visualization, the area under suspicion is brushed back and forth, causing cells to slough off and adhere to the brush. The catheter port of the bronchoscope may be used to irrigate the lung tissue with saline solution to secure material for additional studies. The brush is removed from the bronchoscope, and a slide is made for examination under the microscope. The brush may be cut off and sent to the pathology laboratory for analysis. This procedure is especially useful in the immunologically compromised patient.

In transbronchial needle aspiration, a catheter with a needle is inserted into the tissue through the bronchoscope and aspirated, whereas in transbronchial lung biopsy, biting or cutting forceps are introduced by a fiberoptic bronchoscope to excise the tissue.

In percutaneous needle biopsy, a cutting needle or a spinal-type needle is used to obtain a tissue specimen for histologic study under fluoroscopic or CT guidance. Analgesia may be given before the procedure. The skin over the biopsy site is cleansed and anesthetized and a small incision is made. The biopsy needle is inserted through the incision into the pleura with the patient holding their breath in midexpiration. The surgeon guides the needle into the periphery of the lesion and obtains a tissue sample from the mass.

Nursing Interventions

After the procedure, recovery and home care are similar to those for bronchoscopy and thoracoscopy. Nursing care involves monitoring the patient for complications such as shortness of breath, bleeding, or infection. In preparation for discharge, the patient and the family are instructed to report pain, shortness of breath, visible bleeding, redness of the biopsy site, or purulent drainage (pus) to the primary provider immediately. Patients who have undergone biopsy are often anxious because of the need for the biopsy and the potential findings; the nurse must consider this in providing postbiopsy care and patient education.

Lymph Node Biopsy

The scalene lymph nodes, which are enmeshed in the deep cervical pad of fat overlying the scalenus anterior muscle, drain the lungs and mediastinum and may show histologic changes from intrathoracic disease. If these nodes are palpable on physical examination, a scalene node biopsy may be performed. A biopsy of these nodes may be performed to detect spread of pulmonary disease to the lymph nodes and to establish a diagnosis or prognosis in such diseases as Hodgkin lymphoma, sarcoidosis, fungal disease, tuberculosis, and carcinoma.

Procedure

Mediastinoscopy is the endoscopic examination of the mediastinum for exploration and biopsy of mediastinal lymph nodes that drain the lungs; this examination does not require a thoracotomy. Biopsy is usually performed through a suprasternal incision. Mediastinoscopy is carried out to detect mediastinal involvement of pulmonary malignancy and to obtain tissue for diagnostic studies of other conditions (e.g., sarcoidosis).

An anterior mediastinotomy is thought to provide better exposure and diagnostic possibilities than a mediastinoscopy. An incision is made in the area of the second or third costal cartilage. The mediastinum is explored, and

biopsies are performed on any lymph nodes found. Chest tube drainage is required after the procedure. Mediastinotomy is particularly valuable to determine whether a pulmonary lesion is resectable.

Nursing Interventions

Postprocedure care focuses on providing adequate oxygenation, monitoring for bleeding, and providing pain relief. The patient may be discharged a few hours after the chest drainage system is removed. The nurse should instruct the patient and the family about monitoring for changes in respiratory status, taking into consideration the impact of anxiety about the potential findings of the biopsy on their ability to remember those instructions.

CRITICAL THINKING EXERCISES

1 ebp You are caring for an 82-year-old male who was transferred to the medical-surgical unit from the postanesthesia care unit (PACU), status post appendectomy. The patient is currently alert to time, person, and place and his vital signs are as follows: temperature 37.5°C (99.0°F), HR 79 bpm, BP 125/74, RR 16 breaths/min, and SaO₂ 96% on oxygen at 2 L/min via nasal cannula. The patient is receiving morphine via patient-controlled analgesia (PCA) for pain management. What changes in his assessment would indicate that he is at risk for developing respiratory depression? What evidence-based scales and diagnostic tests could help you to identify this potential complication?

2 pq A patient with a significant pulmonary history is admitted to the medical unit where you work with complaints of shortness of breath. He reports that he worked in the coal mines for 42 years and smokes cigarettes every day. As part of the history, he tells you, “For the past couple of days, I can’t seem to catch my breath.” He informs you that he coughs up “yellow stuff” throughout the day and it has been “thicker” than usual. What components of his assessment are most important for you to perform first?

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*Asterisk indicates nursing research.

**Double asterisk indicates classic reference.

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Resources

- American Association for Respiratory Care (AARC), www.aarc.org
- American Lung Association, www.lung.org
- American Thoracic Society, www.thoracic.org
- Centers for Disease Control and Prevention (CDC), www.cdc.gov
- Cystic Fibrosis Foundation, www.cff.org
- National Heart, Lung, and Blood Institute, National Institutes of Health,
www.nhlbi.nih.gov
- U.S. Food and Drug Administration, www.fda.gov

18 Management of Patients with Upper Respiratory Tract Disorders

LEARNING OUTCOMES

On completion of this chapter, the learner will be able to:

- 1.** Describe nursing management of patients with upper airway disorders and of patients with epistaxis.
- 2.** Compare and contrast the upper respiratory tract infections according to cause, incidence, clinical manifestations, management, and the significance of preventive health care.
- 3.** Use the nursing process as a framework for care of the patient with upper airway infection and the patient undergoing laryngectomy.

NURSING CONCEPTS

Infection

Oxygenation

GLOSSARY

alaryngeal communication: alternative modes of speaking that do not involve the normal larynx; used by patients whose larynx has been surgically removed

aphonia: impaired ability to use one's voice due to disease or injury to the larynx

apnea: cessation of breathing

dysphagia: difficulty swallowing

epistaxis: hemorrhage from the nose due to rupture of tiny, distended vessels in the mucous membrane of any area of the nose

herpes simplex: a cutaneous viral infection with painful vesicles and erosions on the tongue, palate, gingiva, buccal membranes, or lips (*synonym:* cold sore)

laryngectomy: surgical removal of all or part of the larynx and surrounding structures

laryngitis: inflammation of the larynx; may be caused by voice abuse, exposure to irritants, or infectious organisms

nuchal rigidity: stiffness of the neck or inability to bend the neck

pharyngitis: inflammation of the throat

rhinitis: inflammation of the mucous membranes of the nose

rhinitis medicamentosa: rebound nasal congestion commonly associated with overuse of over-the-counter nasal decongestants

rhinorrhea: drainage of a large amount of fluid from the nose

rhinosinusitis: inflammation of the nares and paranasal sinuses, including frontal, ethmoid, maxillary, and sphenoid sinuses; replaces the term *sinusitis*

tonsillitis: inflammation of the tonsils

xerostomia: dryness of the mouth

Upper respiratory tract disorders are those that involve the nose, paranasal sinuses, pharynx, larynx, trachea, or bronchi. Many of these conditions are relatively minor, and their effects are limited to mild and temporary discomfort and inconvenience for the patient. However, others are acute, severe, and life-threatening and may require permanent alterations in breathing and speaking. Therefore, the nurse must have expert assessment skills, an understanding of the wide variety of disorders that may affect the upper airway, and an awareness of the impact of these alterations on patients. Patient education is an important aspect of nursing care because many of these disorders are treated outside the hospital or at home by patients themselves. When caring for patients with acute, life-threatening disorders, the nurse needs highly developed assessment and clinical management skills, along with a focus on rehabilitation needs.

UPPER AIRWAY INFECTIONS

Upper airway infections (otherwise known as upper respiratory infections [URIs]) are the most common cause of illness and affect most people on occasion. Some infections are acute, with symptoms that last several days; others are chronic, with symptoms that may last for weeks or months or recur. A URI is often defined as an infection of the mucous membranes of the nose, sinuses, pharynx, upper trachea, or larynx (Pokorski, 2015).

The common cold is the most frequently occurring example of a URI. URIs occur when microorganisms such as viruses and bacteria are inhaled. There are many causative organisms, and people are susceptible throughout life. Viruses, the most common cause of URIs, affect the upper respiratory passages and lead to subsequent mucous membrane inflammation. URIs are the most common reason for seeking health care and for absences from school and work (Pokorski, 2015).

URIs affect the nasal cavity; ethmoidal air cells; and frontal, maxillary, and sphenoid sinuses; as well as the pharynx, larynx, and upper portion of the trachea. On average, adults typically develop two to four URIs per year because of the wide variety of respiratory viruses that circulate in the community (Weinberger, Cockrill, & Mandel, 2019). Although patients are rarely hospitalized for the treatment of URIs, nurses working in community settings or long-term care facilities may encounter patients who have these infections. It is important for nurses to recognize the signs and symptoms of URIs and provide appropriate care. Nurses in these settings also can influence patient outcomes through patient education. Special considerations with regard to URIs in older adults are summarized in [Chart 18-1](#).

Rhinitis

Rhinitis is a group of disorders characterized by inflammation and irritation of the mucous membranes of the nose. These conditions can have a significant impact on quality of life and contribute to sinus, ear, and sleep problems and learning disorders. Rhinitis often coexists with other respiratory disorders, such as asthma. It affects between 10% and 30% of the population worldwide annually. Viral rhinitis, especially the common cold, affects approximately one billion individuals yearly (Meneghetti, 2018).

Rhinitis may be acute or chronic, and allergic or nonallergic. Allergic rhinitis is further classified as seasonal or perennial rhinitis and is commonly associated with exposure to airborne particles such as dust, dander, or plant pollens in people who are allergic to these substances. Seasonal rhinitis occurs during pollen seasons, and perennial rhinitis occurs throughout the year. See

[Chapter 33](#) for detailed descriptions of allergic disorders, including allergic rhinitis.

Pathophysiology

Rhinitis may be caused by a variety of factors, including changes in temperature or humidity; odors; infection; age; systemic disease; use of over-the-counter (OTC) and prescribed nasal decongestants; and the presence of a foreign body. Allergic rhinitis may occur with exposure to allergens such as foods (e.g., peanuts, walnuts, Brazil nuts, wheat, shellfish, soy, cow's milk, eggs), medications (e.g., penicillin, sulfa medications, aspirin), and particles in the indoor and outdoor environment ([Chart 18-2](#)). The most common cause of nonallergic rhinitis is the common cold (Peters, 2015).

Chart 18-1



Upper Respiratory Tract Disorders in Older Adults

- Upper respiratory infections in older adults may have more serious consequences if patients have concurrent medical problems that compromise their respiratory or immune status.
- Influenza causes exacerbations of chronic obstructive pulmonary disease and reduced pulmonary function.
- Antihistamines and decongestants used to treat upper respiratory disorders must be used cautiously in older adults because of their side effects and potential interactions with other medications.
- The prevalence of nonallergic rhinosinusitis is greater among older adults than among adults of other age groups. Rhinosinusitis is the sixth most common chronic disease among older adults. With anticipated future growth in the older adult population, the need for endoscopic sinus surgery will increase. Older patients with nonallergic rhinosinusitis present with symptoms similar to those of younger adults and experience a similar degree of improvement and quality of life after endoscopic sinus surgery.
- The structure of the nose changes with aging; it lengthens and the tip droops from loss of cartilage. This can cause restriction in airflow and predispose older adult patients to geriatric rhinitis, characterized by increased thin, watery sinus drainage. These structural changes may also adversely affect the sense of smell.
- Laryngitis in older adults is common and may be secondary to gastroesophageal reflux disease (GERD). Older adults are more likely to have impaired esophageal peristalsis and a weaker esophageal sphincter. Treatment measures include sleeping with the head of the bed elevated and the use of medications such as histamine-2 receptor blockers (e.g., famotidine) or proton pump inhibitors (e.g., omeprazole).
- Age-related loss of muscle mass and thinning of the mucous membranes can cause structural changes in the larynx that may change characteristics of the voice. In general, the pitch of voice becomes higher in older adult men and lower in older adult women. The voice also “thins” (decreased projection) and may sound tremulous. These changes should be discriminated from signs that could indicate pathologic conditions.

Adapted from Eliopoulos, C. (2018). *Gerontological nursing* (9th ed.). Philadelphia, PA: Wolters Kluwer; Lehmann, A. E., Scangas, G. A., Sethi, R. K., et al. (2018). Impact of age on sinus surgery outcomes. *The Laryngoscope*, 128, 2681–2687; Valdes, C. J., & Tewfik, M. A. (2018). Rhinosinusitis and allergies in elderly patients. *Clinics in Geriatric Medicine*, 34(2), 217–231.

Drug-induced rhinitis may occur with antihypertensive agents, such as angiotensin-converting enzyme (ACE) inhibitors and beta-blockers; “statins,” such as atorvastatin and simvastatin; antidepressants and antipsychotics such as risperidone; aspirin; and some antianxiety medications (Comerford & Durkin, 2020). [Figure 18-1](#) shows the pathologic processes involved in rhinitis and rhinosinusitis. Other causes of rhinovirus are identified in [Table 18-1](#).

Chart 18-2

Examples of Common Indoor and Outdoor Allergens

Common Indoor Allergens

- Dust mite feces
- Dog dander
- Cat dander
- Cockroach droppings
- Molds

Common Outdoor Allergens

- Trees (e.g., oak, elm, western red cedar, ash, birch, sycamore, maple, walnut, cypress)
- Weeds (e.g., ragweed, tumbleweed, sagebrush, pigweed, cockle weed, Russian thistle)
- Grasses (e.g., timothy, orchard, sweet vernal, bermuda, sour dock, redtop, bluegrass)
- Molds (*Alternaria*, *Cladosporium*, *Aspergillus*)

Adapted from Patel, B. (2017). Aeroallergens. Retrieved on 5/27/2019 at: www.emedicine.medscape.com/article/137911-overview

Clinical Manifestations

The signs and symptoms of rhinitis include **rhinorrhea** (excessive nasal drainage, runny nose); nasal congestion; nasal discharge (purulent with bacterial rhinitis); sneezing; and pruritus of the nose, roof of the mouth, throat, eyes, and ears. Headache may occur, particularly if rhinosinusitis is also present (see later discussion of rhinosinusitis). Nonallergic rhinitis can occur throughout the year.

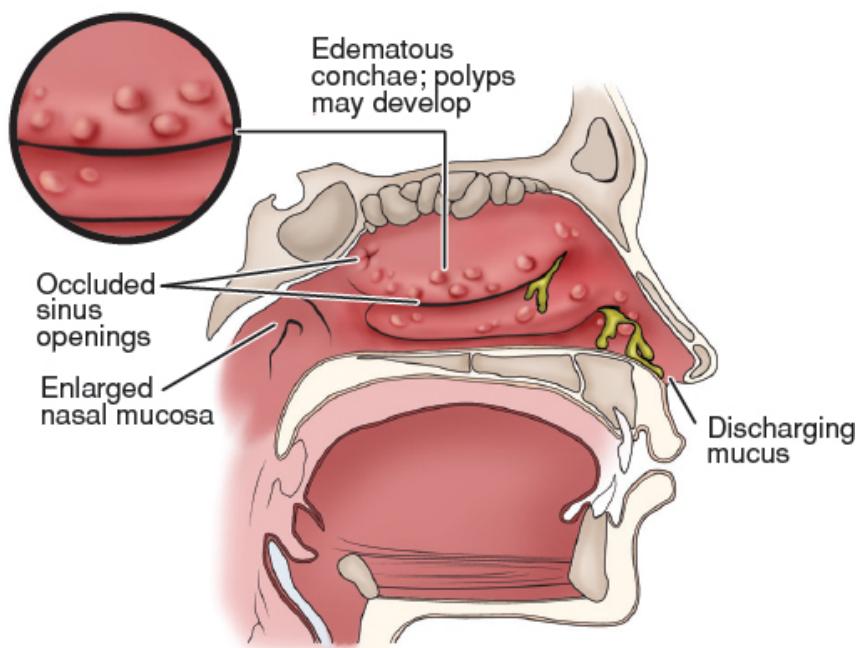
TABLE 18-1 Causes of Rhinosinusitis

Category	Causes
Vasomotor	Idiopathic Abuse of nasal decongestants (rhinitis medicamentosa) Psychological stimulation (anger, sexual arousal) Irritants (smoke, air pollution, exhaust fumes, cocaine)
Mechanical	Tumor Deviated septum Crusting Hypertrophied turbinates Foreign body Cerebrospinal fluid leak
Chronic inflammatory	Polyps (in cystic fibrosis) Sarcoidosis Wegener granulomatosis Midline granuloma
Infectious	Acute viral infection Acute or chronic rhinosinusitis Rare nasal infections (syphilis, tuberculosis)
Hormonal	Pregnancy Use of oral contraceptives Hypothyroidism

Adapted from Peters, A. (2015). Rhinosinusitis: Synopsis. Retrieved on 6/2/2019 at: www.worldallergy.org/professional/allergic_diseases_center/rhinosinusitis/sinusitissynopsis.php

Physiology/Pathophysiology

A. Rhinitis



B. Rhinosinusitis

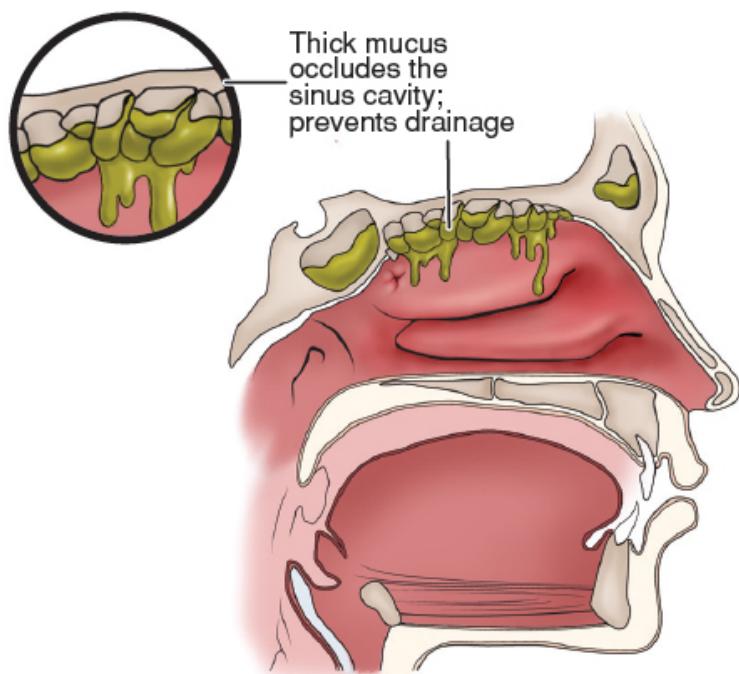


Figure 18-1 • Pathophysiologic processes in rhinitis and rhinosinusitis. Although pathophysiologic processes are similar in

rhinitis and rhinosinusitis, they affect different structures. **A.** In rhinitis, the mucous membranes lining the nasal passages become inflamed, congested, and edematous. The swollen nasal conchae block the sinus openings, and mucus is discharged from the nostrils.

B. Rhinosinusitis is also marked by inflammation and congestion, with thickened mucous secretions filling the sinus cavities and occluding the openings.

Medical Management

The management of rhinitis depends on the cause, which may be identified through the history and physical examination. The nurse asks the patient about recent symptoms as well as possible exposure to allergens in the home, environment, or workplace. If viral rhinitis is the cause, medications may be prescribed to relieve the symptoms. In allergic rhinitis, allergy tests may be performed to identify possible allergens. Depending on the severity of the allergy, desensitizing immunizations and corticosteroids may be required (see [Chapter 33](#) for more details). If symptoms suggest a bacterial infection, an antimicrobial agent is used. Patients with nasal septal deformities or nasal polyps may be referred to an ear, nose, and throat specialist.

Pharmacologic Therapy

Medication therapy for allergic and nonallergic rhinitis focuses on symptom relief. Antihistamines and nasal sprays may be useful. Antihistamines remain the most common treatment and are given for sneezing, pruritus, and rhinorrhea. (Examples of commonly prescribed antihistamines are discussed in more detail in [Chapter 33](#).) Brompheniramine/pseudoephedrine is an example of combination antihistamine/decongestant medications. Cromolyn, a mast cell stabilizer that inhibits the release of histamine and other chemicals, is also used in the treatment of rhinitis. Oral decongestant agents may be used for nasal obstruction. The use of saline nasal spray can act as a mild decongestant and can liquefy mucus to prevent crusting. Two inhalations of intranasal ipratropium can be given in each nostril two to three times per day for symptomatic relief of rhinorrhea. In addition, intranasal corticosteroids may be used for severe congestion, and ophthalmic agents (cromolyn ophthalmic solution 4%) may be used to relieve irritation, itching, and redness of the eyes. Appropriate allergy treatments may include leukotriene modifiers (e.g., montelukast, zafirlukast, zileuton), and immunoglobulin E modifiers (e.g., omalizumab), which are also components of asthma treatment guidelines (discussed further in [Chapter 20](#)). The choice of medications depends on the symptoms, adverse reactions, adherence factors, risk of drug interactions, and cost to the patient (Hauk, 2018).

Nursing Management



Educating Patients About Self-Care

The nurse instructs the patient with allergic rhinitis to avoid or reduce exposure to allergens and irritants, such as dusts, molds, animals, fumes, odors, powders, sprays, and tobacco smoke. Patient education is essential when assisting the patient in the use of all medications. To prevent possible drug interactions, the patient is cautioned to read drug labels before taking any OTC medication.

The nurse instructs the patient about the importance of controlling the environment at home and at work. Saline nasal sprays or aerosols may be helpful in soothing mucous membranes, softening crusted secretions, and removing irritants. The nurse instructs the patient in correct administration of nasal medications. To achieve maximal relief, the patient is instructed to blow the nose before applying any medication into the nasal cavity. In addition, the patient is taught to keep the head upright; spray quickly and firmly into each nostril away from the nasal septum; and wait at least 1 minute before administering the second spray. The container should be cleaned after each use and should never be shared with other people to avoid cross-contamination.

In the case of infectious rhinitis, the nurse reviews hand hygiene technique with the patient as a measure to prevent transmission of organisms. This is especially important for those in contact with vulnerable populations such as the very young, older adults, or people who are immunosuppressed (e.g., patients with human immune deficiency virus [HIV] infection, those taking immunosuppressive medications). In older adults and other high-risk populations, the nurse reviews the importance of receiving an influenza vaccination each year to achieve immunity before the beginning of the flu season.

Viral Rhinitis (Common Cold)

Viral rhinitis is the most frequent viral infection in the general population (Meneghetti, 2018). The term *common cold* often is used when referring to a URI that is self-limited and caused by a virus. The term *cold* refers to an infectious, acute inflammation of the mucous membranes of the nasal cavity characterized by nasal congestion, rhinorrhea, sneezing, sore throat, and general malaise. More broadly, the term refers to an acute URI, whereas terms such as *rhinitis*, *pharyngitis*, and *laryngitis* distinguish the sites of the symptoms. The term is also used when the causative virus is influenza (the flu). Colds are highly contagious because virus is shed for about 2 days before the symptoms appear and during the first part of the symptomatic phase.

Colds caused by rhinoviruses tend to occur in the early fall and spring. Other viruses tend to cause winter colds (Centers for Disease Control and Prevention [CDC], 2019). Seasonal changes in relative humidity may affect the prevalence of colds. The most common cold-causing viruses survive better when humidity is low, in the colder months of the year.

Colds are caused by as many as 200 different viruses. Rhinoviruses are the most likely causative organisms. Other viruses implicated in the common cold include coronavirus, adenovirus, respiratory syncytial virus, influenza virus, and parainfluenza virus. Each virus may have multiple strains; as a result, people are susceptible to colds throughout life (Buensalido, 2019b). Some virus strains may be particularly virulent, causing more severe manifestations than those implicated with common colds, such as the SARS-CoV-2 virion, which caused the COVID-19 pandemic. Development of a vaccine against the multiple strains of virus is almost impossible. Immunity after recovery is variable and depends on many factors, including a person's natural host resistance and the specific virus that caused the cold. Despite popular belief, cold temperatures and exposure to cold rainy weather do not increase the incidence or severity of the common cold.

Clinical Manifestations

Signs and symptoms of viral rhinitis may include low-grade fever, nasal congestion, rhinorrhea and nasal discharge, halitosis, sneezing, tearing watery eyes, “scratchy” or sore throat, general malaise, chills, and often headache and muscle aches. As the illness progresses, cough usually appears. In some people, the virus exacerbates **herpes simplex**, commonly called a *cold sore* (Chart 18-3).

The symptoms of viral rhinitis may last from 1 to 2 weeks. If severe systemic respiratory symptoms occur, it is no longer considered viral rhinitis but one of the other acute URIs. Allergic conditions can affect the nose, mimicking the symptoms of a cold.

Medical Management

Management consists of symptomatic therapy that includes adequate fluid intake, rest, prevention of chilling, and the use of expectorants as needed. Warm salt-water gargles soothe the sore throat, and nonsteroidal anti-inflammatory drugs (NSAIDs), such as aspirin or ibuprofen, relieve aches and pains. Antihistamines are used to relieve sneezing, rhinorrhea, and nasal congestion. Petroleum jelly can soothe irritated, chapped, and raw skin around the nares (Buensalido, 2019b).

Guaifenesin, an expectorant, is available without a prescription and is used to promote removal of secretions. Antimicrobial agents (antibiotics) should not

be used, because they do not affect the virus or reduce the incidence of bacterial complications. In addition, their inappropriate use has been implicated in the development of organisms resistant to therapy.

Chart 18-3

Colds and Cold Sores (Herpes Simplex Virus)

Overview

Herpes labialis is an infection that is caused by herpes simplex virus type 1 (HSV-1). Herpes labialis is extremely contagious and can be spread through contaminated razors, towels, and dishes. It is activated by overexposure to sunlight or wind, colds, influenza and similar infections, heavy alcohol use, and physical or emotional stress.

Statistics

- Once the patient is infected with this virus, it can lie latent in the cells. The incubation period is between 2 and 12 d.
- Between 50% and 80% of Americans are infected by age 30 y, because HSV-1 is typically transmitted during childhood through nonsexual contact.
- Estimates suggest that 80% of people infected are asymptomatic.

Clinical Manifestations

- Herpes labialis is characterized by an eruption of small, painful blisters on the skin of the lips, mouth, gums, tongue, or the skin around the mouth. The blisters are commonly referred to as cold sores or fever blisters.
- Early symptoms of herpes labialis include burning, itching, and increased sensitivity or tingling sensation. These symptoms may occur several days before the appearance of lesions.
- Lesions appear as macules or papules, progressing to small blisters (vesicles) filled with clear, yellowish fluid. They are raised, red, and painful and can break and ooze. The lesions typically extend through the epidermis and penetrate into the underlying dermis, consistent with a partial-thickness wound.
- Eventually, yellow crusts slough over the lesions to reveal pink, healing skin.
- Typically, the virus is no longer detectable in the lesion or wound 5 d after the vesicle has developed.

Medical and Nursing Management

- Antiviral medications (e.g., acyclovir, valacyclovir) may be prescribed to minimize the symptoms and the duration or length of flare-up.
- Acetaminophen may be given for analgesia.
- Topical anesthetics such as lidocaine can help in the control of discomfort.
- Occlusive dressings have been shown to speed the healing process. Occlusive ointments with antiviral properties (e.g., docosanol) might be considered for lip and mucosal lesions.

Patient Education

- Patients should understand that the virus can be transmitted by people who are asymptomatic.
- Patients should seek treatment with antiviral medications and ointments when they are first experiencing symptoms (e.g., tingling, burning, or itching sensations) as early treatment with these drugs can result in a speedier recovery.
- Although herpes simplex virus type 2 (HSV-2) typically causes painful vesicular and ulcerative lesions in the genital and anal areas, HSV-1 may also cause genital herpes. Oral–genital contact can spread oral herpes to the genitals (and vice versa). People with active herpetic lesions should avoid oral sex.



Photo reprinted with permission from Ayoade, F. (2018). Herpes simplex. Retrieved on 5/27/2019 at: www.emedicine.medscape.com/article/218580-overview

Topical nasal decongestants (e.g., phenylephrine nasal and oxymetazoline nasal) should be used with caution. Topical therapy delivers medication directly to the nasal mucosa, and its overuse can produce **rhinitis medicamentosa**, or rebound rhinitis. Most patients treat the common cold with OTC medications that produce moderate clinical benefits, such as relief of symptoms.

In addition, alternative medicines (e.g., echinacea, zinc lozenges, and zinc nasal spray) are frequently used to treat the common cold; however, evidence regarding their effectiveness in shortening the symptomatic phase is limited (Mousa, 2017). The inhalation of steam or heated, humidified air has been a mainstay of home remedies to treat the common cold; however, the value of this therapy has not been demonstrated.

Nursing Management



Educating Patients About Self-Care

Most viruses can be transmitted in several ways: direct contact with infected secretions, inhalation of large particles from others' coughing or sneezing, or inhalation of small particles (aerosol) that may be suspended in the air for up to an hour. Implementation of appropriate hand hygiene measures (see [Chapter 66, Chart 66-1](#) for further information) remains the most effective measure to prevent transmission of organisms. The nurse educates the patient about how to break the chain of infection with appropriate hand hygiene and the use of tissues to avoid the spread of the virus with coughing and sneezing, and to cough or sneeze into the upper arm if tissues are not readily available. The nurse instructs the patient about methods to treat symptoms of the common cold and provides both verbal and written information to assist in the prevention and management of URIs.

Rhinosinusitis

Rhinosinusitis, formerly called *sinusitis*, is an inflammation of the paranasal sinuses and nasal cavity. The American Academy of Otolaryngology–Head and Neck Surgery Foundation (2018; Rosenfeld, Andes, Bhattacharyya, et al., 2015) recommends the use of the term *rhinosinusitis* because sinusitis is almost always accompanied by inflammation of the nasal mucosa. Rhinosinusitis affects about 35 million people in the United States each year and accounts for 16 million office visits (Brook, 2018a).

Uncomplicated rhinosinusitis occurs without extension of inflammation outside of the paranasal sinuses and nasal cavity. Rhinosinusitis is classified by duration of symptoms as acute (less than 4 weeks), subacute (4 to 12 weeks), and chronic (more than 12 weeks). Rhinosinusitis can be caused by a bacterial or viral infection.

Acute Rhinosinusitis

Acute rhinosinusitis is classified as acute bacterial rhinosinusitis (ABRS) or acute viral rhinosinusitis (AVRS). Recurrent acute rhinosinusitis is characterized by four or more acute episodes of ABRS per year (Patel & Hwang, 2019) and is discussed with chronic rhinosinusitis (CRS).

Pathophysiology

Acute rhinosinusitis usually follows a viral URI or cold, such as an unresolved viral or bacterial infection, or an exacerbation of allergic rhinitis. Normally, the sinus openings into the nasal passages are clear and infections resolve

promptly. However, if their drainage is obstructed by a deviated septum or by hypertrophied turbinates, spurs, or nasal polyps or tumors, sinus infection may persist as a secondary infection or progress to an acute suppurative process (causing purulent discharge).

Nasal congestion, caused by inflammation, edema, and transudation of fluid secondary to URI, leads to obstruction of the sinus cavities (see Fig. 18-1). This provides an excellent medium for bacterial growth. Other conditions and activities that can block the normal flow of sinus secretions include abnormal structures of the nose, enlarged adenoids, diving and swimming, tooth infection, trauma to the nose, tumors, and the pressure of foreign objects. Some people are more prone to rhinosinusitis because exposure to environmental hazards such as paint, sawdust, and chemicals may result in chronic inflammation of the nasal passages.

Bacterial organisms account for more than 60% of the cases of acute rhinosinusitis. Typical pathogens include *Streptococcus pneumoniae*, *Haemophilus influenzae*, and less commonly *Staphylococcus aureus*, and *Moraxella catarrhalis* (Brook, 2018b). Biofilms, which consist of organized, heterogeneous communities of bacteria, have been found to be 10 to 1000 times more resistant to antibiotic treatment and more likely to contribute to host resistance when compared with other bacteria. They serve as bacterial reservoirs that can cause systemic illness when released into the circulation. Although antibiotics kill bacteria in the biofilm margin, cells deep in the biofilm are not affected, allowing for regrowth once antibiotic therapy has been discontinued. Pathogens in the upper respiratory tract that form biofilms include those species listed earlier as well as *Pseudomonas aeruginosa*.

Other organisms that are occasionally isolated include *Chlamydia pneumoniae*, *Streptococcus pyogenes*, viruses, and fungi (*Aspergillus fumigatus*). Fungal infections occur most often in patients who are immunosuppressed (Brook, 2018b). The most common organisms found with health care-associated (nosocomial) infections include *P. aeruginosa*, *Escherichia coli*, *Proteus mirabilis*, *Klebsiella pneumoniae*, and *Enterobacter* species, accounting for 60% of those cases (Brook, 2018b).

Clinical Manifestations

Symptoms of ABRS include purulent nasal drainage (anterior, posterior, or both) accompanied by nasal obstruction or a combination of facial pain, pressure, or a sense of fullness (referred to collectively as facial pain–pressure–fullness), or both (Rosenfeld et al., 2015; Sedaghat, 2017). The facial pain–pressure–fullness may involve the anterior face or the periorbital region. The patient may also report cloudy or colored nasal discharge, congestion, blockage, or stuffiness as well as a localized or diffuse headache. Patients with ABRS may present with a high fever (i.e., 39°C [102°F] or higher). In

addition, the occurrence of symptoms for 10 days or more after the initial onset of upper respiratory symptoms indicates ABRS (Brook, 2018a).

The symptoms of AVRS are similar to those of ABRS, except the patient does not present with a high fever, nor with the same intensity of symptoms (e.g., there tends to be an absence of facial pain–pressure–fullness), nor with symptoms that persist for as long a period of time. Symptoms of AVRS occur for fewer than 10 days after the onset of upper respiratory symptoms and do not worsen (Papadakis, McPhee, & Rabow, 2018).

Assessment and Diagnostic Findings

A careful history and physical examination are performed. The head and neck, particularly the nose, ears, teeth, sinuses, pharynx, and chest, are examined. There may be tenderness to palpation over the infected sinus area. The sinuses are percussed using the index finger, tapping lightly to determine whether the patient experiences pain. Although less frequently performed, transillumination of the affected area may reveal a decrease in the transmission of light with rhinosinusitis (see [Chapter 17](#)). Diagnostic imaging (x-ray, computed tomography [CT], magnetic resonance imaging [MRI]) is not recommended and generally not needed for the diagnosis of acute rhinosinusitis if the patient meets clinical diagnostic criteria (Aring & Chan, 2016; Rosenfeld et al., 2015). When a complication or alternative diagnosis is suspected, diagnostic imaging may be indicated to help identify inflammatory changes, bone destruction, and anatomic variations that can guide sinus surgery (if indicated).

To confirm the diagnosis of maxillary and frontal rhinosinusitis and identify the pathogen, sinus aspirates may be obtained. Flexible endoscopic culture techniques and swabbing of the sinuses have been used for this purpose (Papadakis et al., 2018).

Complications

If untreated, acute rhinosinusitis may lead to severe complications. Local complications include osteomyelitis and mucocele (cyst of the paranasal sinuses). Osteomyelitis requires prolonged antibiotic therapy and at times removal of necrotic bone. Intracranial complications, although rare, include cavernous sinus thrombosis, meningitis, brain abscess, ischemic brain infarction, and severe orbital cellulitis (Papadakis et al., 2018). Mucoceles may require surgical treatment to establish intranasal drainage or complete excision with ablation of the sinus cavity. Brain abscesses occur by direct spread and can be life-threatening. Frontal epidural abscesses are usually quiescent but can be detected by CT scan.

Medical Management

Treatment of acute rhinosinusitis depends on the cause; a 14-day course of antibiotics is prescribed for bacterial cases (Tewfik, 2018). The goals of treatment for acute rhinosinusitis are to shrink the nasal mucosa, relieve pain, and treat infection. Because of the inappropriate use of antibiotics for nonbacterial illness, including AVRS, and the resulting resistance that has occurred, oral antibiotics are only prescribed when there is sufficient empiric evidence that the patient has ABRS (e.g., high fever or symptoms that persist for at least 10 days or worsening symptoms following a viral respiratory illness).

Antibiotics should be given as soon as the diagnosis of ABRS is established. Amoxicillin or amoxicillin-clavulanic acid are the antibiotics of choice. For patients who are allergic to penicillin, doxycycline or respiratory quinolones such as levofloxacin or moxifloxacin can be prescribed (CDC, 2017). Other antibiotics prescribed previously to treat ABRS, including cephalosporins (e.g., cephalexin, cefuroxime, cefaclor, and cefixime), macrolides (e.g., clarithromycin and azithromycin), and trimethoprim-sulfamethoxazole are no longer recommended because they are not effective in treating antibiotic-resistant organisms that are now more commonly implicated in ABRS (Tewfik, 2018). Intranasal saline lavage is an effective adjunct therapy to antibiotics in that it may relieve symptoms, reduce inflammation, and help clear the passages of stagnant mucus. Neither decongestants nor antihistamines are recommended adjunctive medications for treating ABRS (Tewfik, 2018).

Treatment of AVRS typically involves nasal saline lavage and decongestants (guaifenesin/pseudoephedrine). Decongestants or nasal saline sprays can increase patency of the ostiomeatal unit and improve drainage of the sinuses. Topical decongestants should not be used for longer than 3 or 4 days. Oral decongestants must be used cautiously in patients with hypertension. OTC antihistamines, such as diphenhydramine and cetirizine, and prescription antihistamines, such as fexofenadine, are used if an allergic component is suspected.

Intranasal corticosteroids have been shown to produce complete or marked improvement in acute symptoms of either bacterial or viral rhinosinusitis; however, they are only recommended for use in patients with a previous history of allergic rhinitis (Rosenfeld et al., 2015). Examples of intranasal corticosteroids, side effects, and contraindications are presented in [Table 18-2](#).

Nursing Management



Educating Patients About Self-Care

Patient education is an important aspect of nursing care for the patient with acute rhinosinusitis. The nurse instructs the patient about symptoms of complications that require immediate follow-up. Referral to the primary provider is indicated if periorbital edema and severe pain on palpation occur. The nurse instructs the patient about methods to promote drainage of the sinuses, including humidification of the air in the home and the use of warm compresses to relieve pressure. The patient is advised to avoid swimming, diving, and air travel during the acute infection. Patients using tobacco are instructed to immediately stop smoking or using any form of tobacco. Many patients use nasal sprays incorrectly, which can lead to several side effects that include nasal irritation, nasal burning, bad taste, and drainage in the throat or even **epistaxis** (hemorrhage from the nose). Therefore, if an intranasal corticosteroid is prescribed, it is important to instruct the patient about the correct use of prescribed nasal sprays through demonstration, explanation, and return demonstration to evaluate the patient's understanding of the correct method of administration. The nurse also educates the patient about the side effects of prescribed and OTC nasal sprays and about rhinitis medicamentosa (rebound congestion). Once the decongestant is discontinued, the nasal passages close and congestion results. Appropriate medications to use for pain relief include acetaminophen and NSAIDs such as ibuprofen, naproxen sodium, and aspirin for adults older than 20 years as long as there are no contraindications to use.

TABLE 18-2 Select Nasal Corticosteroids and Common Side Effects

Nasal Corticosteroids	Side Effects	Contraindications (for All Nasal Corticosteroids)
Beclomethasone	Nasal irritation, headache, nausea, lightheadedness, epistaxis, rhinorrhea, watering eyes, sneezing, dry nose and throat	Avoid in patients with recurrent epistaxis, glaucoma, and cataracts. Patients who have been exposed to measles/varicella or who have adrenal insufficiency should avoid these medications.
Budesonide	Epistaxis, pharyngitis, cough, nasal irritation, bronchospasm	
Mometasone	Headache, viral infection, pharyngitis, epistaxis, cough, dysmenorrhea, musculoskeletal pain, arthralgia	
Triamcinolone	Pharyngitis, epistaxis, cough, headache	

Adapted from Comerford, K. C., & Durkin, M. T. (Eds.). (2020). *Nursing2020 drug handbook*. Philadelphia, PA: Wolters Kluwer; Peters, A. (2015). Rhinosinusitis: Synopsis. Retrieved on 5/8/2019 at:
www.worldallergy.org/professional/allergic_diseases_center/rhinosinusitis/sinusitissynopsis.php

The nurse tells patients with recurrent rhinosinusitis to begin decongestants, such as pseudoephedrine, at the first sign of rhinosinusitis. This promotes drainage and decreases the risk of bacterial infection. Patients should also check with their primary provider or pharmacist before using OTC medications because many cold medications can worsen symptoms or other health problems, specifically hypertension.

The nurse stresses the importance of following the recommended antibiotic regimen because a consistent blood level of the medication is critical to treat the infection. The nurse educates the patient about the early signs of a sinus infection and recommends preventive measures such as following healthy practices and avoiding contact with people with URIs.

The nurse explains to the patient that fever, severe headache, and **nuchal rigidity** (stiffness of the neck or inability to bend the neck) are signs of the potential complication of meningitis. Patients with chronic symptoms of rhinosinusitis who do not have marked improvement in 4 weeks with continuous medical treatment may be candidates for functional endoscopic sinus surgery (FESS, see later discussion) (Tajudeen & Kennedy, 2017).



Quality and Safety Nursing Alert

Patients with nasotracheal and nasogastric tubes in place are at the risk for development of sinus infections (Brook, 2018a; Brook, 2018b). Thus, accurate assessment of patients with these tubes is critical. Removal of the nasotracheal or nasogastric tube as soon as the patient's condition permits allows the sinuses to drain, possibly avoiding septic complications.

Chronic Rhinosinusitis and Recurrent Acute Rhinosinusitis

The prevalence of CRS is about 146 per 1000 population in the United States and occurs most commonly in young and middle-aged adults (Brook, 2018b). It is diagnosed when the patient has experienced 12 weeks or longer of two or more of the following symptoms: mucopurulent drainage, nasal obstruction, facial pain–pressure–fullness, or hyposmia (decreased sense of smell). It is estimated that in about 40% of patients, CRS is accompanied by nasal polyps (Rosenfeld et al., 2015). Recurrent acute rhinosinusitis is diagnosed when four or more episodes of ABRS occur per year with no signs or symptoms of rhinosinusitis between the episodes. The use of antibiotics in patients with recurrent acute rhinosinusitis is higher than in patients with CRS. Both CRS and recurrent acute rhinosinusitis affect quality of life as well as physical and social function (Hamilos, 2018).

Pathophysiology

Mechanical obstruction in the ostia of the frontal, maxillary, and anterior ethmoid sinuses (known collectively as the ostiomeatal complex) is the usual cause of CRS and recurrent acute rhinosinusitis. Obstruction prevents adequate drainage of the nasal passages, resulting in accumulation of secretions and an ideal medium for bacterial growth. Persistent blockage in an adult may occur because of infection, allergy, or structural abnormalities. Other associated conditions and factors may include cystic fibrosis, ciliary dyskinesia, neoplastic disorders, gastroesophageal reflux disease, tobacco use, and environmental pollution (Brook, 2018a).

Both aerobic and anaerobic bacteria have been implicated in CRS and recurrent rhinosinusitis. Common aerobic bacteria include alpha-hemolytic streptococci, microaerophilic streptococci, and *S. aureus*. Common anaerobic bacteria include gram-negative bacilli, *Peptostreptococcus*, and *Fusobacterium*.

In addition, immunodeficiency should be considered in patients with CRS or acute recurrent rhinosinusitis. Acute fulminant/invasive rhinosinusitis is a

life-threatening illness and is commonly attributed to *Aspergillus* in immunocompromised patients. Chronic fungal sinusitis also poses a risk. Chronic invasive fungal sinusitis occurs in immunocompromised patients along with fungus ball/mycetoma and allergic fungal sinusitis—the more common forms of chronic fungal sinusitis—which are considered noninvasive conditions in immunocompromised patients. The fungus ball is characterized by the presence of a noninvasive accumulation of a dense conglomeration of fungal hyphae in one sinus cavity, usually the maxillary sinus. The fungus generally remains contained in the fungus ball, which consists of mucopurulent cheesy or claylike materials within the sinus, but can become invasive when immunosuppression occurs, leading to encephalopathy (Ramadan, 2018). Symptoms include nasal stuffiness, nasal discharge, and facial pain. Vision loss, headache, and cranial nerve palsies have been identified in patients with a sphenoid sinus fungal ball (Ramadan, 2018).

Clinical Manifestations

Clinical manifestations of CRS include impaired mucociliary clearance and ventilation, cough (because the thick discharge constantly drips backward into the nasopharynx), chronic hoarseness, chronic headaches in the periorbital area, periorbital edema, and facial pain. As a result of chronic nasal congestion, the patient is usually required to breathe through the mouth. Snoring, sore throat, and, in some situations, adenoidal hypertrophy may also occur. Symptoms are generally most pronounced on awakening in the morning. Fatigue and nasal congestion are also common. Many patients experience a decrease in smell and taste and a sense of fullness in the ears.

Assessment and Diagnostic Findings

The health assessment focuses on onset and duration of symptoms. It addresses the quantity and quality of nasal discharge and cough, the presence of pain, factors that relieve or aggravate the pain, and allergies. It is essential to obtain any history of comorbid conditions, including asthma and history of tobacco use and smoking or use of electronic nicotine delivery systems (ENDS) including e-cigarettes, e-pens, e-pipes, e-hookah, and e-cigars. A history of fever, fatigue, previous episodes and treatments and previous response to therapies is also obtained.

In the physical assessment, the external nose is evaluated for any evidence of anatomic abnormality. A crooked-appearing external nose may imply septal deviation internally. The nasal mucous membranes are assessed for erythema, pallor, atrophy, edema, crusting, discharge, polyps, erosions, and septal perforations or deviations. Appropriate lighting improves visualization of the nasal cavity and should be used in every examination. Pain on examination of

the teeth, with tapping with a tongue blade, suggests tooth infection (Bickley & Szilagyi, 2017).

Assessment of the posterior oropharynx may reveal purulent or mucoid discharge, which is indicative of an infection caused by CRS. The patient's eyes are examined for conjunctival erythema, tearing, photophobia, and edema of the lids. Additional assessment techniques include transillumination of the sinuses and palpation of the sinuses. The frontal and maxillary sinuses are palpated, and the patient is asked whether this produces tenderness. The pharynx is inspected for erythema and discharge and palpated for cervical node adenopathy (Hamilos, 2018).

Imaging studies such as x-ray, sinoscopy, ultrasound, CT scanning, and MRI may be used in the diagnosis of CRS. X-ray is an inexpensive and readily available tool to assess disorders of the paranasal sinuses. A CT scan of the paranasal sinuses can identify mucosal abnormalities, sinus ostial obstruction, anatomic variants, sinonasal polyposis, and neoplastic disease. In addition, nasal endoscopy allows for visualization of the posterior nasal cavity, nasopharynx, and sinus drainage pathways and can identify posterior septal deviation and polyps. Osseous destruction, extrasinus extension of the disease process, and local invasion suggest malignancy (Rosenfeld et al., 2015).

Complications

Complications of CRS, although uncommon, include severe orbital cellulitis, subperiosteal abscess, cavernous sinus thrombosis, meningitis, encephalitis, and ischemic infarction. CRS can lead to intracranial infection either by direct spread through bone or via venous channels, resulting in epidural abscess, subdural empyema, meningitis, and brain abscess. Clinical sequelae can include personality changes with frontal lobe abscesses, headache, symptoms of elevated intracranial pressure to include alterations of consciousness, visual changes, focal neurologic deficits, seizures, and, ultimately, coma and death.

Frontal rhinosinusitis can lead to osteomyelitis of the frontal bones. Patients typically present with headache, fever, and a characteristic doughy edema over the involved bone. Ethmoid rhinosinusitis may result in orbital cellulitis, which usually begins with edema of the eyelids and rapidly progresses to ptosis (droopy eyelid), proptosis (bulging eye), chemosis (edema of the bulbar conjunctiva), and diminished extraocular movements. Patients are usually febrile and acutely ill and require immediate attention, because pressure on the optic nerve can lead to loss of vision and spread of infection can lead to intracranial infection (Brook, 2018a). Cavernous sinus thrombophlebitis can result from extension of infection along venous channels from the orbit, ethmoid or frontal sinuses, or nose. Symptoms may include altered consciousness, lid edema, and proptosis, as well as third, fourth, and sixth cranial nerve palsies.

Medical Management

Medical management of CRS and recurrent acute rhinosinusitis is similar to that of acute rhinosinusitis. General measures include encouraging adequate hydration and recommending the use of OTC nasal saline sprays, antispasmodic agents such as acetaminophen or NSAIDs, and decongestants such as oxymetazoline and pseudoephedrine (Brook, 2018b; Tewfik, 2018). Patients are instructed to sleep with the head of the bed elevated and to avoid exposure to cigarette smoke and fumes. Patients are cautioned to avoid caffeine and alcohol, which can cause dehydration.

Prescribed antibiotics may include amoxicillin-clavulanic acid, erythromycin-sulfisoxazole, second- or third-generation cephalosporins such as cefuroxime or cefixime, or newer fluoroquinolones such as moxifloxacin (Brook, 2018b). The course of antibiotic treatment for CRS and recurrent ABRS is typically as long as 2 to 4 weeks to effectively eradicate the offending organism, and may be indicated for up to 12 months in some cases (Brook, 2018b). Corticosteroid nasal sprays such as fluticasone or beclomethasone may be indicated in patients with concomitant allergic rhinitis or nasal polyps. Patients with allergic rhinitis may also benefit from the addition of a mast cell stabilizer such as cromolyn. For patients with concomitant asthma, leukotriene inhibitors such as montelukast and zafirlukast may be used (Brook, 2018b).

Surgical Management

If standard medical therapy fails and symptoms persist, FESS may be indicated to correct structural deformities that obstruct the ostia (openings) of the sinuses. FESS is a minimally invasive surgical procedure that is associated with reduced postoperative discomfort and improvement in the patient's quality of life. In particular, FESS is associated with either complete or moderate relief of symptoms in more than 85% to 91% of patients (Patel, 2016). Some of the specific procedures performed include excising and cauterizing nasal polyps, correcting a deviated septum, incising and draining the sinuses, aerating the sinuses, and removing tumors. Computer-assisted or computer-guided surgery is used to increase the precision of the surgical procedure and to minimize complications. Antimicrobial agents are typically prescribed after surgery (Patel, 2016).

Surgical intervention is first-line treatment in acute invasive fungal rhinosinusitis to excise the fungus ball and necrotic tissue and drain the sinuses. Patients require aggressive surgical débridement and drainage as well as systemic antifungal medications (Ramadan, 2018).

Nursing Management

Patients usually perform care measures for rhinosinusitis at home; therefore, nursing management consists of good patient education.



Educating Patients About Self-Care

Many people with sinus infections tend to blow their nose frequently and with force to clear their nasal passages. Doing so often increases the symptoms; therefore, the patient is instructed to blow the nose gently and to use tissue to remove the nasal drainage. Increasing fluid intake, applying local heat (hot wet packs), and elevating the head of the bed promote drainage of the sinuses. The nurse also instructs the patient about the importance of following the prescribed medication regimen. Instructions on the early signs of a sinus infection are provided, and preventive measures are reviewed. The nurse instructs the patient about signs and symptoms that require follow-up and provides these instructions verbally and in writing. Instructions in alternative formats (e.g., large font, patient's language) may be needed to increase the patient's understanding and adherence to the treatment plan. The nurse encourages the patient to follow up with their primary provider if symptoms persist (American Academy of Otolaryngology–Head and Neck Surgery Foundation, 2018).



Quality and Safety Nursing Alert

URIs, specifically CRS and recurrent acute rhinosinusitis, may be linked to primary or secondary immune deficiency or treatment with immunosuppressive therapy (e.g., for cancer or organ transplantation). Typical symptoms may be blunted or absent due to immunosuppression. Immunocompromised patients are at the increased risk for acute or chronic fungal infections; these infections can progress rapidly and become life-threatening (Brook, 2018a; Brook, 2018b). Thus, assessment, early reporting of symptoms to the patient's primary provider, and immediate initiation of treatment are essential.

Pharyngitis

Acute Pharyngitis

Acute **pharyngitis** is a sudden painful inflammation of the pharynx, the back portion of the throat that includes the posterior third of the tongue, soft palate, and tonsils. It is commonly referred to as a sore throat. In the United States,

approximately 12 million health care visits are due to acute pharyngitis each year (Chow & Doron, 2018). Because of environmental exposure to viral agents and poorly ventilated rooms, the incidence of viral pharyngitis peaks during winter and early spring in regions that have warm summers and cold winters. Viral pharyngitis spreads easily in the droplets of coughs and sneezes, as well as from unclean hands that have been exposed to the contaminated fluids.

Pathophysiology

Viral infection causes most cases of acute pharyngitis. Responsible viruses include the adenovirus, influenza virus, Epstein–Barr virus, and herpes simplex virus. Bacterial infection accounts for the remainder of cases. Five percent to 15% of adults with pharyngitis have group A beta-hemolytic streptococcus (GABHS), which is commonly referred to as group A streptococcus (GAS) or streptococcal pharyngitis. Streptococcal pharyngitis warrants the use of antibiotic treatment. When GAS causes acute pharyngitis, the condition is known as strep throat. The body responds by triggering an inflammatory response in the pharynx. This results in pain, fever, vasodilation, edema, and tissue damage, manifested by redness and swelling in the tonsillar pillars, uvula, and soft palate. A creamy exudate may be present in the tonsillar pillars (Fig. 18-2). Other organisms implicated in acute pharyngitis include groups B and G streptococci, *Neisseria gonorrhoeae*, *Mycoplasma pneumoniae*, *C. pneumoniae*, *Arcanobacterium haemolyticum*, and HIV (Chow & Doron, 2018).

Uncomplicated viral infections usually subside promptly, within 3 to 10 days after onset. However, pharyngitis caused by bacteria, such as GAS, is a more severe illness. If left untreated, the complications can be severe and life-threatening. Complications include rhinosinusitis, otitis media, peritonsillar abscess, mastoiditis, and cervical adenitis. In rare cases, the infection may lead to sepsis, pneumonia, meningitis, rheumatic fever, and glomerulonephritis (Buensalido, 2019a).

Clinical Manifestations

The signs and symptoms of acute pharyngitis include a fiery-red pharyngeal membrane and tonsils, lymphoid follicles that are swollen and flecked with white-purple exudate, enlarged and tender cervical lymph nodes, and no cough. Fever (higher than 38.3°C [101°F]) and malaise also may be present. Occasionally, patients with GAS pharyngitis exhibit vomiting, anorexia, and a scarlatina-form rash with urticaria known as scarlet fever.

People who have streptococcal pharyngitis suddenly develop a painful sore throat 1 to 5 days after being exposed to the streptococcus bacteria. They

usually report malaise, fever (with or without chills), headache, myalgia, painful cervical adenopathy, and nausea. The tonsils appear swollen and erythematous, and they may or may not have an exudate. The roof of the mouth is often erythematous and may demonstrate petechiae. Bad breath is common.

Assessment and Diagnostic Findings

Accurate diagnosis of pharyngitis is essential to determine the cause (viral or bacterial) and to initiate treatment early. Rapid antigen detection testing (RADT) uses swabs that collect specimens from the posterior pharynx and tonsil. RADT is reported to be 90% to 95% sensitive, thus facilitating earlier treatment and earlier symptom improvement and reductions in pathogen transmission. Negative results should be confirmed by a throat culture (Acerra, 2018). In most communities, preliminary culture reports are available in 24 hours. Once a definitive diagnosis of GAS is made, administration of appropriate antibiotics hastens symptom resolution and reduces the transmission of the illness.

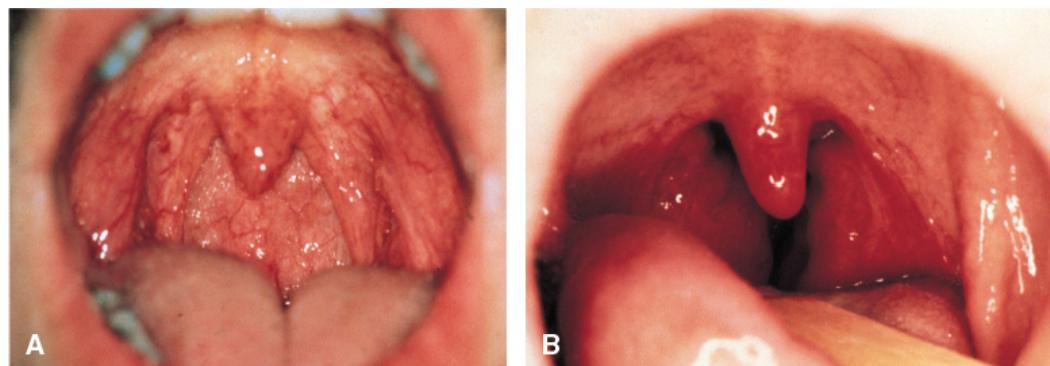


Figure 18-2 • Pharyngitis—inflammation without exudate. **A.** Redness and vascularity of the pillars and uvula are mild to moderate. **B.** Redness is diffuse and intense. Each patient would probably complain of a sore throat. Reprinted with permission from the Wellcome Trust, National Medical Slide Bank, London, UK.

Medical Management

Viral pharyngitis is treated with supportive measures because antibiotics have no effect on the causal organism. Bacterial pharyngitis is treated with a variety of antimicrobial agents (Uyeki, Bernstein, Bradley, et al., 2018).

Pharmacologic Therapy

If the cause of pharyngitis is bacterial, penicillin is usually the treatment of choice. Penicillin V potassium given orally for 10 days is the regimen of choice. Penicillin injections are recommended only if there is a concern that the patient will not adhere to therapy (Papadakis et al., 2018).

For patients who are allergic to penicillin or have organisms that are resistant to erythromycin (one fifth of GAS and most *S. aureus* organisms are resistant to penicillin and erythromycin), cephalosporins and macrolides (clarithromycin and azithromycin) may be used. Once-daily azithromycin may be given for only 3 days due to its long half-life (Acerra, 2018). A 5- or 10-day course of cephalosporin may be prescribed. Five-day administration of cefpodoxime and cefuroxime has also been successful in producing bacteriologic cures.

Severe sore throats can also be relieved by analgesic medications. For example, aspirin or acetaminophen can be taken at 4- to 6-hour intervals; if required, acetaminophen with codeine can be taken three or four times daily. In severe cases, gargles with benzocaine may relieve symptoms.

Nutritional Therapy

A liquid or soft diet is provided during the acute stage of the disease, depending on the patient's appetite and the degree of discomfort that occurs with swallowing. Cool beverages, warm liquids, and flavored frozen desserts such as ice pops are often soothing. Occasionally, the throat is so sore that liquids cannot be taken in adequate amounts by mouth. In severe situations, intravenous (IV) fluids may be needed. Otherwise, the patient is encouraged to drink as much fluid as possible (at least 2 to 3 L/day).

Nursing Management

Nursing care for patients with viral pharyngitis focuses on symptomatic management. For patients who demonstrate signs of strep throat and have a history of rheumatic fever, who have scarlet fever, or who have symptoms suggesting peritonsillar abscess, nursing care focuses on prompt initiation and correct administration of prescribed antibiotic therapy. The nurse instructs the patient about signs and symptoms that warrant prompt contact with the primary provider. These include dyspnea, drooling, inability to swallow, and inability to fully open the mouth.

The nurse instructs the patient to stay in bed during the febrile stage of illness and to rest frequently once up and about. Used tissues should be disposed of properly to prevent the spread of infection. The nurse (or the patient or family member, if the patient is not hospitalized) should examine the skin once or twice daily for possible rash, because acute pharyngitis may precede some other communicable diseases (e.g., rubella).

Depending on the severity of the pharyngitis and the degree of pain, warm saline gargles or throat irrigations are used. The benefits of this treatment depend on the degree of heat that is applied. The nurse educates the patient about these procedures and about the recommended temperature of the solution, which should be high enough to be effective and as warm as the patient can tolerate, usually 40.6° to 43.3°C (105° to 110°F). Irrigating the throat may reduce spasm in the pharyngeal muscles and relieve soreness of the throat.

An ice collar also can relieve severe sore throats. Mouth care may promote the patient's comfort and prevent the development of fissures (cracking) of the lips and oral inflammation when bacterial infection is present. The nurse instructs the patient to resume activity gradually and to delay returning to work or school until after 24 hours of antibiotic therapy. A full course of antibiotic therapy is indicated in patients with strep infection because of the potential complications such as nephritis and rheumatic fever, which may have their onset 2 or 3 weeks after the pharyngitis has subsided. The nurse instructs the patient and family about the importance of taking the full course of antibiotic therapy and informs them about the symptoms to watch for that may indicate complications.

In addition, the nurse instructs the patient about preventive measures that include not sharing eating utensils, glasses, napkins, food, or towels; cleaning telephones after use; using a tissue to cough or sneeze; disposing of used tissues appropriately; coughing or sneezing into the upper arm if tissues are not readily available; and avoiding exposure to tobacco and secondhand smoke. The nurse also instructs the patient with pharyngitis, especially streptococcal pharyngitis, to replace their toothbrush with a new one.

Chronic Pharyngitis

Chronic pharyngitis is a persistent inflammation of the pharynx. It is common in adults who work in dusty surroundings, use their voice to excess, suffer from chronic cough, or habitually use alcohol and tobacco.

There are three types of chronic pharyngitis:

- Hypertrophic—characterized by general thickening and congestion of the pharyngeal mucous membrane
- Atrophic—probably a late stage of the first type (the membrane is thin, whitish, glistening, and at times wrinkled)
- Chronic granular—characterized by numerous swollen lymph follicles on the pharyngeal wall

Clinical Manifestations

Patients with chronic pharyngitis complain of a constant sense of irritation or fullness in the throat, mucus that collects in the throat and can be expelled by coughing, and difficulty swallowing. This is often associated with intermittent postnasal drip that causes minor irritation and inflammation of the pharynx. A sore throat that is worse with swallowing in the absence of pharyngitis suggests the possibility of thyroiditis, and patients with this symptom are referred for the evaluation of possible thyroiditis.

Medical Management

Treatment of chronic pharyngitis is based on relieving symptoms; avoiding exposure to irritants; and correcting any upper respiratory, pulmonary, gastrointestinal, or cardiac condition that might be responsible for a chronic cough.

Nasal congestion may be relieved by short-term use of nasal sprays or medications containing ephedrine sulfate or phenylephrine. For a patient with a history of allergy, one of the antihistamine decongestant medications, such as pseudoephedrine or brompheniramine/pseudoephedrine, is prescribed orally every 4 to 6 hours. Aspirin (for patients older than 20 years) or acetaminophen is recommended for its analgesic properties.

For adults with chronic pharyngitis, tonsillectomy may be offered as an option, although its effectiveness in reaping long-term improvement in symptoms has not been established (Burton, Glasziou, Chong, et al., 2014). For further information, see the Tonsillitis and Adenoiditis section.

Nursing Management



Educating Patients About Self-Care

The nurse recommends avoidance of alcohol, tobacco, ENDS use, secondhand smoke, and exposure to cold or to environmental or occupational pollutants. The patient may minimize exposure to pollutants by wearing a disposable facemask, preferably an N95 mask, which can filter out 95% of small particles, including dusts and molds (National Institute for Occupational Safety and Health, 2018). The nurse encourages the patient to drink plenty of fluids. Gargling with warm saline solution may relieve throat discomfort. Lozenges keep the throat moistened (Stead, 2017).

Tonsillitis and Adenoiditis

The tonsils are composed of lymphatic tissue and are situated on each side of the oropharynx. The faucial or palatine tonsils and lingual tonsils are located behind the pillars of fauces and tongue, respectively. They frequently serve as the site of infection (**tonsillitis**). Acute tonsillitis can be confused with pharyngitis. Chronic tonsillitis is less common and may be mistaken for other disorders such as allergy, asthma, and rhinosinusitis.

The adenoids or pharyngeal tonsils consist of lymphatic tissue near the center of the posterior wall of the nasopharynx. Infection of the adenoids frequently accompanies acute tonsillitis. Frequently occurring bacterial pathogens include GABHS, the most common organism. The most common viral pathogen is Epstein–Barr virus, although cytomegalovirus may also cause tonsillitis and adenoiditis. Often thought of as a childhood disorder, tonsillitis can occur in adults.

Clinical Manifestations

The symptoms of tonsillitis include sore throat, fever, snoring, and difficulty swallowing. Enlarged adenoids may cause mouth breathing, earache, draining ears, frequent head colds, bronchitis, foul-smelling breath, voice impairment, and noisy respiration. Unusually enlarged adenoids fill the space behind the posterior nares, making it difficult for the air to travel from the nose to the throat and resulting in nasal obstruction. Infection can extend to the middle ears by way of the auditory (eustachian) tubes and may result in acute otitis media, which can lead to spontaneous rupture of the tympanic membranes (eardrums) and further extension of the infection into the mastoid cells, causing acute mastoiditis. The infection also may reside in the middle ear as a chronic, low-grade, smoldering process that eventually may cause permanent deafness.

Assessment and Diagnostic Findings

The diagnosis of acute tonsillitis is primarily clinical, with attention given to whether the illness is viral or bacterial in nature. As in acute pharyngitis, RADT is quick and convenient; however, it is less sensitive than the throat swab culture.

A thorough physical examination is performed and a careful history is obtained to rule out related or systemic conditions. The tonsillar site is cultured to determine the presence of bacterial infection. When cytomegalovirus infection is present, the differential diagnosis should include HIV, hepatitis A, and rubella. In adenoiditis, if recurrent episodes of suppurative otitis media result in hearing loss, comprehensive audiometric assessment is warranted (see Chapter 59).

Medical Management

Tonsillitis is treated with supportive measures that include increased fluid intake, antispasmodic agents, salt-water gargles, and rest. Bacterial infections are treated with penicillin (first-line therapy) or cephalosporins. Viral tonsillitis is not effectively treated with antibiotic therapy.

Tonsillectomy (with or without adenoidectomy) continues to be a commonly performed surgical procedure and remains the treatment of choice for patients with chronic tonsillitis (Shah, 2018). Adults who have undergone a tonsillectomy to treat recurrent streptococcal infections experience a decrease in the number of episodes of streptococcal or other throat infections or days with throat pain (Busaba & Doron, 2018).

Tonsillectomy is indicated if the patient has had repeated episodes of tonsillitis despite antibiotic therapy; hypertrophy of the tonsils and adenoids that could cause obstruction and obstructive sleep apnea (OSA); repeated attacks of purulent otitis media; and suspected hearing loss due to serous otitis media that has occurred in association with enlarged tonsils and adenoids. Indications for adenoidectomy include chronic nasal airway obstruction, chronic rhinorrhea, obstruction of the auditory tube with related ear infections, and abnormal speech. Surgery is also indicated if the patient has developed a peritonsillar abscess that occludes the pharynx, making swallowing difficult and endangering the patency of the airway (particularly during sleep). The presence of persistent tonsillar asymmetry should prompt an excisional biopsy to rule out lymphoma (Papadakis et al., 2018). Antibiotic therapy may be initiated for patients undergoing tonsillectomy or adenoidectomy. Therapy may include oral penicillin or a cephalosporin (e.g., cefdinir or moxifloxacin).

Nursing Management

Providing Postoperative Care

Continuous nursing observation is required in the immediate postoperative and recovery periods because of the risk of hemorrhage, which may also compromise the patient's airway (Drake & Carr, 2017). In the immediate postoperative period, the most comfortable position is prone, with the patient's head turned to the side to allow drainage from the mouth and pharynx. The nurse must not remove the oral airway until the patient's gag and swallowing reflexes have returned. The nurse applies an ice collar to the neck, and a basin and tissues are provided for the expectoration of blood and mucus.

Symptoms of postoperative complications include fever, throat pain, ear pain, and bleeding. Pain can be effectively controlled with analgesic medications. Postoperative bleeding may be seen as bright red blood if the patient expectorates it before swallowing it. If the patient swallows the blood, it becomes brown because of the action of the acidic gastric juice. If the patient

vomits large amounts of dark blood or bright-red blood at frequent intervals, or if the pulse rate and temperature rise and the patient is restless, the nurse notifies the surgeon immediately. The nurse should have the following items ready for the examination of the surgical site for bleeding: a light, a mirror, gauze, curved hemostats, and a waste basin.

Occasionally, suture or ligation of a bleeding vessel is required. In such cases, the patient is taken to the operating room and given general anesthesia. After ligation, continuous nursing observation and postoperative care are required, as in the initial postoperative period. If there is no bleeding, water and ice chips may be given to the patient as soon as desired. The patient is instructed to refrain from too much talking and coughing, because these activities can produce throat pain (see [Chapter 16](#) for further discussion of postoperative nursing care).



Educating Patients About Self-Care

Tonsillectomy and adenoidectomy are usually performed as outpatient surgery, and the patient is sent home from the recovery room once awake, oriented, and able to drink liquids and void. The patient and family must understand the signs and symptoms of hemorrhage. Bleeding may occur up to 8 days after surgery. The nurse instructs the patient about the use of liquid acetaminophen with or without codeine for pain control and explains that the pain will subside during the first 3 to 5 days. The nurse informs the patient about the need to take the full course of any prescribed antibiotic for the first postoperative week (Drake & Carr, 2017).

Alkaline mouthwashes and warm saline solutions are useful in coping with the thick mucus and halitosis that may be present after surgery. The nurse should explain to the patient that a sore throat, stiff neck, minor ear pain, and vomiting may occur in the first 24 hours. The patient should eat an adequate diet with soft foods, which are more easily swallowed than hard foods. The patient should avoid spicy, hot, acidic, or rough foods. Milk and milk products (ice cream and yogurt) may be restricted because they make removal of mucus more difficult for some patients. The nurse instructs the patient about the need to maintain good hydration. The patient is advised to avoid vigorous toothbrushing or gargling because these activities can cause bleeding. The nurse encourages the use of a cool-mist vaporizer or humidifier in the home postoperatively. The patient should avoid smoking and heavy lifting or exertion for 10 days.

Peritonsillar Abscess

Peritonsillar abscess (also called *quinsy*) is the most common major suppurative complication of sore throat accounting for roughly 30% of soft tissue head and neck abscesses. It most commonly afflicts adults between the ages of 20 and 40 years, with the incidence roughly the same between men and women (Flores, 2018). This collection of purulent exudate between the tonsillar capsule and the surrounding tissues, including the soft palate, may develop after an acute tonsillar infection that progresses to a local cellulitis and abscess. Several bacteria are typically implicated in the pathogenesis of these abscesses, including *S. pyogenes*, *S. aureus*, *Neisseria* species, and *Corynebacterium* species (Flores, 2018; Shah, 2018). In more severe cases, the infection can spread over the palate and to the neck and chest. Edema can cause airway obstruction, which can be life-threatening and is a medical emergency. Peritonsillar abscess can be life-threatening with mediastinitis, intracranial abscess, and empyemas resulting from spread of infection. Early detection and aggressive management are essential (Flores, 2018).

Clinical Manifestations

The patient with a peritonsillar abscess is acutely ill with a severe sore throat, fever, trismus (inability to open the mouth), and drooling. Inflammation of the medial pterygoid muscle that lies lateral to the tonsil results in spasm, severe pain, and difficulty in opening the mouth fully. The pain may be so intense that the patient has difficulty swallowing saliva. The patient's breath often smells rancid. Other symptoms include a raspy voice, odynophagia (a severe sensation of burning, squeezing pain while swallowing), **dysphagia** (difficulty swallowing), and otalgia (pain in the ear). Odynophagia is caused by the inflammation of the superior constrictor muscle of the pharynx that forms the lateral wall of the tonsil. This causes pain on lateral movement of the head. The patient may also have tender and enlarged cervical lymph nodes. Examination of the oropharynx reveals erythema of the anterior pillar and soft palate as well as a purulent tonsil on the side of the peritonsillar abscess. The tonsil is pushed inferomedially, and the uvula is shifted contralaterally (Flores, 2018).

Assessment and Diagnostic Findings

Emergency department (ED) physicians frequently are the providers who diagnose patients with peritonsillar abscesses. When this occurs in the ED setting, the ED physician decides whether aspiration—an invasive procedure—should be carried out based on the patient's clinical picture. Intraoral ultrasound and transcutaneous cervical ultrasound are used in the diagnosis of peritonsillar cellulitis and abscesses (Gosselin, 2018).

Medical Management

Antimicrobial agents and corticosteroid therapy are used for the treatment of peritonsillar abscess. Antibiotics (usually penicillin) are extremely effective in controlling the infection, and if they are prescribed early in the course of the disease, the abscess may resolve without needing to be incised. However, if the abscess does not resolve, treatment choices include needle aspiration, incision and drainage under local or general anesthesia, and drainage of the abscess with simultaneous tonsillectomy. Following needle aspiration (discussed later) intramuscular administration of clindamycin can be used in the outpatient setting, thus reducing both antibiotic and hospital costs. The use of topical anesthetic agents and throat irrigations may be prescribed to promote comfort along with administration of prescribed analgesic agents (Flores, 2018).

Patients with complications require hospitalization for IV antibiotics, imaging studies, observation, and proper airway management. Rarely, the patient with a peritonsillar abscess presents with acute airway obstruction and requires immediate airway management. Procedures may include intubation, cricothyroidotomy, or tracheotomy (Flores, 2018).

Surgical Management

Needle aspiration may be preferred over a more extensive procedure due to its high efficacy, low cost, and patient tolerance. The mucous membrane over the swelling is first sprayed with a topical anesthetic and then injected with a local anesthetic. Single or repeated needle aspirations are performed to decompress the abscess. Alternatively, the abscess may be incised and drained (Flores, 2018). These procedures are performed best with the patient in the sitting position to make it easier to expectorate the pus and blood that accumulate in the pharynx. The patient experiences almost immediate relief. Incision and drainage is also an effective option but is more painful than needle aspiration.

Tonsillectomy is considered for patients who are poor candidates for needle aspiration or incision and drainage (Flores, 2018).

Nursing Management

If the patient requires intubation, cricothyroidotomy, or tracheotomy to treat airway obstruction, the nurse assists with the procedure and provides support to the patient before, during, and after the procedure. The nurse also assists with the needle aspiration when indicated.

The nurse encourages the patient to use prescribed topical anesthetic agents and assists with throat irrigations or the frequent use of mouthwashes or gargles, using saline or alkaline solutions at a temperature of 40.6° to 43.3°C (105° to 110°F). Gentle gargling after the procedure with a cool normal saline gargle may relieve discomfort. The patient must be upright and clearly

expectorate forward. The nurse instructs the patient to gargle *gently* at intervals of 1 or 2 hours for 24 to 36 hours. Liquids that are cool or at room temperature are usually well tolerated. Adequate fluids must be provided to treat dehydration and prevent its recurrence.

The nurse also observes the patient for complications and instructs the patient about signs and symptoms of complications that require prompt attention by the patient's primary provider. At discharge, the nurse provides verbal and written instructions regarding foods to avoid, when to return to work, and the need to refrain from or cease smoking. The need for continuation of good oral hygiene is also reinforced.

Laryngitis

Laryngitis, an inflammation of the larynx, can occur as a result of voice abuse, exposure to dust, chemicals, smoke and other pollutants; or as part of a URI. It also may be caused by isolated infection involving only the vocal cords. Laryngitis can also be associated with gastroesophageal reflux (referred to as reflux laryngitis).

Laryngitis is very often caused by the pathogens that cause the common cold and pharyngitis; the most common cause is a virus, and laryngitis is often associated with allergic rhinitis or pharyngitis. Bacterial invasion may be secondary. The onset of infection may be associated with exposure to sudden temperature changes, dietary deficiencies, malnutrition, or an immunosuppressed state. Viral laryngitis is common in the winter and is easily transmitted to others.

Clinical Manifestations

Signs of acute laryngitis include hoarseness or **aphonia** (loss of voice) and severe cough. Chronic laryngitis is marked by persistent hoarseness. Other signs of acute laryngitis include sudden onset made worse by cold dry wind. The throat feels worse in the morning and improves when the patient is indoors in a warmer climate. At times, the patient presents with a dry cough and a dry, sore throat that worsens in the evening hours. If allergies are present, the uvula will be visibly edematous. Many patients also complain of a "tickle" in the throat that is made worse by cold air or cold liquids.

Medical Management

Management of acute laryngitis includes resting the voice, avoiding irritants (including smoking), resting, and inhaling cool steam or an aerosol. If the laryngitis is part of a more extensive respiratory infection caused by a bacterial

organism or if it is severe, appropriate antibacterial therapy is instituted. The majority of patients recover with conservative treatment; however, laryngitis tends to be more severe in older adult patients and may be complicated by pneumonia.

For chronic laryngitis, the treatment includes resting the voice, eliminating any primary respiratory tract infection, eliminating smoking, and avoiding secondhand smoke. Corticosteroids, such as beclomethasone, may be given. These preparations have few systemic or long-lasting effects and may reduce local inflammatory reactions. Treatment of reflux laryngitis typically involves use of proton pump inhibitors such as omeprazole given once daily.

Nursing Management

The nurse instructs the patient to rest the voice and to maintain a well-humidified environment. If laryngeal secretions are present during acute episodes, expectorant agents are suggested, along with a daily fluid intake of 2 to 3 L to thin secretions. The nurse instructs the patient about the importance of taking prescribed medications, including proton pump inhibitors, and using continuous positive airway therapy at bedtime, if prescribed for OSA. In cases involving infection, the nurse informs the patient that the symptoms of laryngitis often extend a week to 10 days after completion of antibiotic therapy. The nurse instructs the patient about signs and symptoms that require contacting the primary provider. These signs and symptoms include loss of voice with sore throat that makes swallowing saliva difficult, hemoptysis, and noisy respirations. Continued hoarseness after voice rest or laryngitis that persists for longer than 5 days must be reported because of the possibility of malignancy.

NURSING PROCESS

The Patient with Upper Airway Infection

Assessment

A health history may reveal signs and symptoms of headache, sore throat, pain around the eyes and on either side of the nose, difficulty in swallowing, cough, hoarseness, fever, stuffiness, and generalized discomfort and fatigue. Determining when the symptoms began, what precipitated them, what if anything relieves them, and what aggravates them is part of the assessment. The nurse should also determine any history of allergy or the existence of a concomitant illness. Inspection may reveal swelling, lesions, or asymmetry of the nose as well as bleeding or discharge. The nurse inspects the nasal mucosa for abnormal findings such as increased redness, swelling, exudate, and nasal polyps, which may develop in chronic rhinitis. The mucosa of the nasal turbinates may also be swollen (boggy) and pale bluish-gray. The nurse palpates the frontal and maxillary sinuses for tenderness, which suggests inflammation and then inspects the throat by having the patient open the mouth wide and take a deep breath. Redness, asymmetry, or evidence of drainage, ulceration, or enlargement of the tonsils and pharynx is abnormal. Palpation of the neck lymph nodes for enlargement and tenderness is necessary.

Diagnosis

NURSING DIAGNOSES

Based on the assessment data, nursing diagnoses may include the following:

- Impaired airway clearance associated with excessive mucus production secondary to retained secretions and inflammation
- Acute pain associated with upper airway irritation secondary to an infection
- Impaired verbal communication associated with physiologic changes and upper airway irritation secondary to infection or swelling
- Hypovolaemia associated with decreased fluid intake and increased fluid loss secondary to diaphoresis associated with a fever
- Lack of knowledge regarding prevention of URIs, treatment regimen, surgical procedure, or postoperative self-care

COLLABORATIVE PROBLEMS/POTENTIAL COMPLICATIONS

Based on the assessment data, potential complications include:

- Sepsis
- Meningitis or brain abscess
- Peritonsillar abscess, otitis media, or rhinosinusitis

Planning and Goals

The major goals for the patient may include maintenance of a patent airway, relief of pain, maintenance of effective means of communication, normal hydration, knowledge of how to prevent upper airway infections, and absence of complications.

Nursing Interventions

MAINTAINING A PATENT AIRWAY

An accumulation of secretions can block the airway in patients with an upper airway infection. As a result, changes in the respiratory pattern occur and the work of breathing increases to compensate for the blockage. The nurse can implement several measures to loosen thick secretions or to keep the secretions moist so that they can be easily expectorated. Increasing fluid intake helps thin the mucus. The use of room vaporizers or steam inhalation also loosens secretions and reduces inflammation of the mucous membranes. To enhance drainage from the sinuses, the nurse instructs the patient about positioning; this depends on the location of the infection or inflammation. For example, drainage for rhinosinusitis or rhinitis is achieved in the upright position. In some conditions, topical or systemic medications, when prescribed, help relieve nasal or throat congestion.

PROMOTING COMFORT

URIs usually produce localized discomfort. In rhinosinusitis, pain may occur in the area of the sinuses, or a general headache may be produced. In pharyngitis, laryngitis, or tonsillitis, a sore throat occurs. The nurse encourages the patient to take antispasmodic agents, such as acetaminophen with codeine, as prescribed, to relieve this discomfort. A pain intensity rating scale (see [Chapter 9](#)) may be used to assess effectiveness of pain relief measures. Other helpful measures include topical anesthetic agents for symptomatic relief of herpes simplex blisters (see [Chart 18-3](#)) and sore throats, hot packs to relieve the congestion of rhinosinusitis and promote drainage, and warm water gargles or irrigations to relieve the pain of a sore throat. The nurse encourages rest to relieve the generalized discomfort and fever that accompany many upper airway conditions (especially rhinitis, pharyngitis, and laryngitis). For postoperative care after tonsillectomy and adenoidectomy, an ice collar may reduce swelling and decrease bleeding.

PROMOTING COMMUNICATION

Upper airway infections may result in hoarseness or loss of speech. The nurse instructs the patient to refrain from speaking as much as possible and, if possible, to communicate in writing instead. Additional strain on the vocal cords may delay full return of the voice. The nurse encourages the patient and family to use alternative forms of communication, such as a

memo pad, bell, or a smartphone or other electronic devices to signal for assistance.

ENCOURAGING FLUID INTAKE

Upper airway infections lead to fluid loss. Sore throat, malaise, and fever may interfere with a patient's willingness to eat and drink. The nurse provides a list of easily ingested foods to increase caloric intake during the acute phase of illness. These include soups, gelatin, pudding, yogurt, cottage cheese, high-protein drinks, water, ice, and ice pops. The nurse encourages the patient to drink 2 to 3 L of fluid per day during the acute stage of airway infection, unless contraindicated, to thin the secretions and promote drainage. Liquids (hot or cold) may be soothing, depending on the disorder.

PROMOTING HOME, COMMUNITY-BASED, AND TRANSITIONAL CARE



Educating Patients About Self-Care. Prevention of most upper airway infections is challenging because of the many potential causes. But because most URIs are transmitted by hand-to-hand contact, the nurse educates the patient and family about techniques to minimize the spread of infection to others, including implementing hand hygiene measures. The nurse advises the patient to avoid exposure to people who are at the risk for serious illness if respiratory infection is transmitted (older adults, people who are immunosuppressed, and those with chronic health problems).

The nurse instructs patients and their families about strategies to relieve symptoms of URIs and reinforces the need to complete the treatment regimen, particularly when antibiotics are prescribed.

Continuing and Transitional Care. Referral for home, community-based, or transitional care is rare. However, it may be indicated for people whose health status was compromised before the onset of the respiratory infection and for those who cannot manage self-care without assistance. In such circumstances, the home health nurse assesses the patient's respiratory status and progress in recovery. The nurse may advise older adult patients and those at increased risk from a respiratory infection to consider annual influenza and pneumococcal vaccination. A follow-up appointment with the primary provider may be indicated for patients with compromised health status to ensure that the respiratory infection has resolved.

MONITORING AND MANAGING POTENTIAL COMPLICATIONS

Although major complications of URIs are rare, the nurse must be aware of them and assess the patient for them. Because most patients with URIs are managed at home, patients and their families must be instructed to monitor for signs and symptoms and to seek immediate medical care if the patient's condition does not improve or if the patient's physical status appears to be worsening.

Sepsis or meningitis may occur in patients with compromised immune status or in those with an acute bacterial infection. The patient and caregiver are instructed to seek medical care if the patient's condition fails to improve within several days after the onset of symptoms, if unusual symptoms develop, or if the patient's condition deteriorates. They are instructed about signs and symptoms that require further attention: persistent or high fever, increasing shortness of breath, confusion, and increasing weakness and malaise. The patient with sepsis requires expert care to treat the infection, stabilize vital signs, and prevent or treat septic shock (see [Chapter 11](#)). Deterioration of the patient's condition necessitates intensive care measures (e.g., hemodynamic monitoring and administration of vasoactive medications, IV fluids, nutritional support, and corticosteroids) to monitor the patient's status and to support the patient's vital signs. High doses of antibiotics may be given to treat the causative organism. The nurse's role is to monitor the patient's vital signs, hemodynamic status, and laboratory values; administer needed treatment; alleviate the patient's physical discomfort; and provide explanations, education, and emotional support to the patient and family.

Peritonsillar abscess may develop after an acute infection of the tonsils. The patient requires treatment to drain the abscess and receives antibiotics for infection and topical anesthetic agents and throat irrigations to relieve pain and sore throat. Follow-up is necessary to ensure that the abscess resolves; tonsillectomy may be required. The nurse assists the patient in administering throat irrigations and instructs the patient and family about the importance of adhering to the prescribed treatment regimen and recommended follow-up appointments.

In some severe situations, peritonsillar abscess may progress to meningitis or brain abscess. The nurse assesses for changes in mental status ranging from subtle personality changes through drowsiness to coma, nuchal rigidity, and focal neurologic signs that signal increasing cerebral edema around the abscess (see [Chapter 64](#)). Seizures, typically tonic-clonic, occur in this setting. Intensive care measures are necessary. High doses of antibiotics may be used to treat the causative organism. The nurse's role is similar to caring for the patient with sepsis in an intensive care setting. The nurse monitors the patient's neurologic status and reports changes immediately.

Otitis media and rhinosinusitis may develop with URI. The patient and family are instructed about the signs and symptoms of otitis media and rhinosinusitis and about the importance of follow-up with the primary provider to ensure adequate evaluation and treatment of these conditions.

Evaluation

Expected patient outcomes may include the following:

1. Maintains a patent airway by managing secretions
 - a. Reports decreased congestion
 - b. Assumes best position to facilitate drainage of secretions
 - c. Uses self-care measures appropriately and consistently to manage secretions during the acute phase of illness
2. Reports relief of pain and discomfort using pain intensity scale
 - a. Uses comfort measures: antispasmodic agents, hot packs, gargles, rest
 - b. Demonstrates adequate oral hygiene
3. Demonstrates ability to communicate needs, wants, level of comfort
4. Maintains adequate fluid and nutrition intake
5. Utilizes strategies to prevent upper airway infections and allergic reactions
 - a. Demonstrates hand hygiene technique
 - b. Identifies the value of the influenza vaccine
6. Demonstrates an adequate level of knowledge and performs self-care adequately
7. Becomes free of signs and symptoms of infection
 - a. Exhibits normal vital signs (temperature, pulse, respiratory rate)
 - b. Absence of purulent drainage
 - c. Free of pain in ears, sinuses, and throat
 - d. Absence of signs of inflammation
8. Absence of complications
 - a. No signs of sepsis: fever, hypotension, deterioration of cognitive status
 - b. Vital signs and hemodynamic status normal
 - c. No evidence of neurologic involvement
 - d. No signs of development of peritonsillar abscess
 - e. Resolution of URI without development of otitis media or rhinosinusitis
 - f. No signs and symptoms of brain abscess

OBSTRUCTION AND TRAUMA OF THE UPPER RESPIRATORY AIRWAY

Obstructive Sleep Apnea

OSA is a disorder characterized by recurrent episodes of upper airway obstruction and a reduction in ventilation. It is defined as **apnea** (cessation of breathing) during sleep usually caused by repetitive upper airway obstruction. The estimated prevalence of OSA is approximately 26% of adults between the ages of 30 and 70 years (Wickramasinghe, 2019). It is believed that between 4% and 9% of women and 9% and 24% of men in the United States have OSA, and that up to 90% are not diagnosed; these increased rates have been linked to the increase in rates of obesity (Wickramasinghe, 2019) (see [Chapter 42](#)). OSA interferes with people's ability to obtain adequate rest, thus affecting memory, learning, and decision making.

Risk factors for OSA include obesity, male gender, postmenopausal status in women, and advanced age. The major risk factor is obesity; a larger neck circumference and increased amounts of peripharyngeal fat narrow and compress the upper airway. Because OSA is often found in patients with hypertension, all adult patients with hypertension should be screened for OSA (Showalter & O'Keefe, 2019). Other associated factors include alterations in the upper airway, such as structural changes (e.g., tonsillar hypertrophy, abnormal posterior positioning of one or both jaws, and variations in craniofacial structures) that contribute to the collapsibility of the upper airway (Wickramasinghe, 2019).

Pathophysiology

The pharynx is a collapsible tube that can be compressed by the soft tissues and structures surrounding it. The tone of the muscles of the upper airway is reduced during sleep. Mechanical factors such as reduced diameter of the upper airway or dynamic changes in the upper airway during sleep may result in obstruction. These sleep-related changes may predispose to upper airway collapse when small amounts of negative pressure are generated during inspiration.

Repetitive apneic events result in hypoxia (decreased oxygen saturation) and hypercapnia (increased concentration of carbon dioxide), which triggers a sympathetic response. As a consequence, patients with OSA have a high prevalence of hypertension. In addition, OSA is associated with an increased risk of myocardial infarction and stroke, which may be mitigated with appropriate treatment (Wickramasinghe, 2019).

Clinical Manifestations

OSA is characterized by frequent and loud snoring with breathing cessation for 10 seconds or longer, for at least five episodes per hour, followed by awakening abruptly with a loud snort as the blood oxygen level drops. Patients

with sleep apnea may have anywhere from five apneic episodes per hour to several hundred per night.

Classic signs and symptoms of OSA include the “3 S’s”—namely, snoring, sleepiness, and significant-other report of sleep apnea episodes. Common signs and symptoms of OSA are presented in [Chart 18-4](#). Symptoms typically progress with increases in weight and aging (Wickramasinghe, 2019). Patients are typically unaware of nocturnal upper airway obstruction during sleep. They frequently complain of insomnia, including difficulty in going to sleep, nighttime awakenings, and early morning awakenings with an inability to go back to sleep, as well as chronic fatigue and hypersomnolence (daytime sleepiness). When obtaining the health history, the nurse asks the patient about sleeping during normal activities such as eating or talking. Patients with this symptom are considered to have pathologic hypersomnolence (Wickramasinghe, 2019).

Chart 18-4 ASSESSMENT

Assessing for Obstructive Sleep Apnea

Be alert for the following signs and symptoms of obstructive sleep apnea:

- Excessive daytime sleepiness
- Frequent nocturnal awakening
- Insomnia
- Loud snoring
- Morning headaches
- Intellectual deterioration
- Personality changes, irritability
- Impotence
- Systemic hypertension
- Arrhythmias
- Pulmonary hypertension, cor pulmonale
- Polycythemia
- Enuresis

Adapted from Wickramasinghe, H. (2019). Obstructive sleep apnea. Retrieved on 5/27/2019 at: www.emedicine.medscape.com/article/295807-overview

Assessment and Diagnostic Findings

The diagnosis of sleep apnea is based on clinical features plus a polysomnographic finding (i.e., sleep study), which is the definitive test for OSA. The test is an overnight study, performed in a specialized sleep disorders

center, which continuously measures multiple physiologic signals while the patient sleeps. These signals are analyzed as they are related to stages of sleep; measures include those taken by electroencephalogram (EEG), electro-oculogram, and chin electromyogram (EMG). In addition, cardiac rhythms and arrhythmias are monitored with a single-lead electrocardiogram (ECG) and leg movements are recorded by an anterior tibialis EMG. Airflow at the nose and mouth is monitored using both a thermal sensor and a nasal pressure transducer, breathing effort is monitored using inductance plethysmography, and hemoglobin oxygen saturation is monitored by oximetry. The breathing pattern is analyzed for the presence of apneas and hypopneas. Characteristic findings consistent with OSA include apneic episodes occurring in the presence of respiratory muscle effort, clinically significant apneic episodes lasting 10 seconds or longer, and apneic episodes most prevalent during the rapid eye movement (REM) stage of sleep. Sleep disruption from automated patient arousal is usually seen at the termination of an episode of apnea (Wickramasinghe, 2019).

Medical Management

Patients usually seek medical treatment because their sleeping partners express concern or because they experience excessive sleepiness at inappropriate times or settings (e.g., while driving a car). A variety of treatments are used. Weight loss, avoidance of alcohol, positional therapy (using devices that prevent patients from sleeping on their backs), and oral appliances such as mandibular advancement devices (MADs) are the first steps (American Sleep Apnea Association, 2019; Joshi, 2018). When applied correctly, an MAD advances the mandible so that it is slightly anterior to the upper front teeth, preventing airway obstruction by the tongue and soft tissue during sleep. A randomized controlled trial that compared the effectiveness of these devices among patients with OSA with the more conventional therapy, continuous positive airway pressure (CPAP), found no difference in short-term outcomes between MAD and CPAP, including daytime sleepiness and quality of life, suggesting that MAD is as effective a treatment as CPAP in patients with mild-to-moderate OSA (Petri, Christensen, Svanholt, et al., 2019; Viscuso & Arena, 2016). In more severe cases involving hypoxemia and severe hypercapnia, the treatment includes CPAP or bilevel positive airway pressure (BiPAP) therapy with supplemental oxygen via nasal cannula. CPAP is used to prevent airway collapse, whereas BiPAP makes breathing easier and results in a lower average airway pressure (Patil, Ayappa, Caples, et al., 2019; the use of CPAP and BiPAP is discussed in more detail in [Chapter 19](#)).

Surgical Management

Surgical procedures also may be performed to correct OSA. Simple tonsillectomy may be effective for patients with larger tonsils when deemed clinically necessary, or when other options have failed or are refused by patients (Morgan, 2017). Uvulopalatopharyngoplasty is the resection of pharyngeal soft tissue and removal of approximately 15 mm of the free edge of the soft palate and uvula. Effective in about 50% of patients, it is more effective in eliminating snoring than apnea. Nasal septoplasty may be performed for gross anatomic nasal septal deformities. Maxillomandibular surgery may be performed to advance the maxilla and mandible forward in order to enlarge the posterior pharyngeal region (Morgan, 2017). Tracheostomy relieves upper airway obstruction but has numerous adverse effects, including speech difficulties and increased risk of infections. These procedures, as well as other maxillofacial surgeries, are reserved for patients with concomitant cardiovascular disease and life-threatening arrhythmias or severe disability who have not responded to conventional therapy (Papadakis et al., 2018).

Pharmacologic Therapy

Some medications are useful in managing symptoms associated with OSA. Modafinil is approved by the U.S. Food and Drug Administration (FDA) for use in patients who have residual daytime sleepiness despite optimal use of CPAP. The most improvement has been seen in patients who have taken modafinil at daily doses of 200 to 400 mg. Armodafinil is also now approved by the FDA for use in these patients. It is more potent than modafinil because it is pure R-modafinil, which is the most psychoactive compound of modafinil (Wickramasinghe, 2019). Protriptyline given at bedtime may increase the respiratory drive and improve upper airway muscle tone. Medroxyprogesterone acetate and acetazolamide might be prescribed for sleep apnea associated with chronic alveolar hypoventilation; however, their benefits have not been well established. The patient must understand that these medications are not a substitute for CPAP, BiPAP, or MAD. Administration of low-flow nasal oxygen at night can help relieve hypoxemia in some patients but has little effect on the frequency or severity of apnea.

Nursing Management

The patient with OSA may not recognize the potential consequences of the disorder. Therefore, the nurse explains the disorder in terms that are understandable to the patient and relates symptoms (daytime sleepiness) to the underlying disorder. The nurse also instructs the patient and family about treatments, including the correct and safe use of CPAP, BiPAP, MAD, and oxygen therapy, if prescribed. The nurse educates the patient about the risk of untreated OSA and the benefits of treatment approaches.

Epistaxis

Epistaxis, a hemorrhage from the nose, is caused by the rupture of tiny, distended vessels in the mucous membrane of any area of the nose. Rarely does epistaxis originate in the densely vascular tissue over the turbinates. Most commonly, the site is the anterior septum, where three major blood vessels enter the nasal cavity: (1) the anterior ethmoidal artery on the forward part of the roof (Kiesselbach plexus), (2) the sphenopalatine artery in the posterosuperior region, and (3) the internal maxillary branches (the plexus of veins located at the back of the lateral wall under the inferior turbinate).

Several risk factors are associated with epistaxis ([Chart 18-5](#)).

Medical Management

Management of epistaxis depends on its cause and the location of the bleeding site. A nasal speculum, penlight, or headlight may be used to identify the site of bleeding in the nasal cavity. Most nosebleeds originate from the anterior portion of the nose. Initial treatment may include applying direct pressure. The patient sits upright with the head tilted forward to prevent swallowing and aspiration of blood and is directed to pinch the soft outer portion of the nose against the midline septum for 5 or 10 minutes continuously. Application of nasal decongestants (phenylephrine, one or two sprays) to act as vasoconstrictors may be necessary. If these measures are unsuccessful in stopping the bleeding, the nose must be examined using good illumination and suction to determine the site of bleeding. Visible bleeding sites may be cauterized with silver nitrate or electrocautery (high-frequency electrical current). A supplemental patch of Surgicel or Gelfoam may be used (Papadakis et al., 2018).

Chart 18-5 RISK FACTORS

Epistaxis

- Local infections (vestibulitis, rhinitis, rhinosinusitis)
- Systemic infections (scarlet fever, malaria)
- Drying of nasal mucous membranes
- Nasal inhalation of corticosteroids (e.g., beclomethasone) or illicit drugs (e.g., cocaine)
- Trauma (digital trauma, blunt trauma, fracture, forceful nose blowing)
- Arteriosclerosis
- Hypertension
- Tumor (sinus or nasopharynx)
- Thrombocytopenia
- Use of aspirin
- Liver disease
- Rendu–Osler–Weber syndrome (hereditary hemorrhagic telangiectasia)

Adapted from Nguyen, Q. A. (2018). Epistaxis. Retrieved on 5/27/2019 at: www.emedicine.medscape.com/article/863220-overview

Alternatively, a cotton tampon may be used to try to stop the bleeding. Suction may be used to remove excess blood and clots from the field of inspection. The search for the bleeding site should shift from the anteroinferior quadrant to the anterosuperior, then to the posterosuperior, and finally to the posteroinferior area. The field is kept clear by using suction and by shifting the cotton tampon.

If the origin of the bleeding cannot be identified, the nose may be packed with gauze impregnated with petrolatum jelly or antibiotic ointment; a topical anesthetic spray and decongestant agent may be used before the gauze packing is inserted, or a balloon-inflated catheter may be used (Fig. 18-3). Alternatively, a compressed nasal sponge may be used. Once the sponge becomes saturated with blood or is moistened with a small amount of saline, it will expand and produce tamponade to halt the bleeding. The packing may remain in place for 3 to 4 days if necessary to control bleeding (Nguyen, 2018). Antibiotics may be prescribed because of the risk of iatrogenic rhinosinusitis and sepsis.

Nursing Management

The nurse monitors the patient's vital signs, assists in the control of bleeding, and provides tissues and an emesis basin to allow the patient to expectorate any excess blood. It is common for patients to be anxious in response to a nosebleed. Blood loss on clothing and handkerchiefs can be frightening, and the nasal examination and treatment are uncomfortable. Assuring the patient in

a calm, efficient manner that bleeding can be controlled can help reduce anxiety. The nurse continuously assesses the patient's airway and breathing as well as vital signs. On rare occasions, a patient with significant hemorrhage requires IV infusions of crystalloid solutions (normal saline) as well as cardiac and pulse oximetry monitoring.

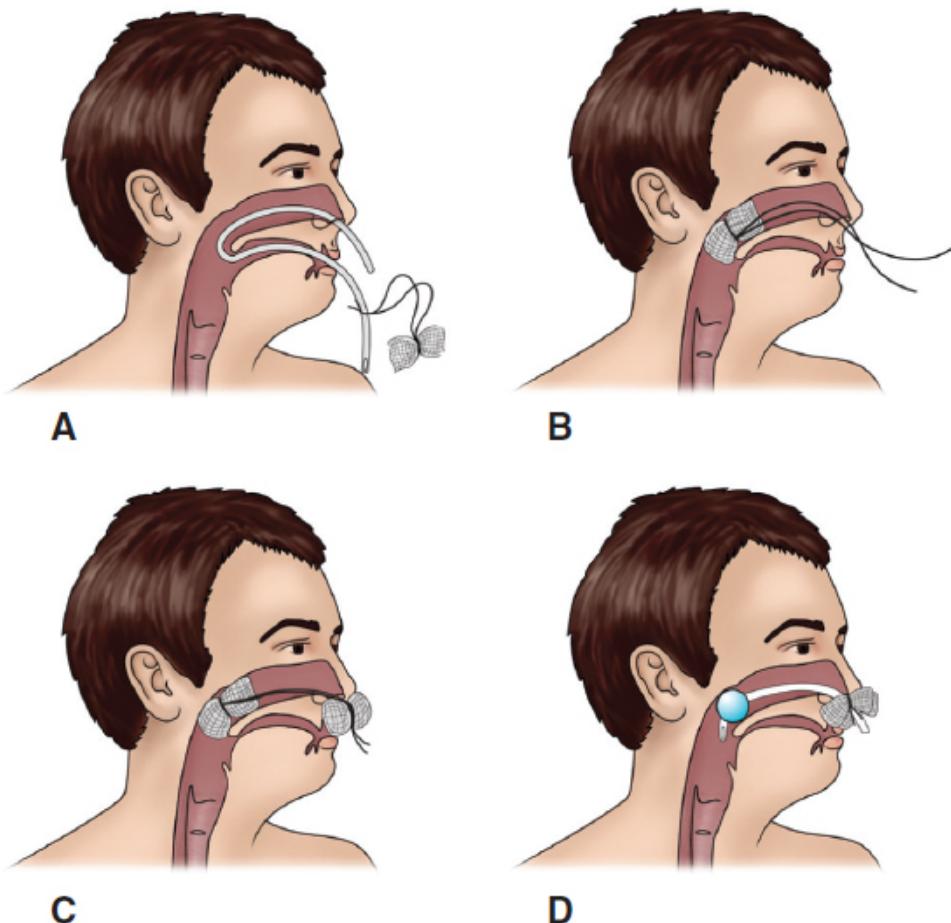


Figure 18-3 • Packing to control bleeding from the posterior nose.
A. Catheter is inserted and packing is attached. **B.** Packing is drawn into position as the catheter is removed. **C.** Strip is tied over a bolster to hold the packing in place with an anterior pack installed “accordion pleat” style. **D.** Alternative method, using a balloon catheter instead of gauze packing.



Educating Patients About Self-Care

Once the bleeding is controlled, the nurse instructs the patient to avoid vigorous exercise for several days and to avoid hot or spicy foods, tobacco use by smoking, or ENDS use, because this may cause vasodilation and increase the risk of rebleeding. Discharge education includes reviewing ways to prevent

epistaxis: avoiding forceful nose blowing, straining, high altitudes, and nasal trauma (including nose picking). Adequate humidification may prevent drying of the nasal passages. The nurse explains how to apply direct pressure to the nose with the thumb and the index finger for 15 minutes in the case of a recurrent nosebleed. If recurrent bleeding cannot be stopped, the patient is instructed to seek additional medical attention.

Nasal Obstruction

The passage of air through the nostrils is frequently obstructed by a deviation of the nasal septum, hypertrophy of the turbinate bones, or the pressure of nasal polyps. Chronic nasal congestion forces the patient to breathe through the mouth, thus producing dryness of the oral mucosa and associated problems including persistent dry, cracked lips. Patients with chronic nasal congestion often suffer from sleep deprivation due to difficulty maintaining an adequate airway while lying flat and during sleep.

Persistent nasal obstruction also may lead to chronic infection of the nose and result in frequent episodes of nasopharyngitis. Frequently, the infection extends to the nasal sinuses. When rhinosinusitis develops and the drainage from these cavities is obstructed by deformity or swelling within the nose, pain is experienced in the region of the affected sinus.

Medical Management

The treatment of nasal obstruction requires the removal of the obstruction, followed by measures to treat whatever chronic infection exists. In many patients, an underlying allergy also requires treatment. Measures to reduce or alleviate nasal obstruction include nonsurgical as well as surgical techniques. Commonly used medications include nasal corticosteroids (see [Table 18-2](#)) as well as oral leukotriene inhibitors, such as montelukast. Treatment with nasal corticosteroids for 1 to 3 months is usually successful for the treatment of small polyps and may even reduce the need for surgical intervention. A short course of oral corticosteroids (6-day course of prednisone) may be beneficial in the treatment of nasal obstruction due to polyps (Papadakis et al., 2018). Additional medications may include antibiotics for the treatment of underlying infection or antihistamines for the management of allergies. Hypertrophied turbinates may be treated by applying an astringent agent to shrink them.

A more aggressive approach in treating nasal obstruction caused by turbinate hypertrophy involves surgical reduction of the hypertrophy. Surgical procedures used to treat obstructive nasal conditions are collectively known as functional rhinoplasty. Technical advances with newer techniques provide a number of options for reconstruction and reshaping of the nose.

Nursing Management

When a surgical procedure is indicated, most often it is performed on an outpatient basis. The nurse explains the procedure to the patient. Postoperatively, the nurse elevates the head of the bed to promote drainage and to alleviate discomfort from edema. Frequent oral hygiene is encouraged to overcome dryness caused by breathing through the mouth. Before discharge from the outpatient or same-day surgical unit, the patient is instructed to avoid blowing the nose with force during the postoperative recovery period. The patient is also instructed about the signs and symptoms of bleeding and infection and when to contact the primary provider. The patient is provided with written postoperative instructions, including emergency phone numbers.

Fractures of the Nose

The location of the nose makes it susceptible to injury. Nasal fracture is the most common facial fracture and the most common fracture in the body (Becker, 2018). Fractures of the nose usually result from a direct assault. Nasal fractures may affect the ascending process of the maxilla and the septum. The torn mucous membrane results in a nosebleed. Complications include hematoma, infection, abscess, and avascular or septic necrosis. However, as a rule, serious consequences usually do not occur.

Clinical Manifestations

The signs and symptoms of a nasal fracture are pain, bleeding from the nose externally and internally into the pharynx, swelling of the soft tissues adjacent to the nose, periorbital ecchymosis, nasal obstruction, and deformity. The patient's nose may have an asymmetric appearance that may not be obvious until the edema subsides.

Assessment and Diagnostic Findings

The nose is examined internally to rule out the possibility that the injury may be complicated by a fracture of the nasal septum and a submucosal septal hematoma. Intranasal examination is performed in all cases to rule out septal hematoma (Papadakis et al., 2018). Because of the swelling and bleeding that occur with a nasal fracture, an accurate diagnosis can be made only after the swelling subsides.

Clear fluid draining from either nostril suggests a fracture of the cribriform plate with leakage of cerebrospinal fluid. Usually, careful inspection or palpation discloses any deviations of the bone or disruptions of the nasal

cartilages. An x-ray may reveal displacement of the fractured bones and may help rule out extension of the fracture into the skull.

Medical Management

A nasal fracture very often produces bleeding from the nasal passage. As a rule, bleeding is controlled with the use of packing. Cold compresses are used to prevent or reduce edema. For the patient who has sustained enough trauma to break the nose or any facial bone, the emergency medical team must consider the possibility of a cervical spine fracture. Therefore, it is essential to ensure a patent airway and to rule out a cervical spine fracture (see [Chapter 63](#)). Uncomplicated nasal fractures may be treated initially with antibiotics, analgesic agents, and a decongestant nasal spray.

Treatment of nasal fractures is aimed at restoring nasal function and returning the appearance of the nose to baseline. The patient is referred to a specialist to evaluate the need to realign the bones. Although improved outcomes are obtained when reduction in the fracture is performed during the first 3 hours after the injury, this is often not possible because of the edema. If immediate reduction of the fracture is not possible, it is performed within 3 to 7 days. Timing is important when treating nasal fractures because further delay in treatment may result in problematic bone healing, which ultimately may require surgical intervention that includes rhinoplasty to reshape the external appearance of the nose (Becker, 2018). A septorhinoplasty is performed when the nasal septum needs to be repaired. In patients who develop a septal hematoma, the physician drains the hematoma through a small incision. A septal hematoma that is not drained can lead to permanent deformity of the nose.

Nursing Management

Immediately after the fracture, the nurse applies ice and encourages the patient to keep the head elevated. The nurse instructs the patient to apply ice packs to the nose to decrease swelling. The patient who experiences epistaxis is usually frightened and anxious and needs reassurance. The packing inserted to stop the bleeding may be uncomfortable and unpleasant, and obstruction of the nasal passages by the packing forces the patient to breathe through the mouth. This in turn causes the oral mucous membranes to become dry. Mouth rinses help to moisten the mucous membranes and to reduce the odor and taste of dried blood in the oropharynx and nasopharynx. The use of analgesic agents such as acetaminophen or NSAIDs (e.g., ibuprofen, naproxen) is encouraged. When removing the cotton pledgets, the nurse carefully inspects the mucosa for lacerations or a septal hematoma. The nurse instructs the patient to avoid sports activities for 6 weeks.

Laryngeal Obstruction

Obstruction of the larynx because of edema is a serious condition that may be fatal without swift, decisive intervention. The larynx is a stiff box that will not stretch. It contains a narrow space between the vocal cords (glottis), through which air must pass. Swelling of the laryngeal mucous membranes may close off the opening tightly, leading to life-threatening hypoxia or suffocation. Edema of the glottis occurs rarely in patients with acute laryngitis, occasionally in patients with urticaria, and more frequently in patients with severe inflammation of the throat, as in scarlet fever. It is an occasional cause of death in severe anaphylaxis (angioedema).

TABLE 18-3 Causes of Laryngeal Obstruction

Precipitating Event	Mechanism of Obstruction
History of allergies; exposure to medications, latex, foods (peanuts, tree nuts [e.g., walnuts, pecans]), bee stings	Anaphylaxis
Foreign body	Inhalation/ingestion of meat or other food items, coin, chewing gum, balloon fragments, drug packets (ingested to avoid criminal arrest)
Heavy alcohol consumption; heavy tobacco use	Obstruction from tumor
Family history of airway problems	Suggests angioedema (type I hypersensitivity reaction)
Use of angiotensin-converting enzyme inhibitor	Increased risk of angioedema of the mucous membranes
Recent throat pain or recent fever	Infectious process
History of surgery or previous tracheostomy	Possible subglottic stenosis

Adapted from Reardon, R. F., Mason, P. E., & Clinton, J. E. (2017). Basic airway management and decision-making. In J. D. Roberts (Ed.). *Roberts & Hedges' clinical procedures in emergency medicine* (7th ed.). Philadelphia, PA: Elsevier Saunders.

Hereditary angioedema is also characterized by episodes of life-threatening laryngeal edema. Laryngeal edema in people with hereditary angioedema can occur at any age, although young adults are at greatest risk (Reardon, Mason, & Clinton, 2017). Some causes of laryngeal obstruction appear in Table 18-3.

When foreign bodies are aspirated into the pharynx, the larynx, or the trachea a twofold problem occurs. First, they obstruct the air passages and cause difficulty in breathing, which may lead to asphyxia; later, they may be drawn farther down, entering the bronchi or a bronchial branch and causing symptoms of irritation, such as a croupy cough, expectoration of blood or mucus, or labored breathing.

Clinical Manifestations

The patient's clinical presentation and x-ray findings confirm the diagnosis of laryngeal obstruction. The patient may demonstrate lowered oxygen saturation; however, normal oxygen saturation should not be interpreted as a sign that the obstruction is not significant. The use of accessory muscles to maximize airflow may occur and is often manifested by retractions in the neck or abdomen during inspirations. Patients who demonstrate these symptoms are at an immediate risk of collapse, and respiratory support (i.e., mechanical ventilation or positive-pressure ventilation) is considered.

Assessment and Diagnostic Findings

A thorough history can be very useful in diagnosing and treating the patient with a laryngeal obstruction. However, emergency measures to secure the patient's airway should not be delayed to obtain a history or perform tests. If possible, the nurse obtains a history from the patient or family about heavy alcohol or tobacco consumption, ENDS use, current medications, history of airway problems, recent infections, pain or fever, dental pain or poor dentition, and any previous surgeries, radiation therapy, or trauma.

Medical Management

Medical management is based on the initial evaluation of the patient and the need to ensure a patent airway. If the airway is obstructed by a foreign body and signs of asphyxia are apparent, immediate treatment is necessary using principles from basic and advanced cardiopulmonary resuscitation (CPR). If all efforts are unsuccessful, an immediate tracheotomy is necessary (see [Chapter 19](#) for further discussion). If the obstruction is caused by edema resulting from an allergic reaction, treatment may include immediate administration of subcutaneous epinephrine and a corticosteroid (see [Chapter 33](#)). Ice may be applied to the neck in an effort to reduce edema. Continuous pulse oximetry is essential in the patient who has experienced acute upper airway obstruction (Reardon et al., 2017).

Cancer of the Larynx

Cancer of the larynx accounts for approximately half of all head and neck cancers. The American Cancer Society (ACS, 2017) estimates that about 12,410 new cases and 3760 deaths occur annually, with a 5-year relative survival rate that ranges from 32% to 90%, depending on the location of the tumor and its stage at the time of diagnosis (ACS, 2017). Cancer of the larynx

is most common in people older than 65 years and is four times more common in men (ACS, 2017) (Chart 18-6).

Chart 18-6 RISK FACTORS

Laryngeal Cancer

Carcinogens

- Tobacco (smoke, smokeless, e-cigarettes, hookahs, secondhand smoke)
- Heavy alcohol consumption (defined as more than one drink daily)
- Combined effects of alcohol and tobacco
- Asbestos
- Paint fumes
- Wood dust
- Chemicals used in metalworking, petroleum, plastics, and textiles

Other Factors

- Nutritional deficiencies (vitamins)
- Genetic predisposition
- Age (higher incidence after 65 years of age)
- Gender (more common in men)
- Race (more prevalent in African Americans and Whites)
- Weakened immune system

Adapted from American Cancer Society (ACS). (2017). What are the risk factors for laryngeal and hypopharyngeal cancers? Retrieved on 5/27/2019 at:

www.cancer.org/Cancer/LaryngealandHypopharyngealCancer/DetailedGuide/laryngeal-and-hypopharyngeal-cancer-risk-factors

Almost all malignant tumors of the larynx arise from the surface epithelium and are classified as squamous cell carcinoma. Approximately 55% of patients with laryngeal cancer present with involved lymph nodes at the time of diagnosis, with bilateral lesions present in 16% of patients (De Vita, Hellman, & Rosenberg, 2018). Recurrence occurs usually within the first 2 to 3 years after diagnosis. The presence of disease after 5 years is often secondary to a new primary malignancy. The incidence of distant metastasis with squamous cell carcinoma of the head and neck (including larynx cancer) is relatively low.

Clinical Manifestations

Hoarseness of more than 2 weeks' duration occurs in the patient with cancer in the glottic area because the tumor impedes the action of the vocal cords during speech. The voice may sound harsh, raspy, and lower in pitch. Affected voice sounds are not always early signs of subglottic or supraglottic cancer, however. The patient may complain of a persistent cough or sore throat and pain and burning in the throat, especially when consuming hot liquids or citrus juices. A lump may be felt in the neck. Later symptoms include dysphagia, dyspnea (difficulty breathing), unilateral nasal obstruction or discharge, persistent hoarseness, persistent ulceration, and foul breath. Cervical lymph adenopathy, unintentional weight loss, a general debilitated state, and pain radiating to the ear may occur with metastasis.

Assessment and Diagnostic Findings

An initial assessment includes a complete history and physical examination of the head and neck. This includes identification of risk factors, family history, and any underlying medical conditions. An indirect laryngoscopy, using a flexible endoscope, is initially performed in the otolaryngologist's office to visually evaluate the pharynx, larynx, and possible tumor. Mobility of the vocal cords is assessed; if normal movement is limited, the growth may affect muscle, other tissue, and even the airway. The lymph nodes of the neck and the thyroid gland are palpated for enlargement.

Diagnostic procedures that may be used include fine-needle aspiration (FNA) biopsy, a barium swallow, endoscopy, CT or MRI scan, and a positron emission tomography (PET) scan (ACS, 2017). FNA biopsy may be done as an initial screening procedure to obtain samples of any enlarged lymph nodes in the neck. A barium swallow may be done if the patient initially presents with a chief complaint of difficulty in swallowing, to outline any structural anomalies of the neck that could pinpoint a tumor. However, if a tumor of the larynx is suspected on an initial examination, a direct laryngoscopic examination is indicated. Laryngoscopy is performed under local or general anesthesia to evaluate all areas of the larynx. In some cases, intraoperative examination obtained by direct microscopic visualization and palpation of the vocal folds may yield a more accurate diagnosis. Samples of the suspicious tissue are obtained for analysis. It is uncommon that human papillomavirus (HPV) is implicated in laryngeal cancers, although it is frequently implicated in oropharyngeal and tonsillar cancers. Whether or not the tumor is positive for HPV does not have an effect on the course of treatment (ACS, 2017).

The classification, including stage of the tumor (i.e., size and histology of the tumor, presence and extent of cervical lymph node involvement) and location of the tumor serve as a basis for treatment. CT scanning and MRI are used to assess regional adenopathy and soft tissues and to stage and determine the extent of a tumor. MRI is also helpful in posttreatment follow-up to detect

a recurrence. PET scanning may also be used to detect recurrence of the laryngeal tumor after treatment.

Medical Management

The goals of treatment of laryngeal cancer include cure; preservation of safe, effective swallowing; preservation of useful voice; and avoidance of permanent tracheostoma (Papadakis et al., 2018). Treatment options include surgery, radiation therapy, and adjuvant chemoradiation therapy. The prognosis depends on the tumor location (i.e., supraglottic, glottis, subglottic), as well as the tumor grade and stage (i.e., using the TNM system; see [Chapter 12, Chart 12-3](#)). The treatment plan also depends on whether the cancer is an initial diagnosis or a recurrence. In addition, before treatment begins, a complete dental examination is performed to rule out any oral disease. A consultation with a dental oncologist may be warranted. Any dental problems are resolved, if possible, before surgery and radiotherapy (ACS, 2017).

For patients with early-stage tumors (i.e., stages I and II) and lesions without lymph node involvement, external-beam radiation therapy or conservation surgery (i.e., less invasive surgery, such as vocal cord stripping or cordectomy) may be effective. Other indicated surgical procedures may include transoral endoscopic laser excision or partial **laryngectomy** (i.e., in this instance, removal of part of the larynx) (National Cancer Institute [NCI], 2019). Patients with stage III and IV tumors that are resectable may be advised to have either total laryngectomies with or without postoperative radiation therapy or radiation therapy with concurrent adjuvant chemotherapy (with single-agent cisplatin) and surgical resection aimed at preserving some of the larynx (i.e., organ preservation surgery). Patients with late-stage tumors that extend through cartilage and into soft tissues are generally advised to have total laryngectomies with postoperative radiation therapy (NCI, 2019).

Patients should be educated so that they carefully consider the various side effects and complications associated with the different treatment modalities. The presence of lymph node involvement in the neck can affect the outcome. Supraglottic tumors metastasize early and bilaterally even when there appears to be no lymph node involvement at the time of diagnosis. When the neck lymph nodes are involved, the treatment includes surgery, chemoradiation, or both (Papadakis et al., 2018).

Surgical Management

The overall goals for the patient undergoing surgical treatment include minimizing the effects of surgery on speech, swallowing, and breathing while maximizing the likelihood of a cure of the cancer. Several different curative procedures are available that can offer voice-sparing results while achieving a positive cure rate for the patient who has an early laryngeal carcinoma.

Surgical options include vocal cord stripping, cordectomy, laser surgery, partial laryngectomy, or total laryngectomy (NCI, 2019).

Vocal Cord Stripping

Stripping of the vocal cord is used to treat dysplasia, hyperkeratosis, and leukoplakia and is often curative for these lesions. The procedure involves removal of the mucosa of the edge of the vocal cord, using an operating microscope. Early vocal cord lesions are initially treated with radiation therapy.

Cordectomy

Cordectomy, which is an excision of the vocal cord, is usually performed via transoral laser. This procedure is used for lesions limited to the middle third of the vocal cord. The resulting voice quality is related to the extent of tissue removed.

Laser Surgery

Laser microsurgery is well known to have several advantages for the treatment of early glottic cancers. Treatment and recovery are shorter, with fewer side effects, and treatment may be less costly than for other forms of therapy. Microelectrodes are useful for surgical resection of smaller laryngeal carcinomas. The carbon dioxide (CO_2) laser can be used for the treatment of many laryngeal tumors, with the exception of large vascular tumors. When compared with the results of other treatments for early laryngeal cancer, laser microsurgery is considered to be the method of choice based on patient outcomes (NCI, 2019).

Partial Laryngectomy

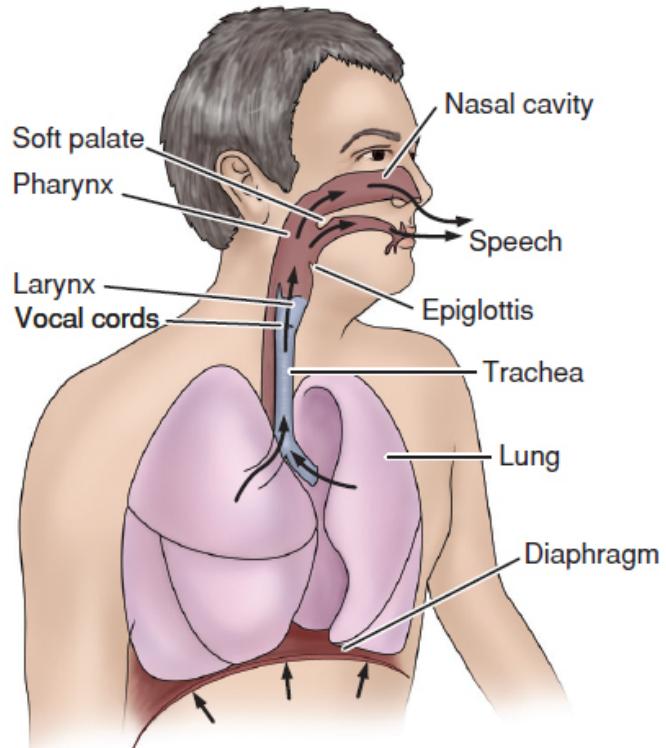
A partial laryngectomy (laryngofissure–thyrotomy) is often used for patients in the early stages of cancer in the glottic area when only one vocal cord is involved. The surgery is associated with a very high cure rate. It may also be performed for recurrence when high-dose radiation has failed. A portion of the larynx is removed, along with one vocal cord and the tumor; all other structures remain. The airway remains intact, and the patient is expected to have no difficulty swallowing. The voice quality may change, or the patient may sound hoarse.

Total Laryngectomy

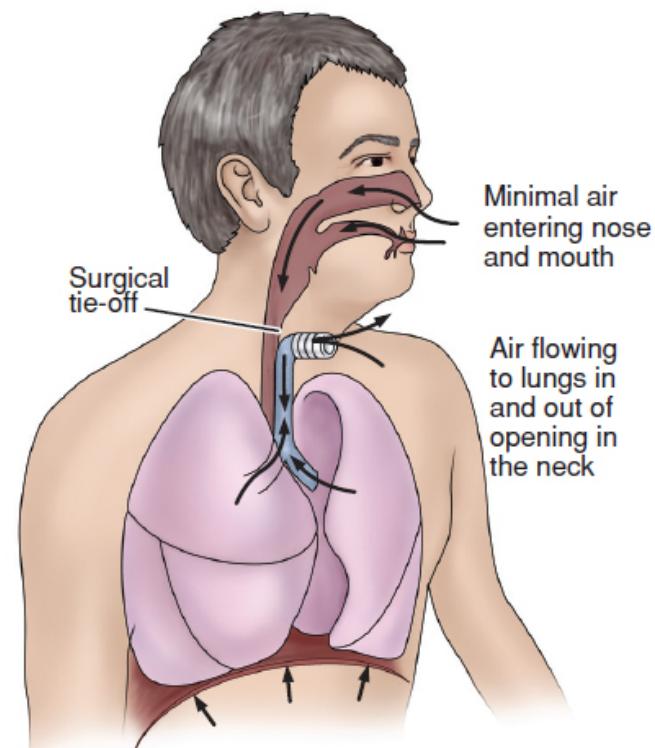
Complete removal of the larynx (total laryngectomy) can provide a cure in most advanced laryngeal cancers, when the tumor extends beyond the vocal cords, or for cancer that recurs or persists after radiation therapy. In a total laryngectomy, the laryngeal structures are removed, including the hyoid bone,

epiglottis, cricoid cartilage, and two or three rings of the trachea. The tongue, pharyngeal walls, and most of the trachea are preserved. A total laryngectomy results in permanent loss of the voice and a change in the airway, requiring a permanent tracheostomy ([Fig. 18-4](#)). Occasionally, patients continue to have a laryngectomy tube in the stoma. Laryngectomy tubes are similar in appearance to tracheostomy tubes; however, a laryngectomy tube can be distinguished from a tracheostomy tube because the patient is unable to speak or breathe when the laryngectomy tube is occluded. Patients who have a total laryngectomy require alternatives to normal speech; these may include a prosthetic device, such as a Blom–Singer valve, to speak without aspirating (see later discussion).

Surgery is more difficult when the lesion involves the midline structures or both vocal cords. With or without neck dissection, a total laryngectomy requires a permanent tracheal stoma because the larynx that provides the protective sphincter is no longer present. The tracheal stoma prevents the aspiration of food and fluid into the lower respiratory tract. The patient has no voice but has normal swallowing. A total laryngectomy changes the manner in which airflow is used for breathing and speaking, as depicted in [Figure 18-4](#). The patient has significant loss of the natural voice and the need to breathe through a stoma (an opening) created in the lower neck. Complications that may occur include a salivary leak, wound infection from the development of a pharyngocutaneous fistula, stomal stenosis, and dysphagia secondary to esophageal stricture. In some cases, the patient may be a candidate for a near-total laryngectomy. In this situation, the patient would be a candidate for chemoradiation therapy regimens postoperatively. Voice preservation can be achieved in most cases and tends to be associated with overall improved quality of life (Adil, 2018). Advances in surgical techniques for treating laryngeal cancer may minimize the cosmetic and functional deficits previously seen with total laryngectomy. Some microlaryngeal surgery can be performed endoscopically.



A



B

Figure 18-4 • Total laryngectomy produces a change in airflow for breathing and speaking. **A.** Normal airflow. **B.** Airflow after total

laryngectomy.

Radiation Therapy

The goal of radiation therapy is to eradicate the cancer and preserve the function of the larynx. The decision to use radiation therapy is based on several factors, including the staging of the tumor and the patient's overall health status, lifestyle (including occupation), and personal preference. Excellent results have been achieved with radiation therapy in patients with early-stage glottic tumors when only one vocal cord is involved and there is normal mobility of the cord (i.e., with phonation), as well as in small supraglottic lesions. One of the benefits of radiation therapy is that patients retain a near-normal voice. A few may develop chondritis (inflammation of the cartilage) or stenosis; a small number may later require laryngectomy.

Radiation therapy may also be used preoperatively to reduce the tumor size. Radiation therapy is combined with surgery in advanced laryngeal cancer as adjunctive therapy to surgery or chemotherapy and as a palliative measure.

Complications from radiation therapy are a result of external radiation to the head and neck area, which may also include the parotid gland, which is responsible for mucus production. Symptoms may include acute mucositis, ulceration of the mucous membranes, pain, **xerostomia** (dry mouth), loss of taste, dysphasia, fatigue, and skin reactions. Later complications may include laryngeal necrosis, edema, and fibrosis (see [Chapter 12](#)).

Speech Therapy

The patient who undergoes a laryngectomy and the patient's family face potentially complex challenges, including significant changes in the ability to communicate. To minimize anxiety and frustration on the part of the patient and family, the loss or alteration of speech is discussed with them. To plan postoperative communication strategies and speech therapy, the speech therapist or pathologist conducts a preoperative evaluation (ACS, 2017). During this time, the nurse discusses with the patient and family the methods of communication that will be available in the immediate postoperative period. These include writing, lip speaking and reading, communication or word boards, or smartphones or other electronic devices. A system of communication is established with the patient, family, nurse, and primary provider and is implemented consistently after surgery.

In addition, a long-term postoperative communication plan for **alaryngeal communication** (modes of speaking not involving the normal larynx) is developed. The three most common techniques of alaryngeal communication are esophageal speech, artificial larynx (electric larynx), and tracheoesophageal puncture. Training in these techniques begins once medical clearance is obtained from the primary provider.

Esophageal Speech

The patient needs the ability to compress air into the esophagus and expel it, setting off a vibration of the pharyngeal esophageal segment for esophageal speech. The technique can be taught once the patient begins oral feedings, approximately 1 week after surgery. First, the patient learns to belch and is reminded to do so an hour after eating. Then, the technique is practiced repeatedly. Later, this conscious belching action is transformed into simple explosions of air from the esophagus for speech purposes. The speech therapist continues to work with the patient to make speech intelligible and as close to normal as possible. Because it takes a long time to become proficient, the success rate is low (ACS, 2017).

Artificial Larynx

If esophageal speech is not successful, or until the patient masters the technique, an electric larynx may be used for communication. This battery-powered apparatus projects sound into the oral cavity. When the mouth forms words (articulation), the sounds from the electric larynx become audible words. The voice that is produced sounds mechanical, and some words may be difficult to understand. The advantage is that the patient is able to communicate with relative ease while working to become proficient at either esophageal or tracheoesophageal puncture speech.

Tracheoesophageal Puncture

The third technique of alaryngeal speech is tracheoesophageal puncture (Fig. 18-5). This technique for voice restoration is simple and has few complications. It is associated with high phonation success, good phonation quality, and steady long-term results. This technique is the most widely used because the speech associated with it most resembles normal speech (the sound produced is a combination of esophageal speech and voice), and it is easily achieved either during the initial surgery to treat the tumor or at a later date (ACS, 2017). A valve is placed in the tracheal stoma to divert air into the esophagus and out the mouth. Once the puncture is surgically created and has healed, a voice prosthesis (Blom–Singer) is fitted over the puncture site. A speech therapist teaches the patient how to produce sounds. Moving the tongue and lips to form the sound into words produces speech as before. To prevent airway obstruction, the prosthesis is removed and cleaned when mucus builds up.

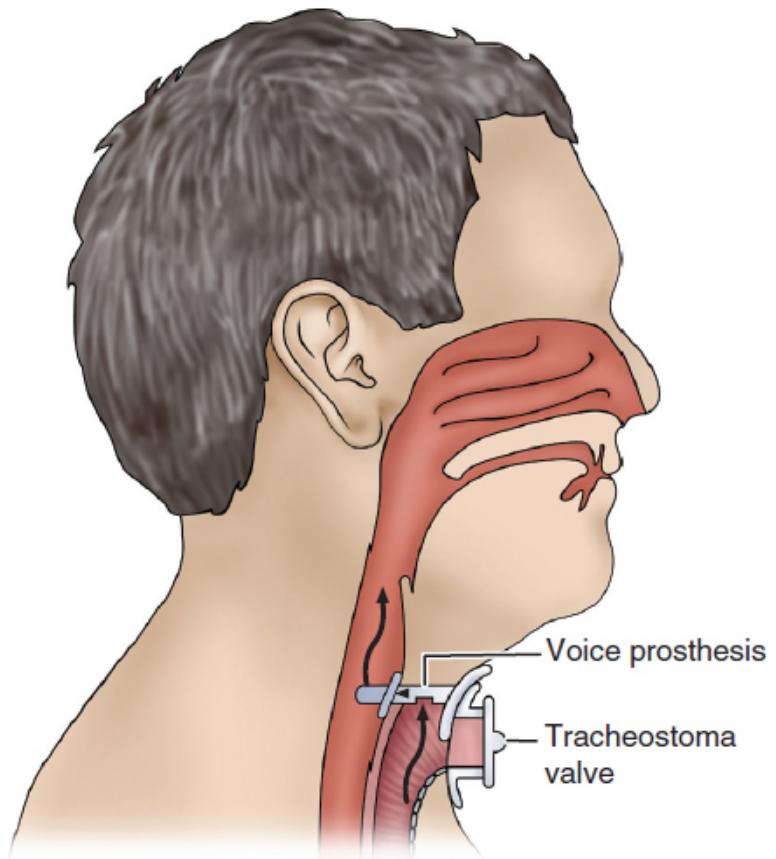


Figure 18-5 • Schematic representation of tracheoesophageal puncture speech. Air travels from the lung through a puncture in the posterior wall of the trachea into the esophagus and out the mouth. A voice prosthesis is fitted over the puncture site.

NURSING PROCESS

The Patient Undergoing Laryngectomy

Assessment

The nurse obtains a health history and assesses the patient's physical, psychosocial, and spiritual domains. The health history focuses on the following symptoms: hoarseness, sore throat, dyspnea, dysphagia, and pain or burning in the throat. The physical assessment includes a thorough head and neck examination with an emphasis on the patient's airway. In addition, the neck and thyroid are palpated for swelling, nodularity, or adenopathy.

The nurse also assesses the patient's general state of nutrition, including height and weight and body mass index and reviews laboratory values that assist in determining the patient's nutritional status (albumin, protein, glucose, and electrolyte levels). If treatment includes surgery, the nurse must know the nature of the surgery to plan appropriate care. If the patient is expected to have no voice as a result of the surgical procedure, a preoperative evaluation by the speech therapist is essential. The patient's ability to hear, see, read, and write is assessed. Visual impairment and functional illiteracy may create additional problems with communication and may require creative approaches to ensure that the patient is able to communicate any needs. Because alcohol abuse is a risk factor for cancer of the larynx, the patient's pattern of alcohol intake must be assessed. Patients who are accustomed to daily consumption of alcohol are at the risk for delirium tremens (alcohol withdrawal syndrome) when alcohol intake is stopped suddenly. It is also not uncommon that patients are active smokers at the time of diagnosis; assessment of readiness for smoking cessation should be done, and nicotine replacements prescribed to avoid nicotine withdrawal, as indicated (NCI, 2019) (see [Chapter 23](#): Promoting Cessation of Tobacco Use).

In addition, the nurse assesses the psychological status of the patient and family. The fear of a diagnosis of cancer is compounded by the possibility of permanent voice loss and, in some cases, some degree of disfigurement. The nurse evaluates the patient's and family's knowledge of the planned surgical procedure and expected postoperative course and assesses their coping methods and support systems. The nurse assesses the patient's spirituality needs based on the patient's individual preferences, beliefs, and culture.

Diagnosis

NURSING DIAGNOSES

Based on the assessment data, major nursing diagnoses may include the following:

- Lack of knowledge about the surgical procedure and postoperative course
- Anxiety associated with the diagnosis of cancer and impending surgery
- Impaired airway clearance associated with excess mucus production secondary to surgical alterations in the airway
- Impaired verbal communication associated with anatomic deficit secondary to removal of the larynx and to edema
- Impaired nutritional intake associated with inability to ingest food secondary to swallowing difficulties
- Disturbed body image and risk for chronic low self-esteem secondary to major neck surgery, change in appearance, and altered structure and function
- Impaired ability to manage regime associated with pain, weakness, fatigue, musculoskeletal impairment related to surgical procedure and postoperative course

COLLABORATIVE PROBLEMS/POTENTIAL COMPLICATIONS

Based on the assessment data, potential complications may include the following:

- Respiratory distress (hypoxia, airway obstruction, tracheal edema)
- Hemorrhage, infection, and wound breakdown
- Aspiration
- Tracheostomal stenosis

Planning and Goals

The major goals for the patient may include attainment of an adequate level of knowledge, reduction in anxiety, maintenance of a patent airway (patient is able to handle own secretions), effective use of alternative means of communication, attainment of optimal levels of nutrition and hydration, improvement in body image and self-esteem, improved self-care management, and absence of complications.

Nursing Interventions



PROVIDING PREOPERATIVE PATIENT EDUCATION

The diagnosis of laryngeal cancer often produces misconceptions and fears. Many people assume that loss of speech and disfigurement are inevitable with this condition. Once the primary provider explains the diagnosis and discusses treatment options with the patient and family, the nurse clarifies any misconceptions by identifying the location of the larynx, its function, the nature of the planned surgical procedure, and its effect on speech. Further, the patient's ability to sing, laugh, and whistle will be lost.

Informational materials (written and audiovisual) about the surgery are given to the patient and family for review and reinforcement. If a complete laryngectomy is planned, the patient must understand that the natural voice will be lost, but that special training can provide a means for communicating. The patient needs to know that until training is started, communication will be possible by using the call light, by writing, or by using a communication device. The interdisciplinary team conducts an initial assessment of the patient and family. In addition to the nurse and the primary provider, the team might include an advanced practice nurse (e.g., nurse practitioner), speech therapist, respiratory therapist, social worker, dietitian, and home health nurse. The services of a spiritual advisor are made available to the patient and family, as appropriate.

The nurse also reviews equipment and treatments for postoperative care with the patient and family, educates the patient about important coughing and deep breathing exercises, and helps the patient perform return demonstrations. The nurse clarifies the patient's role in the postoperative and rehabilitation periods. The family's needs must also be addressed because family members are often responsible for complex care of the patient in the home.

REDUCING ANXIETY

Because surgery of the larynx is performed most often for a malignant tumor, the patient may have many questions: Will the surgeon be able to remove all of the tumor? Is it cancer? Will I die? Will I choke? Will I suffocate? Will I ever speak again? What will I look like? Because of these and other questions, the psychological preparation of the patient is as important as the physical preparation.

Any patient undergoing surgery may have many fears. In laryngeal surgery, these fears may relate to the diagnosis of cancer and the possibility of permanent loss of the voice and disfigurement. The nurse provides the patient and family with opportunities to ask questions, verbalize feelings, and discuss perceptions. The nurse should address any questions and misconceptions the patient and family have. During the preoperative or postoperative period, a visit from someone who has had a laryngectomy may reassure the patient that people are available to assist and that rehabilitation is possible.

In the immediate postoperative period, the nurse attempts to build trust and reduce the patient's anxiety. Active listening provides an environment that promotes open communication and allows the patient to verbalize feelings. Clear instructions and explanations are given to the patient and family in a calm, reassuring manner. The nurse listens attentively, encourages the patient, and identifies and reduces environmental stressors. The nurse seeks to learn from the patient what activities promote feelings of comfort and assists the patient in such activities (e.g., listening to music,

reading). Relaxation techniques such as guided imagery and meditation are often helpful. During episodes of severe anxiety, the nurse remains with the patient and includes them in decision making.

MAINTAINING A PATENT AIRWAY

The nurse helps maintain a patent airway by positioning the patient in the semi-Fowler or Fowler position after recovery from anesthesia. This position decreases surgical edema and promotes lung expansion. Observing the patient for restlessness, labored breathing, apprehension, and increased pulse rate helps identify possible respiratory or circulatory problems. The nurse assesses the patient's lung sounds and reports changes that may indicate impending complications. Medications that depress respiration, particularly opioids, should be used cautiously. However, adequate use of analgesic medications is essential for pain relief because postoperative pain can result in shallow breathing and an ineffective cough (see [Chapter 9](#) for discussion of pain management). The nurse encourages the patient to turn, cough, and take deep breaths. If necessary, suctioning may be performed to remove secretions, but disruption of suture lines must be avoided. The nurse also encourages and assists the patient with early ambulation to prevent atelectasis, pneumonia, and venous thromboemboli formation (e.g., pulmonary embolism and deep vein thrombosis). Pulse oximetry is used to monitor the patient's oxygen saturation level.

If a total laryngectomy was performed, a laryngectomy tube will most likely be in place. In some instances a laryngectomy tube is not used; in others it is used temporarily; and in many it is used permanently. The laryngectomy tube, which is shorter than a tracheostomy tube but has a larger diameter, is the patient's only airway. The care of this tube is similar to that for a tracheostomy tube (see [Chapter 19](#)). The nurse changes the inner cannula (if present) every 8 h if it is disposable. Although nondisposable tubes are used infrequently, if one is used, the nurse cleans the inner cannula every 8 h or more often as needed. If a tracheostomy tube without an inner cannula is used, humidification and suctioning of this tube are essential to prevent formation of mucus plugs. If a T-shaped laryngectomy tube is used, both sides of the T-tube should be suctioned to prevent obstruction due to copious secretions. The nurse should also use secure tracheostomy ties to prevent tube dislodgement. The nurse cleans the stoma daily with soap and water or another prescribed solution and a soft cloth or gauze, taking care to prevent water and soap or solution from entering the stoma. If a non–oil-based antibiotic ointment is prescribed, it is applied around the stoma and suture line. If crusting appears around the stoma, the crusts are removed with sterile tweezers and additional ointment is applied.

Wound drains, inserted during surgery, may be in place to assist in removal of fluid and air from the surgical site. Suction also may be used,

but cautiously, to avoid trauma to the surgical site and incision. The nurse observes, measures, and records drainage. When drainage is less than 30 mL/day for 2 consecutive days, the surgeon usually removes the drains.

Frequently, the patient coughs up large amounts of mucus through this opening. Because air passes directly into the trachea without being warmed and moistened by the upper respiratory mucosa, the tracheobronchial tree compensates by secreting excessive amounts of mucus. Therefore, the patient has frequent coughing episodes and may develop a brassy-sounding, mucus-producing cough. The nurse reassures the patient that these problems will diminish in time as the tracheobronchial mucosa adapts to the altered physiology.

After the patient coughs, the tracheostomy opening must be wiped clean and clear of mucus. A simple gauze dressing, washcloth, or even paper towel (because of its size and absorbency) worn below the tracheostomy may serve as a barrier to protect the clothing from the copious mucus that the patient may initially expel.

One of the most important factors in decreasing cough, mucus production, and crusting around the stoma is adequate humidification of the environment. Mechanical humidifiers and aerosol generators (nebulizers) increase the humidity and are important for the patient's comfort. The laryngectomy tube may be removed when the stoma is well healed, within 3 to 6 wk after surgery. The nurse educates the patient about how to clean and change the tube and remove secretions.

PROMOTING ALTERNATIVE COMMUNICATION METHODS

Establishing an effective means of communication is usually the ultimate goal in the rehabilitation of the laryngectomy patient. To understand and anticipate the patient's postoperative needs, the nurse works with the patient, speech therapist, and family to encourage the use of alternative communication methods. These means of communication are established preoperatively and must be used consistently by all personnel who come in contact with the patient postoperatively. The patient is now unable to use an intercom system. A call bell or hand bell must be placed within easy reach of the patient. In the immediate postoperative period, a handheld communication device like a Magic Slate, electronic tablet, notebook, or smartphone can be used. If the patient cannot write, a picture-word-phrase board or hand signals can be used. The nurse documents which hand is the patient's dominant hand (e.g., used for writing) so that the opposite arm can be used for IV infusions. (To ensure the patient's privacy, the nurse shreds notes used for communication.)

Writing everything or communicating through gestures can be very time-consuming and frustrating. The patient must be given adequate time to communicate their needs. The patient may become impatient and angry when not understood.

PROMOTING ADEQUATE NUTRITION AND HYDRATION

Postoperatively, the patient may not be permitted to eat or drink for at least 7 d (Suslu, 2016). Alternative sources of nutrition and hydration include IV fluids, enteral feedings through a nasogastric or gastrostomy tube, and parenteral nutrition (see Chapters 39 and 41).

When the patient is ready to start oral feedings, a swallow study (a video fluoroscopy radiology procedure) may be conducted to evaluate the patient's risk of aspiration. Once the patient is cleared for oral feedings, the nurse explains that thick liquids will be used first because they are easy to swallow. Different swallowing maneuvers are attempted with various food consistencies. Once the patient is cleared for food intake, the nurse stays with the patient during initial oral feedings and keeps a suction setup at the bedside for needed suctioning. The nurse instructs the patient to avoid sweet foods, which increase salivation and suppress the appetite. Solid foods are introduced as tolerated. The patient is instructed to rinse the mouth with warm water or mouthwash after oral feedings and to brush the teeth frequently.

Because taste and smell are so closely related, taste sensations are altered for a while after surgery because inhaled air passes directly into the trachea, bypassing the nose and the olfactory end organs. In time, however, the patient usually accommodates to this change and olfactory sensation adapts, often with return of interest in eating. The nurse observes the patient for any difficulty in swallowing, particularly when eating resumes, and reports its occurrence to the primary provider.

The patient's weight and laboratory data are monitored to ensure that nutritional and fluid intake are adequate. In addition, skin turgor and vital signs are assessed for signs of decreased fluid volume.

PROMOTING POSITIVE BODY IMAGE AND SELF-ESTEEM

Disfiguring surgery and an altered communication pattern are threats to a patient's body image and self-esteem. The reaction of family members and friends is a major concern for the patient. The nurse encourages the patient to express feelings about the changes brought about by surgery, particularly feelings related to fear, anger, depression, and isolation. Encouraging the use of previous effective coping strategies may be helpful. Referral to a support group, such as the International Association of Laryngectomees (IAL) and WebWhispers, and to resources available through the American Cancer Society may help the patient and family deal with the changes in their lives. Information about these support groups can be found in the Resources section at the end of the chapter.

PROMOTING EFFECTIVE HEALTH MANAGEMENT

A positive approach along with promotion of effective health management is important when caring for the patient. The patient should begin

participating in effective health management activities as soon as possible. The nurse assesses the patient's readiness for decision making and encourages the patient to participate actively in performing care. Positive reinforcement is provided when the patient makes an effort in managing health effectively. The nurse needs to be a good listener and a support to the family, especially when explaining the tubes, dressings, and drains that are in place postoperatively.

MONITORING AND MANAGING POTENTIAL COMPLICATIONS

The potential complications after laryngectomy include respiratory distress and hypoxia, hemorrhage, infection, wound breakdown, aspiration, and tracheostomal stenosis.

Respiratory Distress and Hypoxia. The nurse monitors the patient for signs and symptoms of respiratory distress and hypoxia, particularly restlessness, irritation, agitation, confusion, tachypnea, the use of accessory muscles, and decreased oxygen saturation on pulse oximetry (SpO_2). Any change in respiratory status requires immediate intervention. Hypoxia may cause restlessness and an initial rise in blood pressure; this is followed by hypotension and somnolence. Cyanosis is a late sign of hypoxia. Obstruction needs to be ruled out immediately by suctioning and by having the patient cough and breathe deeply. Hypoxia and airway obstruction, if not treated immediately, are life-threatening.

Other nursing measures include repositioning of the patient to ensure an open airway and administering oxygen as prescribed. Oxygen is used with caution in patients with chronic obstructive pulmonary disease. The nurse should always be prepared for possible intubation and mechanical ventilation and must be knowledgeable about the hospital's emergency code protocols and skilled in the use of emergency equipment. The nurse must remain with the patient at all times during respiratory distress and initiate a call to the rapid response team as necessary.

Hemorrhage. Bleeding from the drains at the surgical site or with tracheal suctioning may signal the occurrence of hemorrhage. The nurse promptly notifies the surgeon of any active bleeding, which can occur at a variety of sites, including the surgical site, drains, and trachea. Rupture of the carotid artery is especially dangerous. Should this occur, the nurse must apply direct pressure over the artery, summon assistance, and provide emotional support to the patient until the vessel is ligated. The nurse monitors vital signs for changes, particularly increased pulse rate, decreased blood pressure, and rapid deep respirations. Cold, clammy, pale skin may indicate active bleeding. IV fluids and blood components may be given and other measures implemented to prevent or treat hemorrhagic shock. (Management of the patient with shock is discussed in detail in [Chapter 11](#).)

Infection. The nurse monitors the patient for signs of postoperative infection. These include an increase in temperature and pulse, a change in the type of wound drainage, and increased areas of redness or tenderness at the surgical site. Other signs include purulent drainage, odor, and increased wound drainage. The nurse monitors the patient's white blood cell (WBC) count; a rise in WBCs may indicate the body's effort to combat infection. In older adult patients, infection can be present without an increase in the patient's WBC count; therefore, the nurse must monitor the patient for more subtle signs, such as lethargy, weakness, and decreased appetite. WBCs are suppressed in the patient with decreased immune function (e.g., patients receiving chemotherapy or radiation therapy); this predisposes the patient to a severe infection and sepsis. Antimicrobial (antibiotic) medications must be given as scheduled. All suspicious drainage is cultured, and the patient may be placed on the appropriate infection prevention precautions. Strategies are implemented to minimize the exposure of the patient to microorganisms and their spread to others. The nurse reports any significant change in the patient's status to the surgeon.

Wound Breakdown. Wound breakdown caused by infection, poor wound healing, development of a fistula, radiation therapy, or tumor growth can create a life-threatening emergency. The carotid artery, which is close to the stoma, may rupture from erosion if the wound does not heal properly. The nurse observes the stoma area for wound breakdown, hematoma, and bleeding and reports their occurrence to the surgeon. If wound breakdown occurs, the patient must be monitored carefully and identified as at high risk for carotid hemorrhage.

Aspiration. The patient who has undergone a laryngectomy is at the risk for aspiration and aspiration pneumonia due to depressed cough, the sedating effects of anesthetic and analgesic medications, alteration in the airway, impaired swallowing, and the administration of tube feedings. The nurse assesses for the presence of nausea and administers antiemetic medications, as prescribed. The nurse keeps a suction setup available in the hospital and instructs the family to do so at home for use if needed. Patients receiving tube feedings are positioned with the head of the bed at 30 degrees or higher during feedings and for 30 to 45 min after tube feedings. Patients receiving oral feedings are positioned with the head of the bed in an upright position for 30 to 45 min after feedings. For patients with a nasogastric or gastrostomy tube, the placement of the tube and residual gastric volume must be checked before each feeding. High amounts of residual volume (greater than 50% of previous intake) indicate delayed gastric emptying; this can lead to reflux and aspiration (Papadakis et al., 2018). Signs or symptoms of aspiration are reported to the primary provider immediately.

Tracheostomal Stenosis. Tracheostomal stenosis is an abnormal narrowing of the trachea or the tracheostomy stoma. Infection at the stoma site, excessive traction on the tracheostomy tube by the connecting tubing, and persistent high tracheostomy cuff pressure are risk factors for tracheostomal stenosis. The incidence of this condition varies widely, and it is often preventable. The nurse assesses the patient's stoma for signs and symptoms of infection and reports any evidence of this to the primary provider immediately. Tracheostomy care is performed routinely. The nurse assesses the connecting tubing (e.g., ventilation tubing) and secures the tubing to avoid excessive traction on the patient's tracheostomy. The nurse ensures that the tracheostomy cuff is deflated (for a patient with a cuffed tube) except for short periods, such as when the patient is eating or taking medications.

PROMOTING HOME, COMMUNITY-BASED, AND TRANSITIONAL CARE



Educating Patients About Self-Care. The nurse has an important role in the recovery and rehabilitation of the patient who has had a laryngectomy. To facilitate the patient's ability to manage self-care, discharge instruction begins as soon as the patient is able to participate. Nursing care and patient education in the hospital, outpatient setting, and rehabilitation or long-term care facility must take into consideration the many emotions, physical changes, and lifestyle changes experienced by the patient. In preparing the patient to go home, the nurse assesses the patient's readiness to learn and the level of knowledge about self-care management. The nurse also reassures the patient and family that most self-care management strategies can be mastered. The patient needs to learn a variety of self-care behaviors, including tracheostomy and stoma care, wound care, and oral hygiene. The nurse also instructs the patient about the need for adequate dietary intake, safe hygiene, and recreational activities.

Tracheostomy and Stoma Care. The nurse provides specific instructions to the patient and family about what to expect with a tracheostomy and its management. The nurse instructs the patient and caregiver how to perform suctioning and emergency measures and tracheostomy and stoma care. The nurse stresses the importance of humidification at home and instructs the family to obtain and set up a humidification system before the patient returns home.



For the procedural guidelines for care of the patient with a tracheostomy tube, go to thepoint.lww.com/Brunner15e.

Hygiene and Safety Measures. The nurse instructs the patient and family about safety precautions that are needed because of the changes in structure and function resulting from the surgery. Special precautions are needed in the shower to prevent water from entering the stoma. Wearing a loose-fitting plastic bib over the tracheostomy or simply holding a hand over the opening is effective. Swimming is not recommended because a person with a laryngectomy can drown without submerging their face. Barbers and beauticians need to be alerted so that hair sprays, loose hair, and powder do not get near the stoma, because they can block or irritate the trachea and possibly cause infection. These self-care points are summarized in [Chart 18-7](#).

The nurse educates the patient and caregiver about the signs and symptoms of infection and identifies indications that require contacting the primary provider after discharge. A discussion regarding cleanliness and infection control behaviors is essential. The nurse educates the patient and family to use hand hygiene before and after caring for the tracheostomy, to use tissues to remove mucus, and to dispose of soiled dressings and equipment properly. If the patient's surgery included cervical lymph node dissection, the nurse instructs the patient about how to perform exercises to strengthen the shoulder and neck muscles. A referral to a physical therapist might be helpful.

Recreation and exercise are important for the patient's well-being and quality of life, and all but very strenuous exercise can be enjoyed safely. Avoidance of strenuous exercise and fatigue is important because the patient will have more difficulty speaking when tired, which can be discouraging. Additional safety points to address include the need for the patient to wear or carry medical identification, such as a bracelet or card, to alert medical personnel to the special requirements for resuscitation should this need arise. If resuscitation is needed, direct mouth-to-stoma ventilation should be performed. For home emergency situations, prerecorded emergency messages for police, the fire department, or other rescue services can be kept near the phone or programmed into smartphones or other electronic devices to be used quickly.

Chart 18-7 HOME CARE CHECKLIST

The Patient with a Laryngectomy

At the completion of education, the patient and/or caregiver will be able to:

- Name the procedure that was performed and identify any permanent changes in anatomic structure or function as well as changes in ADLs, IADLs, communication, roles, relationships, and spirituality.
- State the name, dose, side effects, frequency, and schedule for all medications.
- Identify interventions and strategies (e.g., durable medical equipment, oxygen, nebulizer, humidifier) used in adapting to any permanent changes in structure or function.
- Describe ongoing postoperative therapeutic regimen, including stoma care, diet, and activities to perform (e.g., shoulder and neck exercises if a node dissection was performed) and to limit or avoid (e.g., swimming and contact sports).
 - Demonstrate tracheostomy care and tracheal suctioning to clear the airway and handle secretions.
 - Explain the rationale for maintaining adequate humidification with a humidifier or nebulizer.
 - Demonstrate how to clean the skin around the stoma and how to use ointments and tweezers to remove encrustations.
 - State the rationale for wearing a loose-fitting protective cloth at the stoma and covering the stoma when showering or bathing.
 - Discuss the need to avoid sprays, powders, particulates, and cold air from air-conditioning and the environment to prevent irritation of the airway.
 - Demonstrate safe technique in changing the laryngectomy/tracheostomy tube.
 - Identify fluid and caloric needs.
 - Describe mouth care and discuss its importance.
 - Identify the signs and symptoms of wound infection and state what to do about them.
 - Describe safety or emergency measures to implement in case of breathing difficulty or bleeding.
 - State the rationale for wearing or carrying special medical identification and ways to obtain help in an emergency.
 - Demonstrate alternative communication methods.
- Relate how to reach primary provider with questions or to report complications.
- State time and date of follow-up appointments.

- Obtain an annual influenza vaccine, and discuss vaccination against pneumonia with the primary provider.
- State understanding of community resources, support groups, and referrals (if any).
- Identify the need for health promotion (e.g., weight reduction, smoking cessation, and stress management), disease prevention, and screening activities.

Resources

In student resources for Chapter 19 at thepoint.lww.com/Brunner15e, see Procedural Guidelines: Care of the Patient with a Tracheostomy Tube and Procedural Guidelines: Performing Tracheal Suction.

ADL, activities of daily living; IADL, independent activities of daily living.

The nurse instructs and encourages the patient to perform oral care frequently to prevent halitosis and infection. If the patient is receiving radiation therapy, synthetic saliva may be required because of decreased saliva production. Patients receiving radiation therapy frequently report dry mouth, change in taste, lack of appetite, and mouth sores (Cullen, Baumler, Farrington, et al., 2018) (see the Nursing Research Profile in Chart 18-8). The nurse instructs the patient to drink water or sugar-free liquids throughout the day and to use a humidifier at home. Brushing the teeth or dentures and rinsing the mouth several times a day will assist in maintaining proper oral hygiene.

Continuing and Transitional Care. Referral for home, community-based, or transitional care is an important aspect of postoperative care for the patient who has had a laryngectomy and will assist the patient and family in the discharge home. The nurse assesses the patient's general health status and the ability of the patient and family to care for the stoma and tracheostomy. The surgical incisions, nutritional and respiratory status, and adequacy of pain management are also assessed. The nurse assesses for signs and symptoms of complications and the patient's and family's knowledge of signs and symptoms to be reported to the physician. During the home visit, the nurse identifies and addresses other learning needs and concerns of the patient and family, such as adaptation to physical, lifestyle, and functional changes, as well as the patient's progress with learning and using new communication strategies. The nurse assesses the patient's psychological status, reinforces previous instructions, and provides reassurance and support to the patient and family caregivers as needed.

The person who has had a laryngectomy should have regular physical examinations and seek advice concerning any problems related to recovery and rehabilitation. The nurse reminds the patient to participate in health promotion activities and health screening and about the importance of

keeping scheduled appointments with the physician, speech therapist, and other health care providers.

Evaluation

Expected patient outcomes may include the following:

1. Demonstrates an adequate level of knowledge, verbalizing an understanding of the surgical procedure and performing self-care adequately

Chart 18-8



NURSING RESEARCH PROFILE

Mitigating the Effects of Radiation Therapy on the Oral Mucosa of Patients with Head and Neck Cancers

Cullen, L., Baumler, S., Farrington, M., et al. (2018). Oral care for head and neck cancer symptom management. *American Journal of Nursing*, 118(1), 24–34.

Purpose

Patients diagnosed with laryngeal and oropharyngeal cancer (head and neck cancer [HNC]) commonly receive radiation therapy on an outpatient basis. These patients often develop mucositis, which causes symptoms that include pain, difficulty swallowing, dry mouth, change in taste, lack of appetite, and mouth sores. An evidence-based practice intervention at a radiation oncology center in a large academic medical center in the Midwestern United States was designed to reduce the severity of oral mucositis in adults receiving radiation therapy for HNC.

Design

Study participants included adults with HNC who were receiving outpatient radiation therapy with or without concurrent chemotherapy. Twenty participants were recruited to the usual care group. The usual care group received extensive oral care preparation prior to radiation treatment. This included a visit with an oncologic dentist for a professional dental evaluation, fluoride treatments, the provision of oral care supplies, and tooth extraction if needed. Radiation treatment then proceeded as usual for 6 to 8 wk. These participants served as historical controls for the intervention group.

The 85 participants who were then recruited into the intervention group received the same care as those in the usual care group plus targeted education, a comprehensive oral care kit, and information on how to use the kit. The targeted education included a brochure from the U.S. Department of Health and Human Services, *Head and Neck Radiation Treatment and Your Mouth*, and a one-page additional insert, which was developed by the team. Nurses were integral throughout the study process in educating patients about the intervention.

Both clinicians and participants were surveyed at various intervals. Clinicians' (i.e., nurses, physicians, and radiation therapists) knowledge of oral care and correct use of oral care products, perceptions and attitudes about oral care, and behaviors and practices related to the documentation of patients' oral health and education were assessed. Participant feedback was obtained before radiation treatment, during weeks 4 to 5 of treatment, and 1 mo after treatment. The participants' questionnaires included sections that surveyed oral care practices (the frequency of care and products used), perceptions about oral care (feeling well prepared and the usefulness of oral care products), and oral mucositis symptoms.

Findings

The percentage of clinicians with correct responses to knowledge assessment items improved from 71% preimplementation to 80% postimplementation. The clinicians' mean scores on questions capturing their perceptions were higher postimplementation than preimplementation.

Feedback provided by patients during radiation treatment on weeks 4 to 5 demonstrated improvement in oral hygiene behaviors. More patients in the intervention group reported brushing at least daily, using Biotene toothpaste, performing oral rinses at least twice a day, and using lanolin lip balm, compared with those in the usual care group. Patients in the intervention group showed higher adherence with the targeted education and oral care kit intervention which led to a reduction of symptoms at weeks 4 to 5 of radiation treatment, when symptoms are expected to peak. The intervention group reported less severity than the usual care patients regarding the following symptoms: mouth and throat soreness, difficulty swallowing, difficulty eating, and difficulty talking. Furthermore, the intervention group reported less difficulty with xerostomia 1 mo after radiation was completed.

Nursing Implications

Mucositis is a frequent and distressing complication of radiation therapy in the treatment of patients with HNC. Nurses are key members of the treatment team and play many roles in caring for these patients, from assessing patients' symptoms to educating them on ways to reduce these symptoms. Findings from this study show that the distribution of standardized oral care kits and related educational materials can offer an effective way to meet patients' needs and reduce oral mucositis severity in adults treated with radiation therapy for HNC. The success of the project also highlights the key role nurses play in cancer symptom management, before radiation therapy begins, throughout the course of treatment, and in the months afterward.

2. Demonstrates less anxiety
 - a. Expresses a sense of hope
 - b. Is aware of available community organizations and agencies that provide patient education and support groups
 - c. Participates in support group for people with a laryngectomy
3. Maintains a clear airway and handles own secretions; also demonstrates practical, safe, and correct technique for cleaning and changing the tracheostomy or laryngectomy tube
4. Acquires effective communication techniques
 - a. Uses assistive devices and strategies for communication (Magic Slate, call bell, picture board, sign language, speech reading, handheld electronic devices, smartphones)
 - b. Follows the recommendations of the speech therapist

- c. Demonstrates ability to communicate with new communication strategy
 - d. Reports availability of prerecorded messages to summon emergency assistance by telephone
5. Maintains adequate nutrition and adequate fluid intake
 6. Exhibits improved body image, self-esteem, and self-concept
 - a. Expresses feelings and concerns
 - b. Manages health effectively
 - c. Accepts information about support group
 7. Adheres to rehabilitation and home care program
 - a. Practices recommended speech therapy
 - b. Demonstrates proper methods for caring for stoma and laryngectomy or tracheostomy tube (if present)
 - c. Verbalizes understanding of symptoms that require medical attention
 - d. States safety measures to take in emergencies
 - e. Performs oral hygiene as prescribed
 8. Absence of complications
 - a. Demonstrates a patent airway
 - b. No bleeding from surgical site and minimal bleeding from drains; vital signs (blood pressure, temperature, pulse, respiratory rate) are normal
 - c. No redness, tenderness, or purulent drainage at surgical site
 - d. No wound breakdown
 - e. Clear breath sounds; oxygen saturation level within acceptable range; chest x-ray clear
 - f. No indications of infection, stenosis, or obstruction of tracheal stoma

CRITICAL THINKING EXERCISES

1 pq A 19-year-old college student presents to the student health center where you work as a staff nurse with complaints of a “stuffed up head,” severe headache, green mucous when blowing her nose, and “teeth achiness.” She reports a fever of 100.8 for the past 2 days. What further questions do you have regarding her symptoms? What is your priority focus for your physical examination? What diagnostic tests and treatments may you anticipate?

2 ebp You are attending a wedding shower when the bride’s grandmother starts bleeding from her nose. You find out from her granddaughter that she has been receiving intravenous pembrolizumab for advanced lung cancer and had her last treatment 5 days ago. What is your priority focus for your nursing assessment? What types of interventions are indicated for epistaxis? What additional concerns do you have for this patient related to her immunotherapy regimen? Would you consider transport to an urgent care center or ED? Why or why not? What is the strength of the evidence that might guide your recommendations for follow-up for this older adult woman?

3 ipc You are working in a family practice clinic and are triaging a 58-year-old male who is complaining of weight loss, difficulty swallowing, sore throat, and hoarseness for the past month. He is worried about having cancer. What risk factors would you screen for in this patient? What type of referral do you expect to be made for this patient? Who else might need to be involved in his care?

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*Asterisk indicates nursing research.

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Resources

American Academy of Allergy, Asthma & Immunology (AAAAI), www.aaaai.org
American Academy of Family Physicians, www.aafp.org/home.html
American Academy of Otolaryngology–Head and Neck Surgery, www.entnet.org
American Cancer Society (ACS), www.cancer.org
American Sleep Apnea Association (ASAA), www.sleepapnea.org
International Association of Laryngectomees (IAL), www.theial.com
National Cancer Institute (NCI), www.cancer.gov
National Comprehensive Cancer Network (NCCN), www.nccn.org
National Institute of Allergy and Infectious Diseases (NIAID), www.niaid.nih.gov
National Sleep Foundation, www.sleepfoundation.org
WebWhispers, www.webwhispers.org

19 Management of Patients with Chest and Lower Respiratory Tract Disorders

LEARNING OUTCOMES

On completion of this chapter, the learner will be able to:

1. Identify patients at risk for atelectasis and the nursing interventions related to its prevention and management.
2. Compare the various pulmonary infections with regard to causes, clinical manifestations, nursing management, complications, and prevention.
3. Identify the nursing care of a patient with an endotracheal tube, with mechanical ventilation, or with a tracheostomy.
4. Relate the therapeutic management of acute respiratory distress syndrome to the underlying pathophysiology of the syndrome.
5. Describe preventive measures appropriate for controlling and eliminating occupational lung disease.
6. Discuss the modes of therapy and related nursing management of patients with lung cancer.
7. Use the nursing process as a framework for care of the patient with pneumonia, receiving mechanical ventilation, or with a thoracotomy.
8. Describe the complications of chest trauma and their clinical manifestations and nursing management.
9. Explain the principles of chest drainage and the nursing responsibilities related to the care of the patient with a chest drainage system.

NURSING CONCEPTS

Infection

Oxygenation

GLOSSARY

acute lung injury: an umbrella term for hypoxemic respiratory failure; equivalent to mild acute respiratory distress syndrome (ARDS)

acute respiratory distress syndrome (ARDS): nonspecific pulmonary response to a variety of pulmonary and nonpulmonary insults to the lung; characterized by interstitial infiltrates, alveolar hemorrhage, atelectasis, refractory hypoxemia, and, with the exception of some patients with coronavirus disease 2019 (COVID-19) and ARDS, decreased compliance

airway pressure release ventilation (APRV): mode of mechanical ventilation that allows unrestricted, spontaneous breaths throughout the ventilatory cycle; on inspiration the patient receives a preset level of continuous positive airway pressure, and pressure is periodically released to aid expiration

aspiration: inhalation of either oropharyngeal or gastric contents into the lower airways

atelectasis: collapse or airless condition of the alveoli caused by hypoventilation, obstruction to the airways, or compression

bilevel positive airway pressure (BiPAP): noninvasive spontaneous breath mode of mechanical ventilation that allows for the separate control of inspiratory and expiratory pressures; given via a mask

central cyanosis: bluish discoloration of the skin or mucous membranes due to hemoglobin carrying reduced amounts of oxygen

chest drainage system: the use of a chest tube and closed drainage system to re-expand the lung and to remove excess air, fluid, or blood

consolidation: lung tissue that has become more solid in nature due to collapse of alveoli or infectious process (pneumonia)

continuous mandatory (volume or pressure) ventilation (CMV): also referred to as assist-control (A/C) ventilation; mode of mechanical ventilation in which the patient's breathing pattern may trigger the ventilator to deliver a preset tidal volume or set pressure; in the absence of spontaneous breathing, the machine delivers a controlled breath at a preset minimum rate and tidal volume or set pressure

continuous positive airway pressure (CPAP): positive pressure applied throughout the respiratory cycle to a spontaneously breathing patient to promote alveolar and airway stability and increase functional residual capacity; may be given with endotracheal or tracheostomy tube or by mask

cor pulmonale: "heart of the lungs"; enlargement of the right ventricle from hypertrophy or dilation or as a secondary response to disorders that affect the lungs

empyema: accumulation of purulent material in the pleural space

endotracheal intubation: insertion of a breathing tube (type of artificial airway) through the nose or mouth into the trachea

fraction of inspired oxygen (FiO₂): concentration of oxygen delivered (e.g., 1.0 = 100% oxygen)

hemoptysis: the coughing up of blood from the lower respiratory tract

hemothorax: partial or complete collapse of the lung due to blood accumulating in the pleural space; may occur after surgery or trauma

hypoxemia: decrease in oxygen tension in the arterial blood

hypoxia: decrease in oxygen supply to the tissues and cells

incentive spirometry: method of deep breathing that provides visual feedback to help the patient inhale deeply and slowly and achieve maximum lung inflation

induration: an abnormally hard lesion or reaction, as in a positive tuberculin skin test

intermittent mandatory (volume or pressure) ventilation (IMV):

mode of mechanical ventilation that provides a combination of mechanically assisted breaths at a preset volume or pressure and rate and spontaneous breaths

mechanical ventilator: a positive- or negative-pressure breathing device that supports ventilation and oxygenation

orthopnea: shortness of breath when reclining or in the supine position

pleural effusion: abnormal accumulation of fluid in the pleural space

pleural friction rub: localized grating or creaking sound caused by the rubbing together of inflamed parietal and visceral pleurae

pleural space: the area between the parietal and visceral pleurae; a potential space

pneumothorax: partial or complete collapse of the lung due to positive pressure in the pleural space

positive end-expiratory pressure (PEEP): positive pressure maintained at the end of exhalation (instead of a normal zero pressure) to increase functional residual capacity and open collapsed alveoli

pressure support ventilation (PSV): mode of mechanical ventilation in which preset positive pressure is delivered with spontaneous breaths to decrease work of breathing

proportional assist ventilation (PAV): mode of mechanical ventilation that provides partial ventilatory support in proportion to the patient's inspiratory efforts; decreases the work of breathing

purulent: consisting of, containing, or discharging pus

respiratory weaning: process of gradual, systematic withdrawal or removal of ventilator, breathing tube, and oxygen

restrictive lung disease: disease of the lung that causes a decrease in lung volumes

synchronized intermittent mandatory ventilation (SIMV): mode of mechanical ventilation in which the ventilator allows the patient to breathe spontaneously while providing a preset number of breaths to ensure adequate ventilation; ventilated breaths are synchronized with spontaneous breathing

tension pneumothorax: pneumothorax characterized by increasing positive pressure in the pleural space with each breath; this is an emergency situation, and the positive pressure needs to be decompressed or released immediately

thoracentesis: insertion of a needle or catheter into the pleural space to remove fluid that has accumulated and decrease pressure on the lung tissue; may also be used diagnostically to identify potential causes of a pleural effusion

thoracotomy: surgical opening into the chest cavity

tidal volume: volume of air inspired and expired with each breath

tracheostomy tube: indwelling tube inserted directly into the trachea to assist with ventilation

tracheotomy: surgical opening into the trachea

transbronchial: through the bronchial wall, as in a transbronchial lung biopsy

ventilation–perfusion (V/Q.): refers to the ratio between ventilation and perfusion in the lung; matching of ventilation to perfusion optimizes gas exchange

Disorders affecting the chest and lower respiratory tract range from acute to chronic conditions. Many of these disorders are serious and often life-threatening. Patients with chest and lower respiratory tract disorders require care from nurses with astute assessment and clinical management skills as well as knowledge of evidence-based practice. Nurses must also understand the impact of the particular disorder on the patient's quality of life and ability to carry out activities of daily living. Patient and family education is an important nursing intervention in the management of all chest and lower respiratory tract disorders.

INFLAMMATORY AND INFECTIOUS PULMONARY DISORDERS

Inflammatory pulmonary disorders may include relatively common disorders such as atelectasis, as well as uncommon disorders such as aspiration and

sarcoidosis. Infectious pulmonary disorders are responsible for much morbidity and mortality, and include diseases such as pneumonia and tuberculosis, as well as lung abscesses.

Atelectasis

Atelectasis refers to closure or collapse of alveoli and often is described in relation to chest x-ray findings and clinical signs and symptoms. Atelectasis is one of the most commonly encountered abnormalities seen on a chest x-ray (Stark, 2019). Atelectasis may be acute or chronic and may cover a broad range of pathophysiologic changes, from microatelectasis (which is not detectable on chest x-ray) to macroatelectasis with loss of segmental, lobar, or overall lung volume. The most commonly described is acute atelectasis, which occurs most often in the postoperative setting usually following thoracic and upper abdominal procedures or in people who are immobilized and have a shallow, monotonous breathing pattern (Conde & Adams, 2018; Smetana, 2018). Excess secretions or mucus plugs may also cause obstruction of airflow and result in atelectasis in an area of the lung. Atelectasis also is observed in patients with a chronic airway obstruction that impedes or blocks the flow of air to an area of the lung (e.g., obstructive atelectasis in the patient with lung cancer that is invading or compressing the airways). This type of atelectasis is more insidious and slower in onset (Conde & Adams, 2018; Stark, 2019).

Pathophysiology

Atelectasis may be described as either nonobstructive or obstructive. Nonobstructive atelectasis occurs in adults as a result of reduced ventilation. Obstructive atelectasis results from any blockage that impedes the passage of air to and from the alveoli, reducing alveolar ventilation (Stark, 2019). Obstructive atelectasis is the most common type and results from reabsorption of gas (trapped alveolar air is absorbed into the bloodstream); no additional air can enter into the alveoli because of the blockage. As a result, the affected portion of the lung becomes airless and the alveoli collapse. Causes of atelectasis include foreign body, tumor or growth in an airway, altered breathing patterns, retained secretions, pain, alterations in small airway function, prolonged supine positioning, increased abdominal pressure, reduced lung volumes due to musculoskeletal or neurologic disorders, restrictive defects, and specific surgical procedures (e.g., upper abdominal, thoracic, or open heart surgery) (Conde & Adams, 2018).

Patients are at high risk for atelectasis postoperatively because of several factors. A monotonous, low tidal breathing pattern may cause small airway closure and alveolar collapse. This can result from the effects of anesthesia or

analgesic agents, supine positioning, splinting of the chest wall because of pain, or abdominal distention. Secretion retention, airway obstruction, and an impaired cough reflex may also occur, or patients may be reluctant to cough because of pain (Conde & Adams, 2018). [Figure 19-1](#) shows the mechanisms and consequences of acute atelectasis in postoperative patients.

Atelectasis resulting from bronchial obstruction by secretions may also occur in patients with impaired cough mechanisms (e.g., musculoskeletal or neurologic disorders) as well as in those who are debilitated and confined to bed. In addition, atelectasis may develop because of excessive pressure on the lung tissue (i.e., compressive atelectasis), which restricts normal lung expansion on inspiration (Stark, 2019). Such pressure can be produced by a **pleural effusion** (fluid accumulating within the pleural space), a **pneumothorax** (air in the pleural space), or a **hemothorax** (blood in the pleural space). The **pleural space** is the area between the parietal and the visceral pleurae, and is normally a potential rather than an actual space. Pressure may also be produced by a pericardial effusion (pericardium distended with fluid), tumor growth within the thorax, or an elevated diaphragm.

Physiology/Pathophysiology

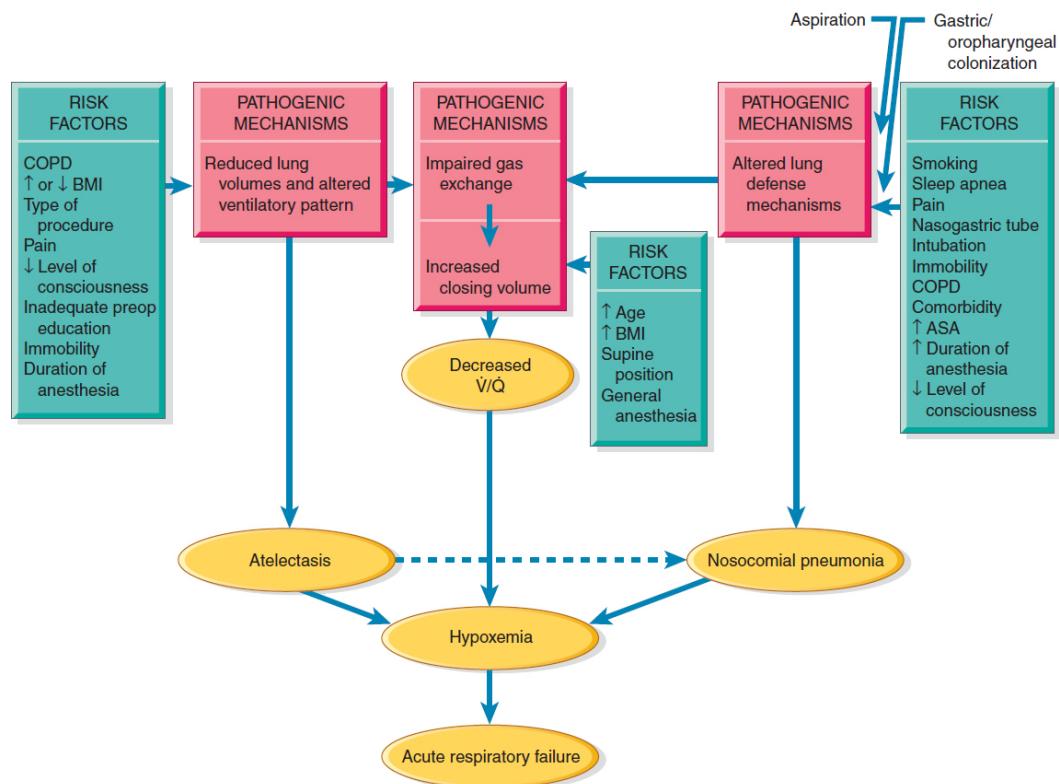


Figure 19-1 • Relationship of risk factors, pathogenic mechanisms, and consequences of acute atelectasis in the postoperative patient. ASA, acetylsalicylic acid; BMI, body mass index; COPD, chronic obstructive pulmonary disease; V./Q., ventilation–perfusion ratio.

Clinical Manifestations

The development of atelectasis usually is insidious. Signs and symptoms include increasing dyspnea (shortness of breath), cough, and sputum production.

In acute atelectasis involving a large amount of lung tissue (lobar atelectasis), marked respiratory distress may be observed. In addition to the previously mentioned signs and symptoms, tachycardia, tachypnea, pleural pain, and **central cyanosis** (a bluish skin hue that is a late sign of hypoxemia) may be anticipated. Patients characteristically have difficulty breathing in the supine position and are anxious.

In chronic atelectasis, signs and symptoms are similar to those of acute atelectasis. The chronic nature of the alveolar collapse predisposes patients to infection distal to the obstruction. Therefore, the signs and symptoms of a pulmonary infection also may be present.

Assessment and Diagnostic Findings

When clinically significant atelectasis develops, it is generally characterized by increased work of breathing and **hypoxemia** (i.e., a decrease in oxygen tension in the arterial blood). Decreased breath sounds and crackles are heard over the affected area. A chest x-ray may suggest a diagnosis of atelectasis before clinical symptoms appear; the x-ray may reveal patchy infiltrates or consolidated areas. Depending on the degree of hypoxemia, pulse oximetry (SpO_2) may demonstrate a low saturation of hemoglobin with oxygen (less than 90%) or a lower-than-normal partial pressure of arterial oxygen (PaO_2).



Quality and Safety Nursing Alert

Tachypnea, dyspnea, and mild-to-moderate hypoxemia are hallmarks of the severity of atelectasis.

Prevention

Nursing measures to prevent atelectasis include frequent turning, early mobilization, and strategies to expand the lungs and to manage secretions. Voluntary deep-breathing maneuvers (at least every 2 hours) assist in preventing and treating atelectasis. The performance of these maneuvers requires the patient to be alert and cooperative. Patient education and reinforcement are key elements to the success of these interventions. The use of incentive spirometry or voluntary deep breathing enhances lung expansion, decreases the potential for airway closure, and may generate a cough. **Incentive spirometry** is a method of deep breathing that provides visual feedback to encourage the patient to inhale slowly and deeply to maximize lung inflation and prevent or reduce atelectasis. The purpose of an incentive spirometer is to ensure that the volume of air inhaled is increased gradually as the patient takes deeper and deeper breaths.

Incentive spirometers are available in two types: volume or flow. In the volume type, the tidal volume is set using the manufacturer's instructions. The patient takes a deep breath through the mouthpiece, pauses at peak lung inflation, and then relaxes and exhales. Taking several normal breaths before attempting another with the incentive spirometer helps avoid fatigue. The volume is periodically increased as tolerated.

In the flow type, the volume is not preset. The spirometer contains a number of movable balls that are pushed up by the force of the breath and held suspended in the air while the patient inhales. The amount of air inhaled and the flow of the air are estimated by how long and how high the balls are suspended (see [Chart 19-1](#)).

Secretion management techniques include directed cough, suctioning, aerosol nebulizer treatments followed by chest physiotherapy (CPT; see [Figs. 20-6](#) and [20-7](#) and further discussion of CPT principles in [Chapter 20](#)), and bronchoscopy. In some settings, a pressurized metered-dose inhaler (pMDI) is used to dispense a bronchodilator rather than an aerosolized, small-volume nebulizer (SVN) (see [Chapter 20](#) for further discussion of pMDIs and SVNs). [Chart 19-2](#) summarizes measures used to prevent atelectasis.

Chart 19-1  **PATIENT EDUCATION**

Performing Incentive Spirometry

The inspired air helps inflate the lungs. The ball or weight in the spirometer rises in response to the intensity of the intake of air. The higher the ball rises, the deeper the breath.

The nurse instructs the patient to:

- Assume a semi-Fowler position or an upright position before initiating therapy.
- Use diaphragmatic breathing.
- Place the mouthpiece of the spirometer firmly in the mouth, breathe air in (inspire) slowly through the mouth, and hold the breath at the end of inspiration for about 3 seconds to maintain the ball/indicator between the lines. Exhale slowly through the mouthpiece.
- Cough during and after each session. Splint the incision when coughing postoperatively.
- Perform the procedure approximately 10 times in succession, repeating the 10 breaths with the spirometer each hour during waking hours.



Chart 19-2

Preventing Atelectasis

- Change patient's position frequently, especially from supine to upright position, to promote ventilation and prevent secretions from accumulating.
- Encourage early mobilization from bed to chair followed by early ambulation.
- Encourage appropriate deep breathing and coughing to mobilize secretions and prevent them from accumulating.
- Educate/reinforce appropriate technique for incentive spirometry.
- Administer prescribed opioids and sedatives judiciously to prevent respiratory depression.
- Perform postural drainage and chest percussion, if indicated.
- Institute suctioning to remove tracheobronchial secretions, if indicated.

Management

The goal of the treatment is to improve ventilation and remove secretions. Strategies to prevent atelectasis, which include frequent turning, early ambulation, lung volume expansion maneuvers (e.g., deep-breathing exercises and incentive spirometry), and coughing, also serve as the first-line measures to minimize or treat atelectasis by improving ventilation. Multidisciplinary, evidence-based standardized intervention programs that incorporate ICOUGHSM (see [Chart 19-3](#)) can prevent atelectasis (Moore, Conway, Thomas, et al., 2017; Smetana, 2018).

In patients who do not respond to first-line measures or who cannot perform deep-breathing exercises, other treatments such as **positive end-expiratory pressure (PEEP)**; a simple mask and one-way valve system that provides varying amounts of expiratory resistance, usually 10 to 15 cm H₂O, continuous positive airway breathing, or bronchoscopy may be used. Before initiating more complex, costly, and labor-intensive therapies, the nurse should ask several questions:

- Has the patient been given an adequate trial of deep-breathing exercises?

Chart 19-3

ICOUGHSM Program

- Incentive spirometry
- Coughing and deep breathing
- Oral care (brushing teeth and using mouthwash twice a day)
- Understanding (patient and staff education)
- Getting out of bed at least three times daily
- Head-of-bed elevation

Adapted from Boston University School of Medicine. (2019). ICOUGHSM.

Retrieved on 8/22/2019 at: www.bumc.bu.edu/surgery/quality-safety/i-cough

- Has the patient received adequate education, supervision, and coaching to carry out the deep-breathing exercises?
- Have other factors been evaluated that may impair ventilation or prevent a good patient effort (e.g., lack of turning, mobilization; excessive pain; excessive sedation)?

If the cause of atelectasis is bronchial obstruction from secretions, the secretions must be removed by coughing or suctioning to allow air to reenter that portion of the lung. CPT and postural drainage may also be used to mobilize secretions. SVN treatments with a bronchodilator may be used to assist patients in the expectoration of secretions. If respiratory care measures fail to remove the obstruction, a bronchoscopy is performed. Although bronchoscopy is an excellent measure to acutely remove secretions and increase ventilation, it is imperative for the nurse to assist the patient with maintaining the patency of the airways after bronchoscopy, using the traditional techniques of deep breathing, coughing, and suctioning. Severe or massive atelectasis may lead to acute respiratory failure, especially in patients with underlying lung disease. Endotracheal (ET) intubation and mechanical ventilation may be necessary.

If the cause of atelectasis is compression of lung tissue, the goal is to decrease the compression. With a large pleural effusion that is compressing lung tissue and causing alveolar collapse, treatment may include **thoracentesis** (removal of the fluid by needle aspiration) or insertion of a chest tube. The measures to increase lung expansion described previously also are used.

Management of chronic atelectasis focuses on removing the cause of the obstruction of the airways or the compression of the lung tissue. For example, bronchoscopy may be used to open an airway obstructed by lung cancer or a nonmalignant lesion, and the procedure may involve cryotherapy or laser therapy. If the atelectasis is a result of obstruction caused by lung cancer, an airway stent or radiation therapy to shrink a tumor may be used to open the airways and provide ventilation to the collapsed area. However, reopening the

airways and reaerating the area of the lung may not be possible in patients who have experienced chronic, long-term collapse. In some cases, surgical management may be indicated.

Acute Tracheobronchitis

Acute tracheobronchitis, an acute inflammation of the mucous membranes of the trachea and the bronchial tree, often follows infection of the upper respiratory tract usually as a result of a viral infection (see [Chapter 18](#)). Patients with viral infections have decreased resistance and can readily develop a secondary bacterial infection. Adequate treatment of upper respiratory tract infection is one of the major factors in the prevention of acute tracheobronchitis.

Pathophysiology

In acute tracheobronchitis, the inflamed mucosa of the bronchi produces mucopurulent sputum, often in response to infection by *Streptococcus pneumoniae*, *Haemophilus influenzae*, or *Mycoplasma pneumoniae*. A fungal infection (e.g., *Aspergillus*) may also cause tracheobronchitis. A sputum culture is essential to identify the specific causative organism. In addition to infection, inhalation of physical and chemical irritants, gases, or other air contaminants can also cause acute bronchial irritation (File, 2019a).

Clinical Manifestations

Initially, the patient has a dry, irritating cough and expectorates a scanty amount of mucoid sputum. The patient may report sternal soreness from coughing and have fever or chills, night sweats, headache, and general malaise. As the infection progresses, the patient may be short of breath, have noisy inspiration and expiration (inspiratory stridor and expiratory wheeze), and produce **purulent** (pus-filled) sputum. In severe tracheobronchitis, blood-streaked secretions may be expectorated as a result of the irritation of the mucosa of the airways.

Medical Management

Antibiotic treatment for an infection may be indicated depending on the symptoms, sputum purulence, and results of the sputum culture and sensitivity. Antihistamines usually are not prescribed, because they can cause excessive drying and make secretions more difficult to expectorate. Fluid intake is increased to thin viscous and tenacious secretions. Copious, purulent

secretions that cannot be cleared by coughing place patients at risk for increasing airway obstruction and the development of more severe lower respiratory tract infections, such as pneumonia. Suctioning and bronchoscopy may be needed to remove secretions. Rarely, ET intubation may be necessary in cases of acute tracheobronchitis leading to acute respiratory failure, such as in patients who are severely debilitated or who have coexisting diseases that impair the respiratory system.

In most cases, treatment of tracheobronchitis is largely symptomatic. Increasing the vapor pressure (moisture content) in the air reduces airway irritation. Cool vapor therapy or steam inhalations may help relieve laryngeal and tracheal irritation. Moist heat to the chest may relieve the soreness and pain, and mild analgesics may be prescribed.

Nursing Management

Acute tracheobronchitis is usually treated in the home setting. A primary nursing function is to encourage bronchial hygiene, such as increased fluid intake and directed coughing to remove secretions. The nurse encourages and assists the patient to sit up frequently to cough effectively and to prevent retention of mucopurulent sputum. If the patient is taking antibiotics for an underlying bacterial infection, the need to complete the full course of antibiotics prescribed is emphasized. Fatigue is a consequence of tracheobronchitis; therefore, the nurse cautions the patient against overexertion, which can induce a relapse or exacerbation of the infection. The patient is advised to rest (File, 2019a).

Pneumonia

Pneumonia is an inflammation of the lung parenchyma caused by various microorganisms, including bacteria, mycobacteria, fungi, and viruses. *Pneumonitis* is a more general term that describes an inflammatory process in the lung tissue that may predispose or place the patient at risk for microbial invasion. Pneumonia and influenza are the most common causes of death from infectious diseases in the United States. Pneumonia and influenza accounted for 55,672 deaths in the United States in 2017 (Centers for Disease Control and Prevention [CDC], 2017a). Together, these diseases were the eighth leading cause of death in the United States in 2017, accounting for 5.9% of all deaths (CDC, 2017a).

Chart 19-4

Classifications and Definitions of Pneumonias

- *Community-acquired pneumonia (CAP)*: Pneumonia occurring in the community or ≤48 hours after hospital admission or institutionalization of patients who do not meet the criteria for health care–associated pneumonia (HCAP)
- *Health care–associated pneumonia (HCAP)*: Pneumonia occurring in a nonhospitalized patient with extensive health care contact with one or more of the following:
 - Hospitalization for ≥2 days in an acute care facility within 90 days of infection
 - Residence in a nursing home or long-term care facility
 - Antibiotic therapy, chemotherapy, or wound care within 30 days of current infection
 - Hemodialysis treatment at a hospital or clinic
 - Home infusion therapy or home wound care
 - Family member with infection due to multidrug-resistant bacteria
- *Hospital-acquired pneumonia (HAP)*: Pneumonia occurring ≥48 hours after hospital admission that did not appear to be incubating at the time of admission
- *Ventilator-associated pneumonia (VAP)*: A type of HAP that develops ≥48 hours after endotracheal tube intubation

Adapted from Klompas, M., File, T. M., & Bond, S. (2019). Treatment of hospital-acquired, ventilator-associated and healthcare-associated pneumonia in adults. *UpToDate*. Retrieved on 8/22/2019 at: www.uptodate.com/contents/treatment-of-hospital-acquired-ventilator-associated-and-healthcare-associated-pneumonia-in-adults

Classification

Pneumonia can be classified into four types: community-acquired pneumonia (CAP), health care–associated pneumonia (HCAP), hospital-acquired pneumonia (HAP), and ventilator-associated pneumonia (VAP) (American Thoracic Society & Infectious Diseases Society of America, 2005; Klompas, 2019a). HCAP was conceived as a specific category in order to identify patients at increased risk for multidrug-resistant organisms (MDRO) versus community-acquired organisms (Klompas, 2019a). [Chart 19-4](#) describes the different classifications and definitions of pneumonias. Other subcategories of HCAPs are those in the immunocompromised host and aspiration pneumonia. There is overlap in how specific pneumonias are classified, because they may occur in differing settings. Risk factors associated for specific pathogens are shown in [Chart 19-5](#).

Community-Acquired Pneumonia

CAP, a common infectious disease, occurs either in the community setting or within the first 48 hours after hospitalization or institutionalization. The need for hospitalization for CAP depends on the severity of the pneumonia. The causative pathogens for CAP by site of care are shown in Table 19-1. The specific etiologic pathogen is identified in about 50% of cases. The rate of CAP increases with age, with 2000 per 100,000 adults 65 years of age and older hospitalized with CAP each year (Ramirez, 2019).

Chart 19-5 RISK FACTORS

Pneumonia Based upon Pathogen Type

Risk Factors for Infection with Penicillin-Resistant and Drug-Resistant Pneumococci

- Age >65 years
- Alcoholism
- Beta-lactam therapy (e.g., cephalosporins) in past 3 months
- Immunosuppressive disorders
- Multiple medical comorbidities
- Exposure to a child in a day care facility

Risk Factors for Infection with Enteric Gram-Negative Bacteria

- Residency in a long-term care facility
- Underlying cardiopulmonary disease
- Multiple medical comorbidities
- Recent antibiotic therapy

Risk Factors for Infection with *Pseudomonas aeruginosa*

- Structural lung disease (e.g., bronchiectasis)
- Corticosteroid therapy
- Broad-spectrum antibiotic therapy (>7 days in the past month)
- Malnutrition

Adapted from Ramirez, J. A. (2019). Overview of community acquired pneumonia in adults. *UpToDate*. Retrieved on 9/23/2019 at: www.uptodate.com/contents/overview-of-community-acquired-pneumonia-in-adults

S. pneumoniae (*pneumococcus*) is the most common bacterial cause of CAP in people younger than 60 years without comorbidity and in those 60 years and older with comorbidity (Baer, 2019; Ramirez, 2019). *S. pneumoniae*, a gram-positive organism that resides naturally in the upper respiratory tract, colonizes

the upper respiratory tract and can cause disseminated invasive infections, pneumonia and other lower respiratory tract infections, and upper respiratory tract infections such as otitis media and rhinosinusitis. It may occur as a lobar or bronchopneumonic form in patients of any age and may follow a recent respiratory illness.

TABLE 19-1 Community-Acquired Pneumonia Microbial Causes by Site of Care^a

Outpatients	Hospitalized Patients	
	Non-ICU	ICU
<i>Streptococcus pneumoniae</i>	<i>S. pneumoniae</i>	<i>S. pneumoniae</i>
<i>Mycoplasma pneumoniae</i>	<i>M. pneumoniae</i>	<i>Staphylococcus aureus</i>
<i>Haemophilus influenzae</i>	<i>Chlamydophila pneumoniae</i>	<i>Legionella</i>
<i>C. pneumoniae</i>	<i>H. influenzae</i>	Gram-negative bacilli
Respiratory viruses	<i>Legionella</i>	<i>H. influenzae</i>

ICU, intensive care unit.

^aListed in descending order of frequency at each site.

Adapted from Klompas, M. (2019b). Treatment of hospital-acquired and ventilator-associated pneumonia in adults. *UpToDate*. Last updated: July 10, 2019. Retrieved on 9/23/2019 at: www.uptodate.com/contents/treatment-of-hospital-acquired-and-ventilator-associated-pneumonia-in-adults/print

H. influenzae causes a type of CAP that frequently affects older adults and those with comorbid illnesses (e.g., chronic obstructive pulmonary disease [COPD], alcoholism, diabetes). The presentation is indistinguishable from that of other forms of bacterial CAP and may be subacute, with cough or low-grade fever for weeks before diagnosis.

Mycoplasma pneumonia is caused by *M. pneumoniae*. Mycoplasma pneumonia is spread by infected respiratory droplets through person-to-person contact. Patients can be tested for mycoplasma antibodies. The inflammatory infiltrate is primarily interstitial rather than alveolar. It spreads throughout the entire respiratory tract, including the bronchioles, and has the characteristics of a bronchopneumonia. Earache and bullous myringitis are common. Impaired ventilation and diffusion may occur.

Viruses are the most common cause of pneumonia in infants and children. Until the advent of the coronavirus disease 2019 (COVID-19) pandemic, viruses were relatively uncommon causes of CAP in adults (see later discussion). Pre-COVID-19, cytomegalovirus was the most commonly implicated viral pathogen in adults with compromised immune systems, followed by herpes simplex virus, adenovirus, and respiratory syncytial virus. The acute stage of a viral respiratory infection occurs within the ciliated cells of the airways, followed by infiltration of the tracheobronchial tree. With

pneumonia, the inflammatory process extends into the alveolar area, resulting in edema and exudation. The clinical signs and symptoms of a viral pneumonia are often difficult to distinguish from those of a bacterial pneumonia.

Health Care–Associated Pneumonia

An important distinction of HCAP is that the causative pathogens are often MDROs because of prior contact with a health care environment. Consequently, identifying this type of pneumonia in areas such as the emergency department is crucial. Because HCAP is often difficult to treat, initial antibiotic treatment must not be delayed. Initial antibiotic treatment of HCAP is often different from that for CAP due to the possibility of MDROs (Ramirez, 2019).

Hospital-Acquired Pneumonia

HAP develops 48 hours or more after hospitalization and does not appear to be incubating at the time of admission. VAP can be considered a subtype of HAP, as the only differentiating factor is the presence of an ET tube (see later discussion of VAP). Certain factors may predispose patients to HAP because of impaired host defenses (e.g., severe acute or chronic illness), a variety of comorbid conditions, supine positioning and aspiration, coma, malnutrition, prolonged hospitalization, hypotension, metabolic disorders. Hospitalized patients are also exposed to potential bacteria from other sources (e.g., respiratory therapy devices and equipment, transmission of pathogens by the hands of health care personnel). Numerous intervention-related factors also may play a role in the development of HAP (e.g., therapeutic agents leading to central nervous system depression with decreased ventilation, impaired removal of secretions, or potential aspiration; prolonged or complicated thoracoabdominal procedures, which may impair mucociliary function and cellular host defenses; ET intubation [VAP]; prolonged or inappropriate use of antibiotics; the use of nasogastric tubes). In addition, patients with compromised immune systems are at particular risk. HAP is associated with a high mortality rate, in part because of the virulence of the organisms, the resistance to antibiotics, and the patient's underlying disorder. It is the most common cause of death among all patients with hospital-acquired infections, with mortality rates up to 33% (Cunha, 2018; Klompas, 2019a).

The common organisms responsible for HAP include the *Enterobacter* species, *Escherichia coli*, *H. influenzae*, *Klebsiella pneumoniae*, *Pseudomonas aeruginosa*, *Acinetobacter* species, methicillin-sensitive or methicillin-resistant *Staphylococcus aureus* (MRSA), and *S. pneumoniae*. Most patients with HAP are colonized by multiple organisms. Pseudomonal pneumonia occurs in patients who are debilitated, those with altered mental status, and those with prolonged intubation or with tracheostomy. Staphylococcal

pneumonia can occur through inhalation of the organism or spread through the hematogenous route. It is often accompanied by sepsis and positive blood cultures. Its mortality rate is high. Specific strains of staphylococci are resistant to many available antimicrobial agents; notable exceptions include vancomycin and linezolid (Klompas, 2019b). Overuse and misuse of antimicrobial agents are major risk factors for the emergence of these resistant pathogens. Because MRSA is highly virulent, steps must be taken to prevent its spread. Patients with MRSA are isolated in a private room, and contact precautions (gown, gloves, and antibacterial soap or alcohol-based hand rub) are used. The number of people in contact with affected patients is minimized, and appropriate precautions must be taken when transporting these patients within or between facilities.

The usual presentation of HAP is a new pulmonary infiltrate on chest x-ray combined with evidence of infection such as fever, respiratory symptoms, purulent sputum, or leukocytosis. Pneumonias from *Klebsiella* or other gram-negative organisms are characterized by the destruction of lung structure and alveolar walls, **consolidation** (tissue that solidifies as a result of collapsed alveoli or infectious process such as pneumonia), and sepsis. Older adult patients and those with alcoholism, chronic lung disease, or diabetes are at increased risk (Klompas, 2019a). Development of a cough or increased cough and sputum production are common presentations, along with low-grade fever and general malaise. In patients who are debilitated or dehydrated, sputum production may be minimal or absent. Pleural effusion, high fever, and tachycardia are common.



Ventilator-Associated Pneumonia

As noted previously, VAP can be thought of as a subtype of HAP; however, in such cases, the patient has been endotracheally intubated and has received mechanical ventilatory support for at least 48 hours (see later discussions on ET intubation and mechanical ventilation). VAP is a complication in as many as 27% of patient who require mechanical ventilation (Gamache, 2019). The incidence of VAP increases with the duration of mechanical ventilation and the mortality rate is variable, depending upon the complexity of the underlying illness. The etiologic bacteriologic agents associated with VAP typically differ based on the timing of the occurrence of the infection relative to the start of mechanical ventilation. VAP occurring within 96 hours of the onset of mechanical ventilation is usually due to antibiotic-sensitive bacteria that colonize the patient prior to hospital admission, whereas VAP developing after 96 hours of ventilatory support is more often associated with MDROs. Prevention remains the key to reducing the burden of VAP (Klompas, File, & Bond, 2019; Timsit, Esaied, Neuville, et al., 2017). See [Chart 19-6](#) for an overview of bundled interventions aimed at preventing VAP.

Chart 19-6

Collaborative Practice Interventions to Prevent Ventilator-Associated Pneumonia

Current best practices can include the implementation of specific evidence-based bundle interventions that, when used together (i.e., as a “bundle”), improve patient outcomes. This chart outlines specific parameters for the ventilator-bundled collaborative interventions that have been found to reduce ventilator-associated pneumonia (VAP).

What are the five key elements of the VAP bundle?

- Elevation of the head of the bed (30° to 45°)
- Daily “sedation vacations” and assessment of readiness to extubate (see below)
- Peptic ulcer disease prophylaxis
- Deep venous thrombosis (DVT) prophylaxis (see below)
- Daily oral care with chlorhexidine (0.12% oral rinses)

What is meant by daily “sedation vacations,” and how does this tie into assessing readiness to extubate?

- Protocols should be developed so that sedative doses are purposely decreased at a time of the day when it is possible to assess the patient’s neurologic readiness for extubation.
- Vigilance must be employed during the time that sedative doses are lower to ensure that the patient does not self-extubate.

What effect does DVT prophylaxis have on preventing VAP?

- The exact relationship is unclear. However, when appropriate, evidence-based methods to ensure DVT prophylaxis are applied (see Chapter 26); then the rates of VAP also drop.

Adapted from Institute for Healthcare Improvement. (2012). How-to guide: Prevent ventilator-associated pneumonia. Cambridge, MA: Institute for Healthcare Improvements. Retrieved on 3/6/2020 at: www.ihi.org/resources/Pages/Tools/HowtoGuidePreventVAP.aspx

Pneumonia in the Immunocompromised Host

Due to advances in immunosuppressive therapy, prevalence of MDROs, and improvements in diagnostic studies, there is an increased incidence of pneumonia in patients who are immunocompromised. Common causative organisms include *Pneumocystis* pneumonia (PCP), fungal pneumonias, and *Mycobacterium tuberculosis*. The organism that causes PCP is now known as *Pneumocystis jiroveci* instead of *Pneumocystis carinii*. The acronym PCP still applies because it can be read “*Pneumocystis* pneumonia.”

Pneumonia in the immunocompromised host can occur with the use of corticosteroids or other immunosuppressive agents, chemotherapy, nutritional

depletion, the use of broad-spectrum antimicrobial agents, acquired immune deficiency syndrome (AIDS), genetic immune disorders, and long-term advanced life support technology (mechanical ventilation). It is seen with increasing frequency because affected patients constitute a growing portion of the population; however, pneumonias that typically occur in people who are immunocompromised may also occur in those who are immunocompetent. Pneumonia carries a higher morbidity and mortality rate in patients who are immunocompromised than in those who are immunocompetent (Zhao & Shin, 2019). Patients with compromised immune systems commonly develop pneumonia from organisms of low virulence. In addition, increasing numbers of patients with impaired defenses develop HAP from gram-negative bacilli (*Klebsiella*, *Pseudomonas*, *E. coli*, Enterobacteriaceae, *Proteus*, *Serratia*) (Zhao & Shin, 2019).

Whether patients are immunocompromised or immunocompetent, the clinical presentation of pneumonia is similar. PCP has a subtle onset, with progressive dyspnea, fever, and a nonproductive cough.

Aspiration Pneumonia

Aspiration pneumonia refers to the pulmonary consequences resulting from entry of endogenous or exogenous substances into the lower airway. The most common form of aspiration pneumonia is bacterial infection from aspiration of bacteria that normally reside in the upper airways. Aspiration pneumonia may occur in the community or hospital setting. Common pathogens are anaerobes, *S. aureus*, *Streptococcus* species, and gram-negative bacilli (Bartlett, 2019a). Substances other than bacteria may be aspirated into the lung, such as gastric contents, exogenous chemical contents, or irritating gases. This type of aspiration or ingestion may impair the lung defenses, cause inflammatory changes, and lead to bacterial growth and a resulting pneumonia (see later discussion of aspiration).

Pathophysiology

Normally, the upper airway prevents potentially infectious particles from reaching the sterile lower respiratory tract. Pneumonia arises from normal flora present in patients whose resistance has been altered or from aspiration of flora present in the oropharynx; patients often have an acute or chronic underlying disease that impairs host defenses. Pneumonia may also result from bloodborne organisms that enter the pulmonary circulation and are trapped in the pulmonary capillary bed.

Pneumonia affects both ventilation and diffusion. An inflammatory reaction can occur in the alveoli, producing an exudate that interferes with the diffusion of oxygen and carbon dioxide. White blood cells, mostly neutrophils, also migrate into the alveoli and fill the normally air-filled spaces. Areas of the

lung are not adequately ventilated because of secretions and mucosal edema that cause partial occlusion of the bronchi or alveoli, with a resultant decrease in alveolar oxygen tension. Bronchospasm may also occur in patients with reactive airway disease. Because of hypoventilation, a **ventilation–perfusion** (V./Q.) mismatch occurs in the affected area of the lung. V./Q. refers to the ratio between ventilation and perfusion in the lung, which is normally approximately 4 to 5, or 0.8; matching of ventilation to perfusion optimizes gas exchange. Venous blood entering the pulmonary circulation passes through the underventilated area and travels to the left side of the heart poorly oxygenated. The mixing of oxygenated and unoxygenated or poorly oxygenated blood eventually results in arterial hypoxemia.

If a substantial portion of one or more lobes is involved, the disease is referred to as lobar pneumonia. The term *bronchopneumonia* is used to describe pneumonia that is distributed in a patchy fashion, having originated in one or more localized areas within the bronchi and extending to the adjacent surrounding lung parenchyma. Bronchopneumonia is more common than lobar pneumonia (see [Fig. 19-2](#)).

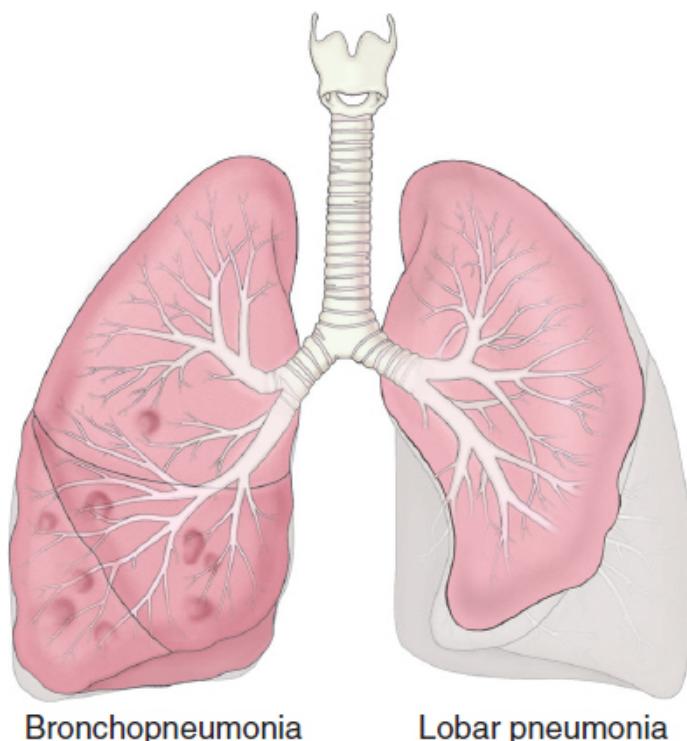


Figure 19-2 • Distribution of lung involvement in bronchial and lobar pneumonia. In bronchopneumonia (*left*), patchy areas of consolidation occur. In lobar pneumonia (*right*), an entire lobe is consolidated.

Risk Factors

Being knowledgeable about the factors and circumstances that commonly predispose people to pneumonia helps identify patients at high risk for the disease (Bartlett, 2019a). **Table 19-2** describes risk factors for pneumonia; additional risk factors are travel or exposure to certain environments and residence in a long-term care facility. Increasing numbers of patients who have compromised defenses against infections are susceptible to pneumonia. Some types of pneumonia, such as those caused by viral infections, occur in previously healthy people, often after a viral illness.

Pneumonia occurs in patients with certain underlying disorders such as heart failure, diabetes, alcoholism, COPD, and AIDS (Klompas, 2019a). Certain diseases also have been associated with specific pathogens. For example, staphylococcal pneumonia has been noted after epidemics of influenza, and patients with COPD are at increased risk for development of pneumonia caused by pneumococci or *H. influenzae*. In addition, cystic fibrosis is associated with respiratory infection caused by pseudomonal and staphylococcal organisms, and PCP has been associated with AIDS. Pneumonias occurring in hospitalized patients often involve organisms not usually found in CAP, including enteric gram-negative bacilli and *S. aureus*.

TABLE 19-2

Risk Factors and Preventive Measures for

Pneumonia

Risk Factor	Preventive Measure
Conditions that produce mucus or bronchial obstruction and interfere with normal lung drainage (e.g., cancer, cigarette smoking, chronic obstructive pulmonary disease)	Promote coughing and expectoration of secretions. Encourage smoking cessation
Patients who are immunosuppressed or neutropenic (low neutrophil count)	Initiate special precautions against infection
Smoking (cigarette smoke disrupts both mucociliary and macrophage activity)	Encourage smoking cessation
Prolonged immobility and shallow breathing pattern	Reposition frequently and promote lung expansion exercises and coughing. Initiate suctioning and chest physical therapy if indicated
Depressed cough reflex (due to medications, a debilitated state, or weak respiratory muscles); aspiration of foreign material into the lungs during a period of unconsciousness (head injury, anesthesia, depressed level of consciousness), or abnormal swallowing mechanism	Reposition frequently to prevent aspiration and administer medications judiciously, particularly those that increase risk for aspiration. Perform suctioning and chest physical therapy if indicated
Nothing-by-mouth (NPO) status; placement of nasogastric, orogastric, or endotracheal tube	Promote frequent oral hygiene. Minimize risk for aspiration by checking placement of tube and proper positioning of patient
Supine positioning in patients unable to protect their airway	Elevate head of bed at least 30 degrees
Antibiotic therapy (in people who are very ill, the oropharynx is likely to be colonized by gram-negative bacteria)	Monitor patients receiving antibiotic therapy for signs and symptoms of pneumonia
Alcohol intoxication (because alcohol suppresses the body's reflexes, may be associated with aspiration, and decreases white cell mobilization and tracheobronchial ciliary motion)	Encourage reduced or moderate alcohol intake (in case of alcohol stupor, position patient to prevent aspiration)
General anesthetic, sedative, or opioid preparations that promote respiratory depression, which causes a shallow breathing pattern and predisposes to the pooling of bronchial secretions and potential development of pneumonia	Observe the respiratory rate and depth during recovery from general anesthesia and before giving medications. If respiratory depression is apparent, withhold the medication and contact the primary provider
Advanced age, because of possible depressed cough and glottic reflexes and nutritional depletion	Promote frequent turning, early ambulation and mobilization, effective coughing, breathing exercises, and nutritious diet

Respiratory therapy with improperly cleaned equipment	Make sure that respiratory equipment is cleaned properly; participate in continuous quality improvement monitoring with the respiratory care department
Transmission of organisms from health care providers	Use strict hand hygiene and gloves. Implement health care provider education

Adapted from Ramirez, J. A. (2019). Overview of community acquired pneumonia in adults. *UpToDate*. Retrieved on 9/23/2019 at: www.uptodate.com/contents/overview-of-community-acquired-pneumonia-in-adults

Clinical Manifestations

Pneumonia varies in its signs and symptoms depending on the type, causal organism, and presence of underlying disease. However, it is not possible to diagnose a specific form or classification of pneumonia by clinical manifestations alone. The patient with streptococcal (pneumococcal) pneumonia usually has a sudden onset of chills, rapidly rising fever (38.5° to 40.5°C [101° to 105°F]), and pleuritic chest pain that is aggravated by deep breathing and coughing. The patient is severely ill, with marked tachypnea (25 to 45 breaths/min), accompanied by other signs of respiratory distress (e.g., shortness of breath and the use of accessory muscles in respiration) (Weinberger, Cockrill, & Mandel, 2019). A relative bradycardia (a pulse–temperature deficit in which the pulse is slower than that expected for a given temperature) may suggest viral infection, mycoplasma infection, or infection with a *Legionella* organism.

Some patients exhibit an upper respiratory tract infection (nasal congestion, sore throat), and the onset of symptoms of pneumonia is gradual and nonspecific. The predominant symptoms may be headache, low-grade fever, pleuritic pain, myalgia, rash, and pharyngitis. After a few days, mucoid or mucopurulent sputum is expectorated. In severe pneumonia, the cheeks are flushed and the lips and nail beds demonstrate central cyanosis (a late sign of hypoxemia).

The patient may exhibit **orthopnea** (shortness of breath when reclining or in the supine position), preferring to be propped up or sitting in bed leaning forward (orthopneic position) in an effort to achieve adequate gas exchange without coughing or breathing deeply. Appetite is poor, and the patient is diaphoretic and tires easily. Sputum is often purulent; however, this is not a reliable indicator of the etiologic agent. Rusty, blood-tinged sputum may be expectorated with streptococcal (pneumococcal), staphylococcal, and *Klebsiella* pneumonia.

Signs and symptoms of pneumonia may also depend on a patient's underlying condition. Different signs occur in patients with conditions such as

cancer, and in those who are undergoing treatment with immunosuppressant medications, which decrease the resistance to infection. Such patients have fever, crackles, and physical findings that indicate consolidation of lung tissue, including increased tactile fremitus (vocal vibration detected on palpation), percussion dullness, bronchial breath sounds, egophony (when auscultated, the spoken “E” becomes a loud, nasal-sounding “A”), and whispered pectoriloquy (whispered sounds are easily auscultated through the chest wall). These changes occur because sound is transmitted better through solid or dense tissue (consolidation) than through normal air-filled tissue; these sounds are described in [Chapter 17](#).

Purulent sputum or slight changes in respiratory symptoms may be the only sign of pneumonia in patients with COPD. Determining whether an increase in symptoms is an exacerbation of the underlying disease process or an additional infectious process may be difficult.

Assessment and Diagnostic Findings

The diagnosis of pneumonia is made by history (particularly of a recent respiratory tract infection), physical examination, chest x-ray, blood culture (bloodstream invasion [bacteremia] occurs frequently), and sputum examination. The sputum sample is obtained by having patients rinse the mouth with water to minimize contamination by normal oral flora, breathe deeply several times, cough deeply, and expectorate the raised sputum into a sterile container.

More invasive procedures may be used to collect specimens. Sputum may be obtained by nasotracheal or orotracheal suctioning with a sputum trap or by fiberoptic bronchoscopy (see [Chapter 17](#)). Bronchoscopy is often used in patients with acute severe infection, in patients with chronic or refractory infection, in patients with compromised immune systems when a diagnosis cannot be made from an expectorated or induced specimen, and in patients who are mechanically ventilated. Bronchoscopic techniques may include a protected brush specimen or bronchoalveolar lavage.

Unfolding Patient Stories: Kenneth Bronson • Part 1



Kenneth Bronson, a 27-year-old man, has a history of fatigue, high fever, and a productive cough for a week and arrives in the emergency department with difficulty breathing. A chest x-ray reveals a right lower lobe pneumonia. What are the clinical manifestations and assessment findings associated with a right lower lobe pneumonia that the nurse should investigate when evaluating the patient? (Kenneth Bronson's story continues in [Chapter 22](#).)

Care for Kenneth and other patients in a realistic virtual environment: **vSim** (theopoint.lww.com/vSimMedicalSurgical). Practice documenting these patients' care in DocuCare (theopoint.lww.com/DocuCareEHR).

Prevention

Pneumococcal vaccination reduces the incidence of pneumonia, hospitalizations for cardiac conditions, and deaths in the older adult population. There are two types of pneumococcal vaccine recommended for adults: a pneumococcal conjugate vaccine (PCV13) and a pneumococcal polysaccharide vaccine (PPSV23) (CDC, 2017c).

PCV13 protects against 13 types of pneumococcal bacteria. PCV13 is recommended for all adults 65 years of age or older as well as adults 19 years or older with conditions that weaken the immune system, such as HIV infection, organ transplantation, leukemia, lymphoma, chronic kidney disease, and asplenia, or with cerebrospinal fluid leak or with cochlear implants (CDC, 2017b). PPSV23 is a newer vaccine and protects against 23 types of pneumococcal bacteria. It is recommended for all adults 65 years of age or older and for those adults 19 through 64 years of age who smoke cigarettes or who have chronic heart, lung, or liver disease, or alcoholism (CDC, 2017b). Most patients who have previously received PCV13 should receive PPSV23. In particular, all adults 65 years of age or older who previously received the PCV13 should receive the PPSV23 vaccine. For immunocompetent adults age 65 or older who have not received PCV13, a dose of PCV13 should be given followed by PPSV23 at least 1 year later. These two vaccines should not be co-administered (CDC, 2017b). As pneumococcal vaccination guidelines may change from year to year, it is important to consult the CDC web site for the most current recommendations. Other preventive measures are summarized in [Table 19-2](#).

Medical Management

Medical management of patients with pneumonia includes prescribing appropriate antibiotics for bacterial pneumonias; assisting the patient to get adequate rest and hydration; and managing complications if they occur. In some patients, supplemental oxygenation may be prescribed.

Pharmacologic Therapy

The treatment of pneumonia includes administration of the appropriate antibiotic as determined by the results of a culture and sensitivity. However, the causative organism is not identified in half of CAP cases when therapy is initiated (File, 2019b). Guidelines are used to guide antibiotic choice; however, the resistance patterns, prevalence of causative organisms, patient risk factors, treatment setting (inpatient vs. outpatient), and costs and availability of newer antibiotic agents must all be considered. See [Table 19-3](#) for the treatment of patients with pneumonia due to specific pathogens.

Inpatients should be switched from intravenous (IV) to oral therapy when they are hemodynamically stable, are improving clinically, are able to take medications/fluids by mouth, and have a normally functioning gastrointestinal tract. As soon as patients are clinically stable, have no medical problems, and have a safe environment for continued care, they should be discharged from the hospital. Clinical stability is defined as temperature less than or equal to 37.8°C (100°F), heart rate less than or equal to 100 bpm, respiratory rate less than or equal to 24 breaths/min, systolic blood pressure greater than or equal to 90 mm Hg, and oxygen saturation greater than or equal to 90%, with ability to maintain oral intake and normal (baseline) mental status.

TABLE 19-3 Commonly Encountered Pneumonias

Type (Causal Organism)	Epidemiology	Clinical Features	Treatment	Complications/Comments
Community-Acquired Pneumonia				
Streptococcal pneumonia (<i>Streptococcus pneumoniae</i>)	Most prevalent in winter months More frequent occurrence in African Americans Incidence greatest in older adults and in patients with COPD, heart failure, alcoholism, asplenia, diabetes, and after influenza Leading infectious cause of illness worldwide among young children, people with underlying chronic health conditions, and older adults Mortality rate (in hospitalized adults with invasive disease): 14%	Abrupt onset, toxic appearance, pleuritic chest pain; usually involves ≥1 lobes Lobar infiltrate common on chest x-ray or bronchopneumonia pattern	Severity determines type of antibiotic and route (IV vs. oral) PCN sensitive: PCN, amoxicillin, ceftriaxone, cefotaxime, cefprozil or a macrolide PCN resistant: levofloxacin, moxifloxacin, vancomycin, or linezolid	Shock, pleural effusion, superinfections, pericarditis, and otitis media
Haemophilus influenzae (<i>Haemophilus influenzae</i>)	Incidence greatest in patients with alcoholism, older adults, patients in long-term care facilities and nursing homes, patients with diabetes or COPD, and children <5 yrs of age Accounts for 5–20% of community-acquired pneumonias Mortality rate: 30%	Frequently insidious onset associated with upper respiratory tract infection 2–6 wks before onset of illness; fever, chills, productive cough; usually involves ≥1 lobes Sepsis is common. Infiltrate, occasional bronchopneumonia pattern on chest x-ray	Severity determines type of antibiotic and route (IV vs. oral) doxycycline, third-generation cephalosporin (ceftriaxone) or a fluoroquinolone	Lung abscess, pleural effusion, meningitis, arthritis, pericarditis, epiglottitis
Legionnaires disease (<i>Legionella pneumophila</i>)	Highest occurrence in summer and fall May cause disease sporadically or as part of an epidemic Incidence greatest in middle-aged and older men, people who smoke, patients with chronic diseases, those receiving immunosuppressive therapy, and those in close proximity to excavation sites Accounts for 15% of community-acquired pneumonias Mortality rate: 15–50%	Fullike symptoms: high fevers, mental confusion, headache, pleuritic pain, myalgias, dyspnea, productive cough, hemoptysis, leukocytosis Bronchopneumonia, unilateral or bilateral disease, lobar consolidation	Severity determines type of antibiotic and route (IV vs. oral) Azithromycin, moxifloxacin, or a fluoroquinolone	Hypotension, shock, and acute kidney injury
Mycoplasma pneumoniae (<i>Mycoplasma pneumoniae</i>)	Increase in fall and winter Responsible for epidemics of respiratory illness Most common type of atypical pneumonia Accounts for 20% of community-acquired pneumonias; more common in children and young adults Mortality rate: <0.1%	Onset is usually insidious. Patients not usually as ill as in other pneumonias. Sore throat, nasal congestion, ear pain, headache, low-grade fever, pleuritic pain, myalgias, diarrhea, erythematous rash, pharyngitis. Interstitial infiltrates on chest x-ray	Severity determines type of antibiotic and route (IV vs. oral) Macrolides, combination drugs (macrolide plus ampicillin and sulbactam) or tetracyclines (doxycycline)	Aseptic meningitis, meningocephalitis, transverse myelitis, cranial nerve palsies, pericarditis, myocarditis
Viral pneumonia (influenza viruses types A, B adenovirus, parainfluenza, cytomegalovirus, coronavirus, varicella-zoster)	Incidence greatest in winter months Epidemics occur every 2–3 yrs. Most common causative organisms in adults; other organisms in children (e.g., cytomegalovirus and respiratory syncytial virus) Accounts for 20% of community-acquired pneumonias	Patchy infiltrate, small pleural effusion on chest x-ray In most patients, influenza begins as an acute upper respiratory infection; others have bronchitis, pleurisy, and so on, and still others develop gastrointestinal symptoms	Treated symptomatically; treat in high-risk patients; oseltamivir or zanamivir (+ other agents depending upon dominant strain [type of virus]) Does not respond to treatment with currently available antimicrobials	Superimposed bacterial infection, bronchopneumonia

Chlamydial pneumonia (<i>Chlamydophila pneumoniae</i>)	Reported mainly in college students, military recruits, and older adults May be a common cause of community-acquired pneumonia or observed in combination with other pathogens Mortality rate is low because the majority of cases are relatively mild. Older adults with coexistent infections, comorbidities, and reinfections may require hospitalization.	Hoarseness, fever, chills, pharyngitis, rhinitis, nonproductive cough, myalgias, arthralgias Single infiltrate on chest x-ray; pleural effusion possible	Macrolide or doxycycline	Reinfection and acute respiratory failure
Hospital-Acquired and Health Care-Associated Pneumonias				
Pseudomonas pneumonia (<i>Pseudomonas aeruginosa</i>)	Incidence greatest in those with preexisting lung disease, cancer (particularly leukemia); those with homograft transplants, burns; people who are debilitated; and patients receiving antimicrobial therapy and treatments such as tracheostomy, suctioning, and in post-operative settings. Almost always of nosocomial origin Accounts for 15% of hospital-acquired pneumonias Mortality rate: 40–60%	Diffuse consolidation on chest x-ray; toxic appearance: fever, chills, productive cough, relative bradycardia, leukocytosis	Sensitivity tests guide choice and severity determines type of antibiotic and route (IV vs. oral): ceftazidime, ciprofloxacin, cefepime, aztreonam, imipenem/cilastatin, meropenem, piperacillin, +/− an aminoglycoside	Lung cavitation; has capacity to invade blood vessels, causing hemorrhage and lung infarction; usually requires hospitalization
Staphylococcal pneumonia (<i>Staphylococcus aureus</i>)	Incidence greatest in immunocompromised patients, IV drug users, and as a complication of epidemic influenza Commonly nosocomial in origin Accounts for 10–30% of hospital-acquired pneumonias Mortality rate: 25–60% MRSA may also cause community-based infection	Severe hypoxemia, cyanosis, necrotizing infection. Sepsis is common	Severity determines type of antibiotic and route (IV vs. oral) MSSA: oxacillin or nafcillin MRSA or PCN allergy: vancomycin or linezolid	Pleural effusion/pneumothorax, lung abscess, empyema, meningitis, endocarditis Frequently requires hospitalization. Treatment must be vigorous and prolonged because disease tends to destroy lung tissue
Klebsiella pneumonia (<i>Klebsiella pneumoniae</i> [Friedländer's bacillus-encapsulated gram-negative aerobic bacillus])	Incidence greatest in older adults; patients with alcoholism; patients with chronic disease, such as diabetes, heart failure, COPD; patients in chronic care facilities and nursing homes Accounts for 2–5% of community-acquired and 10–30% of hospital-acquired pneumonias Mortality rate: 40–50%	Tissue necrosis occurs rapidly. Toxic appearance: fever, cough, sputum production, bronchopneumonia, lung abscess. Lobar consolidation, bronchopneumonia pattern on chest x-ray	Severity determines type of antibiotic and route (IV vs. oral) Hospital acquired: cefepime, ceftazidime, imipenem, meropenem, or piperacillin/tazobactam plus an aminoglycoside or a fluoroquinolone; Community acquired: a levofloxacin plus ciprofloxacin or nitrofurantoin or nitrofurantoin macrocrystals	Multiple lung abscesses with cyst formation, empyema, pericarditis, pleural effusion; may be fulminating, progressing to fatal outcome
Pneumonia in the Immunocompromised Host				
Pneumocystis pneumonia (<i>Pneumocystis jirovecii</i>)	Incidence greatest in patients with AIDS and patients receiving immunosuppressive therapy for cancer, organ transplantation, and other disorders Frequently seen with cytomegalovirus infection Mortality rate 15–20% in hospitalized patients and fatal if not treated	Pulmonary infiltrates on chest x-ray; nonproductive cough, fever, dyspnea	Severity determines type of antibiotic and route (IV vs. oral) Trimethoprim/sulfamethoxazole	Respiratory failure

Fungal pneumonia (<i>Aspergillus fumigatus</i>)	Incidence greatest in patients who are immunocompromised or neutropenic Mortality rate: 15–20%	Cough, hemoptysis, infiltrates, fungus ball on chest x-ray	Severity determines type of antibiotic and route (IV vs. oral) Voriconazole; for invasive disease: amphotericin B or liposomal amphotericin B or caspofungin Lobectomy for fungus ball	Dissemination to brain, myocardium, and thyroid gland
Tuberculosis (<i>Mycobacterium tuberculosis</i>)	Incidence increased in indigent, immigrant, and prison populations; people with AIDS; and people who are homeless Mortality rate: <1% (depending on comorbidity)	Weight loss, fever, night sweats, cough, sputum production, hemoptysis, nonspecific infiltrate (lower lobe), hilar node enlargement, pleural effusion on chest x-ray	Isoniazid + rifampin + ethambutol + pyrazinamide (see section on TB and Table 19-4)	Reinfection and acute respiratory infection
Pneumonia from Aspiration				
Anaerobic bacteria (<i>S. pneumoniae</i> , <i>H. influenzae</i> , <i>S. aureus</i>)	Risk: reduced consciousness, dysphagia, disorders of upper GI tract; mechanical disruption of glottic closure (endotracheal tube, tracheostomy, nasogastric feeding)	Abrupt onset of dyspnea, low-grade fever, cough, predisposing condition for aspiration	Severity determines type of antibiotic and route (IV vs. oral) Clindamycin +/- a fluoroquinolone	Identification of potential aspirate is important for treatment

AIDS, acquired immune deficiency syndrome; COPD, chronic obstructive pulmonary disease; GI, gastrointestinal; IV, intravenous; MRSA, methicillin resistant *Staphylococcus aureus*; MSSA, methicillin-sensitive *Staphylococcus aureus*; PCN, penicillin; TB, tuberculosis.

Adapted from Gilbert, D. N., Chambers, H. F., Eliopoulos, G. M., et al. (2018). *The Sanford guide to antimicrobial therapy 2018* (48th ed.). Sperryville, VA: Antimicrobial Therapy, Inc.

In suspected HAP, treatment is usually initiated with a broad-spectrum IV antibiotic and may be monotherapy or combination therapy. For patients with no known multidrug resistance, monotherapy with ceftriaxone, ampicillin/sulbactam, levofloxacin, or ertapenem is used. With known multidrug resistance, a three-drug combination therapy may be used; this drug regimen may include an antipseudomonal cephalosporin or ceftazidime or antipseudomonal carbapenem or piperacillin/tazobactam plus antipseudomonal fluoroquinolone or aminoglycoside plus linezolid or vancomycin. The patient's status must be assessed 72 hours after the initiation of therapy, and antibiotics should be discontinued or modified based on the culture results. Of concern is the rampant rise in respiratory pathogens that are resistant to available antibiotics. Examples include vancomycin-resistant enterococcus (VRE), MRSA, and drug-resistant *S. pneumoniae*. Providers tend to prescribe antibiotics aggressively in the presence of suspected infection. Mechanisms to monitor and minimize the inappropriate use of antibiotics are in place. In response to antibiotic resistant organisms, the CDC recommends all acute care hospitals participate in an antibiotic stewardship program (CDC, 2019b). Antibiotic stewardship refers to a set of coordinated strategies to improve the use of antimicrobial medications with the goal of enhancing patient health outcomes, reducing resistance to antibiotics, and decreasing unnecessary costs (CDC, 2019a; Nathwani, Varghese, Stephens, et al., 2019). Education of clinicians about the use of evidence-based guidelines in the treatment of respiratory infection is important, and some institutions have implemented algorithms to assist clinicians in choosing the appropriate antibiotics. Monitoring and surveillance of susceptibility patterns for pathogens are also important.

Other Therapeutic Regimens

Antibiotics are ineffective in viral upper respiratory tract infections and pneumonias, and their use may be associated with adverse effects. Antibiotics are indicated with a viral respiratory infection *only* if a secondary bacterial pneumonia, bronchitis, or rhinosinusitis is present. With the exception of the use of antimicrobial therapy, treatment of viral pneumonia is generally the same as that for bacterial pneumonia; however, different treatments have been used for the patient who develops pneumonia as a result of infection with the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), the virion implicated in COVID-19 (Kim & Gandhi, 2020) (see later discussion).

Treatment of viral pneumonia is primarily supportive. Hydration is a necessary part of therapy, because fever and tachypnea may result in insensible fluid losses. Antipyretic agents may be used to treat headache and fever; antitussive medications may be used for the associated cough. Warm, moist inhalations are helpful in relieving bronchial irritation. Antihistamines may provide benefit with reduced sneezing and rhinorrhea. Nasal decongestants may also be used to treat symptoms and improve sleep; however, excessive use can cause rebound nasal congestion. Bed rest is prescribed until the infection shows signs of clearing. If hospitalized, the patient is observed carefully until the clinical condition improves.

If hypoxemia develops, oxygen is administered. Pulse oximetry or arterial blood gas analysis is used to determine the need for oxygen and to evaluate the effectiveness of the therapy. Arterial blood gases may be used to obtain a baseline measure of the patient's oxygenation and acid–base status; however, pulse oximetry is used to continuously monitor the patient's oxygen saturation and response to therapy. More aggressive respiratory support measures include administration of high concentrations of oxygen (**fraction of inspired oxygen [FiO₂]**, or the concentration of oxygen that is delivered), ET intubation, and mechanical ventilation. Different modes of mechanical ventilation may be required. Modes of mechanical ventilation are discussed later in this chapter.

Gerontologic Considerations

Pneumonia in older adult patients may occur as a primary diagnosis or as a complication of a chronic disease. Pulmonary infections in older adults frequently are difficult to treat and result in a higher mortality rate than in younger people (Ramirez, 2019). General deterioration, weakness, abdominal symptoms, anorexia, confusion, tachycardia, and tachypnea may signal the onset of pneumonia. The diagnosis of pneumonia may be missed because the classic symptoms of cough, chest pain, sputum production, and fever may be absent or masked in older adult patients. In addition, the presence of some signs may be misleading. Abnormal breath sounds, for example, may be caused by microatelectasis that occurs as a result of decreased mobility, decreased lung volumes, or other respiratory function changes. Chest x-rays

may be needed to differentiate chronic heart failure, which is often seen in older adults, from pneumonia as the cause of clinical signs and symptoms.

Supportive treatment includes hydration (with caution and with frequent assessment because of the risk of fluid overload in older adults); supplemental oxygen therapy; and assistance with deep breathing, coughing, frequent position changes, and early ambulation. All of these are particularly important in the care of older adult patients with pneumonia. To reduce or prevent serious complications of pneumonia in older adults, vaccination against pneumococcal and influenza infections is recommended.



COVID-19 Considerations

SARS-CoV-2 is a community-acquired coronavirus whose primary pathologic evolution occurs within the respiratory system. Viral transmission is presumed to occur through direct person-to-person contact via respiratory droplets, although it is hypothesized that fomite transmission (i.e., transmission from inanimate surfaces that carry the virus) might be possible (Casella, Rajnik, Cuomo, et al., 2020; Kim & Gandhi, 2020). SARS-CoV-2 enters host cells through ACE2 cellular surface receptors where it replicates; these ACE2 receptors are particularly abundant in type II alveolar and vascular endothelial cells within the pulmonary vascular circuit (see [Chapter 27](#), Fig. 27-2 for an illustration of viral transmission and replication; see [Chapter 66](#) for a discussion of risks of SAR-CoV-2).

At the time of this writing, although it is believed that some patients infected with SARS-CoV-2 may remain asymptomatic, others exhibit signs and symptoms consistent with a type of viral upper respiratory tract infection that may lead to viral pneumonia. Clinical manifestations consistent with mild COVID-19 may include fever, nonproductive cough, sore throat, fatigue, myalgias (muscle aches), nasal congestion, nausea, vomiting, diarrhea, anosmia (loss of smell), and ageusia (loss of taste) (Casella et al., 2020; CDC, 2020). Data derived from epidemiologic studies in China, where the COVID-19 pandemic originated, suggest that approximately 81% of patients with COVID-19 have mild illness, with either mild viral pneumonia or no pneumonia (Wu & McGoogan, 2020).

Ideally, the diagnosis of COVID-19 is confirmed by patient self-administered bilateral nasal swabbing for viral antigen or nucleic acid. Self-swabbing minimizes risk of person-to-person transmission of respiratory droplets. The act of patient self-swabbing ideally should be observed by a health care provider to assure it is performed properly (CDC, 2020).

Most patients with known or suspected mild COVID-19 may be managed on an outpatient basis within their homes, which conserves hospital resources and diminishes likelihood of exposure to others, including health care workers

(Kim & Gandhi, 2020). At the present time, no specific medications are prescribed to either treat COVID-19 or mitigate its effects in patients with mild disease who are managed at home. The therapeutic regimens that patients with mild COVID-19 are advised to follow mirror those for other viral respiratory illnesses. Patients are advised to rest, hydrate, take antipyretic agents (e.g., acetaminophen) and monitor their symptoms. However, given the virulence of SARS-CoV-2, these patients must be capable of maintaining self-quarantine/isolation at home until all of the following criteria are met (CDC, 2020):

- At least 72 hours have transpired since the patient had a fever and the patient has not taken any antipyretic agents during that timeframe;
- The patient reports an improvement in any respiratory manifestations of COVID-19; and
- At least 10 days have elapsed since the patient first noted clinical manifestations suggestive of COVID-19.

Clinicians and others in contact with patients with suspected or known COVID-19 should observe infection control and prevention measures and utilize appropriate personal protective equipment (PPE; CDC, 2020) (see [Chapter 66](#) for further discussion).

Patients with moderate COVID-19 should be hospitalized so that they may be closely observed on an ongoing basis, because many of these patients may rapidly deteriorate to severe COVID-19 and respiratory failure. These patients have clear evidence of viral pneumonia that may be diagnosed based upon clinical examination, chest x-ray or CT scan findings but have SpO₂ levels >93% on room air, suggesting adequate oxygenation (Casella et al., 2020; National Institutes of Health COVID-19 Treatment Guidelines Panel [NIH], 2020). These patients may or may not have dyspnea. Laboratory tests upon admission include a CBC with differential, a complete metabolic panel, creatine kinase (CK), lactate dehydrogenase (LDH), C-reactive protein (CRP), ferritin, and D-dimer. Notable findings may include leukopenia (low white blood cell count), lymphopenia (low lymphocyte count), and elevated CK, LDH, CRP, ferritin, and D-dimer levels (Casella et al., 2020).

It appears at the present time that few patients with COVID-19 have a superinfection with bacterial pathogens (i.e., concomitant bacterial pneumonia); therefore, antibiotic agents are not routinely prescribed for the patient hospitalized to manage moderate COVID-19 pneumonia. However, if it is believed that the patient has a bacterial pneumonia or sepsis, then antibiotic agents indicated to treat CAP are prescribed (Kim & Gandhi, 2020; NIH, 2020) (see previous discussion). Most patients are prescribed anticoagulant agents as prophylaxis, as they have a higher risk of venous thromboembolism (VTE) (see [Chapter 26](#) for further discussion of VTE). The typical agents

prescribed are low-molecular-weight heparins (e.g., enoxaparin, dalteparin), administered twice daily (Kim & Gandhi, 2020).

Currently, there is insufficient evidence to support prescribing any antiviral or immunomodulating agents to manage patients with moderate COVID-19 pneumonia (NIH, 2020). If a patient must be prescribed an inhaled medication (e.g., to manage a preexisting chronic respiratory disease), then to the extent possible, that medication should be administered by a pMDI rather than an SVN, to minimize the likelihood of aerosolizing the patient's respiratory droplets into the ambient air. Ideally, patients hospitalized with moderate COVID-19 pneumonia should be placed in airborne infection isolation rooms, with limitations enforced so that clinicians enter only as necessary, wearing appropriate PPE (NIH, 2020) (see [Chapter 66](#) for further discussion). For instance, the nurse caring for the patient might arrange activities so that assessments are performed and medications are administered at the same time (see [Chart 19-7](#)).



The patient with severe COVID-19 pneumonia has $\text{SpO}_2 \leq 93\%$ on room air with tachypnea and requires supplemental oxygen, perhaps with ET intubation and mechanical ventilation (see later discussions on ET intubation and mechanical ventilation). Chest x-ray findings typically show diffuse, bilateral, “ground-glass” opacities (Casella et al., 2020). Some patients have severe dyspnea, while others report no dyspnea and have been referred to as the *happy hypoxemics* by Caputo, Strayer, and Levitan (2020). Reportedly, many patients deteriorate rapidly and without clear prodromal clinical indicators from moderate to severe disease (Casella et al., 2020).

Chart 19-7 ETHICAL DILEMMA

Is It Ever Ethical to Refuse to Care for a Patient?

Case Scenario

You are a staff nurse in a medical intensive care unit (MICU). Within the past week, there has been a significantly increased incidence of patients infected with severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) in two counties that border the county where your hospital is located. Your nurse manager holds an emergency mandatory staff meeting, and informs all staff present that preparations are being made for the hospital to receive and treat a large volume of patients with coronavirus disease 2019 (COVID-19). The MICU where you work has been designated to exclusively treat these patients who are critically ill, while the surgical ICU (SICU) in the hospital will admit all patients who are critically ill but do not have COVID-19. The MICU nurse manager describes hospital administration's plans to manage the distribution and rationing of personal protective equipment (PPE) for MICU staff and identifies new policies that have been emergently put in place to guide their usage, conservation, and disposal. H.S., a MICU staff nurse who works with you, turns to you and says "I am not going to take care of patients with COVID-19! They can find another safer place for me to work in this hospital or I will quit. I did not sign up to be a nurse here to risk my life."

Discussion

Nurses who work in MICUs confront risks to their health on a continuing basis by being in contact with patients who have infectious diseases. Prior to the COVID-19 pandemic, most of these health risks to nurses were minimal. Most pathogens that caused infectious diseases in patients in MICUs could be effectively treated pharmacologically (e.g., with antibiotics) in people with healthy immune systems. Many patients in MICUs who were critically ill with these infectious diseases had comorbid disorders that hampered their immune responses; however, a healthy nurse who became exposed to the pathogen would likely not become infected. Yet if the nurse did become ill, the nurse could have expected an expedient recovery to health after treatment was instituted. The personal risk to the nurse changes dramatically during pandemics, when the nurse is confronted with a novel aggressive contagious pathogen that can cause life-threatening illness in the previously healthy person, without the benefit of clearly effective evidence-based treatment strategies.

Analysis

- Identify the ethical principles that are in conflict in this case (see [Chapter 1, Chart 1-7](#)). Should the principle of beneficence have preeminence during pandemics? Can the desire to do the greatest good for the greatest number of people ever be given greater moral credence than ensuring that individual rights are preserved?

- Assume that H.S. is a healthy 24-year-old woman without any known risk factors for COVID-19. Now assume she is 62 years old, with diabetes and hypertension, and that her 88-year-old mother resides with her. Do these factors make a difference in whether or not you would support her desire to not care for patients with COVID-19?
- Do you and H.S. have a professional obligation to care for patients with COVID-19 who are critically ill? Do you have the right to refuse to care for these patients? How might your viewpoint change, depending upon the availability or lack of availability of appropriate PPE? How would you evaluate the new policies put in place that guide the usage, conservation, and disposal of PPE in the MICU? What resources are available for you to evaluate the soundness of this policy, to ensure that you, H.S., and your MICU colleagues are not placed at undue risk? Identify professional resources that might help you to resolve this dilemma.

References

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Resources

See [Chapter 1, Chart 1-10](#) for Steps of an Ethical Analysis and Ethics Resources.

The Centers for Disease Control and Prevention (CDC). (2020). Optimizing supply of PPE and other equipment during shortages. Retrieved on 8/6/2020 at: www.cdc.gov/coronavirus/2019-ncov/hcp/ppe-strategy/index.html

Although patients with severe COVID-19 pneumonia were nearly universally managed with ET intubation and mechanical ventilation during the first weeks of the pandemic, case fatality rates were reportedly much higher than anticipated (Caputo et al., 2020). That observation, along with actual or anticipated shortages of mechanical ventilators, led some providers to try managing patients with other strategies, including trials of placing nonintubated hospitalized patients with COVID-19 in the prone position at periodic intervals, along with administering high flow oxygen therapy. Although not universally effective, data from preliminary research suggest that periodic prone positioning with high flow oxygen therapy can prevent eventual ET intubation in some patients with severe COVID-19 pneumonia (Caputo et al., 2020).

At the present time, there are no immunomodulating agents that are recommended to treat severe COVID-19 pneumonia, although interleukin-6 (IL-6) antagonists (e.g., tocilizumab) are currently under investigation. IL-6 is believed to be a key cytokine responsible for propagating the haywire inflammatory response called cytokine release syndrome (CRS) or the “cytokine storm” that occurs in some patients with severe COVID-19 (NIH, 2020) (see [Chapter 12](#) for further discussion of CRS). Another therapy that is under investigation and approved for emergency use is using convalescent plasma, which transfuses antibodies from patients recovered from COVID-19 into patients with severe disease (Kim & Gandhi, 2020).

It is recommended that the antiviral agent remdesivir be prescribed to treat patients with severe COVID-19 pneumonia as it has demonstrated promising results in clinical trials, notably improved recovery times and overall outcomes (Beigel, Tomashek, Dodd, et al., 2020; NIH, 2020; Wang, Zhang, Du, et al., 2020). Among patients with severe COVID-19 pneumonia, a frequent and serious complication is acute respiratory distress syndrome (ARDS), which is commonly managed with ET intubation and mechanical ventilation (see later discussion). Among patients with COVID-19 and ARDS, the mortality rate is reported at 50% (Anesi, 2020).

Complications



Shock and Respiratory Failure

Severe complications of pneumonia include hypotension and septic shock and respiratory failure (especially with gram-negative bacterial disease or with SARS-CoV-2 infection in older adult patients). These complications are encountered chiefly in patients who have received no specific treatment or inadequate or delayed treatment or in patients at risk for severe COVID-19. These complications are also encountered when the infecting organism is resistant to therapy, when a comorbid disease complicates the pneumonia, or when the patient is immune compromised. (See [Chapter 11](#) for further discussion of management of the patient with septic shock.)

Pleural Effusion

A pleural effusion is an accumulation of pleural fluid in the pleural space (space between the parietal and visceral pleurae of the lung). A parapneumonic effusion is any pleural effusion associated with bacterial pneumonia, lung abscess, or bronchiectasis. After the pleural effusion is detected on a chest x-ray, a thoracentesis may be performed to remove the fluid, which is sent to the laboratory for analysis. There are three stages of parapneumonic pleural effusions based on pathogenesis: uncomplicated, complicated, and thoracic

empyema. An **empyema** occurs when thick, purulent fluid accumulates within the pleural space, often with fibrin development and a loculated (walled-off) area where the infection is located (see later discussion). A chest tube may be inserted to treat pleural infection by establishing proper drainage of the empyema. Sterilization of the empyema cavity requires 4 to 6 weeks of antibiotics, and sometimes surgical management is required.

NURSING PROCESS

The Patient with Bacterial Pneumonia



Assessment

Nursing assessment is critical in detecting pneumonia. Fever, chills, or night sweats in a patient who also has respiratory symptoms should alert the nurse to the possibility of bacterial pneumonia. Respiratory assessment further identifies the clinical manifestations of pneumonia: pleuritic-type pain, fatigue, tachypnea, the use of accessory muscles for breathing, bradycardia or relative bradycardia, coughing, and purulent sputum. The nurse monitors the patient for the following: changes in temperature and pulse; amount, odor, and color of secretions; frequency and severity of cough; degree of tachypnea or shortness of breath; changes in physical assessment findings (primarily assessed by inspecting and auscultating the chest); and changes in the chest x-ray findings.

In addition, it is important to assess older adult patients for unusual behavior, altered mental status, dehydration, excessive fatigue, and concomitant heart failure.

Diagnosis

NURSING DIAGNOSES

Based on the assessment data, major nursing diagnoses may include the following:

- Impaired airway clearance associated with copious tracheobronchial secretions
- Fatigue and activity intolerance associated with impaired respiratory function
- Risk for hypovolaemia associated with fever and a rapid respiratory rate
- Impaired nutritional status
- Lack of knowledge about the treatment regimen and preventive measures

COLLABORATIVE PROBLEMS/POTENTIAL COMPLICATIONS

Based on the assessment data, collaborative problems or potential complications that may occur include the following:

- Continuing symptoms after initiation of therapy
- Sepsis and septic shock
- Respiratory failure
- Atelectasis
- Pleural effusion

- Delirium

Planning and Goals

The major goals may include improved airway patency, increased activity, maintenance of proper fluid volume, maintenance of adequate nutrition, an understanding of the treatment protocol and preventive measures, and absence of complications.

Nursing Interventions

IMPROVING AIRWAY PATENCY

Removing secretions is important because retained secretions interfere with gas exchange and may slow recovery. The nurse encourages hydration (2 to 3 L/day), because adequate hydration thins and loosens pulmonary secretions. Humidification may be used to loosen secretions and improve ventilation. A high-humidity facemask (using either compressed air or oxygen) delivers warm, humidified air to the tracheobronchial tree, helps liquefy secretions, and relieves tracheobronchial irritation. Coughing can be initiated either voluntarily or by reflex. Lung expansion maneuvers, such as deep breathing with an incentive spirometer, may induce a cough. To improve airway patency, the nurse encourages the patient to perform an effective, directed cough, which includes correct positioning, a deep inspiratory maneuver, glottic closure, contraction of the expiratory muscles against the closed glottis, sudden glottic opening, and an explosive expiration. In some cases, the nurse may assist the patient by placing both hands on the lower rib cage (either anterior or posterior) to focus the patient on a slow deep breath, and then manually assisting the patient by applying constant, external pressure during the expiratory phase.

CPT is important in loosening and mobilizing secretions (see [Figs. 20-6](#) and [20-7](#) and further discussion in [Chapter 20](#)). Indications for CPT include sputum retention not responsive to spontaneous or directed cough, a history of pulmonary problems previously treated with chest physiotherapy, continued evidence of retained secretions (decreased or abnormal breath sounds, change in vital signs), abnormal chest x-ray findings consistent with atelectasis or infiltrates, and deterioration in oxygenation. The patient is placed in the proper position to drain the involved lung segments, then the chest is percussed and vibrated either manually or with a mechanical percussor. The nurse may consult the respiratory therapist for volume expansion protocols and secretion management protocols that help direct the respiratory care of the patient and match the patient's needs with appropriate treatment schedules.

After each position change, the nurse encourages the patient to breathe deeply and cough. If the patient is too weak to cough effectively, the nurse may need to remove the mucus by nasotracheal suctioning. It may take time for secretions to mobilize and move into the central airways for

expectoration. Therefore, it is important for the nurse to monitor the patient for cough and sputum production after the completion of CPT.

The nurse also administers and titrates oxygen therapy as prescribed or via protocols. The effectiveness of oxygen therapy is monitored by improvement in clinical signs and symptoms, patient comfort, and adequate oxygenation values as measured by pulse oximetry or arterial blood gas analysis.

PROMOTING REST AND CONSERVING ENERGY

The nurse encourages the patient who is debilitated to rest and avoid overexertion and possible exacerbation of symptoms. The patient should assume a comfortable position to promote rest and breathing (e.g., semi-Fowler position) and should change positions frequently to enhance secretion clearance and pulmonary ventilation and perfusion. Outpatients must be instructed to avoid overexertion and to engage in only moderate activity during the initial phases of treatment.

PROMOTING FLUID INTAKE

The respiratory rate of patients with pneumonia increases because of the increased workload imposed by labored breathing and fever. An increased respiratory rate leads to an increase in insensible fluid loss during exhalation and can lead to dehydration. Therefore, unless contraindicated, increased fluid intake (at least 2 L/day) is encouraged. Hydration must be achieved more slowly and with careful monitoring in patients with preexisting conditions such as heart failure (see [Chapter 25](#)).

MAINTAINING NUTRITION

Many patients with shortness of breath and fatigue have a decreased appetite and consume only fluids. Fluids with electrolytes (commercially available drinks, such as Gatorade) may help provide fluid, calories, and electrolytes. Other nutritionally enriched drinks such as oral nutritional supplements may be used to supplement calories. Small, frequent meals may be advisable. In addition, IV fluids and nutrients may be given if necessary.

PROMOTING PATIENTS' KNOWLEDGE

The patient and family are educated about the cause of pneumonia, management of symptoms, signs and symptoms that should be reported to the primary provider or nurse, and the need for follow-up. The patient also needs information about factors (both patient risk factors and external factors) that may have contributed to the development of pneumonia and strategies to promote recovery and prevent recurrence. If the patient is hospitalized, they are instructed about the purpose and importance of management strategies that have been implemented and about the importance of adhering to them during and after the hospital stay.

Explanations should be given simply and in language that the patient can understand. If possible, written instructions and information should be provided, and alternative formats should be provided for patients with hearing or vision loss, if necessary. Because of the severity of symptoms, the patient may require that instructions and explanations be repeated several times.

MONITORING AND MANAGING POTENTIAL COMPLICATIONS

Continuing Symptoms After Initiation of Therapy. The patient is observed for response to antibiotic therapy; patients usually begin to respond to treatment within 24 to 48 hours after antibiotic therapy is initiated. If the patient started taking antibiotics before evaluation by culture and sensitivity of the causative organisms, antibiotics may need to be changed once the results are available. The patient is monitored for changes in physical status (deterioration of condition or resolution of symptoms) and for persistent recurrent fever, which may be a result of medication allergy (signaled possibly by a rash); medication resistance or slow response (greater than 48 hours) of the susceptible organism to therapy; pleural effusion; or pneumonia caused by an unusual organism, such as *P. jiroveci* or *Aspergillus fumigatus*. Failure of the pneumonia to resolve or persistence of symptoms despite changes on the chest x-ray raises the suspicion of other underlying disorders, such as lung cancer. As described previously, lung cancers may invade or compress airways, causing an obstructive atelectasis that may lead to pneumonia.

In addition to monitoring for continuing symptoms of pneumonia, the nurse also monitors for other complications, such as septic shock and multiple organ dysfunction syndrome (MODS) and atelectasis, which may develop during the first few days of antibiotic treatment.

Shock and Respiratory Failure. The nurse assesses for signs and symptoms of septic shock and respiratory failure by evaluating the patient's vital signs, pulse oximetry values, and hemodynamic monitoring parameters. The nurse reports signs of deteriorating patient status and assists in administering IV fluids and medications prescribed to combat shock. Intubation and mechanical ventilation may be required if respiratory failure occurs. (Sepsis and septic shock are described in detail in [Chapter 11](#), and care of the patient receiving mechanical ventilation is described later in this chapter.)

Pleural Effusion. If pleural effusion develops and thoracentesis is performed to remove fluid, the nurse assists in the procedure and explains it to the patient. After thoracentesis, the nurse monitors the patient for pneumothorax or recurrence of pleural effusion. If a chest tube needs to be inserted, the nurse monitors the patient's respiratory status (see discussion on chest tubes later in this chapter).



For the procedural guidelines for assisting the patient

undergoing a thoracentesis, go to the-point.lww.com/Brunner15e.

Delirium. A patient with pneumonia is assessed for delirium and other more subtle changes in cognitive status; this is especially true in the older adult. The Confusion Assessment Method (CAM) is a commonly used screening tool (see [Chapter 8, Chart 8-7](#)). Confusion, suggestive of delirium, and other changes in cognitive status resulting from pneumonia are poor prognostic signs (File, 2019b). Delirium may be related to hypoxemia, fever, dehydration, sleep deprivation, or developing sepsis. The patient's underlying comorbid conditions may also play a part in the development of confusion. Addressing and correcting underlying factors as well as ensuring patient safety are important nursing interventions.

PROMOTING HOME, COMMUNITY-BASED, AND TRANSITIONAL CARE



Educating Patients About Self-Care. Depending on the severity of the pneumonia, treatment may occur in the hospital or in the outpatient setting. Patient education is crucial regardless of the setting, and the proper administration of antibiotics is important. In some instances, the patient may be treated initially with IV antibiotics as an inpatient and then discharged to continue the IV antibiotics at home. A seamless system of care must be maintained for the patient from hospital to home; this includes communication between the nurses caring for the patient in both settings.

If oral antibiotics are prescribed, the nurse educates the patient about their proper administration and potential side effects. The patient should be educated about symptoms that require contacting the primary provider: difficulty breathing, worsening cough, recurrent/increasing fever, and medication intolerance.

After the fever subsides, the patient may gradually increase activities. Fatigue and weakness may be prolonged after pneumonia, especially in older adults. The nurse encourages breathing exercises to promote secretion clearance and volume expansion. A patient who is being treated as an outpatient should be contacted by the health care team or instructed to contact the primary provider 24 to 48 hours after starting therapy. The patient is also instructed to return to the clinic or primary provider's office for a follow-up chest x-ray and physical examination. Often, improvement in chest x-ray findings lags behind improvement in clinical signs and symptoms.

The nurse encourages the patient who smokes to stop smoking. Smoking inhibits tracheobronchial ciliary action, which is the first line of defense of the lower respiratory tract. Smoking also irritates the mucous cells of the bronchi and inhibits the function of alveolar macrophage (scavenger) cells. The patient is instructed to avoid stress, fatigue, sudden changes in temperature, and excessive alcohol intake, all of which lower resistance to pneumonia. The nurse reviews with the patient the principles of adequate nutrition and rest, because one episode of pneumonia may make a patient susceptible to recurring respiratory tract infections.

Continuing and Transitional Care. Patients who are severely debilitated or who cannot care for themselves may require referral for home, transitional, or community-based care. During home visits, the nurse assesses the patient's physical status, monitors for complications, assesses the home environment, and reinforces previous education. The patient's adherence to the therapeutic regimen is evaluated (i.e., taking medications as prescribed; performing breathing exercises; consuming adequate fluid and dietary intake; and avoiding smoking, alcohol, and excessive activity). The nurse stresses to the patient and family the importance of monitoring for complications or exacerbation of the pneumonia. The patient is encouraged to obtain an influenza vaccination at the prescribed times, because influenza increases susceptibility to secondary bacterial pneumonia, especially that caused by staphylococci, *H. influenzae*, and *S. pneumoniae*. The patient also is urged to receive the pneumococcal vaccine(s) according to CDC recommendations (see previous discussion).

Evaluation

Expected patient outcomes may include the following:

1. Demonstrates improved airway patency, as evidenced by adequate oxygenation by pulse oximetry or arterial blood gas analysis, normal temperature, normal breath sounds, and effective coughing
2. Rests and conserves energy by limiting activities and remaining in bed while symptomatic and then slowly increasing activities
3. Maintains adequate hydration, as evidenced by an adequate fluid intake and urine output and normal skin turgor
4. Consumes adequate dietary intake, as evidenced by maintenance or increase in body weight without excess fluid gain
5. Verbalizes increased knowledge about management strategies
6. Adheres to management strategies
7. Exhibits no complications
 - a. Exhibits acceptable vital signs, pulse oximetry, and arterial blood gas measurements
 - b. Reports productive cough that diminishes over time

- Has absence of signs or symptoms of sepsis, septic shock, respiratory
 - c. failure, or pleural effusion
 - d. Remains oriented and aware of surroundings
8. Maintains or increases weight
9. Adheres to treatment protocol and prevention strategies

Aspiration

Aspiration is inhalation of foreign material (e.g., oropharyngeal or stomach contents) into the lungs. It is a serious complication that can cause pneumonia and result in the following clinical picture: tachycardia, dyspnea, central cyanosis, hypertension, hypotension, and potentially death. It can occur when the protective airway reflexes are decreased or absent due to a variety of factors (see [Chart 19-8](#)). Studies suggest that aspiration pneumonia accounts for 5% to 15% of CAP (Gamache, 2019).

Pathophysiology

The primary factors responsible for death and complications after aspiration are the volume and character of the aspirated contents. Aspiration pneumonia develops after inhalation of colonized oral or pharyngeal material. The pathologic process involves an acute inflammatory response to bacteria and bacterial products. Most commonly, the causative organisms in community-acquired aspiration pneumonia may include *S. aureus*, *S. pneumoniae*, *H. influenzae*, and *Enterobacter* species (Gamache, 2019).

Chart 19-8 RISK FACTORS

Aspiration

- Seizure activity
- Brain injury
- Decreased level of consciousness from trauma, drug or alcohol intoxication, excessive sedation, or general anesthesia
- Flat body positioning
- Stroke
- Swallowing disorders
- Cardiac arrest

Adapted from American Association of Critical-Care Nurses. (2017b). AACN practice alert: Prevention of aspiration in adults. *Critical Care Nurse*, 37(3), 88; Bartlett, J. (2019a). Aspiration pneumonia in adults. *UpToDate*. Retrieved on 9/23/2019 at: www.uptodate.com/contents/aspiration-pneumonia-in-adults

A full stomach contains solid particles of food. If these are aspirated, the problem then becomes one of mechanical blockage of the airways and secondary infection. During periods of fasting, the stomach contains acidic gastric juice, which, if aspirated, can be very destructive to the alveoli and capillaries. Fecal contamination (more likely seen in intestinal obstruction) increases the likelihood of death, because the endotoxins produced by intestinal organisms may be absorbed systemically, or the thick proteinaceous material found in the intestinal contents may obstruct the airway, leading to atelectasis and secondary bacterial invasion.

Esophageal conditions may also be associated with aspiration pneumonia. These include dysphagia, esophageal strictures, neoplasm or diverticula, tracheoesophageal fistula, and gastroesophageal reflux disease.

Prevention

The risk of aspiration is indirectly related to the level of consciousness of the patient. Aspiration of small amounts of material from the buccal (oral) cavity is not uncommon, particularly during sleep; however, disease as a result of aspiration does not occur in healthy people because the material is cleared by the mucociliary tree and the macrophages. Witnessed aspiration of large volumes occurs occasionally; however, small-volume clinically silent aspiration is more common. Prevention is the primary goal when caring for patients at risk for aspiration (American Association of Critical Care Nurses [AACN], 2017b).



Quality and Safety Nursing Alert

When a nonfunctioning nasogastric tube allows the gastric contents to accumulate in the stomach, a condition known as silent aspiration may result. Silent aspiration often occurs unobserved and may be more common than suspected. If untreated, massive inhalation of gastric contents develops in a period of several hours.

Compensating for Absent Reflexes

Aspiration may occur if the patient cannot adequately coordinate protective glottic, laryngeal, and cough reflexes. This hazard is increased if the patient has a distended abdomen, is supine, has the upper extremities immobilized in any manner, receives local anesthetic agents to the oropharyngeal or laryngeal area for diagnostic procedures, has been sedated, or has had long-term intubation. Clinical interventions are key to preventing aspiration (see Chart 19-9).

For patients with known swallowing dysfunction or those recently extubated following prolonged ET intubation, a swallowing screen is necessary. Patients deemed at risk are then assessed by a speech therapist. Besides positioning the patient semirecumbent or upright prior to eating, other helpful techniques may include suggesting a soft diet and encouraging the patient to take small bites. The patient should be instructed to keep the chin tucked and the head turned with repeated swallowing. Straws should not be used.

Chart 19-9

Clinical Practices That Prevent Aspiration

- Maintain head-of-bed elevation at an angle of 30 to 45 degrees, unless contraindicated
- Use sedatives as sparingly as possible
- Before initiating enteral tube feeding, confirm the tip location
- For patients receiving tube feedings, assess placement of the feeding tube at 4-hour intervals, assess for gastrointestinal residuals (<150 mL before next feeding) to the feedings at 4-hour intervals
- For patients receiving tube feedings, avoid bolus feedings in those at risk for aspiration
- Consult with primary provider about obtaining a swallowing evaluation before oral feedings are started for patients who were recently extubated but were previously intubated for >2 days
- Maintain endotracheal cuff pressures at an appropriate level, and ensure that secretions are cleared from above the cuff before it is deflated.

American Association of Critical Care Nurses (AACN). (2017b). AACN practice alert: Prevention of aspiration in adults. *Critical Care Nurse*, 37(3), 88.

When vomiting, people can normally protect their airway by sitting up or turning on the side and coordinating breathing, coughing, gag, and glottic reflexes. If these reflexes are active, an oral airway should not be inserted. If an airway is in place, it should be pulled out the moment the patient gags so as not to stimulate the pharyngeal gag reflex and promote vomiting and aspiration. Suctioning of oral secretions with a catheter should be performed with minimal pharyngeal stimulation.

For patients with an ET tube and feeding tube, the ET cuff pressure should be maintained at greater than 20 cm H₂O (but less than 30 cm H₂O to minimize injury) to prevent leakage of secretions from around the cuff into the lower respiratory tract. In addition, hypopharyngeal suctioning is recommended before the cuff is deflated (AACN, 2017a).

Assessing Feeding Tube Placement

Tube feedings must be given only when it is certain that the feeding tube is positioned correctly in the stomach. Many patients receive enteral feeding directly into the duodenum through a small-bore flexible feeding tube or surgically implanted tube. (See [Chapter 39](#) for discussion of enteral tube feedings.)

Identifying Delayed Stomach Emptying

A full stomach can cause aspiration because of increased intragastric or extragastric pressure. The following may delay emptying of the stomach: intestinal obstruction; increased gastric secretions in gastroesophageal reflex disease; increased gastric secretions during anxiety, stress, or pain; and abdominal distention due to paralytic ileus, ascites, peritonitis, the use of opioids or sedatives, severe illness, or vaginal delivery. (See [Chapter 39](#) for discussion of management of patients receiving gastric tube feedings.)

Managing Effects of Prolonged Intubation

Prolonged ET intubation or tracheostomy (see later discussions) can depress the laryngeal and glottic reflexes because of disuse. Patients with prolonged tracheostomies are encouraged to phonate and exercise their laryngeal muscles. For patients who have had long-term intubation or tracheostomies, it may be helpful to have a speech therapist experienced in swallowing disorders work with the patient to address swallowing problems, as noted previously.

Pulmonary Tuberculosis

Tuberculosis (TB) is an infectious disease that primarily affects the lung parenchyma. It also may be transmitted to other parts of the body, including the meninges, kidneys, bones, and lymph nodes. The primary infectious agent, *M. tuberculosis*, is an acid-fast aerobic rod that grows slowly and is sensitive to heat and ultraviolet light. *Mycobacterium bovis* and *Mycobacterium avium* have rarely been associated with the development of a TB infection.

TB is a worldwide public health problem that is closely associated with poverty, malnutrition, overcrowding, substandard housing, and inadequate health care. Mortality and morbidity rates continue to rise; *M. tuberculosis* infects an estimated one third of the world's population and remains the leading cause of death from infectious disease in the world. In 2017, 10 million people were sick with TB throughout the world, and there were 1.3 million TB-related deaths (CDC, 2018b).

In the United States, 9105 cases of TB were reported in 2017, which is a 2.3% decrease from 2016 (CDC, 2018b). Factors that prevent elimination of TB in the United States include the prevalence of TB among foreign-born residents, delays in detecting and reporting cases of TB, the lack of protection of contacts of people with infectious cases of TB, the presence of a substantial number of people with latent TB, and barriers to supporting clinical and public health expertise in this disease (CDC, 2018b).

Transmission and Risk Factors

TB spreads from person to person by airborne transmission. An infected person releases droplet nuclei (usually particles 1 to 5 μm in diameter) through talking, coughing, sneezing, laughing, or singing. Larger droplets settle; smaller droplets remain suspended in the air and are inhaled by a susceptible person. [Chart 19-10](#) lists risk factors for TB. [Chart 19-11](#) summarizes the CDC's recommendations for the prevention of TB transmission in health care settings.

Pathophysiology

TB begins when a susceptible person inhales mycobacteria and becomes infected. The bacteria are transmitted through the airways to the alveoli, where they are deposited and begin to multiply. The bacilli also are transported via the lymph system and bloodstream to other parts of the body (kidneys, bones, cerebral cortex) and other areas of the lungs (upper lobes). The body's immune system responds by initiating an inflammatory reaction. Phagocytes (neutrophils and macrophages) engulf many of the bacteria, and TB-specific lymphocytes lyse (destroy) the bacilli and normal tissue. This tissue reaction results in the accumulation of exudate in the alveoli, causing bronchopneumonia. The initial infection usually occurs 2 to 10 weeks after exposure.

Granulomas, new tissue masses of live and dead bacilli, are surrounded by macrophages, which form a protective wall. They are then transformed to a fibrous tissue mass, the central portion of which is called a *Ghon tubercle*. The material (bacteria and macrophages) becomes necrotic, forming a cheesy mass. This mass may become calcified and form a collagenous scar. At this point, the bacteria become dormant, and there is no further progression of active disease.

Chart 19-10 RISK FACTORS

Tuberculosis

- Close contact with someone who has active TB. Inhalation of airborne nuclei from a person who is infected is proportional to the amount of time spent in the same air space, the proximity of the person, and the degree of ventilation.
- Immunocompromised status (e.g., those with HIV infection, cancer, transplanted organs, and prolonged high-dose corticosteroid therapy).
- Substance use disorder (individuals who use IV/injection drug or abuse alcohol).
- Any person without adequate health care (those experiencing homelessness; those who are impoverished; and racial–ethnic minorities, particularly children <15 years and young adults between ages 15 and 44 years).
- Preexisting medical conditions or special treatment (e.g., diabetes, chronic kidney disease, malnourishment, select malignancies, hemodialysis, transplanted organ, gastrectomy, and jejunoileal bypass).
- Immigration from or recent travel to countries with a high prevalence of TB (southeastern Asia, Africa, Latin America, Caribbean).
- Institutionalization (e.g., long-term care facilities, psychiatric institutions, prisons).
- Living in overcrowded, substandard housing.
- Being a health care worker performing high-risk activities: administration of aerosolized pentamidine and other medications, sputum induction procedures, bronchoscopy, suctioning, coughing procedures, caring for patients who are immune suppressed, home care with the high-risk population, and administering anesthesia and related procedures (e.g., intubation, suctioning).

TB, tuberculosis.

Adapted from Centers for Disease Control and Prevention (CDC). (2018b). *TB fact sheets-infection control and prevention; TB in specific populations*. Retrieved on 9/26/2019 at: www.cdc.gov/tb/statistics/default.htm

After initial exposure and infection, active disease may develop because of a compromised or inadequate immune system response. Active disease also may occur with reinfection and activation of dormant bacteria. In this case, the *Ghon tubercle* ulcerates, releasing the cheesy material into the bronchi. The bacteria then become airborne, resulting in the further spread of the disease. Then, the ulcerated tubercle heals and forms scar tissue. This causes the infected lung to become more inflamed, resulting in the further development of bronchopneumonia and tubercle formation.

Unless this process is arrested, it spreads slowly downward to the hilum of the lungs and later extends to adjacent lobes. The process may be prolonged and is characterized by long remissions when the disease is arrested, followed

by periods of renewed activity. Approximately 10% of people who are initially infected develop active disease (Pozniak, 2019). Some people develop reactivation TB (also called *adult-type progressive TB*). The reactivation of a dormant focus occurring during the primary infection is the cause.

Chart 19-11

Centers for Disease Control and Prevention Recommendations for Preventing Transmission of Tuberculosis in Health Care Settings

- 1. Early identification and treatment of people with active TB**
 - a. Maintain a high index of suspicion for TB to identify cases rapidly.
 - b. Promptly initiate effective multidrug anti-TB therapy based on clinical and drug-resistance surveillance data.
- 2. Prevention of spread of infectious droplet nuclei by source control methods and by reduction of microbial contamination of indoor air**
 - a. Initiate AFB isolation precautions immediately for all patients who are suspected or confirmed to have active TB and who may be infectious. AFB isolation precautions include the use of a private room with negative pressure in relation to surrounding areas and a minimum of six air exchanges per hour. Air from the room should be exhausted directly to the outside. The use of ultraviolet lamps or high-efficiency particulate air filters to supplement ventilation may be considered.
 - b. People entering the AFB isolation room should use disposable particulate respirators that fit snugly around the face.
 - c. Continue AFB isolation precautions until there is clinical evidence of reduced infectiousness (i.e., cough has substantially decreased and the number of organisms on sequential sputum smears is decreasing). If drug resistance is suspected or confirmed, continue AFB precautions until the sputum smear is negative for AFB.
 - d. Use special precautions during cough-inducing procedures.
- 3. Surveillance for TB transmission**
 - a. Maintain surveillance for TB infection among health care workers (HCWs) by routine, periodic tuberculin skin testing. Recommend appropriate preventive therapy for HCWs when indicated.
 - b. Maintain surveillance for TB cases among patients and HCWs.
 - c. Promptly initiate contact investigation procedures among HCWs, patients, and visitors exposed to a patient with infectious TB who is untreated, or ineffectively treated, and for whom appropriate AFB procedures are not in place. Recommend appropriate therapy or preventive therapy for contacts with disease or TB infection without current disease. Therapeutic regimens should be chosen based on the clinical history and local drug-resistance surveillance data.

AFB, acid-fast bacilli; TB, tuberculosis.

Adapted from Centers for Disease Control and Prevention (CDC). (2018b). *TB fact sheets-infection control and prevention; TB in specific populations*. Retrieved on 9/26/2019 at: www.cdc.gov/tb/statistics/default.htm

Clinical Manifestations

The signs and symptoms of pulmonary TB are insidious. Most patients have a low-grade fever, cough, night sweats, fatigue, and weight loss. The cough may

be nonproductive, or mucopurulent sputum may be expectorated. **Hemoptysis** (i.e., coughing up blood) also may occur. Both the systemic and the pulmonary symptoms are chronic and may have been present for weeks to months. Older adult patients usually present with less pronounced symptoms than younger patients. Extrapulmonary disease occurs in up to 20% of cases in the United States (Bernardo, 2019). In patients infected with HIV, extrapulmonary disease is more prevalent.

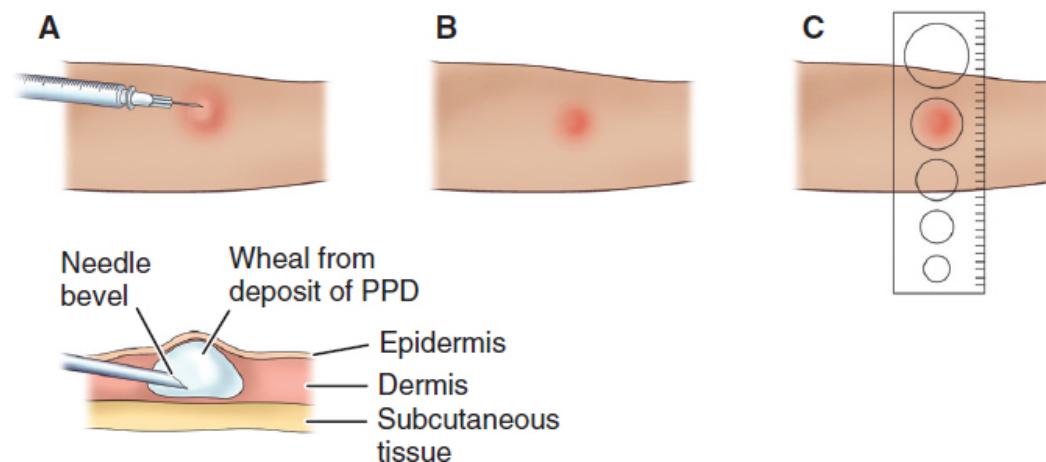


Figure 19-3 • The Mantoux test for tuberculosis. **A.** Correct technique for inserting the needle involves depositing the purified protein derivative (PPD) subcutaneously with the needle bevel facing upward. **B.** The reaction to the Mantoux test usually consists of a wheal, a hivelike, firm welt. **C.** To determine the extent of the reaction, the wheal is measured using a commercially prepared gauge. Interpretation of the Mantoux test is discussed in the text.

Assessment and Diagnostic Findings

Once a patient presents with a positive skin test, blood test, or sputum culture for acid-fast bacilli (AFB; see later discussion on these), additional assessments must be done. These tests include a complete history, physical examination, tuberculin skin test, chest x-ray, and drug susceptibility testing.

Clinical manifestations of fever, anorexia, weight loss, night sweats, fatigue, cough, and sputum production prompt a more thorough assessment of respiratory function—for example, assessing the lungs for consolidation by evaluating breath sounds (diminished, bronchial sounds; crackles), fremitus, and egophony. If the patient is infected with TB, the chest x-ray usually reveals lesions in the upper lobes. For all patients, the initial *M. tuberculosis* isolate should be tested for drug resistance. Drug susceptibility patterns should be repeated at 3 months for patients who do not respond to therapy (Sterling, 2019).

Tuberculin Skin Test

The Mantoux method is used to determine whether a person has been infected with the TB bacillus and is used widely in screening for latent *M. tuberculosis* infection. The Mantoux method is a standardized, intracutaneous injection procedure and should be performed only by those trained in its administration and reading. Tubercle bacillus extract (tuberculin), purified protein derivative (PPD), is injected into the intradermal layer of the inner aspect of the forearm, approximately 4 inches below the elbow (see Fig. 19-3). Intermediate-strength PPD, in a tuberculin syringe with a half-inch 26- or 27-gauge needle, is used. The needle, with the bevel facing up, is inserted beneath the skin. Then, 0.1 mL of PPD is injected, creating an elevation in the skin, a well-demarcated wheal 6 to 10 mm in diameter. The site, antigen name, strength, lot number, date, and time of the test are recorded. The test result is read 48 to 72 hours after injection. Tests read after 72 hours tend to underestimate the true size of **induration** (raised hard area or swelling). A delayed localized reaction indicates that the person is sensitive to tuberculin.

A reaction occurs when both induration and erythema (redness) are present. After the area is inspected for induration, it is lightly palpated across the injection site, from the area of normal skin to the margins of the induration. The diameter of the induration (not erythema) is measured in millimeters at its widest part (see Fig. 19-3), and the size of the induration is documented. Erythema without induration is not considered significant.

The size of the induration determines the significance of the reaction. A reaction of 0 to 4 mm is considered not significant. A reaction of 5 mm or greater may be significant in people who are considered to be at risk. It is defined as positive in patients who are HIV positive or have HIV risk factors and are of unknown HIV status, in those who are close contacts of someone with active TB, and in those who have chest x-ray results consistent with TB. An induration of 10 mm or greater is usually considered significant in people who have normal or mildly impaired immunity. A significant reaction indicates past exposure to *M. tuberculosis* or vaccination with bacille Calmette-Guérin (BCG) vaccine. The BCG vaccine is given to produce a greater resistance to development of TB. The BCG vaccine is used in Europe and Latin America but not routinely in the United States.

A significant (positive) reaction does not necessarily mean that active disease is present in the body. More than 90% of people who are tuberculin-significant reactors do not develop clinical TB (CDC, 2018b). However, all significant reactors are candidates for active TB. In general, the more intense the reaction, the greater the likelihood of an active infection. Additional testing is needed to determine if the person has latent TB infection or active TB.

A nonsignificant (negative) skin test means the person's immune system did not react to the test and that latent TB infection or TB disease is not likely. It does not exclude TB infection or disease, because patients who are

immunosuppressed cannot develop an immune response that is adequate to produce a positive skin test. This is referred to as anergy.

QuantiFERON-TB Gold® Plus and T-SPOT®

There are two TB blood tests (called interferon-gamma release assays or IGRA) available in the United States: the QuantiFERON-TB Gold® Plus (QFT-Plus) test and the T-SPOT®. TB blood tests are the preferred diagnostic tests for patients who have received the BCG vaccine and for patients who are not likely to return for a second appointment to look for a reaction to the tuberculin skin test. The results of both of these tests are available within 24 to 36 hours. A positive IGRA signifies that the patient has been infected with TB bacteria and additional tests are needed. A negative IGRA means that the patient's blood did not react to the test and a latent or active TB infection is not likely (CDC, 2019d; Theel, Hilgart, Breen-Lyles, et al., 2018).

Sputum Culture

A sputum specimen may be used to screen for TB. The presence of AFB on a sputum smear may indicate disease but does not confirm the diagnosis of TB because some AFB are not *M. tuberculosis*. A culture is done to confirm the diagnosis. For all patients, the initial *M. tuberculosis* isolate should be tested for drug resistance (Sterling, 2019).



Gerontologic Considerations

TB may have atypical manifestations in older adult patients, whose symptoms may include unusual behavior and altered mental status, fever, anorexia, and weight loss. In many older adult patients, the tuberculin skin test produces no reaction (loss of immunologic memory) or delayed reactivity for up to 1 week (recall phenomenon). A second skin test is performed in 1 to 2 weeks. Older adults who live in long-term care facilities are at increased risk for primary and reactivated TB as compared to those in the community (Rajagopalan, 2016).

Medical Management

Pulmonary TB is treated primarily with anti-TB agents for 6 to 12 months. A prolonged treatment duration is necessary to ensure eradication of the organisms and to prevent relapse. The continuing and increasing resistance of *M. tuberculosis* to TB medications is a worldwide concern and challenge in TB therapy. Drug resistance must be considered when planning effective therapy, including the following:

- *Multidrug resistance (MDR TB)*: Resistance to two agents, isoniazid and rifampin. The populations at greatest risk for multidrug

resistance are those who are HIV positive, institutionalized, or homeless.

- *Extensively drug resistant (XDR TB)*: Resistance to isoniazid and rifampin, in addition to any fluoroquinolone, and at least one of three injectable second-line agents (i.e., amikacin, kanamycin, or capreomycin). The populations at greatest risk are those with HIV infection or other immunocompromised conditions (CDC, 2019d).

The increasing prevalence of drug resistance points out the need to begin TB treatment with four or more medications, to ensure completion of therapy, and to develop and evaluate new anti-TB medications.

TABLE 19-4



First-Line Antituberculosis Medications for Active

Disease

Commonly Used Agents	Adult Daily Dosage ^a	Most Common Side Effects	Drug Interactions ^b	Nursing Considerations ^a
Isoniazid	5 mg/kg (300 mg maximum daily)	Peripheral neuritis, hepatic enzyme elevation, hepatitis, hypersensitivity	Phenytoin—synergistic Antabuse Alcohol	Bactericidal Pyridoxine is used as prophylaxis for neuritis. Monitor AST and ALT
Rifampin	10 mg/kg (600 mg maximum daily)	Hepatitis, febrile reaction, purpura (rare), nausea, vomiting	Rifampin increases metabolism of oral contraceptives, quindine, corticosteroids, coumarin derivatives and methadone, digoxin, oral hypoglycemics. PAS may interfere with absorption of rifampin	Bactericidal Orange urine and other body secretions Discoloring of contact lenses Monitor AST and ALT
Rifabutin	5 mg/kg (300 mg maximum daily)		Avoid protease inhibitors	
Rifapentine	10 mg/kg (600 mg twice weekly)	Hepatotoxicity, thrombocytopenia		Orange-red coloration of body secretions, contact lenses, dentures Use with caution in older adults or in those with renal disease
Pyrazinamide	15–30 mg/kg (2 g maximum daily) ^a	Hyperuricemia, hepatotoxicity, skin rash, arthralgias, GI distress		Bactericidal Monitor uric acid, AST, and ALT
Ethambutol	15–25 mg/kg (1.6 g maximum daily dose) ^a	Optic neuritis (may lead to blindness; very rare at 15 mg/kg), skin rash		Bacteriostatic Use with caution with renal disease or when eye testing is not feasible. Monitor visual acuity, color, and discrimination ^c
Combinations: isoniazid + rifampin	150-mg and 300-mg caps (2 caps daily)			

ALT, alanine transaminase; AST, aspartate transaminase; GI, gastrointestinal; PAS, para-aminosalicylic acid.

^aCheck product labeling for detailed information on dose, contraindications, drug interactions, adverse reactions, and monitoring.

^bRefer to current literature, particularly on rifampin, because it increases hepatic microenzymes and therefore interacts with many drugs.

^cInitial examination should be performed at start of treatment.

Adapted from Gilbert, D. N., Chambers, H. F., Eliopoulos, G. M., et al. (2018). *The Sanford guide to antimicrobial therapy 2018* (48th ed.). Sperryville, VA: Antimicrobial Therapy, Inc.

In current TB therapy, four first-line medications are used (see Table 19-4): isoniazid, rifampin, pyrazinamide, and ethambutol. Combination medications, such as isoniazid and rifampin or isoniazid, pyrazinamide, and rifampin and medications given twice a week (e.g., rifapentine) are available to help improve patient adherence. However, these medications are more costly.

Multidrug-resistant TB is difficult to treat. Treatment is guided by sputum specimen culture and sensitivity testing as the patient typically is resistant to isoniazid and rifampin. The World Health Organization (WHO, 2019) recently

published recommendations for treatment consisting of multiple medications to combat drug-resistant organisms. It is important to consult current recommendations for treatment (WHO, 2019).

Recommended treatment guidelines for newly diagnosed cases of pulmonary TB have two phases: an initial treatment phase and a continuation phase (CDC, 2019d). The initial phase consists of a multiple-medication regimen of isoniazid, rifampin, pyrazinamide, and ethambutol plus vitamin B₆ 50 mg. All are taken once a day and are oral medications. This initial intensive-treatment regimen is given daily for 8 weeks, after which options for the continuation phase of treatment include isoniazid and rifampin or isoniazid and rifapentine. The continuation regimen lasts for an additional 4 or 7 months. The 4-month period is used for the large majority of patients. The 7-month period is recommended for patients with cavitary pulmonary TB whose sputum culture after the initial 2 months of treatment is positive, for those whose initial phase of treatment did not include pyrazinamide, and for those being treated once weekly with isoniazid and rifapentine whose sputum culture is positive at the end of the initial phase of treatment. People are considered noninfectious after 2 to 3 weeks of continuous medication therapy. The total number of doses taken, not simply the duration of treatment, more accurately determines whether a course of therapy has been completed (CDC, 2019d).

Isoniazid also may be used as a prophylactic (preventive) measure for people who are at risk for significant disease, including:

- Household family members of patients with active disease
- Patients with HIV infection who have a PPD test reaction with 5 mm of induration or more
- Patients with fibrotic lesions suggestive of old TB detected on a chest x-ray and a PPD reaction with 5 mm of induration or more
- Patients whose current PPD test results show a change from former test results, suggesting recent exposure to TB and possible infection (skin test converters)
- Patients who use IV/injection drugs who have PPD test results with 10 mm of induration or more
- Patients with high-risk comorbid conditions and a PPD result with 10 mm of induration or more

Other candidates for preventive isoniazid therapy are those 35 years or younger who have PPD test results with 10 mm of induration or more and one of the following criteria:

- Individuals who are foreign-born from countries with a high prevalence of TB
- Populations that are high-risk and medically underserved
- Patients living in institutions

Prophylactic isoniazid treatment involves taking daily doses for 6 to 12 months. Liver enzymes, blood urea nitrogen (BUN), and creatinine levels are monitored monthly. Sputum culture results are monitored for AFB to evaluate the effectiveness of treatment and the patient's adherence to the treatment regimen.

Nursing Management

Nursing management includes promoting airway clearance, advocating adherence to the treatment regimen, promoting activity and nutrition, and preventing transmission.

Promoting Airway Clearance

Copious secretions obstruct the airways in many patients with TB and interfere with adequate gas exchange. Increasing the fluid intake promotes systemic hydration and serves as an effective expectorant. The nurse instructs the patient about correct positioning to facilitate airway drainage, referred to as postural drainage (see [Chapter 20](#)). Postural drainage allows the force of gravity to assist in the removal of bronchial secretions.

Promoting Adherence to Treatment Regimen

Adherence to the prescribed treatment regimen is key in treating the disease and controlling the spread of infection. The multiple-medication regimen that the patient must follow can be quite complex. Understanding of the medications, schedule, and side effects is important. The nurse educates the patient that TB is a communicable disease and that taking medications is the most effective means of preventing transmission. The major reason treatment fails is that patients do not take their medications regularly and for the prescribed duration. This may be due to side effects or the complexity of the treatment regimen. Risk factors for nonadherence to the drug regimen include patients who have previously failed to complete the course of therapy; patients who are physically, emotionally, or mentally challenged; patients unable to pay for medication; patients actively abusing illicit substances; and patients who do not understand the importance of treatment (Reichman & Lardizabal, 2019).

The nurse educates the patient to take the medication either on an empty stomach or at least 1 hour before meals, because food interferes with medication absorption (although taking medications on an empty stomach frequently results in gastrointestinal upset). Patients taking isoniazid should avoid foods that contain tyramine and histamine (tuna, aged cheese, red wine, soy sauce, yeast extracts), because eating them while taking isoniazid may result in headache, flushing, hypotension, lightheadedness, palpitations, and

diaphoresis. Patients should also avoid alcohol because of the high potential for hepatotoxic effects.

In addition, rifampin can alter the metabolism of certain other medications, making them less effective. These medications include beta-blockers, oral anticoagulants such as warfarin, digoxin, quinidine, corticosteroids, oral hypoglycemic agents, oral contraceptives, theophylline, and verapamil. This issue should be discussed with the primary provider and pharmacist so that medication dosages can be adjusted accordingly. The nurse informs the patient that rifampin may discolor contact lenses and that the patient may want to wear eyeglasses during treatment. The nurse monitors for other side effects of anti-TB medications, including hepatitis, neurologic changes (hearing loss, neuritis), and rash. Liver enzymes, BUN, and serum creatinine levels are monitored to detect changes in liver and kidney function. Sputum culture results are monitored for AFB to evaluate the effectiveness of the treatment regimen and adherence to therapy.

The nurse educates the patient about the risk of drug resistance if the medication regimen is not strictly and continuously followed. The nurse carefully monitors vital signs and observes for spikes in temperature or changes in the patient's clinical status. Caregivers of patients who are not hospitalized are taught to monitor the patient's temperature and respiratory status. Changes in the patient's respiratory status are reported to the primary provider.

For patients at risk for nonadherence, programs used in the community setting may include comprehensive case management and directly observed therapy (DOT). In case management, each patient with TB is assigned a case manager who coordinates all aspects of the patient's care. DOT consists of a health care provider or other responsible person who directly observes that the patient ingests the prescribed medications. Although successful, DOT is a resource intensive program (Herchline, 2020).

Promoting Activity and Adequate Nutrition

Patients with TB are often debilitated from prolonged chronic illness and impaired nutritional status. The nurse plans a progressive activity schedule that focuses on increasing activity tolerance and muscle strength. Anorexia, weight loss, and malnutrition are common in patients with TB. The patient's willingness to eat may be altered by fatigue from excessive coughing; sputum production; chest pain; generalized debilitated state; or cost, if the patient has few resources. Identifying facilities (e.g., shelters, soup kitchens, Meals on Wheels) that provide meals in the patient's neighborhood may increase the likelihood that the patient with limited resources and energy will have access to a more nutritious intake. A nutritional plan that allows for small, frequent meals may be required. Liquid nutritional supplements may assist in meeting basic caloric requirements.

Preventing Transmission of Tuberculosis Infection

To prevent transmission of TB to others, the nurse carefully educates the patient about important hygiene measures, including mouth care, covering the mouth and nose when coughing and sneezing, proper disposal of tissues, and hand hygiene. TB is a disease that must be reported to the health department so that people who have been in contact with the affected patient during the infectious stage can undergo screening and possible treatment, if indicated.

In addition to the risk of transmission of TB infection to other people, it can also be spread to other parts of the body of affected patients. Spread or dissemination of TB infection to nonpulmonary sites of the body is known as miliary TB. Miliary TB is seen in approximately 1.5% of all patients with TB (Lessnau, 2019). It is the result of invasion of the bloodstream by the tubercle bacillus. Usually, it results from late reactivation of a dormant infection in the lung or elsewhere. The origin of the bacilli that enter the bloodstream is either a chronic focus that has ulcerated into a blood vessel or multitudes of miliary tubercles lining the inner surface of the thoracic duct. The organisms migrate from these foci into the bloodstream, are carried throughout the body, and disseminate throughout all tissues, with tiny miliary tubercles developing in the lungs, spleen, liver, kidneys, meninges, and other organs.

The clinical course of miliary TB may vary from an acute, rapidly progressive infection with high fever to a slowly developing process with low-grade fever, anemia, and debilitation. At first, there may be no localizing signs except an enlarged spleen and a reduced number of leukocytes. However, within a few weeks, the chest x-ray reveals small densities scattered diffusely throughout both lung fields; these are the miliary tubercles, which gradually grow.

The possibility of spread to nonpulmonary sites in the body requires careful monitoring for this very serious form of TB. The nurse monitors vital signs and observes for spikes in temperature as well as changes in renal and cognitive function. Few physical signs may be elicited on physical examination of the chest, but at this stage, the patient has a severe cough and dyspnea. Treatment of miliary TB is the same as for pulmonary TB.

Lung Abscess

A lung abscess is a localized collection of pus caused by microbial infection (Kamangar, 2018). It is generally caused by aspiration of anaerobic bacteria. By definition, in a lung abscess, the chest x-ray demonstrates a cavity of at least 2 cm. Patients who are at risk for aspiration of foreign material and development of a lung abscess include those with impaired cough reflexes who cannot close the glottis and those with swallowing difficulties. Other patients at risk include those with central nervous system disorders (e.g., seizure,

stroke), substance use disorder, esophageal disease, or compromised immune function; patients without teeth and those receiving nasogastric tube feedings; and patients with an altered state of consciousness due to anesthesia (Bartlett, 2019a).

Pathophysiology

Most lung abscesses are a complication of bacterial pneumonia or are caused by aspiration of oral anaerobes into the lung. Abscesses also may occur secondary to mechanical or functional obstruction of the bronchi by a tumor, foreign body, or bronchial stenosis, or from necrotizing pneumonias, TB, pulmonary embolism (PE), or chest trauma.

Most lung abscesses are found in areas of the lung that may be affected by aspiration. The site of the lung abscess is related to gravity and is determined by position. For patients who are confined to bed, the posterior segment of an upper lobe and the superior segment of the lower lobe are the most common areas. However, atypical presentations may occur, depending on the position of the patient when the aspiration occurred.

Initially, the cavity in the lung may or may not extend directly into a bronchus. Eventually, the abscess becomes surrounded, or encapsulated, by a wall of fibrous tissue. The necrotic process may extend until it reaches the lumen of a bronchus or the pleural space and establishes communication with the respiratory tract, the pleural cavity, or both. If the bronchus is involved, the purulent contents are expectorated continuously in the form of sputum. If the pleura is involved, the result is an empyema. A communication or connection between the bronchus and pleura is known as a bronchopleural fistula. The organisms frequently associated with lung abscesses are anaerobic; however, aerobic organisms may be involved as well. The organisms vary depending on the underlying predisposing factors (Kamangar, 2018).

Clinical Manifestations

The clinical manifestations of a lung abscess may vary from a mild productive cough to acute illness. Most patients have a fever and a productive cough with moderate to copious amounts of foul-smelling, sometimes bloody, sputum. The fever and cough may develop insidiously and may have been present for several weeks before diagnosis. Leukocytosis may be present. Pleurisy or dull chest pain, dyspnea, weakness, anorexia, and weight loss are common.

Assessment and Diagnostic Findings

Physical examination of the chest may reveal dullness on percussion and decreased or absent breath sounds with an intermittent **pleural friction rub**

(grating or creaking sound) on auscultation. Crackles may be present. Confirmation of the diagnosis is made by chest x-ray, sputum culture, and, in some cases, fiberoptic bronchoscopy. The chest x-ray reveals an infiltrate with an air–fluid level. A computed tomography (CT) scan of the chest may be required to provide more detailed images of different cross-sectional areas of the lung.

Prevention

The following measures reduce the risk of lung abscess:

- Appropriate antibiotic therapy before any dental procedures in patients who must have teeth extracted while their gums and teeth are infected
- Adequate dental and oral hygiene, because anaerobic bacteria play a role in the pathogenesis of lung abscess
- Appropriate antimicrobial therapy for patients with pneumonia

Medical Management

The findings of the history, physical examination, chest x-ray, and sputum culture indicate the type of organism and the treatment required. Adequate drainage of the lung abscess may be achieved through postural drainage and chest physiotherapy. Patients should be assessed for an adequate cough. Some patients require insertion of a percutaneous chest catheter for long-term drainage of the abscess. Therapeutic use of bronchoscopy to drain an abscess is uncommon. A diet high in protein and calories is necessary, because chronic infection is associated with a catabolic state, necessitating increased intake of calories and protein to facilitate healing. Surgical intervention is rare, but pulmonary resection (lobectomy) is performed if massive hemoptysis occurs or if there is little or no response to medical management.

IV antimicrobial therapy depends on the results of the sputum culture and sensitivity and is given for an extended period. Standard treatment of an anaerobic lung infection is clindamycin, ampicillin-sulbactam, or carbapenem (Bartlett, 2019b). Large IV doses are usually required, because the antibiotic must penetrate the necrotic tissue and the fluid in the abscess. The duration of treatment with IV antibiotics is not well studied and remains controversial (Bartlett, 2019b). Treatment with IV antibiotics may continue for 3 weeks and longer, depending upon the clinical severity and organism involved. Improvement is demonstrated by normal temperature, decreased white blood cell count, and improvement on chest x-ray (resolution of surrounding infiltrate, reduction in cavity size, and absence of fluid). Once improvement is demonstrated, IV antibiotics are discontinued and oral administration of

antibiotic therapy is continued for an additional 4 to 12 weeks and sometimes longer. If treatment is stopped too soon, a relapse may occur (Bartlett, 2019b).

Nursing Management

The nurse administers antibiotics and IV treatments as prescribed and monitors for adverse effects. CPT is initiated as prescribed to facilitate drainage of the abscess. The patient is educated on how to perform deep-breathing and coughing exercises to help expand the lungs. To ensure proper nutritional intake, the nurse encourages a diet that is high in protein and calories. The nurse also offers emotional support, because the abscess may take a long time to resolve.

Promoting Home, Community-Based, and Transitional Care



Educating Patients About Self-Care

A patient who has had surgery may return home before the wound closes entirely or with a drain or tube in place. In these cases, the nurse educates the patient or caregivers about how to change the dressings to prevent skin excoriation and odor, how to monitor for signs and symptoms of infection, and how to care for and maintain the drain or tube. The nurse also reminds the patient to perform deep-breathing and coughing exercises every 2 hours during the day and shows caregivers how to perform chest percussion and postural drainage to facilitate expectoration of lung secretions.

Continuing and Transitional Care

A patient whose condition requires therapy at home may need referral for home, transitional, or community-based care. During home visits, the nurse assesses the patient's physical condition, nutritional status, and home environment, as well as the ability of the patient and family to carry out the therapeutic regimen. Patient education is reinforced, and nutritional counseling is provided with the goal of attaining and maintaining an optimal state of nutrition. To prevent relapses, the nurse emphasizes the importance of completing the antibiotic regimen and of following suggestions for rest and appropriate activity. If IV antibiotic therapy is to continue at home, the services of home health nurses may be arranged to initiate IV therapy and to evaluate its administration by the patient or family.

Although most outpatient IV therapy is given in the home setting, the patient may visit a nearby clinic or provider's office for this treatment. In some cases, patients with lung abscess may have ignored their health. Therefore, the nurse should use this opportunity to address health promotion strategies and health screening with the patient.

Sarcoidosis

Sarcoidosis is a type of interstitial lung disease that is also an inflammatory, multisystem, granulomatous disease of unknown etiology (King, 2019a). Although 90% of patients demonstrate thoracic involvement, any organ may be affected. Sarcoidosis usually presents between 20 and 40 years of age and is slightly more common in women than in men (Weinberger et al., 2019). In the United States, the disease is more common in African Americans, and the estimated prevalence is 10 to 20 per 100,000 people (King, 2019a).

Pathophysiology

Sarcoidosis is thought to be a hypersensitivity response to one or more exogenous agents (bacteria, fungi, virus, chemicals) in people with an inherited or acquired predisposition to the disorder. The hypersensitivity response and inflammation result in the formation of a noncaseating granuloma, which is a noninfectious organized collection of macrophages that appear as a nodule. In the lung, granuloma infiltration and fibrosis may occur, resulting in low lung compliance, impaired diffusing capacity, and reduced lung volumes (King, 2019a).

Clinical Manifestations

Hallmarks of sarcoidosis are its insidious onset and lack of prominent clinical signs or symptoms. The clinical picture depends on the systems affected. The lung is most commonly involved; signs and symptoms may include dyspnea, cough, hemoptysis, and congestion. Other signs include uveitis; joint pain; fever; and granulomatous lesions of the skin, liver, spleen, kidney, and central nervous system. With multisystem involvement, patients may also have fatigue, fever, anorexia, and weight loss. The granulomas may disappear or gradually convert to fibrous tissue.

Assessment and Diagnostic Findings

Chest x-rays and CT scans are used to assess pulmonary adenopathy. These may show hilar adenopathy and disseminated miliary and nodular lesions in the lungs. A mediastinoscopy or **transbronchial** biopsy (in which a tissue specimen is obtained through the bronchial wall) may be used to confirm the diagnosis. In rare cases, an open lung biopsy is performed. Diagnosis is confirmed by a biopsy that shows noncaseating granulomas. Pulmonary function test results are abnormal if there is restriction of lung function (reduction in total lung capacity). Arterial blood gas measurements may be

normal or may show hypoxemia (reduced oxygen levels) and hypercapnia (increased carbon dioxide levels).

Medical Management

Many patients undergo remission without specific treatment. Corticosteroids may be beneficial because of their anti-inflammatory effects. Oral corticosteroids have been the most commonly used agents for the relief of symptoms and control of potentially disabling respiratory impairment from pulmonary sarcoidosis. Once begun, corticosteroid therapy is usually continued in tapering doses for 12 months, and longer if the patient has recurrence of symptoms and chest x-ray indications (i.e., continued pulmonary adenopathy) (King, 2019b). Corticosteroids (e.g., prednisone) have been shown to be useful in patients with ocular and myocardial involvement, skin involvement, extensive pulmonary disease that compromises pulmonary function, hepatic involvement, and hypercalcemia. However, it is not known if corticosteroids alter the long-term course of the disease (King, 2019b). When there is inadequate response to prednisone or the dose cannot be decreased, an immune modulator may be added (e.g., methotrexate, azathioprine, leflunomide, mycophenolate). No single test monitors the progression or recurrence of sarcoidosis; multiple tests are used to monitor involved systems.

Nursing Management

The role of the nurse in the care of patients with sarcoidosis includes supporting the medical regimen and providing education and psychosocial support. Since treatment is aimed at reducing inflammation, patients should be educated on the effects and correct usage of corticosteroids. Patients should be instructed to notify their primary provider if symptoms do not improve or respiratory symptoms worsen. Sarcoidosis is a chronic illness warranting follow-ups at 3 to 6 month intervals to assess disease progression. Patients should be encouraged to contact the Foundation for Sarcoidosis Research to identify additional community resources that can be of assistance to them (see Resources section at the end of the chapter).

PLEURAL DISORDERS

Pleural disorders involve the membranes covering the lungs (visceral pleura) and the surface of the chest wall (parietal pleura) or disorders affecting the pleural space.

Pleurisy

Pleurisy (pleuritis) refers to inflammation of both layers of the pleurae (parietal and visceral). Pleurisy may develop in conjunction with pneumonia or an upper respiratory tract infection, TB, or collagen disease; after trauma to the chest, pulmonary infarction, or PE; in patients with primary or metastatic cancer; and after thoracotomy. The parietal pleura has nerve endings, and the visceral pleura does not. When the inflamed pleural membranes rub together during respiration (intensified on inspiration), the result is severe, sharp, knifelike pain.

Clinical Manifestations

The key characteristic of pleuritic pain is its relationship to respiratory movement. Taking a deep breath, coughing, or sneezing worsens the pain. Pleuritic pain is limited in distribution rather than diffuse; it usually occurs only on one side. The pain may become minimal or absent when the breath is held. It may be localized or radiate to the shoulder or abdomen. Later, as pleural fluid develops, the pain decreases (Weinberger et al., 2019).

Assessment and Diagnostic Findings

In the early period, when little fluid has accumulated, a pleural friction rub can be heard with the stethoscope, only to disappear later as more fluid accumulates and separates the inflamed pleural surfaces. Diagnostic tests may include chest x-rays, sputum analysis, thoracentesis to obtain a specimen of pleural fluid for examination, and, less commonly, a pleural biopsy.

Medical Management

The objectives of treatment are to discover the underlying condition causing the pleurisy and to relieve the pain. As the underlying disease (pneumonia, infection) is treated, the pleuritic inflammation usually resolves. At the same time, the patient must be monitored for signs and symptoms of pleural effusion, such as shortness of breath, pain, assumption of a position that decreases pain, and decreased chest wall excursion.

Prescribed analgesic agents and topical applications of heat or cold provide symptomatic relief. A nonsteroidal anti-inflammatory drug may provide pain relief while allowing the patient to take deep breaths and cough more effectively. If the pain is severe, an intercostal nerve block may be required (Weinberger et al., 2019).

Nursing Management

Because the patient has pain on inspiration, the nurse offers suggestions to enhance comfort, such as turning frequently onto the affected side to splint the chest wall and reduce the stretching of the pleurae. The nurse also educates the patient to use the hands or a pillow to splint the rib cage while coughing.

Pleural Effusion

Pleural effusion, a collection of fluid in the pleural space, is rarely a primary disease process; it is usually secondary to other diseases. Normally, the pleural space contains a small amount of fluid (5 to 15 mL), which acts as a lubricant that allows the pleural surfaces to move without friction (see Fig. 19-4). Pleural effusion may be a complication of heart failure, TB, pneumonia, pulmonary infections (particularly viral infections), nephrotic syndrome, connective tissue disease, PE, and neoplastic tumors. The most common malignancy associated with a pleural effusion is bronchogenic carcinoma.

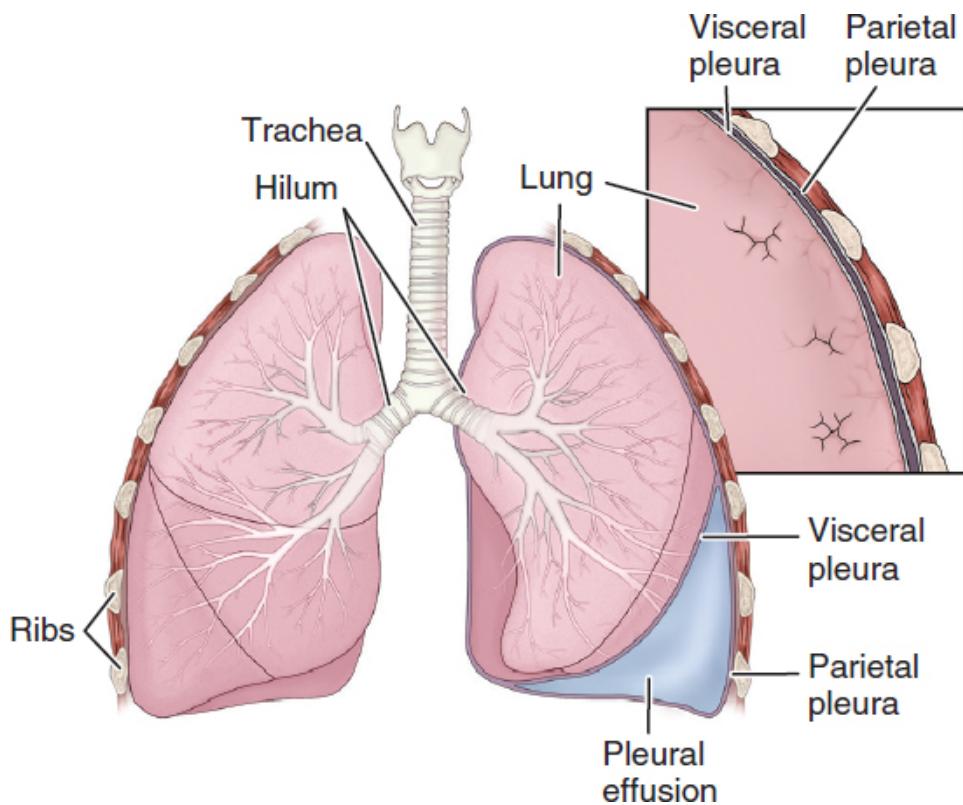


Figure 19-4 • In pleural effusion, an abnormal volume of fluid collects in the pleural space, causing pain and shortness of breath. Pleural effusion is usually secondary to other disease processes.

Pathophysiology

In certain disorders, fluid may accumulate in the pleural space to a point at which it becomes clinically evident. This almost always has pathologic significance. The effusion can be a relatively clear fluid, or it can be bloody or purulent. An effusion of clear fluid may be a transudate or an exudate. A transudate (filtrate of plasma that moves across intact capillary walls) occurs when factors influencing the formation and reabsorption of pleural fluid are altered, usually by imbalances in hydrostatic or oncotic pressures. The finding of a transudative effusion generally implies that the pleural membranes are not diseased. A transudative effusion most commonly results from heart failure. An exudate (extravasation of fluid into tissues or a cavity) usually results from inflammation by bacterial products or tumors involving the pleural surfaces (Heffner, 2019a).

Clinical Manifestations

Usually, the clinical manifestations are caused by the underlying disease. Pneumonia causes fever, chills, and pleuritic chest pain, whereas a malignant effusion may result in dyspnea, difficulty lying flat, and coughing. The severity of symptoms is determined by the size of the effusion, the speed of its formation, and the underlying lung disease. A large pleural effusion causes dyspnea. A small-to-moderate pleural effusion causes minimal or no dyspnea.

Assessment and Diagnostic Findings

Assessment of the area of the pleural effusion reveals decreased or absent breath sounds; decreased fremitus; and a dull, flat sound on percussion. In the case of an extremely large pleural effusion, the assessment reveals a patient in acute respiratory distress. Tracheal deviation away from the affected side may also be apparent.

Physical examination, chest x-ray, chest CT, and thoracentesis confirm the presence of fluid. In some instances, a lateral decubitus x-ray is obtained. For this x-ray, the patient lies on the affected side in a side-lying position. A pleural effusion can be diagnosed because this position allows for the “layering out” of the fluid, and an air–fluid line is visible.

Pleural fluid is analyzed by bacterial culture, Gram stain, AFB stain (for TB), red and white blood cell counts, chemistry studies (glucose, amylase, LDH, and protein), cytologic analysis for malignant cells, and pH. A pleural biopsy also may be performed as a diagnostic tool.

Medical Management

The objectives of treatment are to discover the underlying cause of the pleural effusion; to prevent reaccumulation of fluid; and to relieve discomfort,

dyspnea, and respiratory compromise. Specific treatment is directed at the underlying cause (e.g., heart failure, pneumonia, cirrhosis). If the pleural fluid is an exudate, more extensive diagnostic procedures are performed to determine the cause. Treatment of the primary cause is then instituted.

Thoracentesis is performed to remove fluid, to obtain a specimen for analysis, and to relieve dyspnea and respiratory compromise (see [Chapter 17](#)). Thoracentesis may be performed under ultrasound guidance. Depending on the size of the pleural effusion, the patient may be treated by removing the fluid during the thoracentesis procedure or by inserting a chest tube connected to a water-seal drainage system or suction to evacuate the pleural space and re-expand the lung.

However, if the underlying cause is a malignancy, the effusion tends to recur within a few days or weeks. Repeated thoracenteses result in pain, depletion of protein and electrolytes, and sometimes pneumothorax. Once the pleural space is adequately drained, a chemical pleurodesis may be performed to obliterate the pleural space and prevent reaccumulation of fluid. Pleurodesis may be performed using either a thoracoscopic approach or a chest tube. A chemically irritating agent (e.g., talc or another chemical irritant) is instilled or aerosolized into the pleural space. With the chest tube approach, after the agent is instilled, the chest tube is clamped for 60 to 90 minutes and the patient is assisted to assume various positions to promote uniform distribution of the agent and to maximize its contact with the pleural surfaces (Heffner, 2019b). The tube is unclamped as prescribed, and chest drainage may be continued several days longer to prevent reaccumulation of fluid and to promote the formation of adhesions between the visceral and parietal pleurae.

Other treatments for pleural effusions caused by malignancy include surgical pleurectomy, insertion of a small catheter attached to a drainage bottle for outpatient management (e.g., PleurX® catheter), or implantation of a pleuroperitoneal shunt. A pleuroperitoneal shunt consists of two catheters connected by a pump chamber containing two one-way valves. Fluid moves from the pleural space to the pump chamber and then to the peritoneal cavity. The patient manually pumps on the reservoir daily to move fluid from the pleural space to the peritoneal space.

Nursing Management

The nurse's role in the care of a patient with a pleural effusion includes supporting the medical regimen. The nurse prepares and positions the patient for thoracentesis and offers support throughout the procedure. The nurse ensures the thoracentesis fluid amount is recorded and sent for appropriate laboratory testing. If a chest tube drainage and water-seal system is used, the system's function is monitored and the amount of drainage is recorded at

prescribed intervals (see later discussion). Nursing care related to the underlying cause of the pleural effusion is specific to the underlying condition.

Patients with a pleural effusion secondary to a malignancy may have a chest tube inserted to instill talc (Bhatnagar, Piotrowska, Laskawiec-Szkonter, et al., 2019). Pain management is a priority, and the nurse helps the patient assume positions that are the least painful. However, frequent turning and movement are important to facilitate adequate spreading of the talc over the pleural surface. The nurse evaluates the patient's pain level and administers analgesic agents as prescribed and as needed.

If the patient is to be managed as an outpatient with a pleural catheter for drainage, the nurse educates the patient and family about management and care of the catheter and drainage system.

Empyema

An empyema is an accumulation of thick, purulent fluid within the pleural space, often with fibrin development and a loculated (walled-off) area where infection is located (Strange, 2019).

Pathophysiology

Most empyemas occur as complications of bacterial pneumonia or lung abscess. They also result from penetrating chest trauma, hematogenous infection of the pleural space, nonbacterial infections, and iatrogenic causes (after thoracic surgery or thoracentesis). At first the pleural fluid is thin, with a low leukocyte count, but it frequently progresses to a fibropurulent stage and, finally, to a stage where it encloses the lung within a thick exudative membrane (loculated empyema).

Clinical Manifestations

The patient is acutely ill and has signs and symptoms similar to those of an acute respiratory infection or pneumonia (fever, night sweats, pleural pain, cough, dyspnea, anorexia, weight loss). If the patient is immunocompromised, the symptoms may be vague. If the patient has received antimicrobial therapy, the clinical manifestations may be less obvious.

Assessment and Diagnostic Findings

Chest auscultation demonstrates decreased or absent breath sounds over the affected area, and there is dullness on chest percussion as well as decreased

fremitus. The diagnosis is established by chest CT. Usually, a diagnostic thoracentesis is performed, often under ultrasound guidance.

Medical Management

The objectives of treatment are to drain the pleural cavity and to achieve complete expansion of the lung. The fluid is drained, and appropriate antibiotics (usually begun by the IV route) in large doses are prescribed based on the causative organism. Sterilization of the empyema cavity requires 4 to 6 weeks of antibiotics (Strange, 2019). Drainage of the pleural fluid depends on the stage of the disease and is accomplished by one of the following methods:

- Thoracentesis (needle aspiration) with a thin percutaneous catheter, if the volume is small and the fluid is not too purulent or too thick
- Tube thoracostomy (chest drainage using a large-diameter intercostal tube attached to water-seal drainage; see later discussion) with thrombolytic agents instilled through the chest tube in patients with loculated or complicated pleural effusions
- Open chest drainage via thoracotomy, including potential rib resection, to remove the thickened pleura, pus, and debris and to remove the underlying diseased pulmonary tissue

With long-standing inflammation, an exudate can form over the lung, trapping it and interfering with its normal expansion. This exudate must be removed surgically by decortication. The drainage tube is left in place until the pus-filled space is obliterated completely. The complete obliteration of the pleural space is monitored by serial chest x-rays, and the patient should be informed that treatment may be long term (weeks to months). Patients are frequently discharged from the hospital with a chest tube in place, with instructions to monitor fluid drainage at home.

Nursing Management

Resolution of empyema is a prolonged process. The nurse helps the patient cope with the condition and instructs the patient in lung-expanding breathing exercises to restore normal respiratory function. The nurse also provides care specific to the method of drainage of the pleural fluid (e.g., needle aspiration, closed chest drainage, rib resection, and drainage). When the patient is discharged home with a drainage tube or system in place, the nurse instructs the patient and family on care of the drainage system and drain site, measurement and observation of drainage, signs and symptoms of infection, and how and when to contact the primary provider (see later discussion).



Acute Respiratory Failure

Respiratory failure is a sudden and life-threatening deterioration of the gas exchange function of the lungs and indicates their failure to provide adequate oxygenation or ventilation for the blood. Acute respiratory failure is defined as hypoxemia (a decrease in arterial oxygen tension [PaO_2] to less than 60 mm Hg) and hypercapnia (an increase in arterial carbon dioxide tension [PaCO_2] to greater than 50 mm Hg), with acidosis (an arterial pH of less than 7.35) (Kaynar, 2018).

It is important to distinguish between acute and chronic respiratory failure. Chronic respiratory failure is defined as deterioration in the gas exchange function of the lungs that has developed insidiously or has persisted for a long period after an episode of acute respiratory failure. The absence of acute symptoms and the presence of a chronic respiratory acidosis suggest the chronicity of the respiratory failure. Two causes of chronic respiratory failure are COPD (discussed in [Chapter 20](#)) and neuromuscular diseases (discussed in [Chapter 65](#)). Patients with these disorders develop a tolerance to the gradually worsening hypoxemia and hypercapnia. However, patients with chronic respiratory failure can develop acute failure. For example, a patient with COPD may develop an exacerbation or infection that causes additional deterioration of gas exchange. The principles of management of acute versus chronic respiratory failure are different; the following discussion is limited to acute respiratory failure.

Pathophysiology

In acute respiratory failure, the ventilation or perfusion mechanisms in the lung are impaired. Some of the many ventilatory failure mechanisms leading to acute respiratory failure include impaired function of the central nervous system (e.g., drug overdose, head trauma, infection, hemorrhage, sleep apnea), neuromuscular dysfunction (e.g., myasthenia gravis, Guillain–Barré syndrome, amyotrophic lateral sclerosis, spinal cord trauma), musculoskeletal dysfunction (e.g., chest trauma, kyphoscoliosis, malnutrition), and pulmonary dysfunction (e.g., COPD, asthma, cystic fibrosis).

Oxygenation failure mechanisms leading to acute respiratory failure include pneumonia, ARDS, heart failure, COPD, PE, and **restrictive lung diseases** (diseases that cause decrease in lung volumes).

In the postoperative period, especially after major thoracic or abdominal surgery, inadequate ventilation and respiratory failure may occur because of several factors. During this period, for example, acute respiratory failure may be caused by the effects of anesthetic, analgesic, and sedative agents, which may depress respiration (as described earlier) or enhance the effects of opioids

and lead to hypoventilation. Pain may interfere with deep breathing and coughing. A V/Q. mismatch is the usual cause of respiratory failure after major abdominal, cardiac, or thoracic surgery.

Clinical Manifestations

Early signs are those associated with impaired oxygenation and may include restlessness, fatigue, headache, dyspnea, air hunger, tachycardia, and increased blood pressure. As the hypoxemia progresses, more obvious signs may be present, including confusion, lethargy, tachycardia, tachypnea, central cyanosis, diaphoresis, and finally respiratory arrest. Physical findings are those of acute respiratory distress, including the use of accessory muscles, decreased breath sounds if the patient cannot adequately ventilate, and other findings related specifically to the underlying disease process and cause of acute respiratory failure.

Medical Management

The objectives of treatment are to correct the underlying cause and to restore adequate gas exchange in the lungs. ET intubation and mechanical ventilation may be required to maintain adequate ventilation and oxygenation while the underlying cause is corrected (see later discussion on ET intubation and mechanical ventilation).

Nursing Management

Nursing management of patients with acute respiratory failure includes assisting with intubation and maintaining mechanical ventilation. Patients are usually managed in the intensive care unit (ICU). The nurse assesses the patient's respiratory status by monitoring the level of responsiveness, arterial blood gases, pulse oximetry, and vital signs. In addition, the entire respiratory system is assessed and strategies to prevent complications (e.g., turning schedule, mouth care, skin care, and range of motion of extremities) are implemented. The nurse also assesses the patient's understanding of the management strategies that are used and initiates some form of communication to enable the patient to express concerns and needs to the health care team.

Finally, the problems that led to the acute respiratory failure are addressed. As the patient's status improves, the nurse assesses the patient's knowledge of the underlying disorder and provides education as appropriate to address the disorder.

Endotracheal Intubation

Endotracheal intubation involves passing an ET tube through the nose or mouth into the trachea (see Fig. 19-5). The oral route is preferred since oral intubation is associated with less trauma and lesser rates of infection; furthermore, the oral route can typically accommodate a larger diameter ET tube than may be passed when the nasal route is used. Intubation provides a patent airway when the patient is having respiratory distress that cannot be treated with simpler methods and is the method of choice in emergency care. ET intubation is a means of providing an airway for patients who cannot maintain an adequate airway on their own (e.g., patients who are comatose and patients with upper airway obstruction), for patients needing mechanical ventilation, and for suctioning secretions from the pulmonary tree.

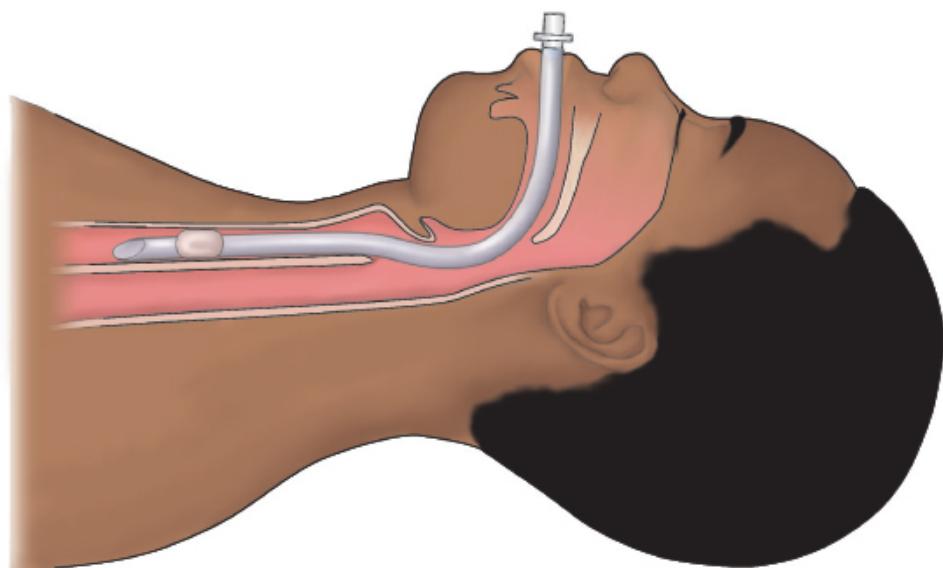


Figure 19-5 • Endotracheal tube in place. The tube has been inserted using the oral route. The cuff has been inflated to maintain the tube's position and to minimize the risk of aspiration.

An ET tube usually is passed with the aid of a laryngoscope by specifically trained medical, nursing, or respiratory therapy personnel. Once the tube is inserted and positioned about 2 cm above the carina, a cuff at the distal end of the ET tube is inflated with the use of a pilot balloon. Inflation of the cuff prevents air from leaking around the outer part of the tube in order to minimize the possibility of aspiration and secure the tube. The position of the ET tube is verified by checking end-tidal carbon dioxide levels and confirmed with chest x-ray. Chart 19-12 discusses the nursing care of the patient with an ET tube.

Complications can occur from pressure exerted by the cuff on the tracheal wall. Cuff pressures should be maintained between 20 and 25 mm Hg (24 and 30 cm H₂O) because high cuff pressure can cause tracheal bleeding, ischemia, and pressure necrosis, whereas low cuff pressure can increase the risk of

aspiration pneumonia. Routine deflation of the cuff is not recommended because of the increased risk of aspiration and **hypoxia** (i.e., decrease in oxygen supply to the tissues and cells) (Urden et al., 2018). Tracheobronchial secretions are suctioned through the tube. Warmed, humidified oxygen should always be introduced through the tube, whether the patient is breathing spontaneously or is receiving ventilatory support. ET intubation may be used for no longer than 14 to 21 days, by which time a tracheostomy must be considered to decrease irritation of and trauma to the tracheal lining, to reduce the incidence of vocal cord paralysis (secondary to laryngeal nerve damage), and to decrease the work of breathing (Wiegand, 2017).

ET and tracheostomy tubes have several disadvantages. The tubes cause discomfort. The cough reflex is depressed because glottis closure is hindered. Secretions tend to become thicker because the warming and humidifying effect of the upper respiratory tract has been bypassed. The swallowing reflexes (glottic, pharyngeal, and laryngeal reflexes) are depressed because of prolonged disuse and the mechanical trauma produced by the ET or tracheostomy tube, increasing the risk of aspiration as well as microaspiration and subsequent VAP (Urden et al., 2018). In addition, ulceration and stricture of the larynx or trachea may develop. Of great concern to the patient is the inability to talk and to communicate needs.

Tracheostomy

A **tracheotomy** is a surgical procedure in which an opening is made into the trachea. The indwelling tube inserted into the trachea is called a **tracheostomy tube** (see Fig. 19-6 for the different types of tracheostomy tubes). A tracheostomy (the stoma that is the product of the tracheotomy) may be either temporary or permanent.

Chart 19-12

Care of the Patient with an Endotracheal Tube

Immediately After Intubation

1. Check symmetry of chest expansion.
2. Auscultate breath sounds of anterior and lateral chest bilaterally.
3. Obtain capnography or end-tidal CO₂ as indicated.
4. Ensure chest x-ray obtained to verify proper tube placement.
5. Check cuff pressure every 6 to 8 hours.
6. Monitor for signs and symptoms of aspiration.
7. Ensure high humidity; a visible mist should appear in the T-piece or ventilator tubing.
8. Administer oxygen concentration as prescribed by the primary provider.
9. Secure the tube to the patient's face with tape, and mark the proximal end for position maintenance.
 - a. Cut proximal end of tube if it is longer than 7.5 cm (3 inches) to prevent kinking.
 - b. Insert an oral airway or mouth device if orally intubated to prevent the patient from biting and obstructing the tube.
10. Use sterile suction technique and airway care to prevent iatrogenic contamination and infection.
11. Continue to reposition patient every 2 hours and as needed to prevent atelectasis and to optimize lung expansion.
12. Provide oral hygiene and suction the oropharynx whenever necessary.

Extubation (Removal of Endotracheal Tube)

1. Explain procedure.
2. Have self-inflating bag and mask ready in case ventilatory assistance is required immediately after extubation.
3. Suction the tracheobronchial tree and oropharynx, remove tape, and then deflate the cuff.
4. Give 100% oxygen for a few breaths, then insert a new, sterile suction catheter inside tube.
5. Have the patient inhale. At peak inspiration, remove the tube, suctioning the airway through the tube as it is pulled out.

Note: In some hospitals, this procedure can be performed by respiratory therapists; in others, by nurses. Check hospital policy.

Care of Patient Following Extubation

1. Give heated humidity and oxygen by facemask and maintain the patient in a sitting or high-Fowler position.
2. Monitor respiratory rate and quality of chest excursions. Note stridor, color change, and change in mental alertness or behavior.
3. Monitor the patient's oxygen level using a pulse oximeter.

4. Keep patient NPO (nothing by mouth), or give only ice chips for next few hours.
5. Provide mouth care.
6. Educate the patient about how to perform coughing and deep-breathing exercises.

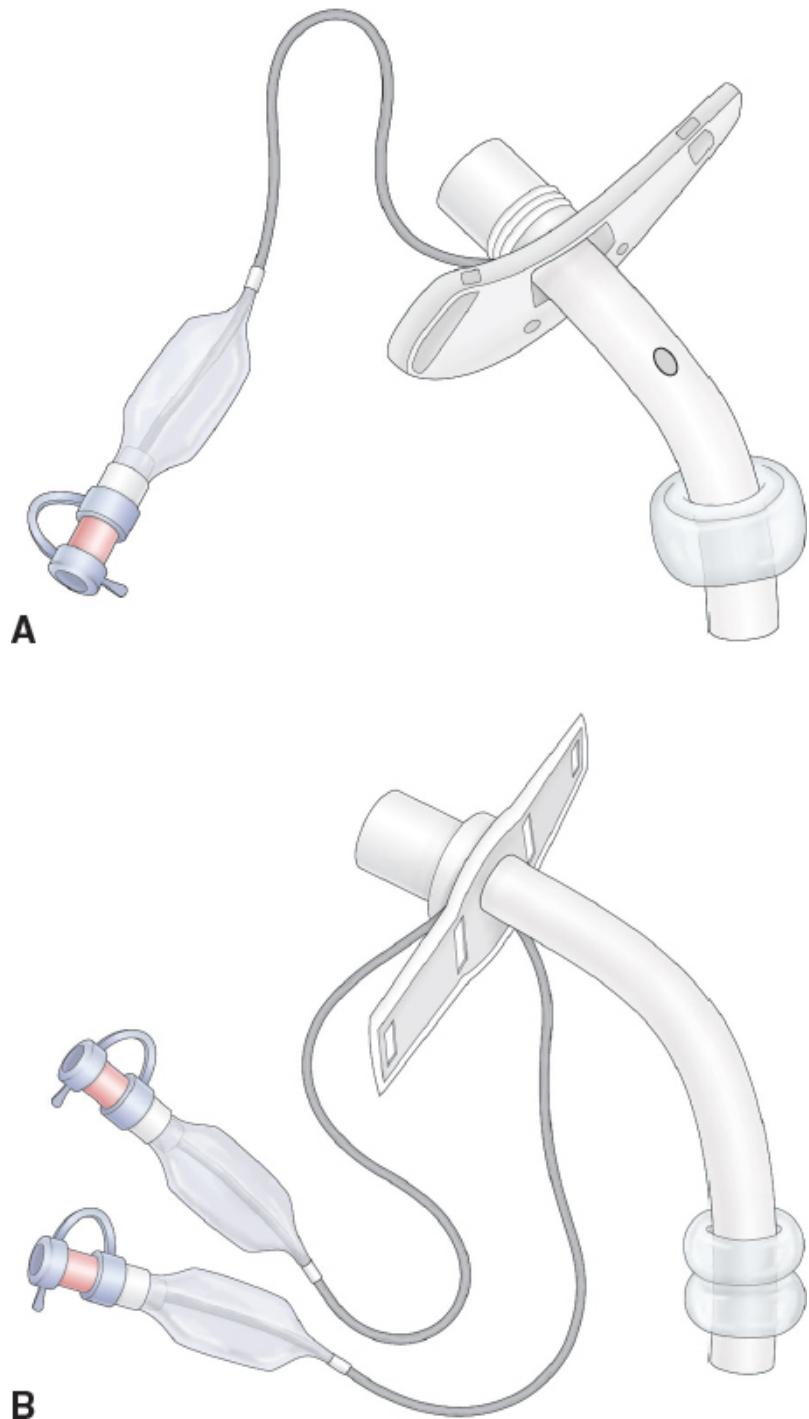


Figure 19-6 • Tracheostomy tubes. **A.** Fenestrated tube, which allows patient to talk. **B.** Double-cuffed tube. Inflating the two cuffs alternately can help prevent tracheal damage.

A tracheotomy is used to maintain a patent airway, bypass an upper airway obstruction, facilitate removal of tracheobronchial secretions, permit the long-term use of mechanical ventilation, replace an ET tube, and prevent aspiration

of oral or gastric secretions in the patient who is unconscious or paralyzed (by closing off the trachea from the esophagus). Many disease processes and emergency conditions make a tracheotomy necessary.

Tracheotomy

The tracheotomy procedure is usually performed in the operating room under general anesthesia, where the patient's ventilation can be well controlled and optimal aseptic technique can be maintained. A surgical opening is made between the second and third tracheal rings. After the trachea is exposed, a cuffed tracheostomy tube of an appropriate size is inserted. The cuff is an inflatable attachment to the tracheostomy tube that is designed to occlude the space between the tracheal walls and the tube, to permit effective mechanical ventilation, and to minimize the risk of aspiration.

For a patient who is intubated and mechanically ventilated, a newer surgical technique referred to as a percutaneous tracheostomy can be performed at the patient's bedside with the use of local anesthesia and sedation and analgesia. Using video-assisted guidance, a bronchoscope is passed down the ET tube. Following ET tube cuff deflation, the ET tube is withdrawn to the subglottic level. An opening is made in the skin between the second and third tracheal ring and enlarged with the use of dilators until the space is large enough to safely insert a tracheostomy tube. The ET tube and bronchoscope are then removed and the tracheostomy is secured into position (Lindman, 2018).

The tracheostomy tube is held in place by a velcro tube holder or twill tape ties fastened around the patient's neck. Usually, a square of sterile gauze is placed between the tube and the skin to absorb drainage and reduce the risk of infection.

Complications

Complications may occur early or late in the course of tracheostomy tube management. They may even occur years after the tube has been removed. Early complications include tube dislodgement, accidental decannulation, bleeding, pneumothorax, air embolism, aspiration, subcutaneous or mediastinal emphysema, recurrent laryngeal nerve damage, and posterior tracheal wall penetration. Long-term complications include airway obstruction from accumulation of secretions or protrusion of the cuff over the opening of the tube, infection, rupture of the innominate artery, dysphagia, tracheoesophageal fistula, tracheal dilation, tracheal ischemia, and necrosis. Tracheal stenosis may develop after the tube is removed. [Chart 19-13](#) outlines measures nurses can take to prevent complications with use of ET and tracheostomy tubes.

Care of the Patient with an Endotracheal Tube or Tracheostomy

The patient requires continuous monitoring and assessment. The newly made opening must be kept patent by proper suctioning of secretions. After the vital signs are stable, the patient is placed in a semi-Fowler position to facilitate ventilation, promote drainage, minimize edema, and prevent strain on the suture lines. Analgesia and sedative agents must be given with caution because of the risk of suppressing the cough reflex.

Chart 19-13

Preventing Complications Associated with Endotracheal and Tracheostomy Tubes

- Administer adequate warmed humidity.
- Maintain cuff pressure at appropriate level.
- Suction as needed per assessment findings.
- Maintain skin integrity. Change tape and dressing as needed or per protocol.
- Auscultate lung sounds.
- Monitor for signs and symptoms of infection, including temperature and white blood cell count.
- Administer prescribed oxygen and monitor oxygen saturation.
- Monitor for cyanosis.
- Maintain adequate hydration of the patient.
- Use sterile technique when suctioning and performing tracheostomy care.

Major objectives of nursing care are to ensure a patent airway, monitor the patient's respiratory status, assess for complications, alleviate the patient's apprehension, and provide an effective means of communication. The nurse keeps paper and pencil or a Magic Slate® or a cellular device and the call light within the patient's reach at all times to ensure a means of communication.



For the procedural guidelines for nursing care of a patient with a tracheostomy tube, go to thepoint.lww.com/Brunner15e.

Suctioning the Tracheostomy or Endotracheal Tube

When a tracheostomy or ET tube is in place, it is usually necessary to suction the patient's secretions because of the decreased effectiveness of the cough mechanism. Tracheal suctioning is performed when adventitious breath sounds are detected or whenever secretions are obviously present. Unnecessary

suctioning can initiate bronchospasm and cause mechanical trauma to the tracheal mucosa.

All equipment that comes into direct contact with the patient's lower airway must be sterile to prevent sepsis.



For the procedural guidelines for suctioning a patient with a tracheostomy tube, go to thepoint.lww.com/Brunner15e.

In patients who are mechanically ventilated (see later discussion), an in-line suction catheter may be used to allow rapid suction when needed and to minimize cross-contamination by airborne pathogens. An in-line suction device allows the patient to be suctioned without being disconnected from the ventilator circuit. In-line suctioning (also called *closed suctioning*) decreases hypoxemia, sustains PEEP, and can decrease patient anxiety associated with suctioning (Wiegand, 2017). Because in-line suctioning protects staff from patient secretions, it can be performed in most cases without using personal protective gear. A notable exception is when the patient has COVID-19, when PPE must be used.

Managing the Cuff

The cuff on an ET or tracheostomy tube should be inflated if the patient requires mechanical ventilation or is at high risk for aspiration. The pressure within the cuff should be the lowest possible pressure (20 to 25 mm Hg) that allows delivery of adequate tidal volumes and prevents pulmonary aspiration (Urden et al., 2018). Cuff pressure must be monitored by the respiratory therapist or nurse at least every 8 hours by attaching a handheld pressure gauge to the pilot balloon of the tube or by using the minimal leak volume or minimal occlusion volume technique.

Promoting Home, Community-Based, and Transitional Care



Educating Patients About Self-Care. If the patient is pending discharge to the home setting with a tracheostomy tube, the nurse should ensure that suction and other appropriate equipment is in place in the home prior to discharge. The nurse also educates the patient and family about daily care, including techniques to prevent infection, as well as measures to take in an emergency. The nurse provides the patient and family with a list of community contacts for education and support needs.

Continuing and Transitional Care. A referral for home, community-based, or transitional care is indicated for ongoing assessment of the patient and of the ability of the patient and family to provide appropriate and safe

care. The nurse assesses the patient's and family's ability to cope with the physical changes and psychological issues associated with having a tracheostomy. Minimizing the amount of dust or particles in the air and providing adequate humidification may make it easier for the patient to breathe. Dust and particles in the air can be decreased by removing drapes and upholstered furniture; using air filters; and washing floors, dusting, and vacuuming frequently. The nurse identifies resources and makes referrals for appropriate services to assist the patient and family to manage the tracheostomy tube at home.

Mechanical Ventilation

Mechanical ventilation may be required to manage acute respiratory failure. It may also be indicated for a variety of other reasons including to: control the patient's respirations during surgery or treatment, oxygenate the blood when the patient's ventilatory efforts are inadequate, and rest the respiratory muscles. Many patients placed on a ventilator can breathe spontaneously, although the effort needed to do so may be exhausting.

A **mechanical ventilator** is a positive- or negative-pressure breathing device that can maintain ventilation and oxygen delivery for a prolonged period.

Indications

If a patient has evidence of respiratory failure or a compromised airway, ET intubation and mechanical ventilation are indicated. This clinical evidence may be corroborated by a continuous decrease in PaO₂, an increase in PaCO₂, and a persistent acidosis (decreased pH); however, if the patient's status appears emergent, then waiting for these laboratory results prior to ensuring these ventilator support measures is imprudent. Conditions such as thoracic or abdominal surgery, drug overdose, neuromuscular disorders, inhalation injury, COPD, multiple trauma, shock, multisystem failure, and coma may lead to respiratory failure and the need for mechanical ventilation. General indications for mechanical ventilation are displayed in [Chart 19-14](#).

Classification of Ventilators

Mechanical ventilators were traditionally classified according to the method by which they supported ventilation. The two general categories are negative- and positive-pressure ventilators. [Figure 19-7](#) displays commonly used positive-pressure ventilators. Negative-pressure ventilators (e.g., "iron lungs," chest cuirass) are older modes of ventilatory support that are rarely utilized today.

Positive-Pressure Ventilators

Positive-pressure ventilators inflate the lungs by exerting positive pressure on the airway, pushing air in, similar to a bellows mechanism, and forcing the

alveoli to expand during inspiration. Expiration occurs passively. ET intubation or tracheostomy is usually necessary. These ventilators are widely used in the hospital setting and are increasingly used in the home for patients with primary lung disease. Three types of positive-pressure ventilators are classified by the method of ending the inspiratory phase of respiration: volume-cycled, pressure-cycled, and high-frequency oscillatory support. The fourth type, noninvasive positive-pressure ventilation (NIPPV), does not require intubation (Wiegand, 2017).

Chart 19-14

Indications for Mechanical Ventilation

Laboratory Values

$\text{PaO}_2 < 55 \text{ mm Hg}$

$\text{PaCO}_2 > 50 \text{ mm Hg}$ and $\text{pH} < 7.32$

Vital capacity $< 10 \text{ mL/kg}$

Negative inspiratory force $< 25 \text{ cm H}_2\text{O}$

$\text{FEV}_1 < 10 \text{ mL/kg}$

Clinical Manifestations

Apnea or bradypnea

Respiratory distress with confusion

Increased work of breathing not relieved by other interventions

Confusion with need for airway protection

Circulatory shock

Controlled hyperventilation (e.g., patient with a severe head injury)

Adapted from Amitai, A. (2018). Introduction to ventilator management.

Medscape. Retrieved on 2/2/2020 at:

emedicine.medscape.com/article/810126-overview

Volume-Cycled Ventilators. Volume-cycled ventilators deliver a preset volume of air with each inspiration. Once this preset volume is delivered to the patient, the ventilator cycles off and exhalation occurs passively. From breath to breath, the volume of air delivered by the ventilator is relatively constant, ensuring consistent, adequate breaths despite varying airway pressures. A major disadvantage to using volume-cycled ventilators is that patients may experience barotrauma (trauma to the trachea or alveoli secondary to positive pressure) because the pressures required to deliver the breaths may be excessive. This trauma causes damage to the alveolar capillary membrane and air to leak into the surrounding tissues (Urden et al., 2018).

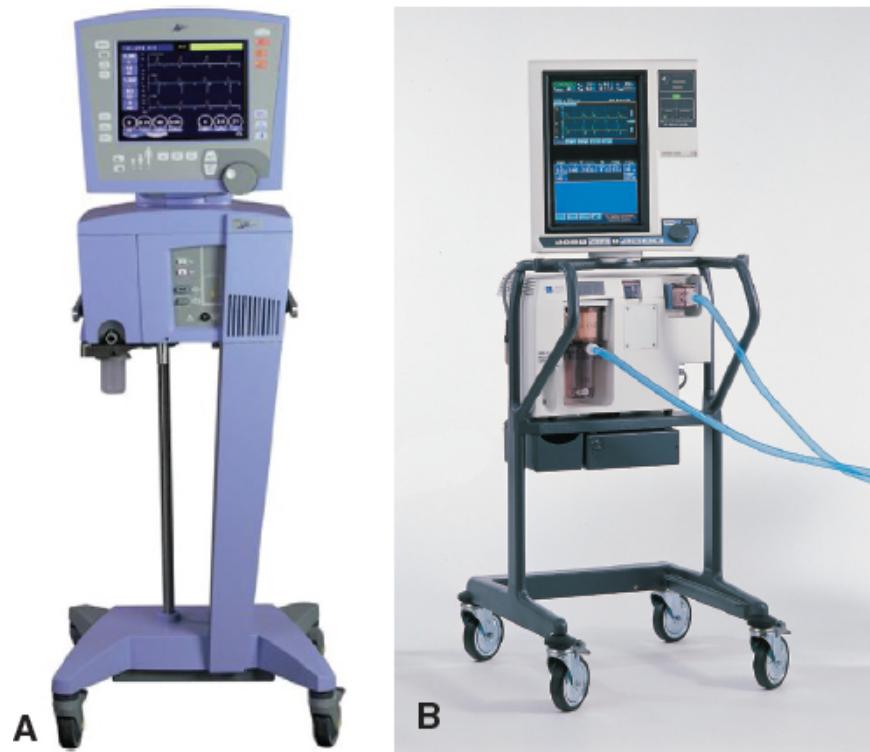


Figure 19-7 • Positive-pressure ventilators. **A.** The AVEA can be used to both ventilate and monitor neonatal, pediatric, and adult patients. It can also deliver noninvasive ventilation with Heliox to adult and pediatric patients. Courtesy of Vyaire Medical Inc., Yorba Linda, CA. **B.** The Puritan-Bennett 840 Ventilator System has volume, pressure, and mixed modes designed for adult, pediatric, and infant ventilation. Courtesy of Tyco Healthcare/Nellcor Puritan Bennett, Pleasanton, CA.

Pressure-Cycled Ventilators. When the pressure-cycled ventilator cycles on, it delivers a flow of air (inspiration) until it reaches a preset pressure, and then cycles off, and expiration occurs. The major limitation is the volume of air or oxygen can vary as the patient's airway resistance or compliance changes. As a result, the **tidal volume** delivered (i.e., volume of air inspired and expired with each breath) may be inconsistent, possibly compromising ventilation.

High-Frequency Oscillatory Support Ventilators. These types of ventilators deliver very high respiratory rates (i.e., 180 to 900 breaths/min) that are accompanied by very low tidal volumes and high airway pressures (hence the name *high-frequency oscillatory support*). These small pulses of oxygen-enriched air move down the center of the airways, allowing alveolar air to exit the lungs along the margins of the airways. This ventilatory mode is used to open the alveoli in situations characterized by closed small airways, such as

atelectasis and ARDS and it is also thought to protect the lung from pressure injury (Wiegand, 2017).

Noninvasive Positive-Pressure Ventilation. NIPPV is a method of positive-pressure ventilation that can be given via facemasks that cover the nose and mouth, nasal masks, or other oral or nasal devices such as the nasal pillow (a small nasal cannula that seals around the nares to maintain the prescribed pressure). NIPPV eliminates the need for ET intubation or tracheostomy and decreases the risk of nosocomial infections such as pneumonia. The most comfortable mode for the patient is pressure-controlled ventilation with pressure support. This eases the work of breathing and enhances gas exchange. The ventilator can be set with a minimum backup rate for patients with periods of apnea.

Patients are candidates for NIPPV if they have acute or chronic respiratory failure, acute pulmonary edema, COPD, chronic heart failure, or a sleep-related breathing disorder. The technique also may be used at home to improve tissue oxygenation and to rest the respiratory muscles while patients sleep at night. NIPPV is contraindicated for those who have experienced respiratory arrest, serious arrhythmias, cognitive impairment, or head or facial trauma. NIPPV may also be used for obstructive sleep apnea, for patients at the end of life, and for those who do not want ET intubation but may need short- or long-term ventilatory support (Wiegand, 2017).

Continuous positive airway pressure (CPAP) provides positive pressure to the airways throughout the respiratory cycle. Although it can be used as an adjunct to mechanical ventilation with a cuffed ET tube or tracheostomy tube to open the alveoli, it is also used with a leak-proof mask to keep alveoli open, thereby preventing respiratory failure. CPAP is an effective treatment of obstructive sleep apnea because the positive pressure acts as a splint, keeping the upper airway and trachea open during sleep. To use CPAP, the patient must be breathing independently.

Bilevel positive airway pressure (BiPAP) ventilation offers independent control of inspiratory and expiratory pressures while providing pressure support ventilation (PSV). It delivers two levels of positive airway pressure provided via a nasal or oral mask, nasal pillow, or mouthpiece with a tight seal and a portable ventilator. Each inspiration can be initiated either by the patient or by the machine if it is programmed with a backup rate. The backup rate ensures that the patient receives a set number of breaths per minute. BiPAP is most often used for patients who require ventilatory assistance at night, such as those with severe COPD or sleep apnea. Tolerance is variable; BiPAP usually is most successful with patients who are highly motivated.

Ventilator Modes

Ventilator mode refers to how breaths are delivered to the patient. The most commonly used modes are controlled mechanical ventilation, continuous

mandatory ventilation, also known as assist-control (A/C), intermittent mandatory ventilation (IMV), synchronized intermittent mandatory ventilation (SIMV), PSV, and airway pressure release ventilation (APRV) (see Fig. 19-8).

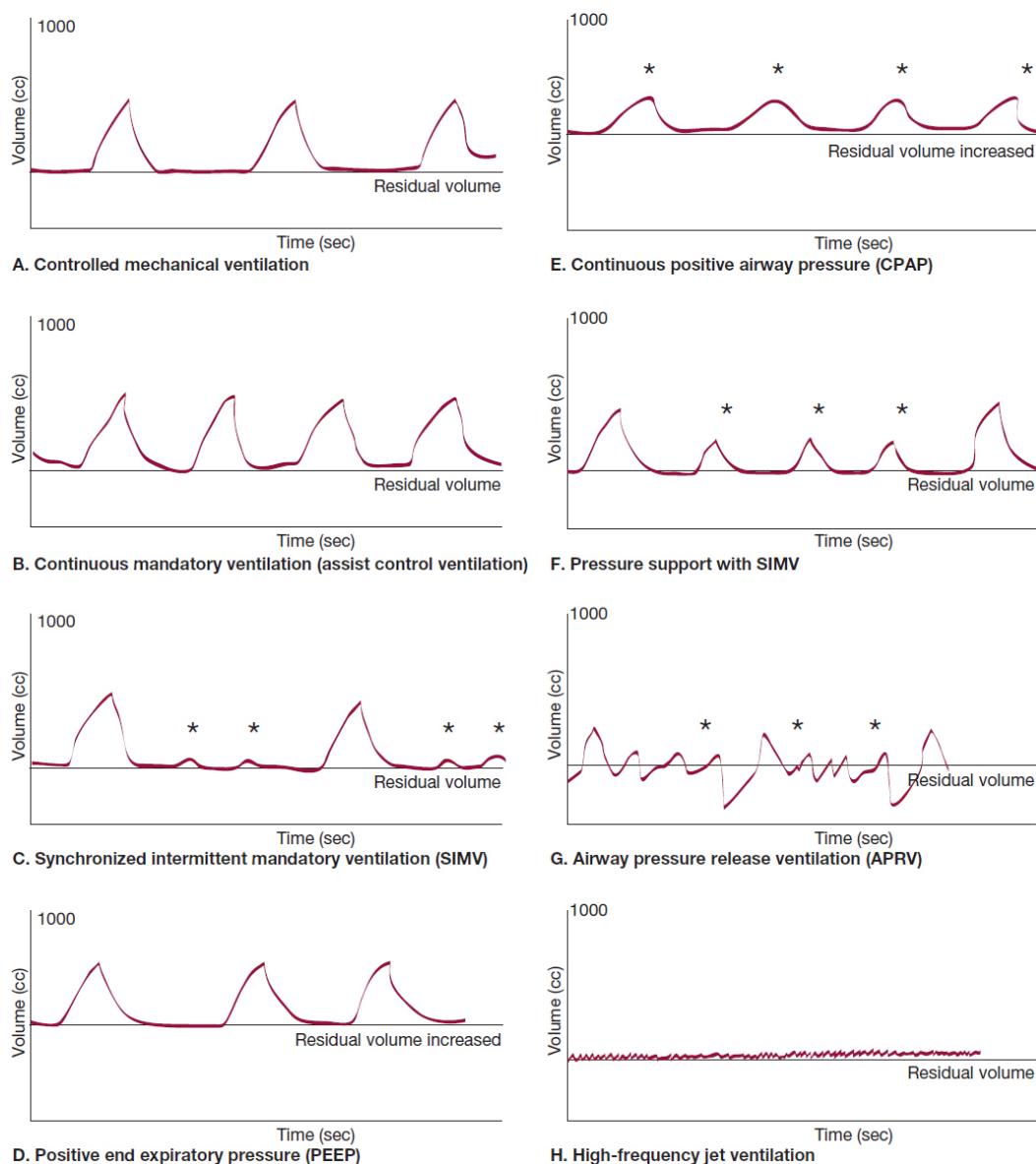


Figure 19-8 • Modes of mechanical ventilation with airflow waveforms. Inhalations marked with an asterisk (*) are spontaneous.

Controlled mechanical ventilation provides full ventilator support by delivering a preset tidal volume and respiratory rate. This mode of ventilation is indicated for patients who are apneic. In A/C ventilation, more commonly called **continuous mandatory (volume or pressure) ventilation (CMV)**, the ventilator delivers a preset tidal volume or pressure at a preset rate of

respirations. However, if the patient initiates a breath between the machine's breaths, the ventilator delivers at the preset volume or pressure (assisted breath). Therefore, every breath is the preset volume or pressure, regardless of whether it is initiated by the patient or the ventilator. Two variations to CMV include: pressure-regulated volume control ventilation (PRVCV) and pressure-controlled inverse ratio ventilation (PC-IRV). PRVCV delivers a preset tidal volume using the minimal amount of airway pressure in patients with rapidly changing airway resistance and lung compliance. PC-IRV provides prolonged inspiratory time in refractory to positive end-expiratory pressure (PEEP) in a patient with hypoxia.

Intermittent mandatory (volume or pressure) ventilation (IMV) provides a combination of mechanically assisted breaths and spontaneous breaths. Mechanical breaths are delivered at preset intervals and a preselected tidal volume, regardless of the patient's efforts. Although the patient can increase the respiratory rate by initiating inspiration between ventilator-delivered breaths, these spontaneous breaths are limited to the tidal volume generated by the patient. IMV allows patients to use their own muscles for ventilation to help prevent muscle atrophy. It lowers mean airway pressure, which can assist in preventing barotrauma. However, patient-ventilator dyssynchrony, evidenced by the patient "fighting the ventilator" or "bucking the ventilator" (i.e., trying to exhale when the ventilator is delivering a breath) may increase.

Synchronized intermittent mandatory ventilation (SIMV) also delivers a preset tidal volume and number of breaths per minute. Between ventilator-delivered breaths, the patient can breathe spontaneously with no assistance from the ventilator on those extra breaths. Because the ventilator senses patient breathing efforts and does not initiate a breath in opposition to the patient's efforts, patient-ventilator dyssynchrony is reduced. As the patient's ability to breathe spontaneously increases, the preset number of ventilator breaths is decreased and the patient does more of the work of breathing. Like IMV, SIMV can be used to provide full or partial ventilatory support. Nursing interventions for patients receiving IMV or SIMV include monitoring progress by recording respiratory rate, minute volume, spontaneous and machine-generated tidal volume, FiO_2 , and arterial blood gas levels.

Pressure support ventilation (PSV) applies a pressure plateau to the airway throughout the patient-triggered inspiration to decrease resistance within the tracheal tube and ventilator tubing. Pressure support is reduced gradually as the patient's strength increases. An SIMV backup rate may be added for extra support. The nurse must closely observe the patient's respiratory rate and tidal volumes on initiation of PSV. It may be necessary to adjust the pressure support to avoid tachypnea or large tidal volumes.

An additional mode of ventilation used to facilitate weaning is volume-assisted pressure support ventilation (VAPS) also referred to as pressure

augmentation (PA). This mode of ventilation ensures the patient receives a minimum tidal volume with each pressure support breath.

A newer mode of ventilation which requires an esophageal catheter to monitor electrical activity of the diaphragm is neurally adjusted ventilatory assist (NAVA). This mode delivers assisted breaths in synchrony with the patient's own breath. The esophageal catheter monitors electrical activity of the diaphragm and signals the ventilator when to initiate a breath.

Another unique mode of ventilation used in special circumstances is independent lung ventilation (ILV). This mode is used in patients with unilateral lung disease. Each lung is ventilated separately via a double lumen ET tube (Urden et al., 2018).

Airway pressure release ventilation (APRV) is a time-triggered, pressure-limited, time-cycled mode of mechanical ventilation that allows unrestricted, spontaneous breathing throughout the ventilatory cycle. The inflation period is long, and breaths may be initiated spontaneously as well as by the ventilator. APRV allows alveolar gas to be expelled through the lungs' natural recoil. APRV has the important advantages of causing less ventilator-induced lung injury and fewer adverse effects on cardiocirculatory function and being associated with lower need for sedation and neuromuscular blockade.

Proportional assist ventilation (PAV) provides partial ventilatory support in which the ventilator generates pressure in proportion to the patient's inspiratory efforts. With every breath, the ventilator synchronizes with the patient's ventilatory efforts. The more inspiratory pressure the patient generates, the more pressure the ventilator generates, amplifying the patient's inspiratory effort without any specific preselected target pressure or volume. It generally adds "additional muscle" to the patient's effort; the depth and frequency of breaths are controlled by the patient.

Other modes of mechanical ventilation that incorporate computerized control of ventilation include adaptive support ventilation (ASV), which adjusts minute ventilation and pressure support based on patient need (Urden et al., 2018).

With various modes of mechanical ventilation, the ventilator constantly monitors many variables and adjusts gas delivery during individual breaths; these within-breath adjustment systems include automatic tube compensation, volume-ensured pressure support, and proportional support ventilation. In other modes, the ventilator evaluates gas delivery during one breath and uses that information to adjust the next breath; these between-breath adjustment systems can be made to ensure a preset tidal volume by adjusting pressure, up to a preset maximum, and include pressure volume support, pressure-regulated volume control, and ASV.

Adjusting the Ventilator

The ventilator is adjusted so that the patient is comfortable and breathes synchronously (i.e., “in sync”) with the machine. Minimal alteration of the normal cardiovascular and pulmonary dynamics is desired. If the volume ventilator is adjusted appropriately, the patient’s arterial blood gas values will be satisfactory and there will be little or no cardiovascular compromise. [Chart 19-15](#) describes initial ventilator settings.

Chart 19-15

Initial Ventilator Settings

The following guide is an example of the steps involved in operating a mechanical ventilator. The nurse, in collaboration with the respiratory therapist, always reviews the manufacturer’s instructions, which vary according to the equipment, before beginning mechanical ventilation.

1. Set the machine to deliver the tidal volume required (6 to 10 mL/kg) or (4 to 8 mL/kg for patients with ARDS).
2. Adjust the machine to deliver the lowest concentration of oxygen to maintain normal PaO₂ (greater than 60 mm Hg) or an SpO₂ level greater than 92%. This setting may be high initially but will gradually be reduced based on arterial blood gas (ABG) results.
3. Record peak inspiratory pressure.
4. Set mode (continuous mandatory ventilation [also known as assist–control], or synchronized intermittent mandatory ventilation) and rate as prescribed by the primary provider. (See the glossary for definitions of modes of mechanical ventilation.) Set positive end-expiratory pressure (PEEP) and pressure support if prescribed.
5. Set sigh settings (usually set at 1.5 times the tidal volume and ranging from 1 to 3 per hour), if applicable.
6. Adjust sensitivity so that the patient can trigger the ventilator with a minimal effort (usually 2 mm Hg negative inspiratory force).
7. Record minute volume and obtain ABGs to measure carbon dioxide partial pressure (PaCO₂), pH, and PaO₂ after 20 minutes of continuous mechanical ventilation.
8. Adjust setting (FiO₂ and rate) according to results of ABG analysis to provide normal values or those set by the primary provider.
9. If there is poor coordination between the breathing rhythms of the patient and the ventilator (i.e., patient-ventilator dyssynchrony), assess for hypoxia and manually ventilate on 100% oxygen with a resuscitation bag.

Adapted from Amitai, A. (2018). Introduction to ventilator management. *Medscape*. Retrieved on 2/2/2020 at: emedicine.medscape.com/article/810126-overview

NURSING PROCESS

The Patient Receiving Mechanical Ventilation

Nursing management of patients with acute respiratory failure includes assisting with intubation and maintaining mechanical ventilation. Furthermore, caring for a patient on mechanical ventilation has become an integral part of nursing care for many patients in critical care or general medical-surgical units, extended care facilities, and the home. Nurses, physicians, and respiratory therapists must understand each patient's specific pulmonary needs and work together to set realistic goals. Positive patient outcomes depend on an understanding of the principles of mechanical ventilation and the patient's care needs as well as open communication among members of the health care team about the goals of therapy, weaning plans, and the patient's tolerance of changes in ventilator settings.

Assessment

The nurse plays a vital role in assessing the patient's status and the functioning of the ventilator. In assessing the patient, the nurse evaluates the patient's physiologic status and how they are coping with mechanical ventilation. Physical assessment includes systematic assessment of all body systems, with an in-depth focus on the respiratory system. Respiratory assessment includes vital signs, respiratory rate and pattern, breath sounds, evaluation of spontaneous ventilatory effort, and potential evidence of hypoxia (e.g., skin color). Increased adventitious breath sounds may indicate a need for suctioning. The nurse maintains the patient's head of the bed so that it is elevated 30 degrees or higher unless contraindicated to prevent the risk of aspiration and VAP. The nurse verifies endotracheal tube position as applicable and evaluates the settings and functioning of the mechanical ventilator. Although the nurse may not be primarily responsible for adjusting the settings on the ventilator or measuring ventilator parameters (these are usually responsibilities of the respiratory therapist), the nurse is responsible for the patient and therefore needs to evaluate how the ventilator affects the patient's overall status.

When monitoring the ventilator, the nurse notes the following:

- Controlling mode (e.g., CMV ventilation and SIMV).
- Tidal volume and rate settings (tidal volume is usually set at 6 to 10 mL/kg [ideal body weight] or 4 to 8 mL/kg for the patient with ARDS [ideal body weight]; rate is usually set at 12 to 16 breaths/min).
- FiO₂ setting may be set between 21% and 100% to maintain an optimal PaO₂ level (e.g., greater than 60 mm Hg) or SpO₂ level greater than 92%.

- Peak inspiratory pressure (PIP) (normal is 15 to 20 cm H₂O; this increases if there is increased airway resistance or decreased compliance).
- Sensitivity (A 2 cm H₂O inspiratory force should trigger the ventilator).
- Inspiratory-to-expiratory ratio (usually 1:2 [1 second of inspiration to 2 seconds of expiration] unless inverse ratio is ordered).
- Minute volume (tidal volume × respiratory rate).
- Sigh settings (usually set at 1.5 times the tidal volume and ranging from 1 to 3 per hour), if applicable.
- Water in the tubing, disconnection or kinking of the tubing, which, if present, are corrected.
- Humidification (humidifier filled with water) and temperature.
- Alarms (turned on and functioning properly at all times per The Joint Commission [TJC] Alarm Safety Goal) (TJC, 2020).
- PEEP and pressure support level, if applicable.

As is true with any type of patient-sensitive life support equipment, mechanical ventilators have multiple alarms that are set to alert the health care team of potential patient problems. With the increased number of alarms and their high sensitivity to subtle changes, members of the health care team, including nurses, are at risk for experiencing alarm fatigue, which means that they may become desensitized to alarms and not respond to them with sufficient speed. According to the National Patient Safety Goals (TJC, 2020), measures must be instituted to prevent alarm fatigue.



Quality and Safety Nursing Alert

To prevent alarm fatigue associated with mechanical ventilators, nurses can manage the physical layout of the critical care unit (e.g., avoid locating patients on mechanical ventilators in close proximity); devise protocols for setting of alarms based upon best practices; and educate staff on how to set alarms and when and how to respond to them.

Assessment also addresses the patient's neurologic status and effectiveness of coping with the need for assisted ventilation and the changes that accompany it. The nurse assesses the patient's comfort level and ability to communicate as well. Because weaning from mechanical ventilation requires adequate nutrition, it is important to assess the patient's gastrointestinal system and nutritional status.

Diagnosis

NURSING DIAGNOSES

Based on the assessment data, major nursing diagnoses may include:

- Impaired gas exchange associated with underlying illness, ventilator setting adjustments, or weaning
- Impaired airway clearance associated with increased mucus production associated with presence of the tube in trachea or continuous positive-pressure mechanical ventilation
- Risk for injury and infection associated with endotracheal intubation or tracheostomy
- Impaired mobility associated with ventilator dependency
- Impaired verbal communication associated with endotracheal tube or tracheostomy tube
- Difficulty coping associated with ventilator dependency

TABLE 19-5 Troubleshooting Problems with Mechanical Ventilation

Problem	Cause	Solution
Ventilator Problems		
Increase in peak airway pressure	Coughing or plugged airway tube Patient-ventilator dyssynchrony Decreasing lung compliance Tubing kinked Pneumothorax Atelectasis or bronchospasm	Suction airway for secretions; empty condensation fluid from circuit. Adjust sensitivity; consider administering sedatives as prescribed Manually ventilate patient. Assess for hypoxia or bronchospasm. Check arterial blood gas values. Sedate only if necessary. Check tubing; reposition patient; insert oral airway if necessary. Manually ventilate patient; notify primary provider. Clear secretions.
Decrease in pressure or loss of volume	Increase in compliance Leak in ventilator or tubing; cuff on tube/humidifier not tight	None. Check entire ventilator circuit for patency. Correct leak.
Patient Problems		
Cardiovascular compromise	Decrease in venous return due to application of positive pressure to lungs	Assess for adequate volume status by measuring heart rate, blood pressure, central venous pressure, pulmonary capillary wedge pressure, and urine output; notify primary provider if values are abnormal.
Barotrauma/pneumothorax	Application of positive pressure to lungs; high mean airway pressures lead to alveolar rupture	Notify primary provider. Prepare patient for chest tube insertion. Avoid high pressure settings for patients with COPD, ARDS, or history of pneumothorax.
Pulmonary infection	Bypass of normal defense mechanisms; frequent breaks in ventilator circuit; decreased mobility;	Use strict aseptic technique. Provide frequent mouth care. Optimize nutritional status.

impaired cough
reflex

ARDS, acute respiratory distress syndrome; COPD, chronic obstructive pulmonary disease.

COLLABORATIVE PROBLEMS/POTENTIAL COMPLICATIONS

Based on the assessment data, potential complications may include the following (see [Table 19-5](#)):

- Ventilator problems (increase in peak airway pressure or decrease in pressure or loss of volume)
- Alterations in cardiac function
- Barotrauma and pneumothorax
- Pulmonary infection and sepsis (e.g., VAP; see [Chart 19-6](#))
- Delirium and postintensive care syndrome

Planning and Goals

The major goals for the patient may include achievement of optimal gas exchange, maintenance of a patent airway, absence of injury or infection, attainment of optimal mobility, adjustment to nonverbal methods of communication, acquisition of successful coping measures, and absence of complications.

Nursing Interventions

Nursing care of the patient who is mechanically ventilated requires expert technical and interpersonal skills. Nursing interventions are similar regardless of the setting; however, the frequency of interventions and the stability of the patient vary from setting to setting. Nursing interventions for the patient who is mechanically ventilated are not uniquely different from those for patients with other pulmonary disorders, but astute nursing assessment and a therapeutic nurse–patient relationship are critical. The specific interventions used by the nurse are determined by the underlying disease process and the patient’s response.

Two general nursing interventions that are important in the care of the patient who is mechanically ventilated are pulmonary auscultation and interpretation of arterial blood gas measurements. The nurse is often the first to note changes in physical assessment findings or significant trends in blood gases that signal the development of a serious problem (e.g., pneumothorax, tube displacement, pulmonary embolus).

ENHANCING GAS EXCHANGE

The purpose of mechanical ventilation is to optimize gas exchange by maintaining alveolar ventilation and oxygen delivery. The alteration in gas exchange may be caused by the underlying illness or by mechanical factors related to adjustment of the ventilator to the patient. The health care team,

including the nurse, physician, and respiratory therapist, continually assesses the patient for adequate gas exchange, signs and symptoms of hypoxia, and response to treatment. Therefore, the nursing diagnosis of impaired gas exchange is, by its complex nature, multidisciplinary and collaborative. The team members must share goals and information freely. All other goals directly or indirectly relate to this primary goal.

Nursing interventions to promote optimal gas exchange include judicious administration of analgesic agents to relieve pain without suppressing the respiratory drive and frequent repositioning to diminish the pulmonary effects of immobility. The nurse also monitors for adequate fluid balance by assessing for the presence of peripheral edema, calculating daily intake and output, and monitoring daily weights. The nurse administers medications prescribed to control the primary disease and monitors for their side effects.

PROMOTING EFFECTIVE AIRWAY CLEARANCE

Continuous positive-pressure ventilation increases the production of secretions regardless of the patient's underlying condition. The nurse assesses for the presence of secretions by lung auscultation at least every 2 to 4 hours. Measures to clear the airway of secretions include suctioning, CPT, frequent position changes, and increased mobility as soon as possible. Frequency of suctioning should be determined by patient assessment. If excessive secretions are identified by inspection or auscultation techniques, suctioning should be performed. Sputum is not produced continuously or every 1 to 2 hours but as a response to a pathologic condition. Therefore, there is no rationale for routine suctioning of all patients every 1 to 2 hours. Although suctioning is used to aid in the clearance of secretions, it can damage the airway mucosa and impair cilia action.

The sigh mechanism on the ventilator may be adjusted to deliver at least 1 to 3 sighs per hour at 1.5 times the tidal volume if the patient is receiving A/C ventilation. Periodic sighs prevent atelectasis and the further retention of secretions. Because of the risk for hyperventilation and trauma to pulmonary tissue from excess ventilator pressure (barotrauma, pneumothorax), the sigh feature is not used frequently. If the SIMV mode is being used, the mandatory ventilations act as sighs because they are of greater volume than the patient's spontaneous breaths.

Humidification of the airway via the ventilator is maintained to help liquefy secretions so that they are more easily removed. Bronchodilators may be indicated to dilate the bronchioles in patients with acute lung injury or COPD and are classified as adrenergic or anticholinergic. Adrenergic bronchodilators (see [Chapter 20, Table 20-4](#)) are mostly inhaled and work by stimulating the beta-receptor sites, mimicking the effects of epinephrine in the body. The desired effect is smooth muscle relaxation, which dilates the constricted bronchial tubes. Anticholinergic bronchodilators (see

[Chapter 20, Table 20-4](#)) produce airway relaxation by blocking cholinergic-induced bronchoconstriction. Patients receiving bronchodilator therapy of either type should be monitored for adverse effects, including dizziness, nausea, decreased oxygen saturation, hypokalemia, increased heart rate, and urine retention. Mucolytic agents (e.g., acetylcysteine) may also be indicated in these patients to liquefy secretions so that they are more easily mobilized. Nursing management of patients receiving mucolytic therapy includes assessment of an adequate cough reflex, sputum characteristics, and (in patients not receiving mechanical ventilation) improvement in incentive spirometry. Side effects include nausea, vomiting, bronchospasm, stomatitis (oral ulcers), urticaria, and rhinorrhea (runny nose) (Karch, 2020).

PREVENTING INJURY AND INFECTION

Maintaining the endotracheal or tracheostomy tube is an essential part of airway management. Cuff pressure is monitored every 8 hours to maintain the pressure at 20 to 25 mm Hg (Urden et al., 2018). The nurse assesses for the presence of a cuff leak at the same time. The nurse positions the ventilator tubing so that there is minimal pulling or distortion of the tube in the trachea, reducing the risk of trauma to the trachea. Unintentional or premature removal of the tube is a potentially life-threatening complication of endotracheal intubation. Removal of the tube is a frequent problem in intensive care units (ICUs) and occurs mainly during nursing care or by the patient. Nurses must instruct and remind patients and family members about the purpose of the tube and the dangers of removing it. Baseline and ongoing assessment of the patient and of the equipment ensures effective care. Providing comfort measures, including opioid analgesia and sedation, can improve the patient's tolerance of the endotracheal tube.



Quality and Safety Nursing Alert

Inadvertent removal of an endotracheal tube can cause laryngeal swelling, hypoxemia, bradycardia, hypotension, and even death. Measures must be taken to prevent premature or inadvertent removal.

To prevent tube removal by the patient, the nurse should explain to the patient and family the purpose of the tube, distract the patient through one-to-one interaction or with television, and maintain comfort measures. If the patient cannot move the arms and hands to the endotracheal tube, restraints are not needed. If the patient is alert, oriented, able to follow directions, and cooperative to the point that it is highly unlikely that they will remove the endotracheal tube, restraints are not needed. However, if the nurse

determines there is a risk that the patient may try to remove the tube, the least invasive method of restraints (e.g., soft wrist restraints and hand mitts) may be appropriate as prescribed by the primary provider (check agency policy) (TJC, 2019). The rationale for use of restraints should be documented, and the patient's significant others should receive explanations why restraints are necessary. Close monitoring of the patient is essential to ensure safety and prevent harm.

Patients with an endotracheal or tracheostomy tube do not have the normal defenses of the upper airway. In addition, these patients frequently have multiple additional body system disturbances that lead to immune compromise. Tracheostomy care is performed at least every 8 hours, and more frequently if needed, because of the increased risk of infection. The ventilator circuit tubing and in-line suction tubing are replaced periodically, according to infection prevention guidelines, to decrease the risk of infection.

The nurse administers oral hygiene frequently because the oral cavity is a primary source of contamination of the lungs in the patient who is intubated. The presence of a nasogastric tube in the patient who is intubated can increase the risk of aspiration, leading to nosocomial pneumonia. The nurse positions the patient with the head elevated above the stomach as much as possible. [Chart 19-6](#) provides an overview of strategies to prevent VAP.

PROMOTING OPTIMAL LEVEL OF MOBILITY

Being connected to a ventilator limits the patient's mobility. Immobility in patients who are mechanically ventilated is associated with decreases in muscle strength and increases length of hospital stay, as well as increased mortality rates (Hodgson, Capell, & Tipping, 2018). The nurse helps the patient whose condition has become stable to get out of bed and move to a chair as soon as possible. If the patient is unable to get out of bed, the nurse encourages performance of active range-of-motion exercises at least every 6 to 8 hours. If the patient cannot perform these exercises, the nurse performs passive range-of-motion exercises at least every 8 hours to prevent contractures and venous stasis.

PROMOTING OPTIMAL COMMUNICATION

It is important to develop alternative methods of communication for the patient who is receiving mechanical ventilation. The nurse assesses the patient's communication abilities to evaluate for limitations. Questions to consider when assessing the ability of the patient who is ventilator dependent to communicate include the following:

- Is the patient conscious and able to communicate? Can the patient nod or shake their head?

- Is the patient's mouth unobstructed by the tube so that words can be mouthed?
- Is the patient's dominant hand strong and available for writing? For example, if the patient is right handed, the IV line should be placed in the left arm if possible so that the right hand is free.
- Is the patient a candidate for a fenestrated tracheostomy tube or a one-way speaking valve (such as Passy-Muir valve® or Olympic Trach-Talk®) that permits talking?

Once the patient's limitations are known, the nurse offers several appropriate communication approaches: lip or speech reading (use single key words), pad and pencil or Magic Slate®, iPad® or tablet, communication board, gesturing, sign language, or electric larynx. The use of a "talking" or fenestrated tracheostomy tube or one-way valve may be suggested to the primary provider, which would allow the patient to talk while on the ventilator. The nurse makes sure that the patient's eyeglasses, hearing aid, sign interpreter, and language translator are available if needed to enhance the patient's ability to communicate.

Some communication methods may be frustrating to the patient, family, and nurse; these need to be identified and minimized. A speech therapist can assist in determining the most appropriate method.

PROMOTING COPING ABILITY

Dependence on a ventilator is frightening to both the patient and the family and disrupts even the most stable families. Encouraging the family to verbalize their feelings about the ventilator, the patient's condition, and the environment in general is beneficial. Explaining procedures every time they are performed helps reduce anxiety and familiarizes the patient with ventilator procedures. To restore a sense of control, the nurse encourages the patient to use alternative methods of communication in order to participate in decisions about care, schedules, and treatment when possible. The patient may become withdrawn or depressed while receiving mechanical ventilation, especially if its use is prolonged. To promote effective coping, the nurse informs the patient about progress when appropriate. It is important to provide diversions such as watching television, playing music, or taking a walk (if appropriate and possible). Stress reduction techniques (e.g., a back rub, relaxation measures) relieve tension and help the patient deal with anxieties and fears about both the condition and the dependence on the ventilator.

MONITORING AND MANAGING POTENTIAL COMPLICATIONS

Alterations in Cardiac Function. Alterations in cardiac output may occur as a result of positive-pressure ventilation. The positive intrathoracic pressure during inspiration compresses the heart and great vessels, thereby reducing venous return and cardiac output. This is usually corrected during

exhalation when the positive pressure is off. The patient may have decreased cardiac output and resultant decreased tissue perfusion and oxygenation.

To evaluate cardiac function, the nurse first observes for signs and symptoms of hypoxia (restlessness, apprehension, confusion, tachycardia, tachypnea, pallor progressing to cyanosis, diaphoresis, transient hypertension, and decreased urine output). If a pulmonary artery catheter is in place, cardiac output, cardiac index, and other hemodynamic values can be used to assess the patient's status (see [Chapter 21](#)).

Barotrauma and Pneumothorax. Excessive positive pressure can cause lung damage, or barotrauma, which may result in a spontaneous pneumothorax, which may quickly develop into a tension pneumothorax, further compromising venous return, cardiac output, and blood pressure (see later discussion). The nurse considers any sudden changes in oxygen saturation or the onset of respiratory distress to be a life-threatening emergency requiring immediate action.

Pulmonary Infection. The patient is at high risk for infection, as described earlier. The nurse reports fever or a change in the color or odor of sputum to the primary provider for follow-up (see earlier discussion of VAP). Subglottic secretions may increase the patients' risk for the development of VAP. Patients expected to be intubated for longer than 72 hours may benefit from the use of an endotracheal tube with a subglottic suction port. This extra port that is connected to continuous suction (20 to 30 cm H₂O) allows for the removal of secretions above the cuff (Urden et al., 2018).

Delirium and Postintensive Care Syndrome. Patients who are critically ill are at risk for delirium during their time in the ICU. They are also at risk for cognitive impairment at a level consistent with mild dementia that may persist for months after they are discharged to the home setting. This critical illness-associated cognitive impairment is called postintensive care syndrome (PICS). The *Awakening and Breathing Coordination, Delirium monitoring and management, Early mobility, Family engagement and empowerment (ABCDEF)* bundle proposes an interdisciplinary process using evidence-based practice to manage delirium and weakness in the patient who is critically ill. It is believed that implementing this bundle can mitigate risks for delirium and possibly PICS. The goals of this bundle are to improve communication among members of the health care team, standardize care related to the assessment and use of sedation, provide nonpharmacologic interventions in the management of delirium, provide early exercise and ambulation, and incorporate family's concerns and participation in care planning (see [Chart 19-16](#)) (Marra, Ely, Pandharipande, et al., 2017).

Chart 19-16

The ABCDEF Bundle

The Awakening and Breathing Coordination, Delirium monitoring and management, Early mobility, Family engagement and empowerment bundle

Overview: Typically, patients on mechanical ventilators require some form of sedation or analgesia during their hospital stay. Recent studies suggest a correlation between the use of potent sedatives and analgesia and ICU-acquired delirium, oversedation, prolonged mechanical ventilation, and postintensive care syndrome (PICS).

Key components of each of the categories of the ABCDEF Bundle include:

1. Awakening and spontaneous breathing trials

Using predefined criteria:

- The nurse determines if it is safe to stop sedation.
- If determined safe, the nurse will determine if patient tolerated the sedation interruption.
- If the patient tolerated the interruption, the respiratory therapist will determine if the patient is a candidate for a breathing trial.
- If the patient is a candidate for a breathing trial, the respiratory therapist and nurse will evaluate the patient's response.

2. Monitoring and management of delirium

- The nurse assesses the patient at least every 2 to 4 hours using a sedation assessment scale (e.g., the CAM-ICU, see [Chapter 11](#)).

3. Early Mobility

The nurse assesses the patient using the following criteria for mobility:

- The patient is able to respond to verbal stimuli.
- The patient is receiving less than 60% FiO₂ and less than 10 cm of PEEP.
- The patient has no circulatory or central catheters or injuries that may contraindicate mobility.

4. Family Engagement

- The nurse encourages engagement of family members and ensures unrestricted access for a designated family support person.

ICU, intensive care unit; PEEP, positive end-expiratory pressure.

Adapted from Shay, A. (2018). Optimizing the ABCDEF bundle. *American Nurse Today*, 13(7), 21–23.

Increasingly, patients are being cared for in extended care facilities or at home while receiving mechanical ventilation, with a tracheostomy tube, or receiving oxygen therapy. Patients receiving home ventilator care usually have a chronic neuromuscular condition or COPD. Providing the opportunity for patients who are ventilator dependent to return home to live with their families in familiar surroundings can be a positive experience. The ultimate goal of home ventilator therapy is to enhance the patient's quality of life, not simply to support or prolong life.



Educating Patients About Self-Care. Caring for the patient with mechanical ventilator support at home can be accomplished successfully. A home or transitional care team consisting of the nurse, physician, respiratory therapist, social service or home care agency, and equipment supplier is needed. The home is evaluated to determine whether the electrical equipment needed can be operated safely. [Chart 19-17](#) summarizes the basic assessment criteria needed for successful home care.

Once the decision to initiate mechanical ventilation at home is made, the nurse prepares the patient and family for home care. The nurse educates the patient and family about the ventilator, suctioning, tracheostomy care, signs of pulmonary infection, cuff inflation and deflation, and assessment of vital signs. Education begins in the hospital and continues at home. Nursing responsibilities include evaluating the patient's and family's understanding of the information presented.

The nurse educates the family about cardiopulmonary resuscitation, including mouth-to-tracheostomy tube (instead of mouth-to-mouth) breathing. The family is also instructed how to handle a power failure, which usually involves converting the ventilator from an electrical power source to a battery power source. Conversion is automatic in most types of home ventilators and lasts approximately 1 hour. In addition, instructions are provided on the use of a manual self-inflation bag, should it be necessary. [Chart 19-18](#) lists some of the patient's and family's responsibilities.

Chart 19-17

Criteria for Successful Home Ventilator Care

The decision to proceed with home ventilation therapy is usually based on the following parameters.

Patient Criteria

- The patient has a chronic underlying pulmonary or neuromuscular disorder.
- The patient's clinical pulmonary status is stable.
- The patient is willing to go home on mechanical ventilation.

Home Criteria

- The home environment is conducive to care of the patient.
- The electrical facilities are adequate to operate all equipment safely.
- The home environment is controlled, without drafts in cold weather and with proper ventilation in warm weather.
- Space is available for cleaning and storing ventilator equipment.

Family Criteria

- Family members are competent, dependable, and willing to spend the time required for proper training as primary caregivers.
- Family members understand the diagnosis and prognosis.
- Family has sufficient financial and supportive resources and can obtain professional support if necessary.

Chart 19-18



HOME CARE CHECKLIST

Ventilator Care

At the completion of education, the patient and/or caregiver will be able to:

- Name the procedure that was performed, as indicated, and how the patient's present status impacts physiologic functioning, ADLs, IADLs, relationships, and spirituality.
- State the name, dose, side effects, frequency, and schedule for all medications.
- State what types of changes are needed (if any) to maintain a clean home environment and prevent infection.
- State how to contact the primary provider, the team of home care professionals overseeing care, respiratory vendor and obtain supplies.
- Complete CPR training program for caregivers.
- Identify a plan for operation of ventilator and other devices during a power outage or other emergency.
- State proper care of patient on ventilator:
 - Observe physical signs such as color, secretions, breathing pattern, and state of consciousness.
 - Perform physical care such as suctioning, postural drainage, and ambulation.
 - Observe the tidal volume and pressure manometer regularly. Intervene when they are abnormal (i.e., suction if airway pressure increases).
 - Provide a communication method for the patient (e.g., pad and pencil, electric larynx, talking tracheostomy tube, and sign language).
 - Monitor vital signs as directed.
 - Use a predetermined signal to indicate when feeling short of breath or in distress.
- Care for and maintain equipment properly:
 - Check the ventilator settings twice each day and whenever the patient is removed from the ventilator.
 - Adjust the volume and pressure alarms if needed.
 - Fill humidifier as needed and check its level three times a day.
 - Empty water in tubing as needed.
 - Use a clean humidifier when circuitry is changed.
 - Keep exterior of ventilator clean and free of any objects.
 - Change external circuitry once a week or more often as indicated.
 - Report malfunction or strange noises immediately.

- Identify the contact details for support services for patients and their caregivers/families.

Resources

See [Chapter 20, Figure 20-6](#) for additional information on postural drainage positions.



For the procedural guidelines for caring for a patient with a tracheostomy tube and performing tracheal suction, go to thepoint.lww.com/Brunner15e.

ADLs, activities of daily living; IADLs, instrumental activities of daily living.

Continuing and Transitional Care. A home health or transitional care nurse monitors and evaluates how well the patient and family are adapting to providing care in the home. The nurse assesses the adequacy of the patient's ventilation and oxygenation as well as airway patency. The nurse addresses any unique adaptation problems that the patient may have and listens to the patient's and family's anxieties and frustrations, offering support and encouragement where possible. The nurse helps identify and contact community resources that may assist in home management of the patient with mechanical ventilation.

The technical aspects of the ventilator are managed by vendor follow-up. A respiratory therapist usually is assigned to the patient and makes home visits to evaluate the patient and perform a maintenance check of the ventilator as needed.

Transportation services are identified in case the patient requires transportation in an emergency. These arrangements must be made before an emergency arises.

Evaluation

Expected patient outcomes may include:

1. Exhibits adequate gas exchange, as evidenced by normal breath sounds, acceptable arterial blood gas levels, and vital signs
2. Demonstrates adequate ventilation with minimal mucus accumulation
3. Is free of injury or infection, as evidenced by normal temperature, white blood cell count, and clear sputum
4. Is mobile within limits of ability
 - a. Gets out of bed to chair, bears weight, or ambulates as soon as possible
 - b. Performs range-of-motion exercises every 6 to 8 hours

5. Communicates effectively through written messages, gestures, or other communication strategies
6. Copes effectively
 - a. Verbalizes fears and concerns about condition and equipment
 - b. Participates in decision making when possible
 - c. Uses stress reduction techniques when necessary
7. Absence of complications
 - a. Absence of cardiac compromise, as evidenced by stable vital signs and adequate urine output
 - b. Absence of pneumothorax, as evidenced by bilateral chest excursion, normal chest x-ray, and adequate oxygenation
 - c. Absence of pulmonary infection, as evidenced by normal temperature, clear pulmonary secretions, and negative sputum cultures
 - d. Absence of delirium and of postintensive care syndrome, as evidenced by no patient-ventilator dyssynchrony, and being oriented to person, place, and time

Weaning the Patient from the Ventilator

Respiratory weaning, the process of withdrawing the patient from dependence on the ventilator, takes place in three stages: the patient is gradually removed from the ventilator, then from either the ET or tracheostomy tube, and finally from oxygen. Weaning from mechanical ventilation is performed at the earliest possible time consistent with patient safety. The decision must be made from a physiologic rather than a mechanical viewpoint. A thorough understanding of the patient's clinical status is required in making this decision. Weaning is started when the patient is physiologically and hemodynamically stable, demonstrates spontaneous breathing capability, recovering from the acute stage of medical and surgical problems, and when the cause of respiratory failure is sufficiently reversed (Wiegand, 2017). [Chart 19-19](#) presents information about patient care during weaning from mechanical ventilation.

Successful weaning involves collaboration among the primary provider, respiratory therapist, and nurse. Each health care provider must understand the scope and function of other team members in relation to patient weaning to conserve the patient's strength, use resources efficiently, and maximize successful outcomes.

Criteria for Weaning

Careful assessment is required to determine whether the patient is ready to be removed from mechanical ventilation. If the patient is stable and showing signs of improvement or reversal of the disease or condition that caused the need for mechanical ventilation, weaning indices should be assessed (see [Chart 19-19](#)).

Stable vital signs and arterial blood gases are also important predictors of successful weaning. Once readiness has been determined, the nurse records baseline measurements of weaning indices to monitor progress.

Patient Preparation

To maximize the likelihood of success of weaning, the nurse must consider the patient as a whole, taking into account factors that impair the delivery of oxygen and elimination of carbon dioxide as well as those that increase oxygen demand (e.g., sepsis, seizures, thyroid imbalances) or decrease the patient's overall strength (e.g., inadequate nutrition, neuromuscular disease). Adequate psychological preparation is necessary before and during the weaning process.

Methods of Weaning

Successful weaning depends on the combination of adequate patient preparation, available equipment, and an interdisciplinary approach to solve patient problems (see [Chart 19-19](#)). All usual modes of ventilation can be used for weaning.

CPAP (also known as spontaneous mode ventilation in this context) allows the patient to breathe spontaneously while applying positive pressure throughout the respiratory cycle to keep the alveoli open and promote oxygenation. Providing CPAP during spontaneous breathing also offers the advantage of an alarm system and may reduce patient anxiety if the patient has been taught that the machine is keeping track of breathing. It also maintains lung volumes and improves the patient's oxygenation status. CPAP is often used in conjunction with PSV. Nurses should carefully assess for

tachypnea, tachycardia, reduced tidal volumes, decreasing oxygen saturations, and increasing carbon dioxide levels.

Chart 19-19

Care of the Patient Being Weaned from Mechanical Ventilation

1. Assess patient for weaning criteria:
 - a. Vital capacity: 10 to 15 mL/kg
 - b. Maximum inspiratory pressure (MIP) at least –20 cm H₂O
 - c. Tidal volume: 7 to 9 mL/kg
 - d. Minute ventilation: 6 L/min
 - e. Rapid/shallow breathing index: Below 100 breaths/min/L; PaO₂ >60 mm Hg with FiO₂ <40%
2. Monitor activity level, assess dietary intake, and monitor results of laboratory tests of nutritional status. Reestablishing independent spontaneous ventilation can be physically exhausting. It is crucial that the patient have enough energy reserves to succeed.
3. Assess the patient's and family's understanding of the weaning process and address any concerns about the process. Explain that the patient may feel short of breath initially and provide encouragement as needed. Reassure the patient that they will be attended closely and that if the weaning attempt is not successful, it can be tried again later.
4. Implement the weaning method as prescribed (e.g., continuous positive airway pressure [CPAP] and T-piece).
5. Monitor vital signs, pulse oximetry, electrocardiogram, and respiratory pattern constantly for the first 20 to 30 minutes and every 5 minutes after that until weaning is complete. Monitoring the patient closely provides ongoing indications of success or failure.
6. Maintain a patent airway; monitor arterial blood gas levels and pulmonary function tests. Suction the airway as needed.
7. In collaboration with the primary provider, terminate the weaning process if adverse reactions occur. These include a heart rate increase of 20 bpm, systolic blood pressure increase of 20 mm Hg, a decrease in oxygen saturation to <90%, respiratory rate <8 or >20 breaths/min, ventricular arrhythmias, fatigue, panic, cyanosis, erratic or labored breathing, paradoxical chest movement.
8. If the weaning process continues, measure tidal volume and minute ventilation every 20 to 30 minutes; compare with the patient's desired values, which have been determined in collaboration with the primary provider.
9. Assess for psychological dependence if the physiologic parameters indicate that weaning is feasible and the patient still resists. Possible causes of psychological dependence include fear of dying and depression from chronic illness. It is important to address this issue before the next weaning attempt.

Adapted from Wiegand, D. J. L. (2017). *AACN procedure manual for critical care* (6th ed.). St. Louis, MO: Elsevier Saunders.

SIMV can also be used as a weaning method. The patient is placed on SIMV mode of ventilation and the rate is slowly decreased by 1 to 3 breaths/min until the patient is fully breathing on their own (Urden et al., 2018).

Furthermore, T-piece spontaneous breathing trials can also be used. When the patient can breathe spontaneously, weaning trials using a T-piece for the patient with an ET tube or tracheostomy mask for the patient with a tracheostomy tube (see Fig. 19-6) are normally conducted with the patient disconnected from the ventilator, receiving humidified oxygen only and performing all work of breathing. Because patients do not have to overcome the resistance of the ventilator, they may find this mode more comfortable, or they may become anxious as they breathe with no support from the ventilator. During these trial periods, the nurse monitors the patient closely and provides encouragement. This method of weaning is usually used when the patient is awake and alert, is breathing without difficulty, has good gag and cough reflexes, and is hemodynamically stable. During the weaning process, the patient is maintained on the same or a higher oxygen concentration than when receiving mechanical ventilation. While the patient is using the T-piece or tracheostomy mask, they are observed for signs and symptoms of hypoxia, increasing respiratory muscle fatigue, or systemic fatigue. These include restlessness, increased respiratory rate (greater than 35 breaths/min), the use of accessory muscles, tachycardia with premature ventricular contractions, and paradoxical chest movement (asynchronous breathing, chest contraction during inspiration and expansion during expiration). Fatigue or exhaustion is initially manifested by an increased respiratory rate associated with a gradual reduction in tidal volume; later there is a slowing of the respiratory rate.

If the patient appears to be tolerating the T-piece/tracheostomy mask trial, a second set of arterial blood gas measurements is drawn 20 minutes after the patient has been on spontaneous ventilation at a constant FiO_2 PSV. (Alveolar–arterial equilibration takes 15 to 20 minutes to occur.)

Signs of exhaustion and hypoxia correlated with deterioration in the blood gas measurements indicate the need for ventilatory support. The patient is placed back on the ventilator each time signs of fatigue or deterioration develop.

If clinically stable, the patient usually can be extubated within 2 or 3 hours after weaning and allowed spontaneous ventilation by means of a mask with humidified oxygen. Patients who have had prolonged ventilatory assistance usually require more gradual weaning; it may take days or even weeks. They are weaned primarily during the day and placed back on the ventilator at night to rest.

Because patients respond in different manners to weaning methods, there is no definitive way to assess which method is best. Regardless of the weaning method being used, ongoing assessment of respiratory status is essential to monitor patient progress.

Successful weaning from the ventilator is supplemented by intensive pulmonary care. The following methods are used: oxygen therapy; arterial blood gas evaluation; pulse oximetry; bronchodilator therapy; CPT; adequate nutrition, hydration, and humidification; blood pressure measurement; and incentive spirometry. Daily spontaneous breathing trials may be used to evaluate the patient's ability to breathe without ventilatory support. If the patient is receiving IV sedatives (e.g., propofol, dexmedetomidine), current guidelines recommend that the patient's sedative dose be decreased by 25% to 50% prior to weaning. In order to decrease agitation in patients who do not tolerate withdrawal of sedation, dexmedetomidine may be initiated for spontaneous breathing trials without causing significant respiratory depression (Devlin, Skrobik, Gélinas, et al., 2018; Urden et al., 2018). A patient may still have borderline

pulmonary function and need vigorous supportive therapy before their respiratory status returns to a level that supports activities of daily living.

Removal of the Tracheostomy Tube

Removal of the tracheostomy tube is considered when the patient can breathe spontaneously; maintain an adequate airway by effectively coughing up secretions, swallow, and move the jaw. Secretion clearance and aspiration risks are assessed to determine whether active pharyngeal and laryngeal reflexes are intact.

Once the patient can clear secretions adequately, a trial period of mouth breathing or nose breathing is conducted. This can be accomplished by several methods. The first method requires changing to a smaller size tube to increase the resistance to airflow or plugging the tracheostomy tube (deflating the cuff first). The smaller tube is sometimes replaced by a cuffless tracheostomy tube, which allows the tube to be plugged at lengthening intervals to monitor patient progress. A second method involves changing to a fenestrated tube (a tube with an opening or window in its bend). This permits air to flow around and through the tube to the upper airway and enables talking. A third method involves switching to a smaller tracheostomy button (stoma button). A tracheostomy button is a plastic tube approximately 1 inch long that helps keep the windpipe open after the larger tracheostomy tube has been removed. Finally, when the patient demonstrates the ability to maintain a patent airway, the tube can be removed. An occlusive dressing is placed over the stoma, which heals in several days to weeks.

Weaning from Oxygen

The patient who has been successfully weaned from the ventilator, cuff, and tube and has adequate respiratory function is then weaned from oxygen. The FiO₂ is gradually reduced until the PaO₂ is in the range of 70 to 100 mm Hg while the patient is breathing room air. If the PaO₂ is less than 70 mm Hg on room air, supplemental oxygen is recommended. To be eligible for financial reimbursement from the Centers for Medicare and Medicaid Services (CMS) for in-home oxygen, the patient must have a PaO₂ at or less than 55 mm Hg while awake and at rest or arterial oxygen saturation at or below 88%, breathing room air (American Association of Respiratory Care, 2007; CMS, 1993).

Nutrition

Success in weaning the patient who is long-term ventilator dependent requires early and aggressive but judicious nutritional support. The respiratory muscles (diaphragm and especially intercostals) become weak or atrophied after just a few days of mechanical ventilation and may be catabolized for energy, especially if nutrition is inadequate. Compensation for inadequate nutrition must be undertaken with care; excessive intake can increase the production of carbon dioxide and the demand for oxygen and lead to prolonged ventilator dependence and difficulty in weaning. Because the metabolism of fat produces less carbon dioxide than the metabolism of carbohydrates, it was long presumed that a high-fat and limited carbohydrate diet would be most therapeutic; however, evidence-based findings do not support its efficacy (Seres, 2020). Adequate protein intake is important in increasing respiratory muscle strength. Protein intake should be approximately 25% of total daily kilocalories, or 1.2 to 1.5 g/kg/day. Daily nutrition should be closely monitored.

Soon after the patient is admitted, a consultation with a dietitian or nutrition support team should be arranged to plan the best form of nutritional replacement. Adequate nutrition may decrease the duration of mechanical ventilation and prevent other complications, especially sepsis. Sepsis can occur if bacteria enter the bloodstream and release toxins that, in turn, cause vasodilation and hypotension, fever, tachycardia, increased respiratory rate, and coma. Aggressive treatment of sepsis is essential to reverse this threat to survival and to promote weaning from the ventilator when the patient's condition improves.



Acute Respiratory Distress Syndrome



Acute respiratory distress syndrome (ARDS) can be thought of as a spectrum of disease, progressing from mild to moderate to its most severe, fulminant form. **Acute lung injury** is a term commonly used to describe mild ARDS. ARDS is a clinical syndrome characterized by a severe inflammatory process causing diffuse alveolar damage that results in sudden and progressive pulmonary edema, increasing bilateral infiltrates on chest x-ray, hypoxemia unresponsive to oxygen supplementation regardless of the amount of PEEP, and the absence of an elevated left atrial pressure (Siegel, 2019a). Patients often demonstrate reduced lung compliance. A wide range of factors are associated with the development of ARDS (see [Chart 19-20](#)), including direct injury to the lungs (e.g., smoke inhalation) or indirect insult to the lungs (e.g., shock). ARDS has been associated with a mortality rate ranging from 27% to 50%. Patients who survive the initial cause of ARDS may die later, commonly from HCAP or sepsis (Anesi, 2020; Siegel, 2019a).

Chart 19-20



RISK FACTORS

Acute Respiratory Distress Syndrome

- Aspiration (gastric secretions, drowning, hydrocarbons)
- COVID-19 pneumonia
- Drug ingestion and overdose
- Fat or air embolism
- Hematologic disorders (disseminated intravascular coagulation, massive transfusions, cardiopulmonary bypass)
- Localized infection (bacterial, fungal, viral pneumonia)
- Major surgery
- Metabolic disorders (pancreatitis, uremia)
- Prolonged inhalation of high concentrations of oxygen, smoke, or corrosive substances
- Sepsis
- Shock (any cause)
- Trauma (pulmonary contusion, multiple fractures, head injury)

COVID-19, coronavirus disease 2019.

Adapted from Cascella, M., Rajnik, M., Cuomo, A., et al. (2020). Features, evaluation and treatment Coronavirus (COVID-19). *StatPearls*. Treasure Island, FL: StatPearls Publishing. Retrieved on 6/9/2020 at: www.ncbi.nlm.nih.gov/books/NBK554776/; Siegel, M. D. (2019a). Acute respiratory distress syndrome: Epidemiology, pathophysiology, pathology, and etiology in adults. *UpToDate*. Retrieved on 9/23/2019 at: www.uptodate.com/contents/acute-respiratory-distress-syndrome-epidemiology-pathophysiology-pathology-and-etiology-in-adults



Quality and Safety Nursing Alert

Be alert for the development of acute lung injury in the patient population using e-cigarettes, also known as vaping. This syndrome is called e-cigarette or vaping associated acute lung injury (EVALI). According to the CDC (2019c), patients diagnosed with EVALI have been identified in most states.

Pathophysiology

Inflammatory triggers initiate the release of cellular and chemical mediators, causing injury to the alveolar capillary membrane in addition to other structural damage to the lungs. Severe V/Q mismatching occurs. Alveoli collapse because of the inflammatory infiltrate, blood, fluid, and surfactant dysfunction. Small airways are narrowed because of interstitial fluid and bronchial obstruction. Lung compliance may markedly decrease, resulting in decreased functional residual capacity and severe hypoxemia. The blood returning to the lung for gas exchange is pumped through the nonventilated, nonfunctioning areas of the lung, causing shunting. This means that blood is interfacing with nonfunctioning alveoli and gas exchange is markedly impaired, resulting in severe, refractory hypoxemia. Figure 19-9 shows the sequence of pathophysiologic events leading to ARDS.

Clinical Manifestations

Initially, ARDS closely resembles severe pulmonary edema. The acute phase of ARDS is marked by a rapid onset of severe dyspnea that usually occurs less than 72 hours after the precipitating event. Arterial hypoxemia that does not respond to supplemental oxygen is characteristic. ARDS is classified according to the severity of hypoxemia experienced by the patient as (Siegel, 2019a):

Physiology/Pathophysiology

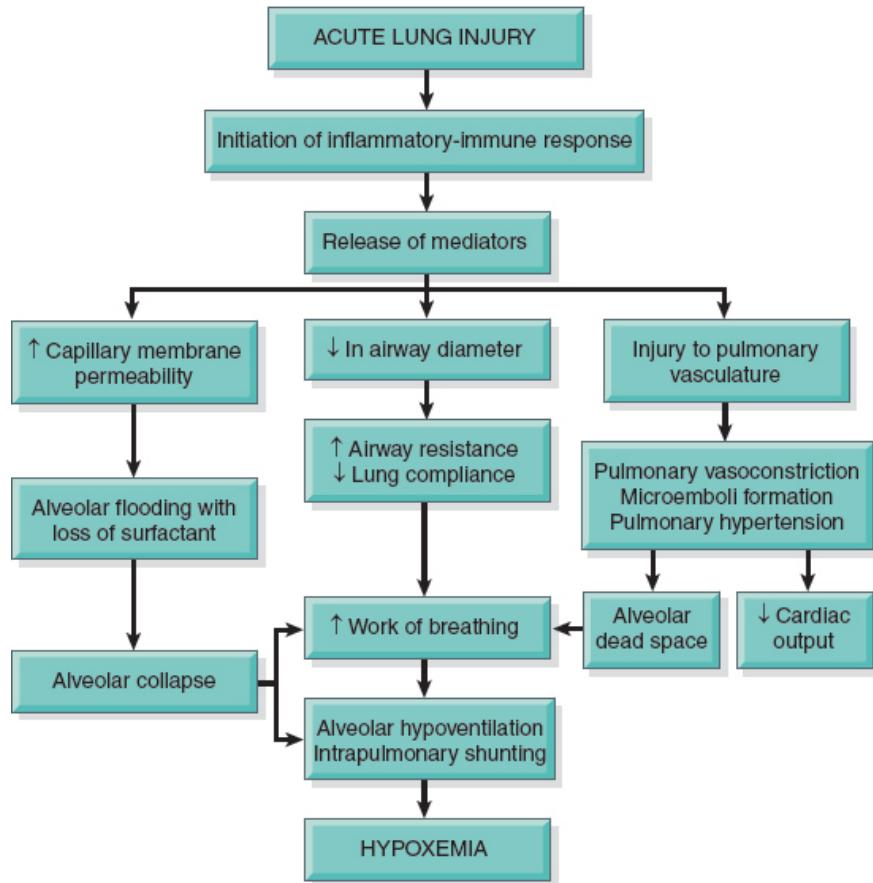


Figure 19-9 • Pathogenesis and pathophysiology of acute respiratory distress syndrome.

- mild ARDS, with arterial oxygen tension (PaO_2)/fraction of inspired oxygen (FIO_2) $> 200 \text{ mm Hg}$ but $\leq 300 \text{ mm Hg}$,
- moderate ARDS, with $\text{PaO}_2/\text{FIO}_2 > 100 \text{ mm Hg}$ but $\leq 200 \text{ mm Hg}$, or
- severe ARDS, with $\text{PaO}_2/\text{FIO}_2 \leq 100 \text{ mm Hg}$.

Findings on chest x-ray are similar to those seen with cardiogenic pulmonary edema and are visible as bilateral infiltrates that quickly worsen. Mild ARDS progresses to fibrosing alveolitis with persistent, severe hypoxemia. The patient also has increased alveolar dead space (ventilation to alveoli but poor perfusion) and typically has

decreased pulmonary compliance (“stiff lungs,” which are difficult to ventilate). Clinically, the patient is thought to be in the recovery phase if the hypoxemia gradually resolves, the chest x-ray improves, and the lungs become more compliant.

Assessment and Diagnostic Findings

On physical examination, intercostal retractions and crackles may be present as the fluid begins to leak into the alveolar interstitial space. Common diagnostic tests performed in patients with potential ARDS include plasma brain natriuretic peptide (BNP) levels, echocardiography, and pulmonary artery catheterization. The BNP level is helpful in distinguishing ARDS from cardiogenic pulmonary edema. Transthoracic echocardiography may be used if the BNP is not conclusive.

Medical Management

The primary focus in the management of ARDS includes identification and treatment of the underlying condition. Aggressive, supportive care must be provided to compensate for the severe respiratory dysfunction. This supportive therapy almost always includes ET intubation and mechanical ventilation. In addition, circulatory support, adequate fluid volume, and nutritional support are important. Supplemental oxygen is used as the patient begins the initial spiral of hypoxemia. As the hypoxemia progresses, intubation and mechanical ventilation are instituted. The concentration of oxygen and ventilator settings and modes are determined by the patient’s status. This is monitored by arterial blood gas analysis, pulse oximetry, and bedside pulmonary function testing.

Providing ventilatory PEEP support is a critical part of the treatment of ARDS. PEEP usually improves oxygenation, but it does not influence the natural history of the syndrome. The use of PEEP helps increase functional residual capacity and reverse alveolar collapse by keeping the alveoli open, resulting in improved arterial oxygenation and a reduction in the severity of the V/Q. imbalance. By using PEEP, a lower FiO_2 may be required. The goal is a PaO_2 greater than 60 mm Hg or an oxygen saturation level of greater than 90% at the lowest possible FiO_2 .

Systemic hypotension may occur in ARDS as a result of hypovolemia secondary to leakage of fluid into the interstitial spaces and depressed cardiac output from high levels of PEEP therapy. Hypovolemia must be carefully treated without causing further overload. Inotropic or vasopressor agents may be required. Additional supportive treatments may include prone positioning, sedation, paralysis, and nutritional support (Siegel, 2019b).

Pharmacologic Therapy

There is no specific pharmacologic treatment of ARDS except supportive care. Neuromuscular blocking agents, sedatives, and analgesics may be used to improve patient–ventilator synchronization and help to decrease severe hypoxemia (see later discussion in Ventilator Considerations section). Inhaled nitric oxide (an endogenous vasodilator) was thought to reduce V/Q. mismatch and improve oxygenation; however, findings from clinical trials have not shown an improvement in mortality rates between patients who did and did not receive nitric oxide (Harman, 2018).

Nutritional Therapy

Adequate nutritional support is vital in the treatment of ARDS. Patients with ARDS require 35 to 45 kcal/kg/day to meet caloric requirements. Enteral feeding is the first consideration; however, parenteral nutrition also may be required.

Nursing Management

General Measures

A patient with ARDS is critically ill and requires close monitoring in an ICU. Respiratory modalities used in this situation include oxygen administration, nebulizer therapy, CPT, ET intubation or tracheostomy, mechanical ventilation, suctioning, and bronchoscopy. Frequent assessment of the patient's status is necessary to evaluate the effectiveness of treatment.

In addition to supporting the medical plan of care, the nurse considers other needs of the patient. Positioning is important. The nurse turns the patient frequently to improve ventilation and perfusion in the lungs and enhance secretion drainage. However, the nurse must closely monitor the patient for deterioration in oxygenation with changes in position. Oxygenation in patients with ARDS is sometimes improved in the prone position; this seems to be particularly true for patients with COVID-19 and ARDS (see later discussion). This position may be evaluated for improvement in oxygenation and used in special circumstances. Devices and specialty beds are available to assist the nurse in placing the patient in a prone position.

The patient is extremely anxious and agitated because of the increasing hypoxemia and dyspnea. It is important to reduce the patient's anxiety because anxiety increases oxygen expenditure by preventing rest. Rest is essential to limit oxygen consumption and reduce oxygen needs.

Ventilator Considerations

Several considerations must be addressed for the patient intubated and receiving mechanical ventilation with PEEP. PEEP, which causes increased end-expiratory pressure, is an unnatural pattern of breathing and feels strange to the patient. The patient may be anxious, and patient-ventilator dyssynchrony may be the consequence. Nursing assessment is important to identify problems with ventilation that may be causing the anxiety reaction: tube blockage by kinking or retained secretions, other acute respiratory problems (e.g., pneumothorax and pain), a sudden decrease in the oxygen level, the level of dyspnea, or ventilator malfunction. In some cases, sedation may be required to decrease the patient's oxygen consumption, allow the ventilator to provide full support of ventilation, and decrease the patient's anxiety. Sedatives that may be prescribed are lorazepam, midazolam, dexmedetomidine, propofol, and short-acting barbiturates.

If the PEEP level cannot be maintained despite the use of sedatives, neuromuscular blocking agents (paralytic agents) may be given to paralyze the patient. Examples of these agents include pancuronium, vecuronium, atracurium, and rocuronium. The resulting paralysis allows the patient to be ventilated more easily. With paralysis, the patient appears to be unconscious; loses motor function; and cannot breathe, talk, or blink independently. However, the patient retains sensation and is awake and able to

hear. The nurse must reassure the patient that the paralysis is a result of the medication and is temporary. Paralysis should be used for the shortest possible time and never without adequate sedation and pain management.

Peripheral nerve stimulators are used to assess nerve impulse transmissions at the neuromuscular junction of select skeletal muscles when neuromuscular blocking agents are used. A “train-of-four” test may be used to measure the level of neuromuscular blockade. With this test, four consecutive stimuli are delivered along the path of a nerve, and the response of the muscle is measured in order to evaluate whether or not stimuli are effectively blocked. Four equal muscle contractions, seen as “twitches,” will result if there is no neuromuscular blockade. However, if neuromuscular blockade is present, there will be a loss of twitch height and number, which will indicate the degree of blockade. If all four stimulations result in an absence of twitches, it is estimated that 100% of the receptors are blocked (Wiegand, 2017).

The use of neuromuscular blocking agents has many dangers and side effects. The nurse must be sure the patient does not become disconnected from the ventilator, because respiratory muscles are paralyzed and the patient will be apneic. Consequently, the nurse ensures that the patient is closely monitored; all ventilator and patient alarms must be on at all times. Eye care is important as well, because the patient cannot blink, increasing the risk of corneal abrasions. Neuromuscular blockers predispose the patient to venous thromboembolism (VTE), muscle atrophy, foot drop, stress ulcers that may cause hemorrhage, and skin breakdown.



Quality and Safety Nursing Alert

Nursing assessment is essential to minimize the complications related to neuromuscular blockade. The patient may have discomfort or pain but cannot communicate these sensations. In addition, frequent oral care and suctioning may be needed.

Analgesia must be given concurrently with neuromuscular blocking agents (Saenz, 2019). The nurse must anticipate the patient’s needs regarding pain and comfort. The nurse checks the patient’s position to ensure it is comfortable without excessive pressure points and in normal alignment. Talking to and not about the patient while in the patient’s presence is important.

In addition, the nurse must describe the purpose and effects of the neuromuscular blocking agents to the patient’s family. If family members are unaware that these agents have been given, they may become distressed by the change in the patient’s status.



COVID-19 Considerations

The most serious complication and most frequent cause of death among patients with COVID-19 is ARDS (Anesi, 2020). In China, where the SARS-CoV-2 virus first emerged, approximately one quarter of patients who were hospitalized in the early days of the pandemic required treatment in critical care units, the majority with respiratory

failure and ARDS. Of these, 52.4% died secondary to complications of ARDS (Niederman, Richeldi, Chotirmall, et al., 2020; Wu & McGoogan, 2020).

The pathogenesis of ARDS in patients with COVID-19 pneumonia appears to have some differences from other cases of ARDS. In particular, although there is evidence of damage to epithelial cells within alveoli, epithelial cells within the pulmonary endothelium are not damaged, resulting in less exudative pathologic changes than with other types of ARDS. In terms of clinical manifestations, some patients with severe COVID-19 pneumonia do not voice complaints of dyspnea but nonetheless may deteriorate rapidly into respiratory failure. Furthermore, some patients with COVID-19 and ARDS who are mechanically ventilated do not exhibit the poor lung compliance that is a classic manifestation of typical ARDS. In addition, the onset of most non-COVID-19 cases of ARDS is typically one week or less from the time of the causative insult; however, the median time from onset of COVID-19 symptoms to ARDS is longer, at between 8 to 12 days (Li & Ma, 2020).

The same classification system used to diagnosis other cases of ARDS is used to classify patients with COVID-19 pneumonia with ARDS (i.e., as having mild, moderate, or severe ARDS) (Casella et al., 2020). Many of the same strategies used to manage patients without COVID-19 who have ARDS apply to the patient with COVID-19 and ARDS. For instance, it is recommended that the patient with COVID-19 and ARDS who is mechanically ventilated receive low tidal volumes (i.e., 4 to 8 mL/kg ideal body weight). However, there are some specific differences in the recommended treatment of the adult with COVID-19 and ARDS who is mechanically ventilated, which include the following (Alhazzani, Moller, Arabi, et al., 2020; Anesi, 2020):

- PEEP > 5 cm H₂O should be delivered (although the patient should be closely monitored for barotrauma if the PEEP is >10 cm H₂O);
- Low dosages of intravenous corticosteroids (e.g., dexamethasone, methylprednisolone) may be prescribed;
- Nitric oxide should not be routinely prescribed; however, for patients with severe ARDS refractory to other treatments, nitric oxide might be tried;
- For the patient with moderate or severe ARDS, prone positioning for 12 to 16 hours daily is recommended, if feasible; and
- For the patient with moderate or severe ARDS, intermittent boluses of neuromuscular blocking agents are preferred over continuous infusions, unless there is persistent patient-ventilator dyssynchrony.

Other treatments recommended for patients with severe COVID-19 pneumonia should also be followed (see previous discussion on COVID-19 pneumonia).

It has been reported that more patients with COVID-19 and ARDS who are mechanically ventilated have neurologic impairment (e.g., delirium, encephalopathy) than other patients with ARDS who are mechanically ventilated. Therefore, sedative requirements for these patients are reportedly higher than for most other patients with ARDS (Anesi, 2020). These neurologic manifestations are that much more difficult to manage because family members and friends, who may be a source of solace to the patient who is agitated, are typically not permitted to visit. Furthermore, the nurse caring for these patients must also practice isolation precautions and minimize interactions with the patient, which can serve to make the patient feel more isolated and agitated.

PULMONARY VASCULAR DISORDERS



Pulmonary Edema (Noncardiogenic)



Pulmonary edema is defined as abnormal accumulation of fluid in the lung tissue, the alveolar space, or both. It is a severe, life-threatening condition. Pulmonary edema can be classified as cardiogenic or noncardiogenic (see [Chapter 25](#) for further discussion of cardiogenic pulmonary edema). Noncardiogenic pulmonary edema occurs due to damage of the pulmonary capillary lining. It may be due to direct injury to the lung (e.g., chest trauma, aspiration, and smoke inhalation), hematogenous injury to the lung (e.g., sepsis, pancreatitis, multiple transfusions, cardiopulmonary bypass), or injury plus elevated hydrostatic pressures. Management of noncardiogenic pulmonary edema mirrors that of cardiogenic pulmonary edema; however, hypoxemia may persist despite high concentrations of supplemental oxygen, due to the intrapulmonary shunting of blood.

Pulmonary Hypertension

Pulmonary hypertension (PH) is characterized by elevated pulmonary arterial pressure greater than 25 mm Hg at rest and greater than 30 mm Hg with exercise and secondary right heart ventricular failure (Rubin & Hopkins, 2019). It may be suspected in a patient with dyspnea with exertion without other clinical manifestations. Unlike systemic blood pressure, the pulmonary pressures cannot be measured indirectly. In the absence of these measurements, clinical recognition becomes the only indicator of PH. However, PH is a condition that is often not clinically evident until late in its progression. Patients are classified by the World Health Organization (WHO) into five groups based upon the mechanism of PH (Rubin & Hopkins, 2019) (see [Chart 19-21](#)).

Pathophysiology

Conditions such as collagen vascular disease, congenital heart disease, anorexigens (specific appetite depressants), chronic use of stimulants, portal hypertension, and HIV infection increase the risk of PH in susceptible patients. Vascular injury occurs with endothelial dysfunction and vascular smooth muscle dysfunction, which leads to disease progression (vascular smooth muscle hypertrophy, adventitial and intimal proliferation [thickening of the wall], and advanced vascular lesion formation). Normally, the pulmonary vascular bed can handle the blood volume delivered by the right ventricle. It has a low resistance to blood flow and compensates for increased blood volume by dilation of the vessels in the pulmonary circulation. However, if the pulmonary vascular bed is destroyed or obstructed, as in PH, the ability to handle whatever flow or volume of blood it receives is impaired, and the increased blood flow then increases the pulmonary artery pressure. As the pulmonary arterial pressure increases, the pulmonary vascular resistance also increases. Both pulmonary artery constriction (as in hypoxemia or hypercapnia) and a reduction of the pulmonary

vascular bed (which occurs with PE) result in increased pulmonary vascular resistance and pressure. This increased workload affects right ventricular function. The myocardium ultimately cannot meet the increasing demands imposed on it, leading to right ventricular hypertrophy (enlargement and dilation) and failure. Passive hepatic congestion may also develop.

Chart 19-21

Clinical Classification of Pulmonary Hypertension (PH)

Group 1: Pulmonary Arterial Hypertension (PAH)

- Sporadic idiopathic PAH
- Heritable idiopathic PAH
- Drug and toxin-induced PAH
- PAH due to diseases such as connective tissues disorders, HIV infection, portal hypertension, congenital heart disease

Group 2: PH due to left heart disease

- Systolic dysfunction
- Diastolic dysfunction
- Valvular heart disease

Group 3: PH due to chronic lung diseases and/or hypoxemia

- Chronic obstructive pulmonary disease
- Interstitial lung disease
- Mixed restrictive and obstructive lung disease
- Sleep disordered breathing

Group 4: Chronic thromboembolic pulmonary hypertension (CTEPH)

- Due to thromboembolic occlusion of the proximal or distal pulmonary vasculature

Group 5: PH with unclear multifactorial mechanisms

- Hematologic disorders
- Systemic disorders (e.g., sarcoidosis)
- Metabolic disorders

Adapted from Rubin, L., & Hopkins, W. (2019). Overview of pulmonary hypertension in adults. *UpToDate*. Retrieved on 8/22/2019 at: www.uptodate.com/contents/overview-of-pulmonary-hypertension-in-adults

Clinical Manifestations

Dyspnea, the main symptom of PH, occurs at first with exertion and eventually at rest. Substernal chest pain also is common. Other signs and symptoms include weakness, fatigue, syncope, occasional hemoptysis, and signs of right-sided heart failure (peripheral edema, ascites, distended neck veins, liver engorgement, crackles, heart murmur). Anorexia and abdominal pain in the right upper quadrant may also occur.

Assessment and Diagnostic Findings

Diagnostic testing is used to confirm that PH exists, determine its severity, and identify its causes. Initial diagnostic evaluation includes a history, physical examination, chest x-ray, pulmonary function studies, electrocardiogram (ECG), and echocardiogram. Echocardiography can be used to estimate the pulmonary artery systolic pressure and to assess right ventricular size, thickness, and function. It can also evaluate the right atrial size, left ventricular system, and diastolic function as well as valve function. Right heart catheterization is necessary to confirm the diagnosis of PH and to accurately assess the hemodynamic abnormalities. PH is confirmed with a mean pulmonary artery pressure greater than 25 mm Hg. If left heart disease is identified via echocardiography and correlates with the degree of estimated PH, then exercise testing and both a right and left heart catheterization may be done to determine the functional severity of the disease and the abnormalities in pressures (left heart filling, pulmonary vascular resistance, transpulmonary gradient) (Rubin & Hopkins, 2019).

Pulmonary function studies may be normal or show a slight decrease in vital capacity and lung compliance, with a mild decrease in the diffusing capacity. The PaO₂ also is decreased (hypoxemia). The ECG reveals right ventricular hypertrophy, right axis deviation, and tall peaked P waves in inferior leads; tall anterior R waves; and ST-segment depression, T-wave inversion, or both anteriorly. An echocardiogram can assess the progression of the disease and rule out other conditions with similar signs and symptoms. A V/Q scan or pulmonary angiography detects defects in pulmonary vasculature, such as PE.

Medical Management

The primary goal of treatment is to manage the underlying condition related to PH if the cause is known. Recommendations regarding therapy are tailored to the patient's individual situation, functional New York Heart Association class, and specific needs (Rubin & Hopkins, 2019). All patients with PH should be considered for the following therapies: diuretics, oxygen, anticoagulation, digoxin, and exercise training. Diuretics and oxygen should be added as needed. Appropriate oxygen therapy reverses the vasoconstriction and reduces the PH in a relatively short time. Most patients with PH do not have hypoxemia at rest but require supplemental oxygen with exercise. Anticoagulation should be considered for patients at risk for intrapulmonary thrombosis. Digoxin may improve right ventricular ejection fraction in some patients and may help to control heart rate; however, patients must be monitored closely for potential complications (Rubin & Hopkins, 2019).

Pharmacologic Therapy

Recent advances in pharmacologic management and medication delivery options have offered more effective treatment regimens for patients affected with PH. Medications prescribed to treat PH include calcium channel blockers and specific pathogenetic therapies, including prostanoids, endothelin receptor antagonists, phosphodiesterase-5 inhibitors, and soluble guanylate cyclase stimulants. The choice of therapeutic agents is based on many facets, including the classification group status of the patient with PH (see Chart 19-21), as well as the cost and the patient's tolerance of the agents (Hopkins

& Rubin, 2019). In addition, a vasoreactivity test may be done to identify which medication is best suited for the patient with PH; this is done during cardiac catheterization using vasodilating medications such as inhaled nitric oxide, adenosine, or prostacyclin. A positive vasoreactivity test occurs when there is a decrease of at least 10 mm Hg in the pulmonary artery pressure with an overall pressure that is less than 40 mm Hg in the presence of both an increased or unchanged cardiac output and a minimally decreased or unchanged systemic blood pressure (Hopkins & Rubin, 2019).

Patients with a positive vasoreactivity test and who do not have right-sided heart failure may be prescribed calcium channel blockers. Calcium channel blockers have a significant advantage over some medications taken to treat PH in that they may be taken orally and are generally less costly; however, because calcium channel blockers are indicated in only a small percentage of patients, other treatment options, including prostanoids, are often necessary (Hopkins & Rubin, 2019).

Prostanoids mimic the effect of the prostaglandin prostacyclin. Prostacyclin relaxes vascular smooth muscle by stimulating the production of cyclic 3',5'-adenosine monophosphate (AMP) and inhibits the growth of smooth muscle cells. Prostanoids used to treat PH include epoprostenol, iloprost, treprostinil, and selexipag. Limitations of the prostanoids include their short half-life and variable patient responses to therapy (Hopkins & Rubin, 2019). IV epoprostenol was the first FDA-approved prostanoid and is the most widely studied advanced therapy for PH. Epoprostenol has a half-life of less than 3 minutes and must be continuously delivered through a permanently implanted central venous catheter using a portable infusion pump in order to maintain therapeutic effectiveness. Although a useful therapy, it requires extensive patient education and caregiver support. An advantage to iloprostis over epoprostenol is that it is an inhaled preparation; however, it needs to be administered six to nine times daily. The first formulations of treprostinil could only be taken parenterally; however, it has recently been approved in an inhaled formulation, and an oral preparation is under development. Parenteral trepostinil can be administered IV or subcutaneously, although the subcutaneous method causes severe pain at the injection site (Hopkins & Rubin, 2019). Selexipag is the newest FDA-approved prostanoid. It is available in tablet form administered in twice-daily doses, a clear advantage over-the-other prostanoids. However, it is a costly medication and not all insurance plans cover all of its costs (Pulmonary Hypertension Association Scientific Leadership Council, 2016).

Endothelin receptor antagonists bind to vascular endothelin-1 receptors, effectively blocking constriction of the pulmonary arteries, resulting in vasodilation. Endothelin receptor antagonists used to treat PH include bosentan, ambrisentan, and macitentan. These medications are available as oral preparations. A disadvantage to them is that they are hepatotoxic. Liver function must be monitored in patients using these agents.

The oral medications sildenafil, tadalafil, and vardenafil are potent, specific phosphodiesterase-5 inhibitors that degrade cyclic 3',5'-guanosine monophosphate (cGMP) and promotes pulmonary vasodilation. These drugs are also prescribed to treat erectile dysfunction (Hopkins & Rubin, 2019; Korokina, Zhernakova, Korokin, et al., 2018).

Soluble guanylate cyclase stimulants, which act on the nitrous oxide pathway, are currently undergoing clinical trials to target many cardiopulmonary diseases. Riociguat, a medication in this category, is newly FDA approved for use in PH. Riociguat, an oral preparation administered three times daily, is contraindicated in patients with liver or kidney disease (Tsai, Sung, & de Jesus Perez, 2016).

Surgical Management

Lung transplantation remains an option for a select group of patients with PH who are refractory to medical therapy. Bilateral lung or heart-lung transplantation is the procedure of choice. Atrial septostomy may be considered for select patients with severe disease (Hopkins & Rubin, 2019); this procedure results in shunting of blood from the right side of the heart to the left, decreasing the strain on the right side of the heart and maintaining left ventricular output.

Nursing Management

The major nursing goal is to identify patients at high risk for PH, such as those with COPD, PE, congenital heart disease, and mitral valve disease so that early treatment can commence. The nurse must be alert for signs and symptoms, administer oxygen therapy appropriately, and instruct the patient and family about the use of home oxygen therapy. In patients treated with some of the prostanooids, education about the need for central venous access (epoprostenol), subcutaneous infusion (treprostinil), proper administration and dosing of the medication, pain at the injection site, and potential severe side effects is extremely important. Emotional and psychosocial aspects of this disease must be addressed. It is important to provide contact details for support services for patients and families.

Pulmonary Heart Disease (Cor Pulmonale)

Cor pulmonale is a condition that results from PH, which causes the right side of the heart to enlarge because of the increased work required to pump blood against high resistance through the pulmonary vascular system. This causes right-sided heart failure (see [Chapter 25](#) for further discussion of management of right-sided heart failure).

Pulmonary Embolism

PE refers to the obstruction of the pulmonary artery or one of its branches by a thrombus (or thrombi) that originates somewhere in the venous system or in the right side of the heart. Deep vein thrombosis (DVT), a related condition, refers to thrombus formation in the deep veins, usually in the calf or thigh, but sometimes in the arm, especially in patients with peripherally inserted central catheters. VTE is a term that includes both DVT and PE. (VTE and the medical and nursing management of patients with DVT and with PE are discussed in detail in [Chapter 26](#).)

OCCUPATIONAL LUNG DISEASE: PNEUMOCONIOSES

Pneumoconiosis is a general term given to any lung disease caused by dusts that are breathed in and then deposited deep in the lungs causing damage. Pneumoconiosis is usually considered an occupational lung disease, and includes asbestosis, silicosis and coal workers' pneumoconiosis, also known as "Black Lung Disease" (American Lung Association [ALA], 2018a) (see [Table 19-6](#)). Pneumoconiosis refers to a non-

neoplastic alteration of the lung resulting from inhalation of mineral or inorganic dust (e.g., “dusty lung”). This alteration results in pulmonary fibrosis and parenchymal changes. Usually, extended exposure to irritating or toxic substances accounts for these changes, although severe single exposures may also lead to chronic lung disease. Occupational lung disease is the number one work-related illness in the United States based on its frequency, severity, and preventability (ALA, 2018a). Many people with early pneumoconiosis are asymptomatic, but advanced disease often is accompanied by disability and premature death.

TABLE 19-6 Occupational Lung Diseases: Pneumoconioses

Disease (Source)	Pathophysiology	Clinical Manifestations
Silicosis (glass manufacturing, foundry work, stone cutting)	Inhaled silica dust produces nodular lesions in the lungs. Nodules enlarge and coalesce. Dense masses form on upper portion of lungs, resulting in loss of pulmonary volume. Fibrotic destruction of pulmonary tissue can lead to restrictive lung disease, emphysema, pulmonary hypertension, and cor pulmonale	<i>Acute silicosis:</i> dyspnea, fever, cough, weight loss <i>Chronic silicosis:</i> progressive symptoms indicative of hypoxemia, severe airflow obstruction, and right-sided heart failure
Asbestosis (shipbuilding, building demolition)	Inhaled asbestos fibers enter alveoli and are surrounded by fibrous tissue. Fibrous changes can also affect the pleura, which thicken and develop plaque. These changes lead to restrictive lung disease, with a decrease in lung volume, diminished exchange of oxygen and carbon dioxide, hypoxemia, cor pulmonale, and respiratory failure. It also increases risk of lung cancer, mesothelioma, and pleural effusion	Progressive dyspnea; persistent, dry cough; mild-to-moderate chest pain; anorexia; weight loss; malaise; clubbing of the fingers
Coal worker’s pneumoconiosis	Encompasses a variety of lung diseases; is also known as black lung disease. Inhaled dusts that are mixtures of coal, kaolin, mica, and silica are deposited in the alveoli and respiratory bronchioles. When macrophages that engulf the dust can no longer be cleared, they aggregate and fibroblasts appear. The bronchioles and alveoli become clogged with dust, dying macrophages, and fibroblasts, leading to formation of coal macules. Fibrotic lesions develop and subsequently localized emphysema develops, with cor pulmonale and respiratory failure	Chronic cough, dyspnea, and expectoration of black or gray sputum, especially in coal workers who smoke and who have cavitation in the lungs

Adapted from American Lung Association (ALA). (2018a). Lung health & diseases: Pneumoconiosis. Retrieved on 10/4/2019 at: www.lung.org/lung-health-and-diseases/lung-disease-lookup/pneumoconiosis

Diseases of the lungs occur in numerous occupations as a result of exposure to several different types of agents, such as mineral dusts, metal dusts, biologic dusts, and

toxic fumes. Smoking may compound the problem and may increase the risk of lung cancers in people exposed to the mineral asbestos and other potential carcinogens (ALA, 2018b). The effects of inhaling these materials depend on the composition of the substance, its concentration, its ability to initiate an immune response, its irritating properties, the duration of exposure, and the person's response or susceptibility to the irritant.

These diseases are not curable; however, they are preventable. Therefore, a major role for nurses, especially occupational health nurses, is that of advocate for employees. Nurses need to make every effort to promote measures to reduce the exposure of workers to industrial products. Strategies to control exposure should be identified and encouraged; these strategies include the use of protective devices (facemasks, hoods, industrial respirators) to minimize exposure and screening/monitoring of individuals at risk.

Key aspects of any assessment of patients with a potential occupational respiratory history include job and job activities, exposure levels, general hygiene, time frame of exposure, smoking history, effectiveness of respiratory protection used, and direct versus indirect exposures (Goldman, 2019). Specific information that should be obtained includes the following:

- Exposure to an agent known to cause an occupational disorder
- Length of time from exposure of agent to onset of symptoms
- Congruence of symptoms with those of known exposure-related disorder
- Lack of other more likely explanations of the signs and symptoms

More than one million workers are exposed to silica each year. Symptoms rarely develop in less than 5 years. Progression of the disease results in extreme shortness of breath, loss of appetite, chest pains, and potentially respiratory failure (ALA, 2018a). Asbestosis is progressive and causes severe scarring of the lung, which leads to fibrosis. The lungs become stiff, making it difficult to breathe or to oxygenate well. The disease may not evidence manifestations until 10 to 40 years after exposure (ALA, 2018a). Coal worker's pneumoconiosis is a collection of lung disease caused by exposure to inhaled dusts.

The nurse provides education about preventive measures to patients and their families, assesses patients for a history of exposure to environmental agents, and makes referrals so that pulmonary function can be evaluated and the patient can be treated early in the course of the disease. These diseases have no effective treatment because damage is irreversible. Supportive therapy is aimed at preventing infections and managing complications.



Veterans Considerations

Many American veterans who served in Iraq and Afghanistan are experiencing respiratory disorders as a result of exposure to pollutants in situations such as sand storms and car bombings. Their illnesses can range from a new onset of asthma to constrictive bronchiolitis (Harrington, Schmidt, Szema, et al., 2017). These veterans could also have been exposed to organic contamination within the sand that could further irritate airways. When providing care to a veteran, it is important to assess

exposure to airway irritants, particularly when the patient is complaining of chronic respiratory symptoms.

CHEST TUMORS

Tumors of the lung may be benign or malignant. A malignant chest tumor can be primary, arising within the lung, chest wall, or mediastinum or it can be a metastasis from a primary tumor site elsewhere in the body.

Lung Cancer (Bronchogenic Carcinoma)

Lung cancer is the leading cancer killer among men and women in the United States, with about 1 out of 4 cancer deaths from lung cancer; over 135,000 deaths were estimated in 2018 (Midthun, 2019). Each year, more people die of lung cancer than of colon, breast, and prostate cancers combined. Approximately 228,820 new cases of lung cancer are diagnosed annually; 13% of new cancers for men and women involve the lung or bronchus (American Cancer Society [ACS], 2019). In approximately 48.5% of patients with lung cancer, the disease has spread to regional lymphatics and other sites by the time of diagnosis. As a result, the long-term survival rate is low. Overall, the 5-year survival rate is 21.7% (ALA, 2020; Thomas & Gould, 2019).

Pathophysiology

The most common cause of lung cancer is inhaled carcinogens, most often cigarette smoke (>85%); other carcinogens include radon gas and occupational and environmental agents (ALA, 2020). Lung cancers arise from a single transformed epithelial cell in the tracheobronchial airways, in which the carcinogen binds to and damages the cell's DNA. This damage results in cellular changes, abnormal cell growth, and eventually a malignant cell. As the damaged DNA is passed on to daughter cells, the DNA undergoes further changes and becomes unstable. With the accumulation of genetic changes, the pulmonary epithelium undergoes malignant transformation from normal epithelium eventually to invasive carcinoma. Carcinoma tends to arise at sites of previous scarring in the lung (e.g., TB, fibrosis).

Classification and Staging

For purposes of staging and treatment, over 95% of lung cancers are classified into one of two major categories: small cell lung cancer (SCLC) and non-small cell lung cancer (NSCLC). SCLC represents approximately 13% of tumors, and includes small cell and combined small cell cancers. NSCLC represents approximately 84% of tumors, and these are further classified by cell type, including squamous cell (20%), large cell (5%), adenocarcinoma (41%), and others, some of which cannot be classified (18%) (ACS, 2019; Midthun, 2019).

TABLE 19-7 Five-Year Relative Survival Rates for Lung Cancer based on Surveillance, Epidemiology, End Results (SEER) Stage^a

SEER Stage	5-Year Relative Survival Rate (%)
NSCLC	
Localized	60
Regional	33
Distant	6
All SEER stages combined	23
SCLC	
Localized	29
Regional	15
Distant	3
All SEER stages combined	6

^aData are for patients diagnosed between the years 2009 and 2015. The SEER database does not group patients by the TNM system; rather, SEER categorizes patients based upon whether or not cancer has spread to distant organs/tissues (*distant*), or to proximal tissues or lymph nodes (*regional*), or has not spread outside the lung (*localized*).

NSCLC, non-small cell lung cancer; SCLC, small cell lung cancer; TNM system, a tumor staging system promulgated by the American Joint Committee on Cancer that stages cancer based upon evidence of the size of the tumor (*T*), extent of lymph node involvement (*N*), and whether or not metastasis has occurred (*M*).

Adapted from American Cancer Society (ACS). (2019). Lung cancer survival rates. Last updated 10/1/2019. Retrieved on 10/4/2019 at: www.cancer.org/cancer/lung-cancer/detection-diagnosis-staging/survival-rates.html

In terms of specific types of NSCLC, squamous cell cancer is usually more centrally located and arises more commonly in the segmental and subsegmental bronchi. Adenocarcinoma is the most prevalent carcinoma of the lung in both men and women; it occurs peripherally as peripheral masses or nodules and often metastasizes. Large cell carcinoma (also called *undifferentiated carcinoma*) is a fast-growing tumor that tends to arise peripherally. Bronchoalveolar cell cancer is found in the terminal bronchi and alveoli and is usually slower growing compared with other bronchogenic carcinomas.

In addition to classification according to cell type, lung cancers are staged using the TNM staging system. The stage of the tumor refers to the size of the tumor, its location, whether lymph nodes are involved, and whether the cancer has spread (ACS, 2019). NSCLC is staged as I to IV. Stage I is the earliest stage and has the highest cure rate, whereas stage IV designates metastatic spread. Survival rates for NSCLC are shown in Table 19-7. (Diagnostic tools and further information on staging are described in Chapter 12.)

Risk Factors

The National Comprehensive Cancer Network (NCCN; 2020) asserts that 85% to 90% of all lung cancer cases are caused by cigarette smoke, whether it is from voluntary or involuntary (secondhand) smoking. Other factors that have been associated with lung cancer include genetic predisposition, dietary deficits, and underlying respiratory

diseases, such as COPD and TB. Some familial predisposition to lung cancer exists. The incidence of lung cancer in close relatives of patients with lung cancer is two to three times higher than the general population, regardless of smoking status (ACS, 2019).

Tobacco Smoke

The risk of developing lung cancer is about 23 times higher in men who smoke and 13 times higher in women who smoke compared to individuals who have never smoked (ACS, 2019). Risk is determined by the pack-year history (number of packs of cigarettes used each day, multiplied by the number of years smoked), the age of initiation of smoking, the depth of inhalation, and the tar and nicotine levels in the cigarettes smoked. The younger a person is when they start smoking, the greater the risk of developing lung cancer. People who smoke and use smokeless products as a supplemental source of nicotine have an increased overall risk of lung cancer (ACS, 2019).

Almost all cases of SCLC are due to cigarette smoking. SCLC is rare in people who have never smoked. It is the most aggressive form of lung cancer, grows quickly, and usually starts in the airways in the center of the chest (ACS, 2019).

Electronic Nicotine Delivery Systems

Electronic nicotine delivery systems (ENDS) include e-cigarettes, e-pens, e-pipes, e-hookahs, and e-cigars. According to a 2018 survey of 44,000 high school adolescents, 37% of 12th graders self-reported use of e-cigarettes (NIH News in Health, 2019). The amounts of nicotine and other substances a person gets from each cartridge are also unclear and have been found to vary greatly even when comparing same brand cartridges from the same manufacturer. Since these ENDS products have only been available for about a decade, the link between their use and lung cancer is unclear at the present time (ACS, 2019).

Secondhand Smoke

Secondhand or involuntary smoking has been identified as a cause of lung cancer in people who do not smoke. People who are involuntarily exposed to tobacco smoke in a closed environment (house, automobile, building) have an increased risk of lung cancer when compared with unexposed individuals who do not smoke (CDC, 2018a; NCCN, 2020).

Environmental and Occupational Exposure

Various carcinogens have been identified in the atmosphere, including motor vehicle emissions and pollutants from refineries and manufacturing plants. Evidence suggests that the incidence of lung cancer is greater in urban areas as a result of the buildup of pollutants and motor vehicle emissions (ALA, 2018b).

Radon is a colorless, odorless gas found in soil and rocks. For many years, it has been associated with uranium mines, but it is now known to seep into homes through ground rock. High levels of radon have been associated with the development of lung cancer, especially when combined with cigarette smoking. Homeowners are advised to

have radon levels checked in their houses and to arrange for special venting if the levels are high.

Chronic exposure to industrial carcinogens, such as arsenic, asbestos, mustard gas, chromates, coke oven fumes, nickel, oil, and radiation, has been associated with the development of lung cancer. Laws have been passed to control exposure to these carcinogens in the workplace.

Genetic Mutations

Genetic mutations can cause certain changes in the DNA of lung cells. These changes can lead to abnormal cell growth and, sometimes, cancer. Acquired mutations in lung cells often result from exposure to factors in the environment, such as cancer-causing chemicals in tobacco smoke (ACS, 2019). The most common genetic mutations occur in *EGFR* (the gene that produces epidermal growth factor receptor) and the *K-RAS* or *ALK* oncogenes. *EGFR* is abnormal in about 50% of all patients with lung cancer. Abnormalities in *K-RAS* or *ALK* oncogenes are thought to be important in the development of NSCLC (ACS, 2019).

Clinical Manifestations

Often, lung cancer develops insidiously and is asymptomatic until late in its course. The signs and symptoms depend on the location and size of the tumor, the degree of obstruction, and the existence of metastases to regional or distant sites.

The most frequent symptom of lung cancer is cough or change in a chronic cough. People frequently ignore this symptom and attribute it to smoking or a respiratory infection. The cough may start as a dry, persistent cough, without sputum production. When obstruction of airways occurs, the cough may become productive due to infection.



Quality and Safety Nursing Alert

A cough that changes in character should arouse suspicion of lung cancer.

Dyspnea is prominent in patients early in their disease. Causes of dyspnea may include tumor occlusion of the airway or lung parenchyma, pleural effusion, pneumonia, or complications of treatment. Hemoptysis or blood-tinged sputum may be expectorated. Chest or shoulder pain may indicate chest wall or pleural involvement by a tumor. Pain also is a late manifestation and may be related to metastasis to the bone.

In some patients, a recurring fever is an early symptom in response to a persistent infection in an area of pneumonitis distal to the tumor. In fact, cancer of the lung should be suspected in people with repeated unresolved upper respiratory tract infections. If the tumor spreads to adjacent structures and regional lymph nodes, the patient may present with chest pain and tightness, hoarseness (involving the recurrent laryngeal nerve), dysphagia, head and neck edema, and symptoms of pleural or pericardial effusion. The most common sites of metastases are lymph nodes, bone, brain, contralateral lung, adrenal glands, and liver (see Fig. 19-10). Nonspecific

symptoms of weakness, anorexia, and weight loss also may be present (Eldridge, 2020).

Assessment and Diagnostic Findings

If pulmonary symptoms occur in individuals who currently smoke or who formerly smoked, or in people chronically exposed to secondhand smoke, cancer of the lung should be considered. A chest x-ray is performed to search for pulmonary density, a solitary pulmonary nodule (coin lesion), atelectasis, and infection. CT scans of the chest are used to identify small nodules not easily visualized on the chest x-ray and also to serially examine areas for lymphadenopathy. Additionally, the U.S. Preventive Services Task Force (USPSTF) recommends annual lung cancer screening using low dose CT (LDCT) for adults 55 to 80 years of age who have a 30 pack-year smoking history and either currently smoke or have quit smoking less than 15 years ago. Each pack-year is calculated based upon smoking one pack of cigarettes daily for 1 year; for instance, a 30 pack-year is defined as smoking one pack of cigarettes daily for 30 years, or 3 packs daily for 10 years (CDC, 2019e).

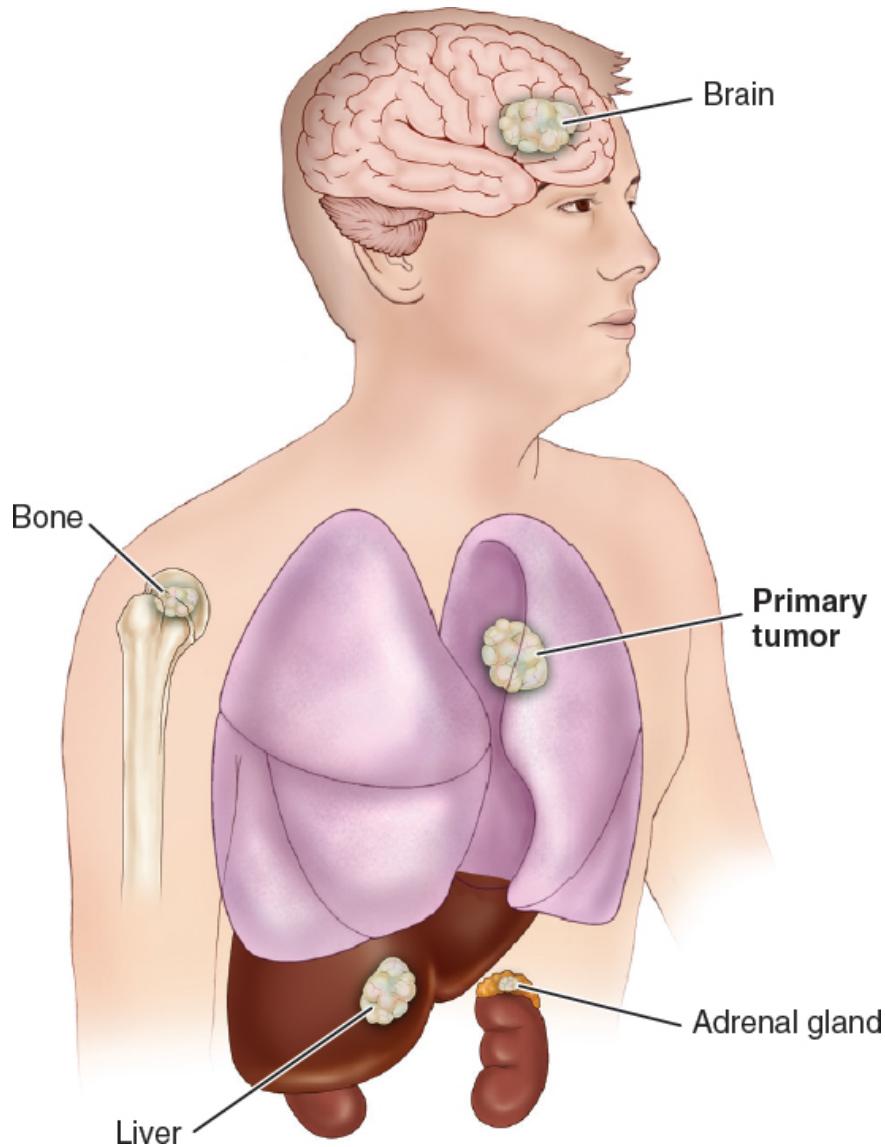


Figure 19-10 • Frequent sites of lung cancer metastasis.

Fiberoptic bronchoscopy is commonly used to diagnose lung cancer; it provides a detailed study of the tracheobronchial tree and allows for brushings, washings, and biopsies of suspicious areas. For peripheral lesions not amenable to bronchoscopic biopsy, a transthoracic fine-needle aspiration may be performed under CT guidance to aspirate cells from a suspicious area.

A variety of scans may be used to assess for metastasis of the cancer. These may include bone scans, abdominal scans, positron emission tomography (PET) scans, and liver ultrasound. CT scan of the brain, magnetic resonance imaging (MRI), and other neurologic diagnostic procedures are used to detect central nervous system metastases. Mediastinoscopy or mediastinotomy may be used to obtain biopsy samples from lymph nodes in the mediastinum. Endobronchial ultrasound biopsy of mediastinal nodes is also used. In some circumstances, an endoscopy with esophageal ultrasound may be used to obtain a transesophageal biopsy of enlarged subcarinal lymph nodes.

If surgery is a potential treatment, the patient is evaluated to determine whether the tumor is resectable and whether the patient can tolerate the physiologic impairment resulting from such surgery. Preoperative diagnostic studies provide a baseline for comparison during the postoperative period and detect additional abnormalities. Studies can be comprehensive and may include a bronchoscopic examination (a lighted scope is inserted into the airways to examine the bronchi), chest x-ray, MRI, ECG (for arteriosclerotic heart disease, conduction defects), nutritional assessment, determination of BUN and serum creatinine levels (to assess renal function), determination of glucose tolerance or blood glucose level (to check for diabetes), serum electrolytes and protein levels, blood volume determinations, complete blood cell count (CBC), pulmonary function tests, arterial blood gas analysis, V/Q scans, and exercise testing.

Medical Management

The objective of management is to provide a cure, if possible. Treatment depends on the cell type, the stage of the disease, and the patient's physiologic status (particularly cardiac and pulmonary status). In general, treatment for patients with NSCLC may involve surgery, radiation therapy, chemotherapy, immunotherapy—or a combination of these. Immunotherapy specifically targets patients' immune cells so that they are primed to more effectively kill cancer cells. Gene therapy using agents that target specific genetic mutations including *EGFR* mutations and *ALK* and *ROS1* rearrangements have shown promising results (Eldridge, 2020).

Treatment for patients with SCLC may include surgery (but only if the cancer is in one lung and there is no metastasis), radiation therapy, laser therapy to open airways blocked by tumor growth, and endoscopic stent placement (to open an airway). Although the cancer cells are small, they grow very quickly and create large tumors. These tumors often metastasize (spread) rapidly to other parts of the body, including the brain, liver, and bone. Typically, by the time a patient is diagnosed with SCLC, it is late in the course of the disease and metastasis has occurred.

Surgical Management: Thoracotomy

A **thoracotomy** (creation of a surgical opening into the thoracic cavity) may be performed to treat lung cancer. As noted previously, surgery is primarily used for patients with NSCLC, because SCLC grows rapidly and metastasizes early and extensively. Surgical resection is the preferred method of treating patients with localized NSCLCs without evidence of metastatic spread, and with adequate cardiopulmonary function. However, coronary artery disease, pulmonary insufficiency, and other comorbidities may contraindicate surgical intervention. The cure rate of surgical resection depends on the type and stage of the cancer. Several different types of lung resection may be performed (see [Chart 19-22](#)). The most common surgical procedure for a small, apparently curable tumor of the lung is lobectomy (removal of a lobe of the lung). In some cases, pneumonectomy (removal of an entire lung) may be required.

Nursing Management of the Patient Having a Thoracotomy

Patients are typically admitted on the day of surgery. The nurse in the outpatient surgical clinic setting is responsible for performing the preoperative assessment and education and for alleviating the anxiety experienced by the patient and family members by providing them with anticipatory guidance. Postoperatively, the patient may be managed by the nurse in the ICU. Successfully managing transitions in care for the patient from the ICU to other inpatient acute care settings (e.g., medical-surgical unit, step-down unit) to the outpatient setting is a key nursing responsibility.



Educating the Patient Preoperatively

The nurse informs the patient about what to expect, from administration of anesthesia to thoracotomy, and the likely use of chest tubes and a drainage system in the postoperative period. The patient is also informed about the usual postoperative administration of oxygen to facilitate breathing and the possible use of a ventilator. It is essential to explain the importance of frequent turning to promote drainage of lung secretions. Instruction in the use of incentive spirometry begins before surgery to familiarize the patient with its correct use. The nurse educates the patient on the use of diaphragmatic and pursed-lip breathing, and the patient should begin practicing these techniques (see [Chapter 20, Chart 20-5](#)).

Because a coughing schedule is necessary in the postoperative period to promote the clearance or removal of secretions, the nurse instructs the patient in the technique of coughing and warns the patient that the coughing routine may be uncomfortable. The nurse educates the patient about how to splint the incision with the hands, a pillow, or a folded towel.

Encouraging the use of forced expiratory technique (FET) may be helpful for the patient with diminished expiratory flow rates or for the patient who refuses to cough because of severe pain. FET is the expulsion of air through an open glottis. This technique stimulates pulmonary expansion and assists in alveolar inflation (Kacmarek, Stoller, Heuer, et al., 2017). The nurse instructs the patient as follows:

- Take a deep diaphragmatic breath and exhale forcefully against the hand in a quick, distinct pant, or huff.
- Practice doing small huffs and progress to one strong huff during exhalation.

Patients should be informed preoperatively that blood and other fluids may be given, oxygen will be given, and vital signs will be checked often for several hours after surgery. If a chest tube is indicated (see later discussion on Chest Drainage Systems), the patient should be informed that it will drain the fluid and air that normally accumulate after chest surgery. The patient and family are informed that the patient may be admitted to the ICU for 1 to 2 days after surgery, that the patient may experience pain at the incision site, and that medication is available to relieve pain and discomfort.

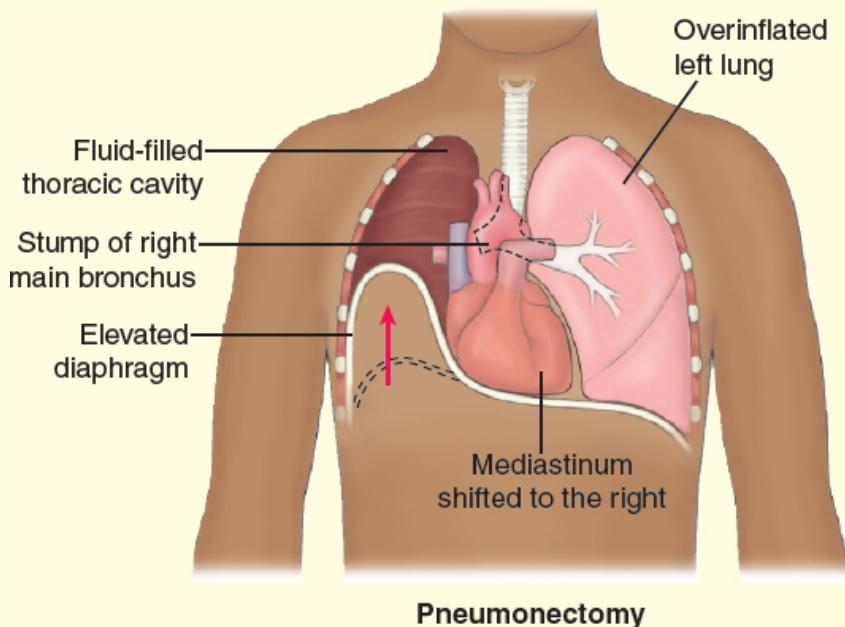
Chart 19-22

Thoracic Surgeries and Procedures

Pneumonectomy

The removal of an entire lung, referred to as pneumonectomy, is performed chiefly for cancer when the lesion cannot be removed by a less extensive procedure. It also may be performed for lung abscesses, bronchiectasis, or extensive unilateral tuberculosis. The removal of the right lung is riskier than the removal of the left, because the right lung has a larger vascular bed and its removal imposes a greater physiologic burden.

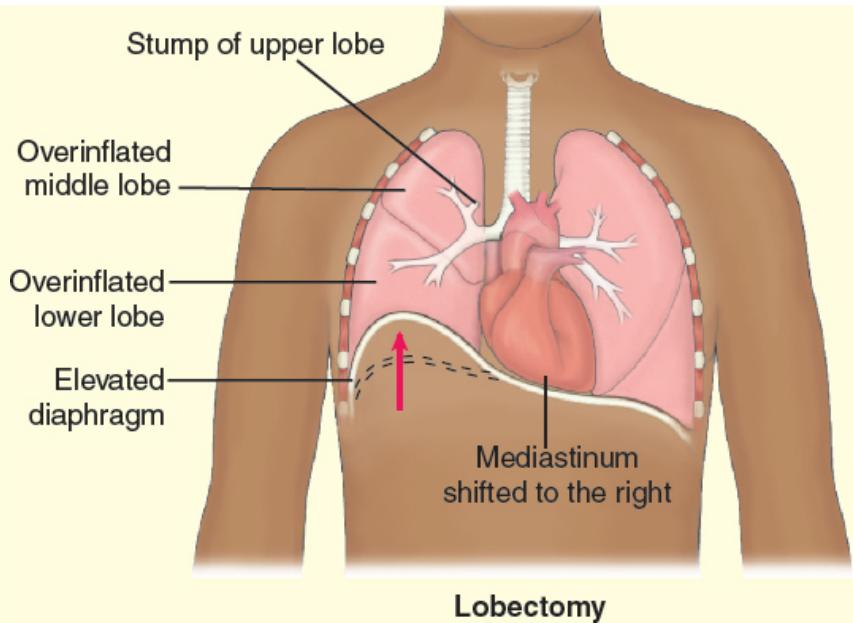
A posterolateral or anterolateral thoracotomy incision is made, sometimes with resection of a rib. The pulmonary artery and the pulmonary veins are ligated and severed. The main bronchus is divided and the lung removed. The bronchial stump is stapled, and usually no drains are used because the accumulation of fluid in the empty hemithorax prevents mediastinal shift.



Pneumonectomy

Lobectomy

When the pathology is limited to one area of a lung, a lobectomy (removal of a lobe of a lung) is performed. Lobectomy, which is more common than pneumonectomy, may be carried out for bronchogenic carcinoma, giant emphysematous blebs or bullae, benign tumors, metastatic malignant tumors, bronchiectasis, and fungal infections.



Lobectomy

The surgeon makes a thoracotomy incision. Its exact location depends on the lobe to be resected. When the pleural space is entered, the involved lung collapses and the lobar vessels and the bronchus are ligated and divided. After the lobe is removed, the remaining lobes of the lung are re-expanded. Usually, two chest catheters are inserted for drainage. The upper tube is for air removal; the lower one is for fluid drainage. Sometimes, only one catheter is needed. The chest tube is connected to a chest drainage apparatus for several days.

Segmentectomy (Segmental Resection)

Some lesions are located in only one segment of the lung. Bronchopulmonary segments are subdivisions of the lung that function as individual units. They are held together by delicate connective tissue. Disease processes may be limited to a single segment. Care is used to preserve as much healthy and functional lung tissue as possible, especially in patients who already have limited cardiopulmonary reserve. Single segments can be removed from any lobe; the right middle lobe, which has only two small segments, invariably is removed entirely. On the left side, corresponding to a middle lobe, is a "lingular" segment of the upper lobe. This can be removed as a single segment or by linguectomy. This segment frequently is involved in bronchiectasis.

Wedge Resection

A wedge resection of a small, well-circumscribed lesion may be performed without regard to the location of the intersegmental planes. The pleural cavity usually is drained because of the possibility of an air or blood leak. This procedure is performed for diagnostic lung biopsy and for the excision of small peripheral nodules.

Bronchoplasty or Sleeve Resection

Bronchoplasty is a procedure in which only one lobar bronchus, together with a part of the right or left bronchus, is excised. The distal bronchus is reanastomosed to the proximal bronchus or trachea.

Lung Volume Reduction

Lung volume reduction is a surgical procedure involving the removal of 20% to 30% of a patient's lung through a midsternal incision or video thoracoscopy. The diseased lung tissue is identified on a lung perfusion scan. This surgery leads to significant improvements in dyspnea, exercise capacity, quality of life, and survival of a subgroup of people with end-stage emphysema.

Video Thoracoscopy

A video thoracoscopy is an endoscopic procedure that allows the surgeon to look into the thorax without making a large incision. The procedure is performed to obtain specimens of tissue for biopsy, to treat recurrent spontaneous pneumothorax, and to diagnose either pleural effusions or pleural masses. Thoracoscopy has also been found to be an effective diagnostic and therapeutic alternative for the treatment of mediastinal disorders. Some advantages of video thoracoscopy are rapid diagnosis and treatment of some conditions, a decrease in postoperative complications, and a shortened hospital stay.

Adapted from Urden, L. D., Stacy, K. M., & Lough, M. E. (2018). *Critical care nursing: Diagnosis and management* (8th ed.). St. Louis, MO: Elsevier Mosby.

The nurse listens to the patient and family to evaluate their feelings about the illness and proposed treatment. The nurse also determines the patient's motivation to return to normal or baseline function. The patient may reveal significant concerns: fear of hemorrhage because of bloody sputum, fear of discomfort from a chronic cough and chest pain, fear of ventilator dependence, or fear of death because of dyspnea and the underlying disease.

The nurse helps the patient to address fears and to cope with the stress of surgery by correcting any misconceptions, supporting the patient's decision to undergo surgery, and dealing honestly with questions about pain and discomfort and the patient's treatment. The management and control of pain begin before surgery, when the nurse informs the patient that many postoperative problems can be overcome by following certain routines related to deep breathing, coughing, turning, and moving. Nonopioid preemptive analgesic agents (e.g., acetaminophen and nonsteroidal anti-inflammatory drugs [NSAIDs]) may also be prescribed to help decrease the dose of postoperative opioid agents. This also helps to facilitate deep-breathing techniques and return to normal respiratory function. If patient-controlled analgesia (PCA) or patient-controlled epidural analgesia (PCEA) is to be used after surgery, the nurse instructs the patient in its use.



Postoperative Management

After surgery, the vital signs are checked frequently. Oxygen is given by a mechanical ventilator, nasal cannula, or mask for as long as necessary. A reduction in lung capacity requires a period of physiologic adjustment, and fluids may be given at a low hourly rate to prevent fluid overload and pulmonary edema. After the patient has recovered from anesthesia and the vital signs have stabilized, the head of the bed may be elevated 30 to 45 degrees. Careful positioning of the patient is important. After pneumonectomy, a patient is usually turned every hour from the back to the operative side and should not be completely turned to the unoperated side. This allows the fluid left in the space to consolidate and prevents the remaining lung and the heart from

shifting (mediastinal shift) toward the operative side. The patient with a lobectomy may be turned to either side, and a patient with a segmental resection usually is not turned onto the operative side unless the surgeon prescribes this position (see [Chart 19-23: Plan of Nursing Care: Care of the Patient After Thoracotomy](#)).

Complications after thoracic surgery are always possible and must be identified and managed early. The nurse monitors the patient at regular intervals for signs of respiratory distress or developing respiratory failure, arrhythmias, bronchopleural fistula, hemorrhage and shock, atelectasis, and incisional or pulmonary infection. Arrhythmias are often related to the effects of hypoxia or the surgical procedure. They are treated with antiarrhythmic medication and supportive therapy (see [Chapter 22](#)). Pulmonary infections or effusion, often preceded by atelectasis, may occur a few days into the postoperative course.

Pneumothorax may occur after thoracic surgery if there is an air leak from the surgical site to the pleural cavity or from the pleural cavity to the environment. Failure of the chest drainage system prevents return of negative pressure in the pleural cavity and results in pneumothorax. In the patient who is postoperative, pneumothorax is often accompanied by hemothorax. The nurse maintains the chest drainage system and monitors the patient for signs and symptoms of pneumothorax (see later discussions): increasing shortness of breath, tachycardia, increased respiratory rate, and increasing respiratory distress. Bronchopleural fistula is a serious but rare complication that prevents the return of negative intrathoracic pressure and lung re-expansion. Depending on its severity, it is treated with continued closed chest drainage and mechanical ventilation.

Hemorrhage and shock are managed by treating the underlying cause, whether by reoperation or by administration of blood products or fluids. Pulmonary edema from overinfusion of IV fluids is a significant danger. Early symptoms are dyspnea; crackles; tachycardia; and pink, frothy sputum. This constitutes an emergency and must be reported and treated immediately (see [Chapter 25](#) for further discussion).

Medication for pain is needed for several days after surgery; it is usually a combination of epidural analgesia, PCA, and scheduled or as-needed oral analgesics. Because coughing can be painful, the patient should be encouraged to splint the chest as taught in the preoperative period. Exercises are resumed early in the postoperative period to facilitate lung ventilation. The nurse assesses for signs of complications, including cyanosis, dyspnea, and acute chest pain. These may indicate atelectasis and should be reported immediately. Increased temperature or white blood cell count may indicate an infection, and pallor and increased pulse may indicate internal hemorrhage. Dressings are assessed for fresh bleeding.

Promoting Home, Community-Based, and Transitional Care

The nurse educates the patient and family about postoperative care that will be continued in the community setting and at home.



Educating Patients About Self-Care

The nurse explains signs and symptoms that should be reported to the primary provider. These include the following:

- Change in respiratory status, such as increasing shortness of breath, fever, increased restlessness or other changes in mental or cognitive status, increased respiratory rate, change in respiratory pattern, change in amount or color of sputum
- Bleeding or other drainage from the surgical incision or chest tube exit sites
- Increased chest pain

In addition, respiratory care and other treatment modalities (oxygen; incentive spirometry; CPT; and oral, inhaled, or IV medications) may be continued at home. Therefore, the nurse needs to instruct the patient and family in their correct and safe use.

The nurse emphasizes the importance of progressively increased activity. The patient is instructed to ambulate within limits and informed that return of strength is likely to be very gradual. Another important aspect of patient education addresses shoulder exercises. The patient is instructed to do these exercises five times daily (see [Chart 19-24](#)). Additional patient education is described in [Chart 19-25](#).

Chart 19-23 PLAN OF NURSING CARE

Care of the Patient After Thoracotomy

NURSING DIAGNOSIS: Impaired gas exchange associated with lung impairment and surgery

Goal: Improvement of gas exchange and breathing

Nursing Interventions	Rationale	Expected Outcomes
<ol style="list-style-type: none"> 1. Monitor pulmonary status as directed and as needed. <ol style="list-style-type: none"> a. Auscultate breath sounds. b. Check rate, depth, and pattern of respirations. c. Assess blood gases for signs of hypoxemia or CO₂ retention. d. Evaluate patient's color for cyanosis. 2. Monitor and record blood pressure, apical pulse, and temperature every 2 to 4 hours, and central venous pressure (if indicated) every 2 hours. 3. Monitor continuous electrocardiogram for pattern and arrhythmias. 4. Elevate head of bed 30° to 40° when patient is oriented and hemodynamic status is stable. 5. Encourage deep-breathing exercises and effective use of incentive spirometer. 6. Encourage and promote an effective cough routine to be performed every hour during first 24 hours. 7. Assess and monitor the chest drainage system.^a <ol style="list-style-type: none"> a. Assess for leaks and patency as needed (see procedural guidelines for setting up and managing chest drainage systems at thepoint.lww.com/Brunner15e). b. Monitor amount and character of drainage and document every 2 hours. Notify primary provider if drainage is ≥150 mL/h. 	<ol style="list-style-type: none"> 1. Changes in pulmonary status indicate improvement or onset of complications. 2. Vital signs aid in evaluating effect of surgery on cardiac status. 3. Arrhythmias (especially atrial fibrillation and atrial flutter) are more frequently seen after thoracic surgery. A patient with total pneumonectomy is especially prone to cardiac irregularity. 4. Maximum lung excursion is achieved when patient is as close to upright as possible. 5. Helps to achieve maximal lung inflation and to open closed airways 6. Coughing is necessary to remove retained secretions. 7. System is used to eliminate any residual air or 	<ul style="list-style-type: none"> • Lungs are clear on auscultation. • Respiratory rate is within acceptable range with no episodes of dyspnea. • Vital signs are stable. • Arrhythmias are not present or are treated effectively. • Demonstrates deep, controlled, effective breathing to allow maximal lung expansion. • Uses incentive spirometer every 2 hours while awake. • Demonstrates deep, effective coughing technique. • Lungs are expanded to capacity (evidenced by chest x-ray).

fluid after thoracotomy.

NURSING DIAGNOSIS: Impaired airway clearance associated with lung impairment, anesthesia, and pain

Goal: Improvement of airway clearance and achievement of a patent airway

Nursing Interventions	Rationale	Expected Outcomes
<ol style="list-style-type: none">1. Maintain an open airway.2. Perform endotracheal suctioning until patient can cough effectively.3. Assess and medicate for pain. Encourage deep-breathing and coughing exercises. Help splint incision during coughing.4. Monitor amount, viscosity, color, and odor of sputum. Notify primary provider if sputum is excessive or contains bright-red blood.5. Administer humidification and small-volume nebulizer therapy as prescribed.6. Perform postural drainage, percussion, and vibration as prescribed. Do not percuss or vibrate directly over operative site.7. Auscultate both sides of chest to determine changes in breath sounds.	<ol style="list-style-type: none">1. Provides for adequate ventilation and gas exchange.2. Endotracheal secretions are present in excessive amounts in patients who are postthoracotomy due to trauma to the tracheobronchial tree during surgery, diminished lung ventilation, and cough reflex.3. Helps to achieve maximal lung inflation and to open closed airways. Coughing is painful; incision needs to be supported.4. Changes in sputum suggest presence of infection or change in pulmonary status. Colorless sputum is not unusual; opacification or coloring of sputum may indicate	<ul style="list-style-type: none">• Airway is patent.• Coughs effectively.• Splints incision while coughing.• Sputum is clear or colorless.• Lungs are clear on auscultation.

- dehydration or infection.
5. Secretions must be moistened and thinned if they are to be raised from the chest with the least amount of effort.
 6. Chest physiotherapy uses gravity to help remove secretions from the lung.
 7. Indications for tracheal suctioning are determined by chest auscultation.

NURSING DIAGNOSIS: Acute pain associated with incision, drainage tubes, and the surgical procedure

Goal: Relief of pain and discomfort

Nursing Interventions	Rationale	Expected Outcomes
<ol style="list-style-type: none"> 1. Evaluate location, character, quality, and severity of pain. Administer analgesic medication as prescribed and as needed. Observe for respiratory effect of opioid. Note if patient seems too somnolent to cough or if respirations are depressed. 2. Maintain care postoperatively in positioning the patient. <ol style="list-style-type: none"> a. Place patient in semi-Fowler position. b. Patients with limited respiratory reserve may not be able to turn on unoperated side. c. Assist or turn patient every 2 hours. 3. Assess incision area every 8 hours for redness, heat, 	<ol style="list-style-type: none"> 1. Pain limits chest excursions and thereby decreases ventilation. 2. The patient who is comfortable and free of pain will be less likely to splint the chest while breathing. A semi-Fowler position permits residual air in the pleural space to rise to upper portion of pleural space 	<ul style="list-style-type: none"> • Asks for pain medication but verbalizes that they expect some discomfort while deep breathing and coughing. • Verbalizes that they are comfortable and not in acute distress. • No signs of incisional infection evident.

- induration, swelling, separation, and drainage.
- Request order for patient-controlled analgesia pump if appropriate for patient.
 - These signs indicate possible infection.
 - Encouraging patient control over frequency and dose improves comfort and adherence with treatment regimen.

NURSING DIAGNOSIS: Anxiety associated with outcomes of surgery, pain, technology

Goal: Reduction of anxiety to a manageable level

Nursing Interventions	Rationale	Expected Outcomes
<ol style="list-style-type: none"> Explain all procedures in understandable language. Assess for pain and medicate, especially before potentially painful procedures. Silence all <i>unnecessary</i> alarms on technology (monitors, ventilators). Encourage and support patient while increasing activity level. Mobilize resources (family, clergy, social worker) to help patient cope with outcomes of surgery (diagnosis, change in functional abilities). 	<ol style="list-style-type: none"> Explaining what can be expected in understandable terms decreases anxiety and increases cooperation. Premedication before painful procedures or activities improves comfort and minimizes undue anxiety. <i>Unnecessary</i> alarms increase the risk of sensory overload and may increase anxiety. <i>Essential</i> alarms must be turned on at all times. 	<ul style="list-style-type: none"> States that anxiety is at a manageable level. Participates with health care team in treatment regimen. Uses appropriate coping skills (verbalization; pain relief strategies; the use of support systems such as family, clergy). Demonstrates basic understanding of technology used in care.

- Positive
4. reinforcement improves patient motivation and independence.
 5. A multidisciplinary approach promotes the patient's strengths and coping mechanisms.

NURSING DIAGNOSIS: Impaired mobility of the upper extremities associated with thoracic surgery

Goal: Increased mobility of the affected shoulder and arm

Nursing Interventions	Rationale	Expected Outcomes
<ol style="list-style-type: none"> 1. Assist patient with normal range of motion and function of shoulder and trunk. <ol style="list-style-type: none"> a. Educate about use of breathing exercises to mobilize thorax. b. Encourage skeletal exercises to promote abduction and mobilization of shoulder (see Chart 19-23). c. Assist out of bed to chair as soon as pulmonary and circulatory systems are stable (usually by evening of surgery). 2. Encourage progressive activities according to level of fatigue. 	<ol style="list-style-type: none"> 1. Necessary to regain normal mobility of arm and shoulder and to speed recovery and minimize discomfort 2. Increases patient's use of affected shoulder and arm 	<ul style="list-style-type: none"> • Demonstrates arm and shoulder exercises and verbalizes intent to perform them on discharge. • Regains previous range of motion in shoulder and arm.

NURSING DIAGNOSIS: Risk for hypovolaemia associated with the surgical procedure

Goal: Maintenance of adequate fluid volume

Nursing Interventions	Rationale	Expected Outcomes
1. Monitor and record hourly intake and output. Urine output should be at least 0.5 mL/kg/h over 6 hours and at least 400 mL in 24 hours after surgery.	1. Fluid management may be altered before, during, and after surgery, and patient's response to and need for fluid management must be assessed.	<ul style="list-style-type: none"> Patient is adequately hydrated, as evidenced by: <ul style="list-style-type: none"> Urine output >0.5 mL/kg/h over 6 hours, and >400 mL in 24 hours Vital signs stable, heart rate, and central venous pressure approaching normal No excessive peripheral edema
2. Administer blood component therapy and parenteral fluids and diuretics as prescribed to restore and maintain fluid volume.	2. Pulmonary edema due to transfusion or fluid overload is an ever-present threat; after pneumonectomy, the pulmonary vascular system has been greatly reduced.	

NURSING DIAGNOSIS: Lack of knowledge of home care procedures

Goal: Increased ability to carry out care procedures at home

Nursing Interventions	Rationale	Expected Outcomes
1. Encourage patient to practice arm and shoulder exercises 5 times daily at home.	1. Exercise accelerates recovery of muscle function and reduces long-term pain and discomfort.	<ul style="list-style-type: none"> Demonstrates arm and shoulder exercises. Verbalizes need to try to assume an erect posture. Verbalizes the importance of relieving discomfort, alternating walking and rest, performing breathing exercises, avoiding heavy lifting, avoiding undue fatigue, avoiding bronchial irritants, preventing colds or lung infections, getting influenza
2. Instruct patient to practice assuming a functionally erect position	2. Practice will help restore normal posture. 3. Knowing what to expect facilitates recovery.	

<p>in front of a full-length mirror.</p> <p>3. Instruct patient about home care (see Chart 19-25).</p>	<p>vaccine, keeping follow-up visits, and stopping smoking.</p>
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^aA patient with a pneumonectomy usually does not have water-seal chest drainage because it is desirable that the pleural space fill with an effusion, which eventually obliterates this space. Some surgeons do use a modified water-seal system.

Continuing and Transitional Care

Depending on the patient's physical status and the availability of family assistance, a referral for home, community-based, or transitional care may be indicated. The home health nurse assesses the patient's recovery from surgery, with special attention to respiratory status, the surgical incision, chest drainage, pain control, ambulation, and nutritional status. The patient's use of respiratory modalities is assessed to ensure that they are being used correctly and safely. In addition, the nurse assesses the patient's adherence to the postoperative treatment plan and identifies acute or late postoperative complications.

The recovery process may take longer than the patient had expected, and providing support to the patient is an important task for the nurse. Because of shorter hospital stays, follow-up appointments with the primary provider are essential. The nurse educates the patient about the importance of keeping follow-up appointments and completing laboratory tests as prescribed to assist the primary provider in evaluating recovery. The nurse provides continuous encouragement and education to the patient and family during the process. As recovery progresses, the patient and family are reminded about the importance of participating in health promotion activities and recommended health screening.

Radiation Therapy

Radiation therapy may offer cure in a small percentage of patients with lung cancer. It is useful in controlling neoplasms that cannot be surgically resected but are responsive to radiation. Irradiation also may be used to reduce the size of a tumor, to make an inoperable tumor operable, or to relieve the pressure of the tumor on vital structures. It can reduce symptoms of spinal cord metastasis and superior vena caval compression. In addition, prophylactic brain irradiation is used in certain patients to treat microscopic metastases to the brain. Radiation therapy may help relieve cough, chest pain, dyspnea, hemoptysis, and bone and liver pain. Relief of symptoms may last from a few weeks to many months and is important in improving the quality of the remaining period of life. Stereotactic ablative radiotherapy (SABR) is a treatment option that delivers higher-than-typical doses of radiation directly to the tumor. This treatment is given over 1 to 5 days and is indicated for early stages of lung cancers in

patients who either elect to not have surgery or are considered ineligible for surgery (ACS, 2019).

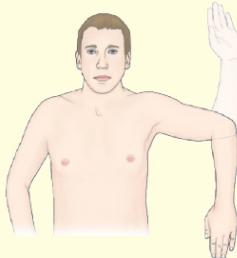
Chart 19-24 PATIENT EDUCATION

Performing Arm and Shoulder Exercises

Arm and shoulder exercises are performed after thoracic surgery to restore movement, prevent painful stiffening of the shoulder, and improve muscle power. The nurse instructs the patient to perform these exercises as follows:



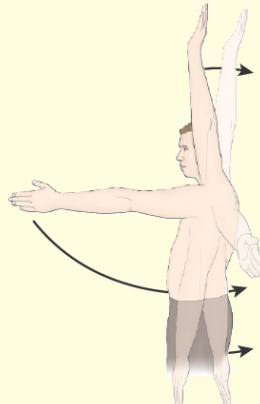
Hold hand of the affected side with the other hand, palms facing in. Raise the arms forward, upward, and then overhead, while taking a deep breath. Exhale while lowering the arms. Repeat five times.



Raise arm sideward, upward, and downward in a waving motion



Place arm at side. Raise arm sideward, upward, and then overhead. Repeat five times. These exercises can also be performed while lying in bed.



Extend the arm up and back, out to the side and back, down at the side, and back.



Place hands in small of back. Push elbows as far back as possible.



Sit erect in an armchair; place the hands on arms of the chair. Press down on hands, consciously pulling the abdomen in and stretching up from the waist. Inhale while raising the body until elbows are extended completely. Hold this position a moment, and begin exhaling while lowering the body slowly to the original position.

Radiation therapy usually is toxic to normal tissue within the radiation field, and this may lead to complications such as esophagitis, pneumonitis, and radiation lung fibrosis, although the incidence of these complications has decreased over time with improvements in delivery of radiation therapy (ACS, 2019). These complications may impair ventilatory and diffusion capacity and significantly reduce pulmonary reserve. The patient's nutritional status, psychological outlook, fatigue level, and signs of

anemia and infection are monitored throughout the treatment (see [Chapter 12](#) for management of the patient receiving radiation therapy).

Chart 19-25



HOME CARE CHECKLIST

The Patient with a Thoracotomy

At the completion of education, the patient and/or caregiver will be able to:

- Name the procedure that was performed and identify any permanent changes in anatomic structure or function as well as changes in ADLs, IADLs, roles, relationships, and spirituality.
- State the name, dose, side effects, frequency, and schedule for all medications.
- Identify interventions and strategies (e.g., durable medical equipment, oxygen, and adaptive equipment) used in adapting to any permanent changes in structure or function.
- Describe ongoing postoperative therapeutic regimen, including diet and activities to perform (e.g., walking and breathing exercises) and to limit or avoid (e.g., lifting weights, driving a car, and contact sports).
 - Alternate walking and other activities with frequent rest periods, expecting weakness and fatigue for the first 3 weeks.
 - Walk at a moderate pace, gradually and persistently extending walking time and distance.
 - Perform arm and shoulder exercises as prescribed.
 - Perform breathing exercises several times daily for the first few weeks at home.
 - Avoid lifting >20 lb until complete healing has taken place; the chest muscles and incision may be weaker than normal for 3 to 6 months after surgery.
 - Use local heat and oral analgesia to relieve intercostal pain.
 - Immediately stop any activity that causes undue fatigue, increased shortness of breath, or chest pain.
 - Avoid bronchial irritants (smoke, fumes, air pollution, aerosol sprays).
 - Avoid others with known colds or lung infections.
- Describe signs and symptoms of complications (e.g., increased shortness of breath, fever, restlessness, mental status changes, change in rate or pattern of respiration, increased pain, or bleeding from incision).
- Relate how to reach primary provider with questions or complications.
- State time and date of follow-up appointments.
- Obtain an annual influenza vaccine, and discuss vaccination against pneumonia with the primary provider.
- State understanding of community resources and referrals (if any).
- Identify the need for health promotion (e.g., weight reduction, smoking cessation, and stress management), disease prevention and screening activities

Resources

See Chapter 20, Chart 20-7 for additional information on oxygen therapy at home and Chart 19-23 for additional information on performing arm and shoulder exercises.

ADLs, activities of daily living; IADLs, instrumental activities of daily living.

Chemotherapy

Chemotherapy is used to alter tumor growth patterns, to treat distant metastases or small cell cancer of the lung, and as an adjunct to surgery or radiation therapy. Chemotherapy may provide relief, especially of pain, but it does not usually cure the disease or prolong life to any great degree. Chemotherapy is also accompanied by side effects. It is valuable in reducing pressure symptoms of lung cancer and in treating brain, spinal cord, and pericardial metastasis (see [Chapter 12](#) for a discussion of chemotherapy for the patient with cancer).

The choice of agent depends on the growth of the tumor cell and the specific phase of the cell cycle that the medication affects. In combination with surgery, chemotherapy may be given before surgery (neoadjuvant therapy) or after surgery (adjuvant therapy). Specific guidelines are available for the treatment of differing stages of NSCLC and SCLC through the NCCN (2020).

Immunotherapy

Advances in immunotherapy have provided additional options for the treatment of advanced NSCLC and SCLC. Immunotherapy drugs referred to as checkpoint inhibitors are indicated for the treatment of unresectable stage III tumors in addition to lung cancers that have metastasized. These agents target programmed cell death proteins such as PD-1 or PD-L1 on T cells that prevent T cells from attacking other cells in the body. By blocking these PD proteins, the T cells are able to mount a better immune response against the tumor cells, more quickly and effectively killing them. Four checkpoint inhibitors are FDA-approved for use with lung cancer. The first three, pembrolizumab, nivolumab, and atezolizumab, are approved for use in metastatic lung cancer (Hellman & West, 2020; Yang, Zhang, & Wang, 2019). In addition, pembrolizumab combined with chemotherapy may be used as a first-line treatment for metastatic NSCLC. Durvalumab is the only agent approved for nonoperable stage III NSCLC (Hellmann & West, 2020). Checkpoint inhibitors are delivered by IV infusion every 2, 3, or 4 weeks over several months or up to 1 year. They are generally well tolerated with few adverse effects, particularly as compared to chemotherapeutic agents. Side effects include fatigue, rashes, and diarrhea (ACS, 2019).

Palliative Care

Palliative care, concurrent with standard oncologic care for lung cancer, should be considered early in the course of illness for any patient with metastatic cancer or high symptom burden. In lung cancer, palliative therapy may include radiation therapy to shrink the tumor to provide pain relief, a variety of bronchoscopic interventions to open a narrowed bronchus or airway, and pain management and other comfort measures. Evaluation and referral for hospice care are important in planning for comfortable and dignified end-of-life care for the patient and family (see [Chapter 13](#) for further discussion).

Complications

A variety of complications may occur as a result of treatment of lung cancer. Surgical resection may result in respiratory failure, particularly if the cardiopulmonary system is compromised before surgery. Surgical complications and prolonged mechanical

ventilation are potential outcomes. Despite advances in improved delivery of radiation therapy, complications may still ensue, including diminished cardiopulmonary function and other complications, such as pulmonary fibrosis, pericarditis, myelitis, and cor pulmonale (Benveniste, Gomez, Brett, et al., 2019). Chemotherapy, particularly in combination with radiation therapy, can cause pneumonitis. Pulmonary toxicity is a potential side effect of chemotherapy.

Nursing Management

Nursing care of patients with lung cancer is similar to that for other patients with cancer (see [Chapter 12, Chart 12-6](#)) and addresses the physiologic and psychological needs of the patient. The physiologic problems are primarily due to the respiratory manifestations of the disease. Nursing care includes strategies to ensure relief of pain and discomfort and to prevent complications.

Managing Symptoms

The nurse educates the patient and family about the potential side effects of the specific treatment and strategies to manage them. Strategies for managing such symptoms as dyspnea, fatigue, nausea and vomiting, and anorexia help the patient and family cope with therapeutic measures.

Relieving Breathing Problems

Airway clearance techniques are key to maintaining airway patency through the removal of excess secretions. This may be accomplished through deep-breathing exercises, chest physiotherapy, directed cough, suctioning, and in some instances bronchoscopy. Bronchodilator medications may be prescribed to promote bronchial dilation. As the tumor enlarges or spreads, it may compress a bronchus or involve a large area of lung tissue, resulting in an impaired breathing pattern and poor gas exchange. At some stage of the disease, supplemental oxygen will probably be necessary.

Nursing measures focus on decreasing dyspnea by encouraging the patient to assume positions that promote lung expansion and to perform breathing exercises for lung expansion and relaxation. Patient education about energy conservation and airway clearance techniques is also necessary. Many of the techniques used in pulmonary rehabilitation can be applied to patients with lung cancer. Depending on the severity of disease and the patient's wishes, a referral to a pulmonary rehabilitation program may be helpful in managing respiratory symptoms.

Reducing Fatigue

Fatigue is a devastating symptom that affects quality of life in patients with cancer. It is commonly experienced by patients with lung cancer and may be related to the disease itself, the cancer treatment and complications (e.g., anemia), sleep disturbances, pain and discomfort, hypoxemia, poor nutrition, or the psychological ramifications of the disease (e.g., anxiety and depression) (see [Chapter 12](#) for nursing strategies to reduce fatigue).

Providing Psychological Support

Another important part of the nursing care of patients with lung cancer is provision of psychological support and identification of potential resources for the patient and family. Often, the nurse must help the patient and family deal with the following:

- The poor prognosis and relatively rapid progression of this disease
- Informed decision making regarding the possible treatment options
- Methods to maintain the patient's quality of life during the course of this disease
- End-of-life treatment options

Oncology nurses are employed as *nurse navigators* in oncology practice settings to help patients and their families manage and coordinate the many challenging aspects of cancer care. Jeyathevan, Lemonde, and Cooper Brathwaite (2017) studied the effectiveness of the oncology nurse navigator role in helping patients and families deal with the complexities of a diagnosis of lung cancer (see Nursing Research Profile in Chart 19-26).

Gerontologic Considerations

At the time of diagnosis of lung cancer, most patients are older than 65 years and have stage III or IV disease (Midthun, 2019). In older patients, the management of a cancer is complex and challenging. Although age is not a significant prognostic factor for overall survival and response to treatment of either NSCLC or SCLC, older patients have specific needs. The presence of comorbidities and the patient's cognitive, functional, nutritional, and social status are important issues to consider with the patient of advanced age. Depending on the comorbidities and functional status of older adult patients, chemotherapy agents, doses, and cycles may need to be adjusted to maintain quality of life.

Tumors of the Mediastinum

Tumors of the mediastinum include neurogenic tumors, tumors of the thymus, lymphomas, germ cell tumors, cysts, and mesenchymal tumors. These tumors may be malignant or benign. They are usually described in relation to location: anterior, middle, or posterior masses or tumors.

Clinical Manifestations

Nearly all symptoms of mediastinal tumors result from the pressure of the mass against important intrathoracic organs. Symptoms may include cough, wheezing, dyspnea, anterior chest or neck pain, bulging of the chest wall, heart palpitations, angina, other circulatory disturbances, central cyanosis, superior vena cava syndrome (i.e., swelling of the face, neck, and upper extremities), marked distention of the veins of the neck and the chest wall (evidence of the obstruction of large veins of the mediastinum by extravascular compression or intravascular invasion), and dysphagia and weight loss from pressure or invasion into the esophagus (Berry, 2019).

Assessment and Diagnostic Findings

Chest x-rays are the major method used initially to diagnose mediastinal tumors and cysts. A CT scan is the standard diagnostic test for the assessment of the mediastinum and surrounding structures. MRI, as well as PET, may be used in some circumstances (Berry, 2019).

Chart 19-26



NURSING RESEARCH PROFILE

The Role of the Oncology Nurse Navigator

Jeyathevan, G., Lemonde, M., & Cooper Brathwaite, A. (2017). The role of oncology nurse navigators in facilitating continuity of care within the diagnostic phase for adult patients with lung cancer. *Canadian Oncology Nursing Journal*, 27(1), 74–87.

Purpose

An emerging trend in the effective management of cancer care and treatment is the use of nurse navigators. The purpose of this phenomenologic qualitative research study was to explore the effectiveness of the oncology nurse navigator (ONN) in facilitating the care of the patient with lung cancer during the diagnostic period. Through the lens of both the ONN and the patient, the researchers explored the organizational and clinical component of the role and the impact on continuity of care and patient empowerment. This published report focused on continuity of care through the dimensions of informational, management, and relational continuity.

Design

A Bi-Dimensional Framework examining the organization and clinical role of the ONN guided this study. Using a phenomenologic approach, the “lived experience” of the patient and the ONN were explored. Purposive sampling yielded eight participants, four patients, and four ONNs. Criteria for patient participation in the study included: adults 18 years of age and older, symptoms suspicious of lung cancer, English speaking, and at least two prior contacts with the ONN. Criteria for nurse navigator participation in the study included: certification in oncology nursing, completion of courses specific to lung disease, and employed in the lung cancer diagnostic department as a nurse navigator. Semi-structured individual interviews were conducted with each participant; in addition, the ONNs participated in a focus group.

Findings

Five major themes emerged through an iterative process of thematic analysis from the perspective of the patient with lung cancer and the ONN. Themes identified included: patient focused care, needs assessment, shared decision making, accessibility, and eliminating barriers. These themes correspond to the continuity of care related to informational, management, and relational continuity.

Nursing Implications

Little is known about the impact of nurse navigators on the patient experience during the diagnostic and cancer treatment periods. This research provides empirical evidence on the importance of this role throughout the diagnostic period of cancer as perceived by both patients and ONNs. Patient-focused care was enhanced through the provision of timely, personalized information which aided in the patients' understanding of diagnostic tests and subsequent follow-up. Telephone needs assessment proved to be vital as the ONN explored not only medical symptoms and social aspects, but also included an assessment of cultural concerns prior to the patients' first visit to the cancer center. These interactions supported the theme of shared decision making; the participants felt empowered, rather than powerless, as the ONN involved them in their care. Empathy and therapeutic communication were expressed through the theme of accessibility. Participants acknowledged the “professional-personal” connection with the ONN. Through the trusting relationship that was formed, barriers were eliminated, and all aspects of care could be addressed during this phase of care. This research supports best practice standards

for the role of the nurse navigator and provides a framework for continued study in other specialties of care.

Medical Management

If the tumor is malignant and has infiltrated the surrounding tissue and complete surgical removal is not feasible, radiation therapy, chemotherapy, or both are used.

Many mediastinal tumors are benign and operable. The location of the tumor (anterior, middle, or posterior compartment) in the mediastinum dictates the type of incision. The common incision used is a median sternotomy; however, a thoracotomy may be used, depending on the location of the tumor. Additional approaches include a bilateral anterior thoracotomy (clamshell incision) and video-assisted thoracoscopic surgery. The care is the same as for any patient undergoing thoracic surgery. Major complications include hemorrhage, injury to the phrenic or recurrent laryngeal nerve, and infection.



Chest Trauma

Thoracic injuries occurred in over 194,622 patients and accounted for 22.58% of the types of trauma recently recorded in a national trauma database (American College of Surgeons, 2016). Four of the top 10 complications in trauma patients were related to the respiratory system: pneumonia, DVT/PE, unplanned extubation, and acute lung injury/ARDS (American College of Surgeons, 2016). Major chest trauma may occur alone or in combination with multiple other injuries. Chest trauma is classified as either blunt or penetrating. Blunt chest trauma results from sudden compression or positive pressure inflicted to the chest wall. Penetrating trauma occurs when a foreign object penetrates the chest wall.

Blunt Trauma

Overall, blunt thoracic injuries are directly responsible for 20% to 25% of all trauma deaths (Mancini, 2018). Although blunt chest trauma is more common than penetrating trauma, it is often difficult to identify the extent of the damage because the symptoms may be generalized and vague. In addition, patients may not seek immediate medical attention, which may complicate the problem.

Pathophysiology

The most common causes of blunt chest trauma are motor vehicle crashes (trauma from steering wheel, seat belt), falls, and bicycle crashes (trauma from handlebars). Types of blunt chest trauma include chest wall fractures, dislocations, and barotraumas (including diaphragmatic injuries); injuries of the pleura, lungs, and aerodigestive tracts; and blunt injuries of the heart, great arteries, veins, and lymphatics (Mancini,

2018). Injuries to the chest are often life-threatening and result in one or more of the following pathologic states:

- Hypoxemia from disruption of the airway; injury to the lung parenchyma, rib cage, and respiratory musculature; massive hemorrhage; collapsed lung; and pneumothorax
- Hypovolemia from massive fluid loss from the great vessels, cardiac rupture, or hemothorax
- Cardiac failure from cardiac tamponade, cardiac contusion, or increased intrathoracic pressure

These pathologic states frequently result in impaired V/Q, leading to acute kidney injury, hypovolemic shock, and death.

Assessment and Diagnostic Findings

Because time is critical in treating chest trauma, the patient must be assessed immediately to determine the following: time elapsed since injury occurred, mechanism of injury, level of responsiveness, specific injuries, estimated blood loss, recent drug or alcohol use, and prehospital treatment. Initial assessment of thoracic injuries includes assessment of airway obstruction, tension pneumothorax, open pneumothorax, massive hemothorax, flail chest, and cardiac tamponade. These injuries are life-threatening and require immediate treatment. Secondary assessment includes assessment of simple pneumothorax, hemothorax, pulmonary contusion, traumatic aortic rupture, tracheobronchial disruption, esophageal perforation, traumatic diaphragmatic injury, and penetrating wounds to the mediastinum. Although listed as secondary, these injuries may be life-threatening as well.

The physical examination includes inspection of the airway, thorax, neck veins, and breathing difficulty. Specifics include assessing the rate and depth of breathing for abnormalities such as stridor, cyanosis, nasal flaring, the use of accessory muscles, drooling, and overt trauma to the face, mouth, or neck. The chest is assessed for symmetric movement, symmetry of breath sounds, open chest wounds, entrance or exit wounds, impaled objects, tracheal shift, distended neck veins, subcutaneous emphysema, and paradoxical chest wall motion. In addition, the chest wall is assessed for bruising, petechiae, lacerations, and burns. The vital signs and skin color are assessed for signs of shock. The thorax is palpated for tenderness and crepitus, and the position of the trachea is also assessed.

The initial diagnostic workup includes a chest x-ray, CT scan, complete blood count, clotting studies, type and cross-match, electrolytes, oxygen saturation, arterial blood gas analysis, and ECG. The patient is completely undressed to avoid missing additional injuries that may complicate care. Many patients with injuries involving the chest have associated head and abdominal injuries that require attention. Ongoing assessment is essential to monitor the patient's response to treatment and to detect early signs of clinical deterioration.

Medical Management

The goals of treatment are to evaluate the patient's condition and to initiate aggressive resuscitation. An airway is immediately established with oxygen support and, in some

cases, ET intubation and ventilatory support. Reestablishing fluid volume and negative intrapleural pressure and draining intrapleural fluid and blood are essential.

The potential for massive blood loss and exsanguination with blunt or penetrating chest injuries is high because of injury to the great blood vessels. Many patients die at the scene of the injury or are in shock by the time help arrives. Agitation and irrational and combative behavior are signs of decreased oxygen delivery to the cerebral cortex. Strategies to restore and maintain cardiopulmonary function include ensuring an adequate airway and ventilation; stabilizing and reestablishing chest wall integrity; occluding any opening into the chest (open pneumothorax); and draining or removing any air or fluid from the thorax to relieve pneumothorax, hemothorax, or cardiac tamponade. Hypovolemia and low cardiac output must be corrected. Many of these treatment efforts, along with the control of hemorrhage, are carried out simultaneously at the scene of the injury or in the emergency department. Depending on the success of efforts to control the hemorrhage in the emergency department, the patient may be taken immediately to the operating room. Principles of management are essentially those pertaining to care of the postoperative thoracic patient (Urden et al., 2018).

Sternal and Rib Fractures

Sternal fractures are most common in motor vehicle crashes with a direct blow to the sternum via the steering wheel. Rib fractures are the most common type of chest trauma with blunt chest injury (Mancini, 2018). Most rib fractures are benign and are treated conservatively; ribs 4 through 10 are most frequently involved. Fractures of the first three ribs are rare but can result in a high mortality rate because they are associated with laceration of the subclavian artery or vein. Fractures of the lower ribs are associated with injury to the spleen and liver, which may be lacerated by fragmented sections of the rib. Older adult patients with three or more rib fractures have been shown to have a fivefold increased mortality rate and a fourfold increased incidence of pneumonia (Mancini, 2018).

Clinical Manifestations

Patients with sternal fractures have anterior chest pain, overlying tenderness, ecchymosis, crepitus, swelling, and possible chest wall deformity. For patients with rib fractures, clinical manifestations are similar: severe pain, point tenderness, and muscle spasm over the area of the fracture that are aggravated by coughing, deep breathing, and movement. The area around the fracture may be bruised. To reduce the pain, the patient splints the chest by breathing in a shallow manner and avoids sighs, deep breaths, coughing, and movement. This reluctance to move or breathe deeply results in diminished ventilation, atelectasis (collapse of unaerated alveoli), pneumonitis, and hypoxemia. Respiratory insufficiency and failure can be the outcomes of such a cycle.

Assessment and Diagnostic Findings

The patient must be closely evaluated for underlying cardiac injuries. A crackling, grating sound in the thorax (subcutaneous crepitus) may be detected with auscultation. The diagnostic workup may include a chest x-ray, rib films of a specific area, ECG, continuous pulse oximetry, and arterial blood gas analysis.

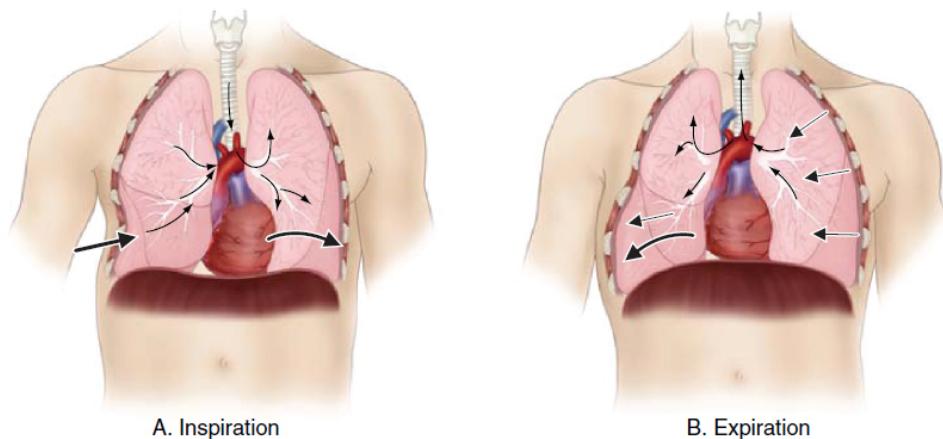


Figure 19-11 • Flail chest is caused by a free-floating segment of rib cage resulting from multiple rib fractures. **A.** Paradoxical movement on inspiration occurs when the flail rib segment is sucked inward and the mediastinal structures shift to the unaffected side. The amount of air drawn into the affected lung is reduced. **B.** On expiration, the flail segment bulges outward and the mediastinal structures shift back to the affected side.

Medical Management

Medical management is directed toward relieving pain, avoiding excessive activity, and treating any associated injuries. Surgical fixation is rarely necessary unless fragments are grossly displaced and pose a potential for further injury.

The goals of treatment of rib fractures are to control pain and to detect and treat the injury. Sedation is used to relieve pain and to allow deep breathing and coughing. Care must be taken to avoid oversedation and suppression of respiratory drive. Alternative strategies to relieve pain include an intercostal nerve block and ice over the fracture site. A chest binder may be used as supportive treatment to provide stability to the chest wall and may decrease pain. The patient is instructed to apply the binder snugly enough to provide support, but not to impair respiratory excursion. Usually, the pain abates in 5 to 7 days, and discomfort can be relieved with epidural analgesia, PCA, or nonopioid analgesia. Most rib fractures heal in 3 to 6 weeks. The patient is monitored closely for signs and symptoms of associated injuries.

Flail Chest

Flail chest is frequently a complication of blunt chest trauma, which may occur from a steering wheel injury, motor vehicle crash involving a pedestrian or cyclist, a significant fall onto the chest, or an assault with a blunt weapon. The incidence of flail chest among patients with chest wall injury is 5% to 13% (Sarani, 2019). It occurs when three or more adjacent ribs (multiple contiguous ribs) are fractured at two or more sites, resulting in free-floating rib segments. It may also result as a combination fracture of ribs and costal cartilages or sternum. As a result, the chest wall loses stability, causing respiratory impairment and usually severe respiratory distress.

Pathophysiology

During inspiration, as the chest expands, the detached part of the rib segment (flail segment) moves in a paradoxical manner (pendelluft movement) in that it is pulled inward during inspiration, reducing the amount of air that can be drawn into the lungs. On expiration, because the intrathoracic pressure exceeds atmospheric pressure, the flail segment bulges outward, impairing the patient's ability to exhale. The mediastinum then shifts back to the affected side (see Fig. 19-11). This paradoxical action results in increased dead space, a reduction in alveolar ventilation, and decreased compliance. Retained airway secretions and atelectasis frequently accompany flail chest. The patient has hypoxemia, and if gas exchange is greatly compromised, respiratory acidosis develops as a result of carbon dioxide retention. Hypotension, inadequate tissue perfusion, and metabolic acidosis often follow as the paradoxical motion of the mediastinum decreases cardiac output.

Medical Management

As with rib fracture, treatment of flail chest is usually supportive. Management includes providing ventilatory support, clearing secretions from the lungs, and controlling pain. Specific management depends on the degree of respiratory dysfunction. If only a small segment of the chest is involved, the objectives are to clear the airway through positioning, coughing, deep breathing, and suctioning to aid in the expansion of the lung, and to relieve pain by intercostal nerve blocks, high thoracic epidural blocks, or cautious use of IV opioids.

For mild-to-moderate flail chest injuries, the underlying pulmonary contusion is treated by monitoring fluid intake and appropriate fluid replacement while relieving chest pain. Pulmonary physiotherapy focusing on lung volume expansion and secretion management techniques is performed. The patient is closely monitored for further respiratory compromise.

For severe flail chest injuries, ET intubation and mechanical ventilation are required to provide internal pneumatic stabilization of the flail chest and to correct abnormalities in gas exchange. This helps to treat the underlying pulmonary contusion, serves to stabilize the thoracic cage to allow the fractures to heal, and improves alveolar ventilation and intrathoracic volume by decreasing the work of breathing. This treatment modality requires ET intubation and mechanical ventilator support. Differing modes of ventilation are used depending on the patient's underlying disease and specific needs.

Rib-specific plating systems may be used for three or more rib fractures or flail chest in order to achieve chest wall stabilization (CWS). These systems are inserted internally in the operating room, preferably within the first 72 hours of injury (see Fig. 19-12). The benefits of their use include decreased bleeding, less inflammation, and reduced chest wall deformities. Contraindications for CWS include traumatic brain injury and unstable spine fracture. With coexisting pulmonary contusion the overall efficacy of CWS remains controversial (Milanez de Campos & White, 2018).



Figure 19-12 • Chest wall stabilization (CWS) plating system provides chest wall stability for multiple fractures or a flail chest. Reproduced from Moya, M., Nirula, R., & Biffl, W. (2017). Rib fixation: Who, What, When? *Trauma Surgery & Acute Care Open*, 2(1):e000059. Copyright © The American Association for the Surgery of Trauma with permission from BMJ Publishing Group Ltd. doi:10.1136/tsaco-2016-000059.

Regardless of the type of treatment, the patient is carefully monitored by serial chest x-rays, arterial blood gas analysis, pulse oximetry, and bedside pulmonary function monitoring. Pain management is key to successful treatment. PCA, intercostal nerve blocks, epidural analgesia, and intrapleural administration of opioids may be used to relieve or manage thoracic pain.

Pulmonary Contusion

Pulmonary contusion is a common thoracic injury and is frequently associated with flail chest. It is defined as damage to the lung tissues resulting in hemorrhage and localized edema. It is associated with chest trauma when there is rapid compression and decompression to the chest wall (i.e., blunt trauma). Pulmonary contusion represents a spectrum of lung injury characterized by the development of infiltrates and various degrees of respiratory dysfunction and sometimes respiratory failure. It is often cited as the most common potentially life-threatening chest injury; however, mortality is often attributed to other associated injuries. Pulmonary contusion may not be evident initially on examination but develops in the posttraumatic period; it may involve a small portion of one lung, a massive section of a lung, one entire lung, or both lungs. Depending on the extent of injury, this type of trauma may be associated with a mortality rate greater than 50% (Mancini, 2018).

Pathophysiology

The primary pathologic defect is an abnormal accumulation of fluid in the interstitial and intra-alveolar spaces. It is thought that injury to the lung parenchyma and its capillary network results in a leakage of serum protein and plasma. The leaking serum protein exerts an osmotic pressure that enhances loss of fluid from the capillaries. Blood, edema, and cellular debris (from cellular response to injury) enter the lung and accumulate in the bronchioles and alveoli, where they interfere with gas exchange. An increase in pulmonary vascular resistance and pulmonary artery pressure occurs. The patient has hypoxemia and carbon dioxide retention.

Clinical Manifestations

Pulmonary contusion may be mild, moderate, or severe. The clinical manifestations vary from decreased breath sounds, tachypnea, tachycardia, chest pain, hypoxemia, and blood-tinged secretions to more severe tachypnea, tachycardia, crackles, frank bleeding, severe hypoxemia (cyanosis), and respiratory acidosis. Changes in sensorium, including increased agitation or combative irrational behavior, may be signs of hypoxemia.

In addition, patients with moderate pulmonary contusion have a large amount of mucus, serum, and frank blood in the tracheobronchial tree; patients often have a constant cough but cannot clear the secretions. Patients with severe pulmonary contusion have signs and symptoms that mirror ARDS, which may include central cyanosis; agitation; combativeness; and productive cough with frothy, bloody secretions.

Assessment and Diagnostic Findings

The efficiency of gas exchange is determined by pulse oximetry and arterial blood gas measurements. Pulse oximetry is also used to measure oxygen saturation continuously. The initial chest x-ray may show no changes; changes may not appear for 1 or 2 days after the injury and appear as pulmonary infiltrates on chest x-ray.

Medical Management

Treatment priorities include maintaining the airway, providing adequate oxygenation, and controlling pain. In mild pulmonary contusion, adequate hydration via IV fluids and oral intake is important to mobilize secretions. However, fluid intake must be closely monitored to avoid hypervolemia. Volume expansion techniques, postural drainage, physiotherapy including coughing, and ET suctioning are used to remove the secretions. Pain is managed by intercostal nerve blocks or by opioids via PCA or other methods. Usually, antimicrobial therapy is given because the damaged lung is susceptible to infection. Supplemental oxygen is usually given by mask or cannula for 24 to 36 hours.

In patients with moderate pulmonary contusion, bronchoscopy may be required to remove secretions. Intubation and mechanical ventilation with PEEP may also be necessary to maintain the pressure and keep the lungs inflated. A nasogastric tube is inserted to relieve gastrointestinal distention.

In patients with severe contusion, who may develop respiratory failure, aggressive treatment with ET intubation and ventilatory support, diuretics, and fluid restriction

may be necessary. Antimicrobial medications may be prescribed for the treatment of pulmonary infection. This is a common complication of pulmonary contusion (especially pneumonia in the contused segment) because the fluid and blood that extravasate into the alveolar and interstitial spaces serve as an excellent culture medium.

Penetrating Trauma

Any organ or structure within the chest is potentially susceptible to traumatic penetration. These organs include the chest wall, lung and pleura, tracheobronchial system, esophagus, diaphragm, and major thoracic blood vessels, as well as heart and other mediastinal structures. The clinical consequence of penetrating trauma to the chest depends on the mechanism of injury, location, associated injuries, and underlying illnesses (Shahani, 2017). Common injuries include pneumothorax and cardiac tamponade.

Medical Management

The objective of immediate management is to restore and maintain cardiopulmonary function. After an adequate airway is ensured and ventilation is established, examination for shock and intrathoracic and intra-abdominal injuries is necessary. The patient is undressed completely so that additional injuries are not missed (see [Chapter 67](#) for discussion of primary and secondary survey). There is a high risk of associated intra-abdominal injuries with stab wounds below the level of the fifth anterior intercostal space. Death can result from exsanguinating hemorrhage or intra-abdominal sepsis.

The diagnostic workup includes a chest x-ray, chemistry profile, arterial blood gas analysis, pulse oximetry, and ECG. The patient's blood is typed and cross-matched in case blood transfusion is required. After the status of the peripheral pulses is assessed, a large-bore IV line is inserted. An indwelling catheter is inserted to monitor urinary output. A nasogastric tube is inserted and connected to low suction to prevent aspiration, minimize leakage of abdominal contents, and decompress the gastrointestinal tract.

Hemorrhagic shock is treated simultaneously with colloid solutions, crystalloids, or blood, as indicated by the patient's condition. Diagnostic procedures are carried out as dictated by the needs of the patient (e.g., CT scans of chest or abdomen, flat plate x-ray of the abdomen) (see [Chapter 11](#)).

A chest tube is inserted into the pleural space in most patients with penetrating wounds of the chest to achieve rapid and continuing re-expansion of the lungs. The insertion of the chest tube frequently results in a complete evacuation of the blood and air. The chest tube also allows early recognition of continuing intrathoracic bleeding, which would make surgical exploration necessary. If the patient has a penetrating wound of the heart or great vessels, the esophagus, or the tracheobronchial tree, surgical intervention is required.

Pneumothorax

Pneumothorax occurs when the parietal or visceral pleura is breached and the pleural space is exposed to positive atmospheric pressure. Normally, the pressure in the pleural space is negative or subatmospheric; this negative pressure is required to maintain lung inflation. When either pleura is breached, air enters the pleural space, and the lung or a portion of it collapses.

Types of Pneumothorax

Types of pneumothorax include simple, traumatic, and tension pneumothorax.

Simple Pneumothorax

A simple, or spontaneous, pneumothorax occurs when air enters the pleural space through a breach of either the parietal or visceral pleura. Most commonly, this occurs as air enters the pleural space through the rupture of a bleb or a bronchopleural fistula. A spontaneous pneumothorax may occur in an apparently healthy person in the absence of trauma due to rupture of an air-filled bleb, or blister, on the surface of the lung, allowing air from the airways to enter the pleural cavity. It may be associated with diffuse interstitial lung disease and severe emphysema.

Traumatic Pneumothorax

A traumatic pneumothorax occurs when air escapes from a laceration in the lung itself and enters the pleural space or from a wound in the chest wall. It may result from blunt trauma (e.g., rib fractures), penetrating chest or abdominal trauma (e.g., stab wounds or gunshot wounds), or diaphragmatic tears. Traumatic pneumothorax may occur during invasive thoracic procedures (i.e., thoracentesis, transbronchial lung biopsy, and insertion of a subclavian line) in which the pleura is inadvertently punctured, or with barotrauma from mechanical ventilation.

A traumatic pneumothorax resulting from major injury to the chest is often accompanied by hemothorax (collection of blood in the pleural space resulting from torn intercostal vessels, lacerations of the great vessels, or lacerations of the lungs). Hemopneumothorax (both blood and air in the chest cavity) is also common after major trauma. Chest surgery can be classified as a traumatic pneumothorax as a result of the entry into the pleural space and the accumulation of air and fluid in the pleural space.

Open pneumothorax is one form of traumatic pneumothorax. It occurs when a wound in the chest wall is large enough to allow air to pass freely in and out of the thoracic cavity with each attempted respiration. Because the rush of air through the wound in the chest wall produces a sucking sound, such injuries are termed *sucking chest wounds*. In such patients, not only does the lung collapse, but the structures of the mediastinum (heart and great vessels) also shift toward the uninjured side with each inspiration and in the opposite direction with expiration. This is termed *mediastinal flutter* or *swing*, and it produces serious circulatory problems.



Quality and Safety Nursing Alert

Traumatic open pneumothorax calls for emergency interventions. Stopping the flow of air through the opening in the chest wall is a lifesaving measure.

Tension Pneumothorax

A **tension pneumothorax** occurs when air is drawn into the pleural space from a lacerated lung or through a small opening or wound in the chest wall. It may be a complication of other types of pneumothorax. In contrast to open pneumothorax, the air that enters the chest cavity with each inspiration is trapped; it cannot be expelled during expiration through the air passages or the opening in the chest wall. In effect, a one-way valve or ball valve mechanism occurs where air enters the pleural space but cannot escape. With each breath, tension (positive pressure) is increased within the affected pleural space. This causes the lung to collapse and the heart, the great vessels, and the trachea to shift toward the unaffected side of the chest (mediastinal shift). Both respiration and circulatory function are compromised because of the increased intrathoracic pressure, which decreases venous return to the heart, causing decreased cardiac output and impairment of peripheral circulation. In extreme cases, the pulse may be undetectable—this is known as pulseless electrical activity.

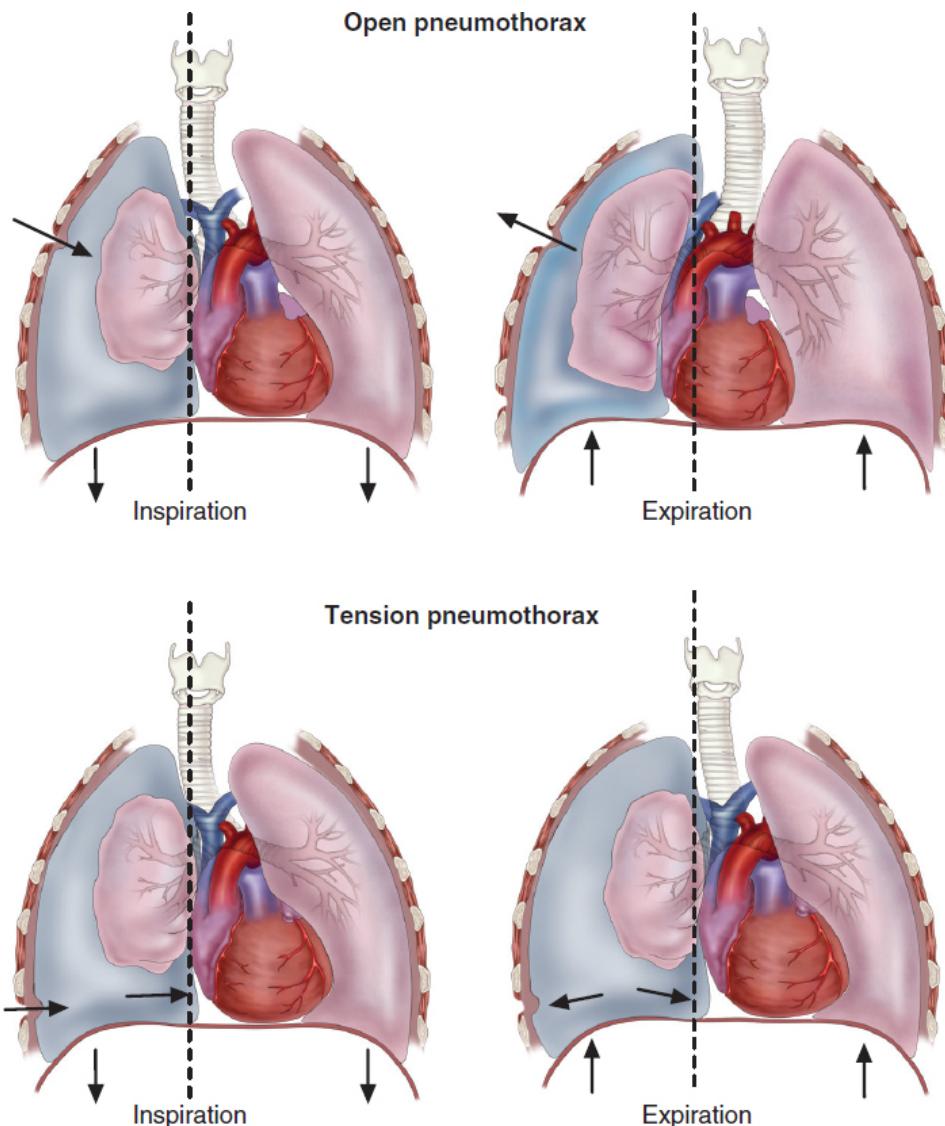


Figure 19-13 • Open pneumothorax (top) and tension pneumothorax (bottom). In open pneumothorax, air enters the chest during inspiration and exits during expiration. A slight shift of the affected lung may occur because of a decrease in pressure as air moves out of the chest. In tension pneumothorax, air enters but cannot leave the chest. As the pressure increases, the heart and great vessels are compressed and the mediastinal structures are shifted toward the opposite side of the chest. The trachea is pushed from its normal midline position toward the opposite side of the chest, and the unaffected lung is compressed.

Clinical Manifestations

The signs and symptoms associated with pneumothorax depend on its size and cause. Pain is usually sudden and may be pleuritic. The patient may have only minimal respiratory distress with slight chest discomfort and tachypnea with a small simple or uncomplicated pneumothorax. If the pneumothorax is large and the lung collapses totally, acute respiratory distress occurs. The patient is anxious, has dyspnea and air

hunger, has increased use of the accessory muscles, and may develop central cyanosis from severe hypoxemia.

In assessing the chest for any type of pneumothorax, the nurse assesses tracheal alignment, expansion of the chest, breath sounds, and percussion of the chest. In a simple pneumothorax, the trachea is midline, expansion of the chest is decreased, breath sounds may be diminished or absent, and percussion of the chest may reveal normal sounds or hyperresonance depending on the size of the pneumothorax. In a tension pneumothorax, the trachea is shifted away from the affected side, chest expansion may be decreased or fixed in a hyperexpansion state, breath sounds are diminished or absent, and percussion to the affected side is hyperresonant. The clinical picture is one of air hunger, agitation, increasing hypoxemia, central cyanosis, hypotension, tachycardia, and profuse diaphoresis. [Figure 19-13](#) compares open and tension pneumothorax.

Medical Management

Medical management of pneumothorax depends on its cause and severity. The goal of treatment is to evacuate the air or blood from the pleural space. A small chest tube (28 Fr) is inserted near the second intercostal space; this space is used because it is the thinnest part of the chest wall, minimizes the danger of contacting the thoracic nerve, and leaves a less visible scar. If a patient also has a hemothorax, a large-diameter chest tube (32 Fr or greater) is inserted, usually in the fourth or fifth intercostal space at the midaxillary line. The tube is directed posteriorly to drain the fluid and air. Once the chest tube or tubes are inserted and suction is applied (usually to 20 mm Hg suction), effective decompression of the pleural cavity (drainage of blood or air) occurs.

If an excessive amount of blood enters the chest tube in a relatively short period, an autotransfusion may be needed. This technique involves taking the patient's own blood that has been drained from the chest, filtering it, and then transfusing it back into the vascular system.

In such an emergency, anything may be used that is large enough to fill the chest wound—a towel, a handkerchief, or the heel of the hand. If conscious, the patient is instructed to inhale and strain against a closed glottis. This action assists in re-expanding the lung and ejecting the air from the thorax. In the hospital, the opening is plugged by sealing it with gauze impregnated with petrolatum. A pressure dressing is applied. Usually, a chest tube connected to water-seal drainage is inserted to remove air and fluid. Antibiotics usually are prescribed to combat infection from contamination.

The severity of open pneumothorax depends on the amount and rate of thoracic bleeding and the amount of air in the pleural space. The pleural cavity can be decompressed by thoracentesis or by chest tube drainage of the blood or air. The lung is then able to re-expand and resume the function of gas exchange. As a rule of thumb, thoracotomy is performed if more than 1500 mL of blood is aspirated initially by thoracentesis (or is the initial chest tube output) or if chest tube output continues at greater than 200 mL/h (Shahani, 2017). The urgency with which the blood must be removed is determined by the degree of respiratory compromise. An emergency thoracotomy may also be performed in the emergency department if a cardiovascular injury secondary to chest or penetrating trauma is suspected. The patient with a possible tension pneumothorax should immediately be given a high concentration of supplemental oxygen to treat the hypoxemia, and pulse oximetry should be used to

monitor oxygen saturation. In an emergency situation, a tension pneumothorax can be decompressed or quickly converted to a simple pneumothorax by inserting a large-bore needle (14 gauge) at the second intercostal space, midclavicular line on the affected side. This relieves the pressure and vents the positive pressure to the external environment. A chest tube is then inserted and connected to suction to remove the remaining air and fluid, reestablish the negative pressure, and re-expand the lung. If the lung re-expands and air leakage from the lung parenchyma stops, further drainage may be unnecessary. If a prolonged air leak continues despite chest tube drainage to underwater seal, surgery may be necessary to close the leak.

Chest Drainage

Chest tubes and a closed drainage system are used to re-expand the involved lung and to remove excess air, fluid, and blood, and may be used in patients who have had a thoracotomy (see previous discussion). Chest drainage systems also are frequently indicated in the treatment of spontaneous pneumothorax and trauma resulting in pneumothorax. [Table 19-8](#) describes and compares the main features of these systems.



For the procedural guidelines for setting up and managing chest drainage systems, go to thepoint.lww.com/Brunner15e.

The normal breathing mechanism operates on the principle of negative pressure. The pressure in the chest cavity normally is lower than the pressure of the atmosphere, causing air to move into the lungs during inspiration. Whenever the chest is opened, there is a loss of negative pressure, which results in collapse of the lung. The collection of air, fluid, or other substances in the chest can compromise cardiopulmonary function and can also cause the lung to collapse. Pathologic substances that can collect in the pleural space include fibrin or clotted blood, liquids (serous fluids, blood, pus, chyle), and gases (air from the lung, tracheobronchial tree, or esophagus).

Chest tubes may be inserted to drain fluid or air from any of the three compartments of the thorax (the right and left pleural spaces and the mediastinum). The pleural space, located between the visceral and parietal pleura, normally contains 20 mL or less of fluid, which helps lubricate the visceral and parietal pleura (Norris, 2019).

There are two types of chest tubes: small-bore and large-bore catheters. Small-bore catheters (7 Fr to 12 Fr) have a one-way valve apparatus to prevent air from moving back into the chest. They can be inserted through a small skin incision. Large-bore catheters, which range in size up to 40 Fr, are usually connected to a chest drainage system to collect any pleural fluid and monitor for air leaks. After the chest tube is positioned, it is sutured to the skin and connected to a drainage apparatus to remove the residual air and fluid from the pleural or mediastinal space. This results in the re-expansion of remaining lung tissue.

TABLE 19-8 Comparison of Chest Drainage Systems^a

Types of Chest Drainage Systems	Description	Comments
Traditional Water Seal		
Also referred to as wet suction	Has three chambers: a collection chamber, water-seal chamber (middle chamber), and wet suction control chamber	Requires that sterile fluid be instilled into water seal and suction chambers Has positive- and negative-pressure release valves Intermittent bubbling indicates that the system is functioning properly. Additional suction can be added by connecting system to a suction source.
Dry Suction Water Seal		
Also referred to as dry suction	Has three chambers: a collection chamber, water-seal chamber (middle chamber), and suction regulator dial	Requires that sterile fluid be instilled in water-seal chamber at 2-cm level No fluid-filled suction chamber Suction pressure is set with a suction regulator dial. Has positive- and negative-pressure release valves Has an indicator to signify that the suction pressure is adequate Quieter than traditional water-seal systems
Dry Suction		
Also referred to as one-way valve system	Has a one-way mechanical valve that allows air to leave the chest and prevents air from moving back into the chest	No need to fill suction chamber with fluid; thus, can be set up quickly in an emergency Works even if knocked over, making it ideal for patients who are ambulatory

^aIf no fluid drainage is expected, a drainage collection device may not be needed.

Chest Drainage Systems

Chest drainage systems have a suction source, a collection chamber for pleural drainage, and a mechanism to prevent air from reentering the chest with inhalation (see Fig. 19-14). Various types of chest drainage systems are available for use in the removal of air and fluid from the pleural space and re-expansion of the lungs. Chest drainage systems come with either wet (water seal) or dry suction control. In wet suction systems, the amount of suction is determined by the amount of water instilled in the suction chamber. The amount of bubbling in the suction chamber indicates the strength of the suction. Wet systems use a water seal to prevent air from moving back into the chest on inspiration. Dry systems use a one-way valve and may have a suction

control dial in place of the water. Both systems can operate by gravity drainage, without a suction source.



Figure 19-14 • Chest drainage systems. **A.** The Atrium Ocean is an example of a water-seal chest drain system composed of a drainage chamber and water-seal chamber. The suction control is determined by the height of the water column in that chamber (usually 20 cm). *A*, suction control chamber; *B*, water-seal chamber; *C*, air leak zone; *D*, collection chamber. **B.** The Atrium Oasis is an example of a dry suction water-seal system that uses a mechanical regulator for vacuum control, a water-seal

chamber, and a drainage chamber. *A*, dry suction regulator; *B*, water-seal chamber; *C*, air leak monitor; *D*, collection chamber; *E*, suction monitor bellows. Photos used with permission from Atrium Medical Corporation, Hudson, NH.



Quality and Safety Nursing Alert

When the wall vacuum is turned off, the drainage system must be open to the atmosphere so that intrapleural air can escape from the system. This can be done by detaching the tubing from the suction port to provide a vent.

Water-Seal Systems

The traditional water-seal system (or wet suction) for chest drainage has three chambers: a collection chamber, a water-seal chamber, and a wet suction control chamber. The collection chamber acts as a reservoir for fluid draining from the chest tube. It is graduated to permit easy measurement of drainage. Suction may be added to create negative pressure and promote drainage of fluid and removal of air. The suction control chamber regulates the amount of negative pressure applied to the chest. The amount of suction is determined by the water level. It is usually set at 20 cm H₂O; adding more fluid results in more suction. After the suction is turned on, bubbling appears in the suction chamber. A positive-pressure valve is located at the top of the suction chamber that automatically opens with increases in positive pressure within the system. Air is automatically released through a positive-pressure relief valve if the suction tubing is inadvertently clamped or kinked.

The water-seal chamber has a one-way valve or water seal that prevents air from moving back into the chest when the patient inhales. There is an increase in the water level with inspiration and a return to the baseline level during exhalation; this is referred to as tidalizing. Intermittent bubbling in the water-seal chamber is normal, but continuous bubbling can indicate an air leak. Bubbling and tidalizing do not occur when the tube is placed in the mediastinal space; however, fluid may pulsate with the patient's heartbeat. If the chest tube is connected to gravity drainage only, suction is not used. The pressure is equal to the water seal only. Two-chamber chest drainage systems (water-seal chamber and collection chamber) are available for use with patients who need only gravity drainage.

The water level in the water-seal chamber reflects the negative pressure present in the intrathoracic cavity. A rise in the water level indicates negative pressure in the pleural or mediastinal space. Excessive negative pressure can cause trauma to tissue. Most chest drainage systems have an automatic means to prevent excessive negative pressure. By pressing and holding a manual high-negativity vent (usually located on the top of the chest drainage system) until the water level in the water-seal chamber returns to the 2-cm mark, excessive negative pressure is avoided, preventing damage to tissue.



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If the chest tube and drainage system become disconnected, air can enter the pleural space, producing a pneumothorax. To prevent pneumothorax if the chest tube is inadvertently disconnected from the drainage system, a temporary water seal can be established by immersing the chest tube's open end in a bottle of sterile water.

Dry Suction Water-Seal Systems

Dry suction water-seal systems, also referred to as dry suction, have a collection chamber for drainage, a water-seal chamber, and a dry suction control regulator. The water-seal chamber is filled with water to the 2-cm level. Bubbling in this area can indicate an air leak. The dry suction control regulator provides a dial that conveniently regulates vacuum to the chest drain. The system does not contain a suction control chamber filled with water. Without a water-filled suction chamber, the machine is quieter. However, if the container is knocked over, the water seal may be lost.

Once the tube is connected to the suction source, the regulator dial allows the desired level of suction to be set; the suction is increased until an indicator appears. The indicator has the same function as the bubbling in the traditional water-seal system—that is, it indicates that the vacuum is adequate to maintain the desired level of suction. Some drainage systems use a bellows (a chamber that can be expanded or contracted) or an orange-colored float device as an indicator of when the suction control regulator is set.

When the water in the water seal rises above the 2-cm level, intrathoracic pressure increases. Dry suction water-seal systems have a manual high-negativity vent located on top of the drain. The manual high-negativity vent is pressed until the indicator appears (either a float device or bellows) and the water level in the water seal returns to the desired level, indicating that the intrathoracic pressure is decreased.



Quality and Safety Nursing Alert

The manual vent should not be used to lower the water level in the water seal when the patient is on gravity drainage (no suction) because intrathoracic pressure is equal to the pressure in the water seal.

Dry Suction Systems with a One-Way Valve

A third type of chest drainage system is dry suction with a one-way mechanical valve. This system has a collection chamber, a one-way mechanical valve, and a dry suction control chamber. The valve permits air and fluid to leave the chest but prevents their movement back into the pleural space. This model lacks a water-seal chamber and therefore can be set up quickly in emergency situations, and the dry control drain still works even if it is knocked over. This makes the dry suction systems useful for the patient who is ambulating or being transported. However, without the water-seal chamber, there is no way to tell by inspection whether the pressure in the chest has changed, even though an air leak indicator is present so that the system can be checked. If an air leak is suspected, 30 mL of water is injected into the air leak indicator or the container is tipped so that fluid enters the air leak detection chamber. Bubbles will appear if a leak is present.

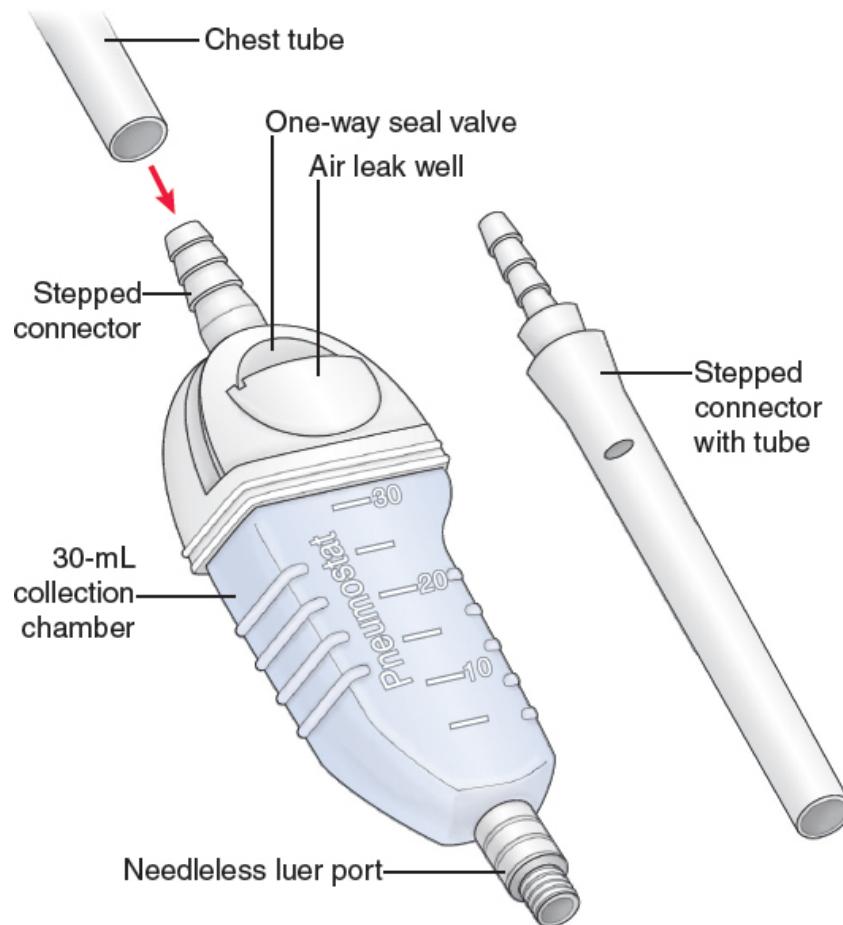


Figure 19-15 • One-way (Heimlich) valve, a disposable, single-use chest drainage system with 30-mL collection volume. Used when minimal volume of chest drainage is expected.

If the chest tube has been inserted to re-expand a lung after pneumothorax, or if very little fluid drainage is expected, a one-way valve (Heimlich valve) may be connected to the chest tube. This valve may be attached to a collection bag (see Fig. 19-15) or covered with a sterile dressing if no drainage is expected.

Cardiac Tamponade

Cardiac tamponade is compression of the heart resulting from fluid or blood within the pericardial sac. It usually is caused by blunt or penetrating trauma to the chest. A penetrating wound of the heart is associated with a high mortality rate. Cardiac tamponade also may follow diagnostic cardiac catheterization, angiographic procedures, and pacemaker insertion, which can produce perforations of the heart and great vessels. Pericardial effusion with fluid compressing the heart also may develop from metastases to the pericardium from malignant tumors of the breast, lung, or mediastinum and may occur with lymphomas and leukemias, kidney injury, TB, and high-dose radiation to the chest (see Chapter 25 for a detailed discussion of cardiac tamponade).

Subcutaneous Emphysema

No matter what kind of chest trauma a patient has, when the lung or the air passages are injured, air may enter the tissue planes and pass for some distance under the skin (e.g., neck and chest). The tissues give a crackling sensation when palpated, and the subcutaneous air produces an alarming appearance as the face, neck, body, and scrotum become misshapen by subcutaneous air. Subcutaneous emphysema is of itself usually not a serious complication. The subcutaneous air is spontaneously absorbed if the underlying air leak is treated or stops spontaneously. In severe cases in which there is widespread subcutaneous emphysema, a tracheostomy is indicated if airway patency is threatened by pressure of the trapped air on the trachea.

CRITICAL THINKING EXERCISES

1 ipc An 84-year-old male is brought to the ED by his daughter with reports of increasing shortness of breath over the past 2 days. You begin your assessment and note that the patient's vital signs include a BP of 110/72 mm Hg, heart rate of 92 bpm, RR of 26/min, and temperature is 38°C (100.4°F). The patient has marked inspiratory and expiratory wheezes that are audible upon auscultation. Oxygen saturation is 92% on room air. The patient denies chest pain; however, he admits to general fatigue, shortness of breath with exertion, and a moist unproductive cough. The daughter explains he resides at home with her and is wheelchair dependent. His past medical history includes an occipital stroke, open reduction internal fixation (ORIF) of right and left hip following fractures, bilateral pulmonary emboli, and paroxysmal atrial fibrillation. The patient's daughter tells you that he has difficulty with dentition with frequent episodes of coughing while eating. The patient admits he stopped taking his prescribed warfarin 6 months ago since he experienced several falls. What are the potential causes of his respiratory problem and what nursing interventions are important? What interdisciplinary team members warrant consultation in the care of the patient?

2 pq A 26-year-old male arrives via Emergency Medical Services (EMS) to the ED following a motor vehicle crash (MVC). The patient is awake and alert; however, he complains of sharp pain in his chest that extends to his back, neck, and shoulders. You begin your assessment and note that the patient's vital signs include a BP of 90/42 mm Hg, heart rate of 101 bpm, and RR of 32/min. He is pale and dyspneic with an oxygen saturation of 89% on 4 L of O₂ via nasal cannula. Inspection of the chest wall reveals areas of ecchymoses over the right shoulder and right anterior chest wall. The emergency medical technician (EMT) reports the patient was the sole driver of the automobile and bystanders stated the driver swerved to avoid a deer and hit a telephone pole. The patient was wearing a seatbelt; however, the air bags did not deploy. Auscultation of the chest reveals an absence of lung sounds on the right side with diminished lung sounds on the left side. What are the possible respiratory conditions associated with the clinical presentation of this patient? Describe your priorities of care.

3 ebp An 18-year-old female is admitted to the ICU from the ED with a diagnosis of acute respiratory failure. She is endotracheally intubated and placed on mechanical ventilation. Her past medical history includes a fractured left ulnar at the age of 10 but is otherwise unremarkable. She denies drug use; however, she admits to use of e-cigarettes since the 10th grade. The intensivist suspects EVALI. Forty-eight hours following intubation, diffuse hazy opacities are noted on chest x-ray throughout all lung fields. What evidence is available associating the use of electronic nicotine delivery systems (ENDS) with acute lung injury? What strategies should you implement to prevent ventilator-associated pneumonia (VAP) in this patient? What is the evidence base for the strategies that you consider? How would you evaluate the strength of the evidence?

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*Asterisk indicates nursing research.

**Double asterisk indicates classic references.

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Resources

- Agency for Healthcare Research and Quality (AHRQ), ahrq.gov
 American Association for Respiratory Care (AARC), aarc.org
 American Cancer Society, cancer.org
 American College of Chest Physicians (ACCP), chestnet.org
 American Lung Association, lung.org
 American Thoracic Society (ATS), thoracic.org
 Foundation for Sarcoidosis Research, www.stopsarcoidosis.org
 National Cancer Institute (NCI), cancer.gov
 Occupational Safety and Health Administration (OSHA), osha.gov
 Pulmonary Hypertension Association (PHA), phassociation.org
 Respiratory Nursing Society (RNS), respiratorynursingsociety.org

20 Management of Patients with Chronic Pulmonary Disease

LEARNING OUTCOMES

On completion of this chapter, the learner will be able to:

1. Describe the pathophysiology, clinical manifestations, treatment, and medical and nursing management of chronic pulmonary diseases, including chronic obstructive pulmonary disease, bronchiectasis, asthma, and cystic fibrosis.
2. Discuss the major risk factors for developing chronic obstructive pulmonary disease and nursing interventions to minimize or prevent these risk factors.
3. Use the nursing process as a framework for care of the patient with chronic obstructive pulmonary disease.
4. Develop an education plan for patients with chronic obstructive pulmonary disease.
5. Discuss nursing management of and patient education and transitions in care considerations for patients receiving oxygen therapy.
6. Describe asthma self-management strategies.

NURSING CONCEPTS

Oxygenation

GLOSSARY

air trapping: incomplete emptying of alveoli during expiration due to loss of lung tissue elasticity (emphysema), bronchospasm (asthma), or airway obstruction

alpha₁-antitrypsin deficiency: genetic disorder resulting from deficiency of alpha₁-antitrypsin, a protective agent for the lung; increases patient's risk for developing panacinar emphysema even in the absence of smoking

asthma: a heterogeneous disease, usually characterized by chronic airway inflammation; defined by history of symptoms such as wheeze, shortness of breath, chest tightness, and cough that vary over time and in intensity

bronchiectasis: chronic, irreversible dilation of the bronchi and bronchioles that results from the destruction of muscles and elastic connective tissue; dilated airways become saccular and are a medium for chronic infection

chest percussion: manually cupping hands over the chest wall and using vibration to mobilize secretions by mechanically dislodging viscous or adherent secretions in the lungs

chest physiotherapy (CPT): therapy used to remove bronchial secretions, improve ventilation, and increase the efficiency of the respiratory muscles; types include postural drainage, chest percussion, and vibration, and breathing retraining

chronic bronchitis: a disease of the airways defined as the presence of cough and sputum production for at least a combined total of 3 months in each of 2 consecutive years

chronic obstructive pulmonary disease (COPD): disease state characterized by airflow limitation that is not fully reversible; sometimes referred to as chronic airway obstruction or chronic obstructive lung disease

desaturate: a precipitous drop in the saturation of hemoglobin with oxygen

dry-powder inhaler (DPI): a compact, portable inspiratory flow–driven inhaler that delivers dry-powder medications into the patient's lungs

emphysema: a disease of the airways characterized by destruction of the walls of overdistended alveoli

flutter valve: portable handheld mucous clearance device; consisting of a tube with an oscillating steel ball inside; upon expiration, high-frequency oscillations facilitate mucous expectoration

fraction of inspired oxygen (FiO₂): concentration of oxygen delivered (e.g., 1.0 equals to 100% oxygen)

hypoxemia: decrease in arterial oxygen tension in the blood

hypoxia: decrease in oxygen supply to the tissues and cells

polycythemia: increase in the red blood cell concentration in the blood; in COPD, the body attempts to improve oxygen-carrying capacity by producing increasing amounts of red blood cells

postural drainage: positioning the patient to allow drainage from all lobes of the lungs and airways

pressurized metered-dose inhaler (pMDI): a compact, portable patient-activated pressurized medication canister that provides aerosolized medication that the patient inhales into the lungs

small-volume nebulizer (SVN): a handheld generator-driven medication delivery system that provides aerosolized liquid medication that the patient inhales into the lungs

spirometry: pulmonary function tests that measure specific lung volumes (e.g., FEV₁, FVC) and rates (e.g., FEF_{25%–75%}); may be measured before and after bronchodilator administration

vibration: a type of massage given by quickly tapping the chest with the fingertips or alternating the fingers in a rhythmic manner, or by using a mechanical device to assist in mobilizing lung secretions

Chronic pulmonary disorders are a leading cause of morbidity and mortality in the United States. Nurses care for patients with chronic pulmonary disease across the spectrum of care, from outpatient and home care to emergency department (ED), critical care, and hospice settings. To care for these patients, nurses not only need to have astute assessment and clinical management skills, but they also need knowledge of how these disorders can affect quality of life. In addition, the nurse's knowledge of palliative and end-of-life care is important for applicable patients. Patient and family education is an important nursing intervention to enhance self-management in patients with any chronic pulmonary disorder.

Chronic Obstructive Pulmonary Disease

Chronic obstructive pulmonary disease (COPD) is a preventable and treatable slowly progressive respiratory disease of airflow obstruction involving the airways, pulmonary parenchyma, or both (Global Initiative for Chronic Obstructive Lung Disease [GOLD], 2019). The parenchyma includes any form of lung tissue, including bronchioles, bronchi, blood vessels, interstitium, and alveoli. The airflow limitation or obstruction in COPD is not fully reversible. Most patients with COPD present with overlapping signs and symptoms of emphysema and chronic bronchitis, which are two distinct disease processes.

COPD may include diseases that cause airflow obstruction (e.g., emphysema, chronic bronchitis) or any combination of these disorders. Other

diseases such as cystic fibrosis (CF), bronchiectasis, and asthma are classified as chronic pulmonary disorders. Asthma is considered a distinct, separate disorder and is classified as an abnormal airway condition characterized primarily by reversible inflammation. COPD can coexist with asthma. Both of these diseases have the same major symptoms; however, symptoms are generally more variable in asthma than in COPD. This chapter discusses COPD as a disease and describes chronic bronchitis and emphysema as distinct disease states, providing a foundation for understanding the pathophysiology of COPD. Bronchiectasis, asthma, and CF are discussed separately.

While COPD and lower respiratory diseases are the fourth leading cause of death for people of all ages in the United States, they are the third leading cause of death for people ages 65 and over (Centers for Disease Control and Prevention [CDC], 2018a). In 2016, approximately 154,596 Americans died from COPD and lower respiratory diseases (CDC, 2017a). The CDC (2018b) reports that over 16 million Americans live with COPD. This number does not account for the millions of Americans who have COPD but are not diagnosed. Although the rate of hospitalizations for COPD is slowly decreasing, the Agency for Healthcare Research and Quality (AHRQ) reported in 2016 that there were still 501,849 hospitalizations that had COPD as a primary diagnosis (AHRQ, 2016). The cost of individual hospital admissions for patients with COPD is approximately \$6245 more per year than admissions for patients without COPD. COPD's economic burden goes beyond the direct medical costs. Patients with COPD were 60% more likely to call in sick to work and 2.6 times more likely to incur short-term disability than patients without COPD (Patel, Coutinho, Lunacsek, et al., 2018).

Pathophysiology

People with COPD commonly become symptomatic during the middle adult years, and the incidence of the disease increases with age. Although certain aspects of lung function normally decrease with age—for example, vital capacity and forced expiratory volume in 1 second (FEV_1)—COPD accentuates and accelerates these physiologic changes as described later. In COPD, the airflow limitation is both progressive and associated with the lungs' abnormal inflammatory response to noxious particles or gases. The inflammatory response occurs throughout the proximal and peripheral airways, lung parenchyma, and pulmonary vasculature (GOLD, 2019). Because of the chronic inflammation and the body's attempts to repair it, changes and narrowing occur in the airways. In the proximal airways (trachea and bronchi greater than 2 mm in diameter), changes include increased numbers of goblet cells and enlarged submucosal glands, both of which lead to hypersecretion of mucus. In the peripheral airways (bronchioles less than 2 mm diameter),

inflammation causes thickening of the airway wall, peribronchial fibrosis, exudate in the airway, and overall airway narrowing (obstructive bronchiolitis). Over time, this ongoing injury-and-repair process causes scar tissue formation and narrowing of the airway lumen (GOLD, 2019). Inflammatory and structural changes also occur in the lung parenchyma (respiratory bronchioles and alveoli). Alveolar wall destruction leads to loss of alveolar attachments and a decrease in elastic recoil. Finally, the chronic inflammatory process affects the pulmonary vasculature and causes thickening of the lining of the vessel and hypertrophy of smooth muscle, which may lead to pulmonary hypertension (GOLD, 2019).

Processes related to imbalances of substances (proteinases and antiproteinases) in the lung may also contribute to airflow limitation. When activated by chronic inflammation, proteinases and other substances may be released, damaging the parenchyma of the lung. These parenchymal changes may also occur as a consequence of inflammation or environmental or genetic factors (e.g., alpha₁-antitrypsin deficiency).

Chronic Bronchitis

Chronic bronchitis, a disease of the airways, is defined as the presence of cough and sputum production for at least 3 months in each of 2 consecutive years. Although *chronic bronchitis* is a clinically and epidemiologically useful term, it does not reflect the major impact of airflow limitation on morbidity and mortality in COPD (GOLD, 2019). In many cases, smoke or other environmental pollutants irritate the airways, resulting in inflammation and hypersecretion of mucus. Constant irritation causes the mucus-secreting glands and goblet cells to increase in number, leading to increased mucus production. Mucus plugging of the airway reduces ciliary function. Bronchial walls also become thickened, further narrowing the bronchial lumen ([Fig. 20-1](#)). Alveoli adjacent to the bronchioles may become damaged and fibrosed, resulting in altered function of the alveolar macrophages. This is significant because the macrophages play an important role in destroying foreign particles, including bacteria. As a result, the patient becomes more susceptible to respiratory infection. A wide range of viral, bacterial, and mycoplasma infections can produce acute episodes of bronchitis. Exacerbations of chronic bronchitis are most likely to occur during the winter when viral and bacterial infections are more prevalent.

Physiology/Pathophysiology

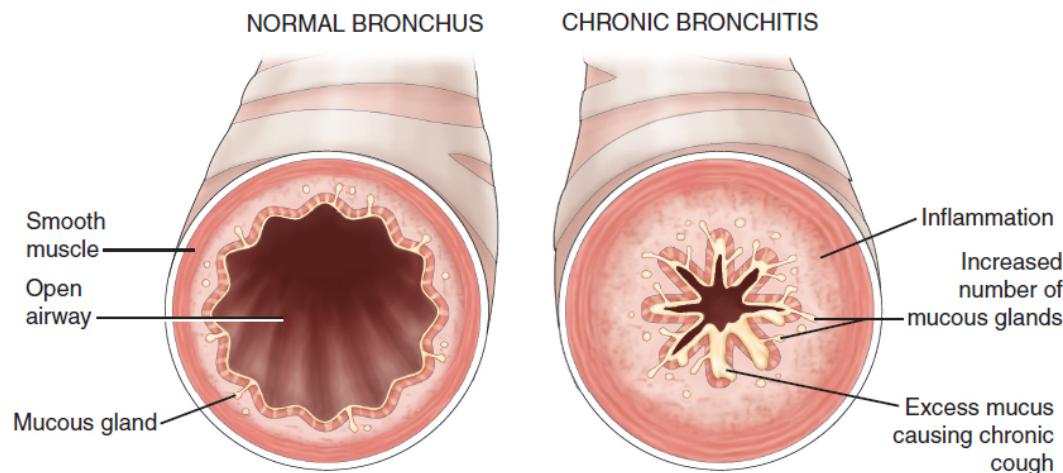


Figure 20-1 • Pathophysiology of chronic bronchitis as compared to a normal bronchus. The bronchus in chronic bronchitis is narrowed and has impaired airflow due to multiple mechanisms: inflammation, excess mucus production, and potential smooth muscle constriction (bronchospasm).

Emphysema

In **emphysema**, impaired oxygen and carbon dioxide exchange results from destruction of the walls of overdistended alveoli. *Emphysema* is a pathologic term that describes an abnormal distention of the airspaces beyond the terminal bronchioles and destruction of the walls of the alveoli (GOLD, 2019; Han, Dransfield, & Martinez, 2018). In addition, a chronic inflammatory response may induce disruption of the parenchymal tissues. This end-stage process progresses slowly for many years. As the walls of the alveoli are destroyed (a process accelerated by recurrent infections), the alveolar surface area in direct contact with the pulmonary capillaries continually decreases. This causes an increase in dead space (lung area where no gas exchange can occur) and impaired oxygen diffusion, which leads to hypoxemia. In the later stages of disease, carbon dioxide elimination is impaired, resulting in hypercapnia (increased carbon dioxide tension in arterial blood) leading to respiratory acidosis. As the alveolar walls continue to break down, the pulmonary capillary bed is reduced in size. Consequently, resistance to pulmonary blood flow is increased, forcing the right ventricle to maintain a higher blood pressure in the pulmonary artery. Hypoxemia may further increase pulmonary artery pressures (pulmonary hypertension). Cor pulmonale, one of the complications of emphysema, is right-sided heart failure brought on by long-term high blood pressure in the pulmonary arteries. This high pressure in the pulmonary arteries and right ventricle lead to back up of blood in the venous

system, resulting in dependent edema, distended neck veins, or pain in the region of the liver (see [Chapter 25](#) for further discussion).

There are two main types of emphysema, based on the changes taking place in the lung ([Fig. 20-2](#)). Both types may occur in the same patient. In the panlobular (panacinar) type of emphysema, there is destruction of the respiratory bronchiole, alveolar duct, and alveolus. All airspaces within the lobule are essentially enlarged, but there is little inflammatory disease. A hyperinflated (hyperexpanded) chest, marked dyspnea on exertion, and weight loss typically occur. To move air into and out of the lungs, negative pressure is required during inspiration, and an adequate level of positive pressure must be attained and maintained during expiration. Instead of being an involuntary passive act, expiration becomes active and requires muscular effort.

Physiology/Pathophysiology

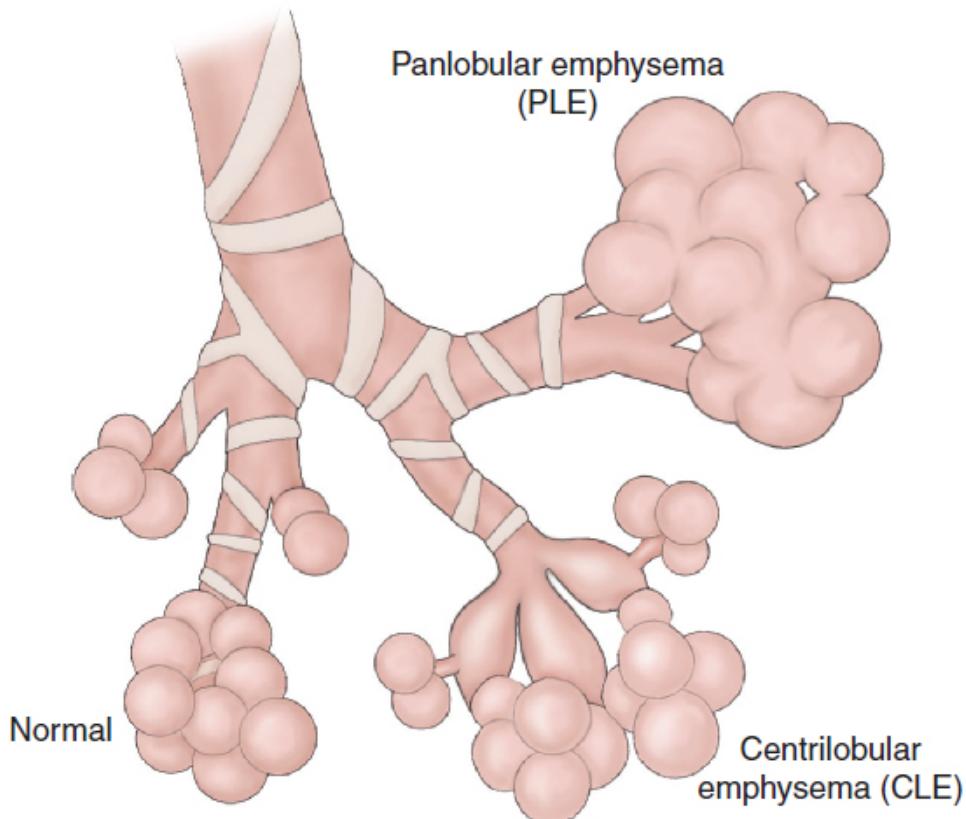


Figure 20-2 • Changes in alveolar structure in centrilobular and panlobular emphysema. In panlobular emphysema, the bronchioles, alveolar ducts, and alveoli are destroyed, and the airspaces within the lobule are enlarged. In centrilobular emphysema, the pathologic changes occur in the lobule, whereas the peripheral portions of the acinus are preserved.

In the centrilobular (centroacinar) form, pathologic changes take place mainly in the center of the secondary lobule, preserving the peripheral portions of the acinus (i.e., the terminal airway unit where gas exchange occurs). Frequently, there is a derangement of ventilation–perfusion ratios, producing chronic hypoxemia, hypercapnia, **polycythemia** (i.e., an increase in red blood cells), and episodes of right-sided heart failure. This leads to central cyanosis and respiratory failure. The patient also develops peripheral edema.

Risk Factors

Risk factors for COPD include environmental exposures and host factors ([Chart 20-1](#)). The most important environmental risk factor for COPD worldwide is cigarette smoking. A dose–response relationship exists between the intensity of smoking (pack-year history) and the decline in pulmonary function. Other environmental risk factors include smoking other types of tobacco (e.g., pipes, cigars) and marijuana. Secondhand smoke also contributes to respiratory symptoms and COPD (GOLD, 2019). Smoking depresses the activity of scavenger cells and affects the respiratory tract's ciliary cleansing mechanism, which keeps breathing passages free of inhaled irritants, bacteria, and other foreign matter. When smoking damages this cleansing mechanism, airflow is obstructed and air becomes trapped behind the obstruction. The alveoli greatly distend, which diminishes lung capacity. Smoking also irritates the goblet cells and mucous glands, causing an increased accumulation of mucus, which in turn produces more irritation, infection, and damage to the lung (U.S. Department of Health & Human Services [HHS], 2014). In addition, carbon monoxide (a by-product of smoking) combines with hemoglobin to form carboxyhemoglobin. Hemoglobin that is bound by carboxyhemoglobin cannot carry oxygen efficiently. Cigarette smoking is the best studied COPD risk factor; however, it is not the only risk factor and studies have demonstrated nonsmokers may also develop chronic airflow obstruction.

Chart 20-1 RISK FACTORS

Chronic Obstructive Pulmonary Disease

- Exposure to tobacco smoke accounts for an estimated 80–90% of cases of chronic obstructive pulmonary disease
- Secondhand smoke
- Increased age
- Occupational exposure—dust, chemicals
- Indoor and outdoor air pollution
- Genetic abnormalities, including a deficiency of alpha₁-antitrypsin, an enzyme inhibitor that normally counteracts the destruction of lung tissue by certain other enzymes

Adapted from Global Initiative for Chronic Obstructive Lung Disease (GOLD). (2019). Global strategy for the diagnosis, management, and prevention of chronic obstructive pulmonary disease. Retrieved on 6/23/2019 at: www.goldcopd.org/wp-content/uploads/2018/11/GOLD-2019-v1.7-FINAL-14Nov2018-WMS.pdf

Other environmental risk factors for COPD include prolonged and intense exposure to occupational dusts and chemicals, indoor air pollution, and outdoor air pollution (GOLD, 2019). Recent studies indicate that the use of electronic nicotine delivery systems (ENDS; e.g., e-cigarettes, e-pens, e-pipes, e-hookahs, e-cigars) could increase the risk for developing COPD, but additional research is needed to better understand how their use causes changes similar to COPD in the lungs (Canistro, Vivarelli, Cirillo, et al., 2017; Evans, Burton, & Schwartz, 2018; Larcombe, Janka, Mullins, et al., 2017). Smoke from ENDS has been shown to trigger lung changes (i.e., airway hyperreactivity and lung tissue destruction) that are normally associated with the development of COPD (Garcia-Arcos, Geraghty, Baumlin, et al., 2016). Further research demonstrated that different flavored e-cigarette fluids, aerosols, and solvents can produce different patterns of cytotoxicity (Behar, Wang, & Talbot, 2018). The Surgeon General reported that more than one third of adults ages 18 to 24 years of age had tried e-cigarettes (HHS, 2016). Young adults who have used e-cigarettes report being attracted to them due to perceptions of low harm, the flavorings/tastes of the product, and curiosity (HHS, 2016).

Host risk factors include a person's genetic makeup. One well-documented genetic risk factor is a deficiency of alpha₁-antitrypsin, an enzyme inhibitor that protects the lung parenchyma from injury. This deficiency may lead to lung and liver disease. Worldwide, **alpha₁-antitrypsin deficiency** impacts between 1/1500 and 1/3000 people with European ancestry (U.S. National Library of Medicine [NLM], 2019). This genetic risk is uncommon in people of Asian descent (NLM, 2019). Approximately 2% of people with COPD have been diagnosed with this deficiency (Stoller, Barnes, & Hollingsworth, 2018).

This deficiency predisposes young people to rapid development of lobular emphysema, even in the absence of smoking. Among Caucasians, alpha₁-antitrypsin deficiency is one of the most common genetically linked lethal diseases. COPD may also result from gene–environment interactions (GOLD, 2019). People who are genetically susceptible are sensitive to environmental factors (e.g., smoking, air pollution, infectious agents, allergens) and eventually develop chronic obstructive symptoms. Carriers must be identified so that they can modify environmental risk factors to delay or prevent overt symptoms of disease. Genetic counseling should be offered. Alpha-protease inhibitor replacement therapy, which slows the progression of the disease, is available for patients with this genetic defect and for those with severe disease. However, this infusion therapy is costly and is required on an ongoing basis.

Other genetic risk factors may predispose a patient to COPD. Work is ongoing to identify specific variants of genes hypothesized to be involved in the development of COPD. These may include specific phenotypes to several chromosomal regions in families with multiple members developing early-onset COPD (see [Chapter 17, Chart 17-8](#)).

Age is often identified as a risk factor for COPD, but it is unclear whether healthy aging is an independent risk or whether the risk is related to cumulative exposures to risks over time (GOLD, 2019). There is a strong inverse relationship between COPD and lower socioeconomic status. However, perhaps it is not the lower socioeconomic status but how the socioeconomic status places the person at risk for increased patterns of exposure (indoor and outdoor pollutants, crowding, poor nutrition, infections, and increased smoking).

Clinical Manifestations

Although the natural history of COPD is variable, it is generally a progressive disease characterized by three primary symptoms: chronic cough, sputum production, and dyspnea (GOLD, 2019). These symptoms often worsen over time. Chronic cough and sputum production often precede the development of airflow limitation by many years. However, not all people with cough and sputum production develop COPD. The cough may be intermittent and may be unproductive in some patients (GOLD, 2019). Dyspnea may be severe and interfere with the patient's activities and quality of life. It is usually progressive, worse with exercise, and persistent. As COPD progresses, dyspnea may occur at rest. Weight loss is common, because dyspnea interferes with eating and the work of breathing is energy depleting. As the work of breathing increases over time, the accessory muscles are recruited in an effort to breathe. Patients with COPD are at risk for respiratory insufficiency and respiratory infections or COPD exacerbation, which in turn increase the risk of acute and chronic respiratory failure.

In patients with COPD who have a primary emphysematous component, chronic hyperinflation leads to the “barrel chest” thorax configuration. This configuration results from a more fixed position of the ribs in the inspiratory position (due to hyperinflation) and from loss of lung elasticity (Fig. 20-3). Retraction of the supraclavicular fossae occurs on inspiration, causing the shoulders to heave upward (Fig. 20-4). In advanced emphysema, the abdominal muscles may also contract on inspiration.

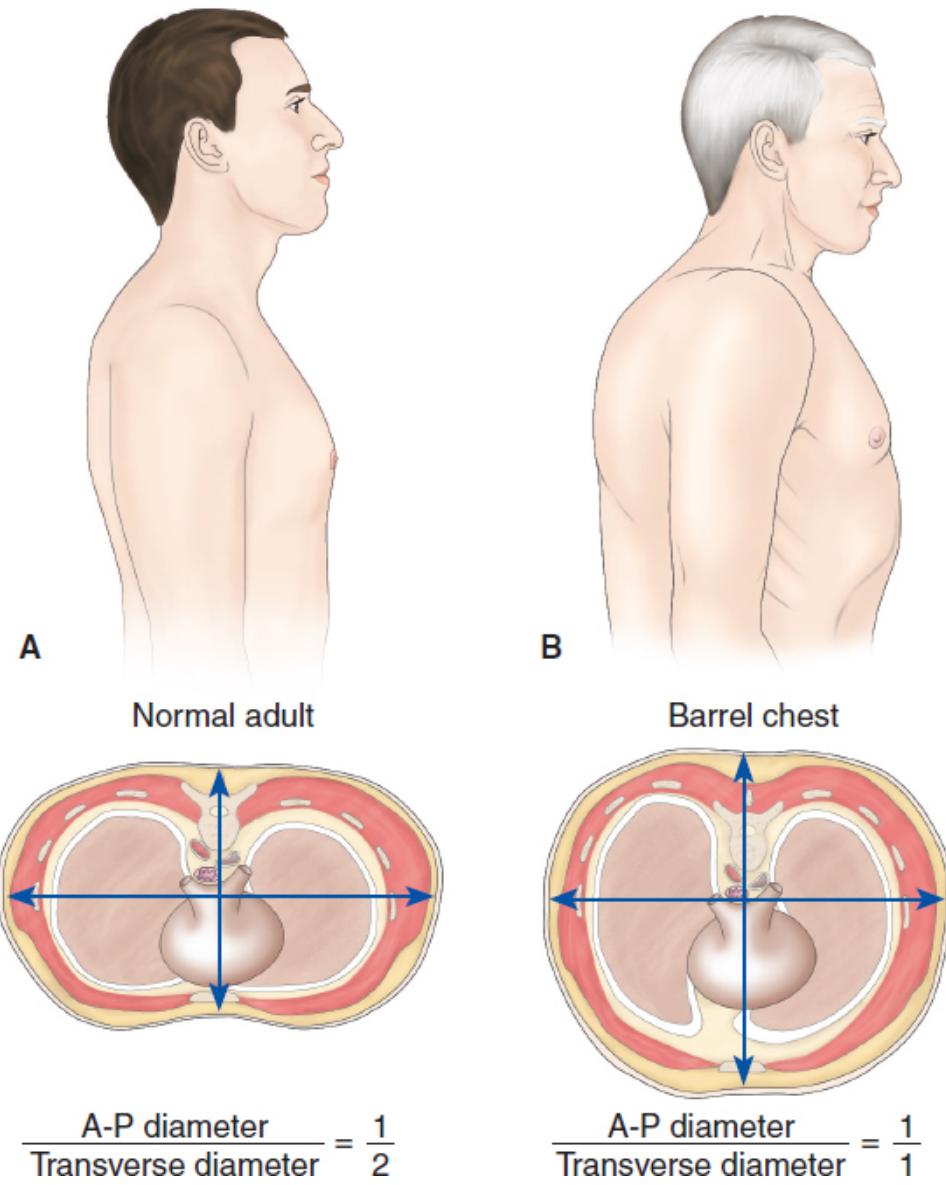


Figure 20-3 • Characteristics of normal chest wall and chest wall in emphysema. **A.** The normal chest wall and its cross-section. **B.** The barrel-shaped chest of emphysema and its cross-section.

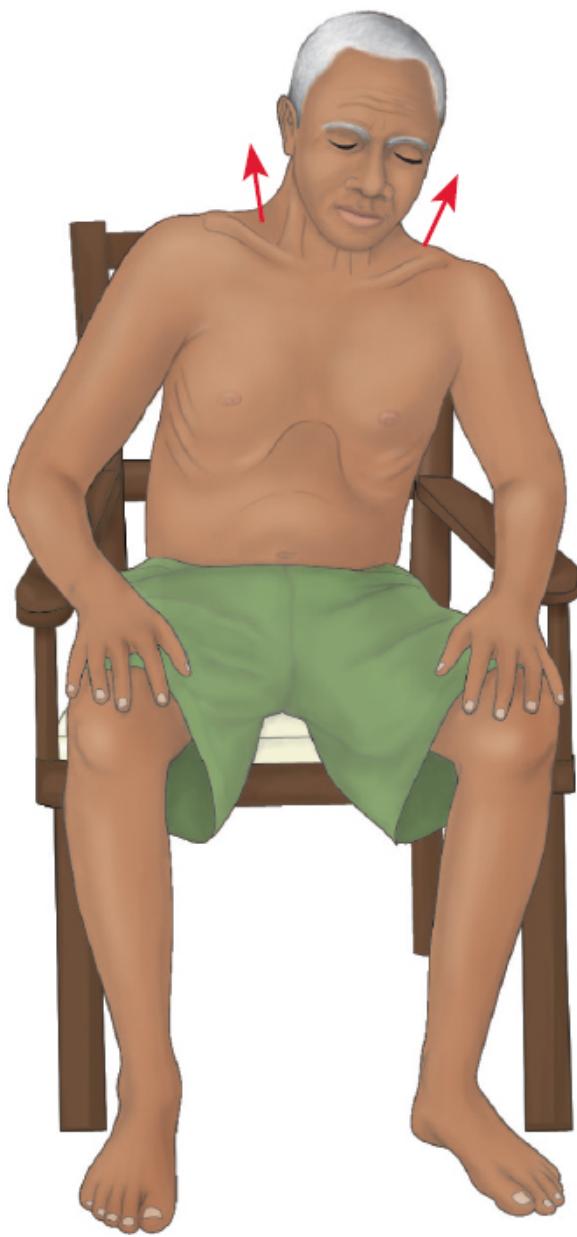


Figure 20-4 • Typical posture of a person with chronic obstructive pulmonary disease—primarily emphysema. The person tends to lean forward and uses the accessory muscles of respiration to breathe, forcing the shoulder girdle upward and causing the supraclavicular fossae to retract on inspiration.

There are systemic or extrapulmonary manifestations of COPD. These include musculoskeletal wasting (see [Chapter 4](#) for discussion of nutrition assessment and [Chapters 39 and 40](#) for discussion of nutrition therapy), metabolic disturbances, and depression (a frequent comorbidity that accompanies chronic debilitating illnesses). These clinical manifestations beyond the lungs must also be assessed and treated in order to decrease the

morbidity and improve the quality of life of the patient with COPD. For example, research has indicated that depression, metabolic syndrome, and diabetes are frequent comorbidities of COPD (Raherison, Ouaalaya, Bernady, et al., 2018). It is speculated that measures to promote healthy eating and activity that may ameliorate metabolic syndrome, diabetes, and depression may also deter the development of COPD.

Assessment and Diagnostic Findings

The nurse obtains a thorough health history from patients with known or potential COPD. [Chart 20-2](#) lists the key factors to assess for patients with known or suspected COPD. Pulmonary function studies are used to help confirm the diagnosis of COPD, determine disease severity, and monitor disease progression. **Spirometry** is used to evaluate airflow obstruction, which is determined by the ratio of FEV₁ to forced vital capacity (FVC). Spirometric results are expressed as an absolute volume and as a percentage of the predicted value using appropriate normal values for gender, age, and height. With obstruction, the patient either has difficulty exhaling or cannot forcibly exhale air from the lungs, reducing the FEV₁. Spirometry is also used to determine reversibility of obstruction after the use of bronchodilators (GOLD, 2019). Spirometry is initially performed, the patient is given an inhaled bronchodilator treatment according to a standard protocol, and then spirometry is repeated. The patient demonstrates a degree of reversibility if the pulmonary function values improve after administration of the bronchodilator.

Chart 20-2 ASSESSMENT

Assessing Patients with Chronic Obstructive Pulmonary Disease

Health History

- Has the patient been exposed to risk factors (see [Chart 20-1](#))? If so, inquire about types, intensity, and duration of exposure; for instance:
 - How much exposure has the patient had to secondhand smoke?
 - Is there occupational exposure to smoke or other pollutants?
- Does the patient have a past medical history of respiratory diseases/problems, including asthma, allergy, sinusitis, nasal polyps, or respiratory infections?
- Does the patient have a family history of chronic obstructive pulmonary disease or other chronic respiratory diseases?
- How long has the patient had respiratory difficulty?
- What is the pattern of symptom development?
- Does exertion increase the dyspnea? What type of exertion?
- What are the limits of the patient's tolerance for exercise?
- At what times during the day does the patient complain most of fatigue and shortness of breath?
- Does the patient describe any discomfort or pain in any part of the body? If so, where does it occur, how intense is this pain, when does it occur, and does it interfere with activities of daily living? Is there any intervention that helps to alleviate the pain or discomfort?
- Which eating and sleeping habits have been affected?
- What is the impact of respiratory disease on quality of life?
- What does the patient know about the disease and their condition?
- What is the patient's smoking history?
- Does the patient have a history of using electronic nicotine delivery systems (ENDS) (e.g., vaping, e-cigarettes, e-pens, e-pipes, e-hookah, e-cigars)?
- What are the triggering events (e.g., exertion, strong odors, dust, exposure to animals)?
- Does the patient have a history of exacerbations or previous hospitalizations for respiratory problems?
- Are comorbidities present?
- How appropriate are current medical treatments?
- Does the patient have available social and family support?
- What is the potential for reducing risk factors (e.g., smoking cessation)?

Physical Assessment

- What position does the patient assume during the interview?
- What are the pulse and the respiratory rates?
- What is the character of respirations? Even and without effort? Other?

- Can the patient complete a sentence without having to take a breath?
- Does the patient contract the abdominal muscles during inspiration?
- Does the patient use accessory muscles of the shoulders and neck when breathing?
- Does the patient take a long time to exhale (prolonged expiration)?
- Is central cyanosis evident?
- Are the patient's neck veins distended?
- Does the patient have peripheral edema?
- Is the patient coughing?
- What are the color, amount, and consistency of the sputum?
- Is clubbing of the fingers present?
- What types of breath sounds (i.e., clear, diminished or distant, crackles, wheezes) are heard? Describe and document findings and locations.
- Are there any sensory deficits?
- Is there short- or long-term memory impairment?
- Is there increasing stupor?
- Is the patient apprehensive?

Arterial blood gas measurements may also be obtained to assess baseline oxygenation and gas exchange and are especially important in advanced COPD. A chest x-ray may be obtained to exclude alternative diagnoses. A computed tomography (CT) chest scan is not routinely obtained in the diagnosis of COPD, but a high-resolution CT scan may help in the differential diagnosis. Screening for alpha₁-antitrypsin deficiency is suggested for all adults who are symptomatic, especially for patients younger than 45 years. Screening in young adults is important for those with a family history of COPD, particularly if they have a family history of blood relatives with alpha₁-antitrypsin deficiency or COPD that is primarily emphysematous in nature (Han et al., 2018).

COPD is classified into four grades depending on the severity measured by pulmonary function tests, as shown in [Table 20-1](#) (GOLD, 2019). However, pulmonary function is not the only way to assess or classify COPD; pulmonary function is evaluated in conjunction with symptoms, health status impairment with COPD, and the potential for exacerbations. Factors that determine the clinical course and survival of patients with COPD include history of cigarette smoking, exposure to secondhand smoke, age, rate of decline of FEV₁, hypoxemia, pulmonary artery pressure, resting heart rate, weight loss, reversibility of airflow obstruction, and comorbidities.

In diagnosing COPD, several differential diagnoses must be ruled out. The primary differential diagnosis is asthma. It may be difficult to differentiate between a patient with COPD and one with chronic asthma. Other diseases

that must be considered in the differential diagnosis include heart failure, bronchiectasis, tuberculosis, obliterative bronchiolitis, and diffuse panbronchiolitis (GOLD, 2019). Key factors in determining the diagnosis are the patient's history, severity of symptoms, and responsiveness to bronchodilators.

TABLE 20-1 Grades of Chronic Obstructive Pulmonary Disease

Grade	Severity	Pulmonary Function
Grade I	Mild	FEV ₁ /FVC <70% FEV ₁ ≥80% predicted
Grade II	Moderate	FEV ₁ /FVC <70% FEV ₁ 50–79% predicted
Grade III	Severe	FEV ₁ /FVC <70% FEV ₁ 30–49% predicted
Grade IV	Very severe	FEV ₁ /FVC <70% FEV ₁ <30% predicted

FEV₁, forced expiratory volume in 1 s; FVC, forced vital capacity.

Adapted from Global Initiative for Chronic Obstructive Lung Disease (GOLD). (2019). Global strategy for the diagnosis, management, and prevention of chronic obstructive pulmonary disease. Retrieved on 06/23/2019 at: www.goldcopd.org/wp-content/uploads/2018/11/GOLD-2019-v1.7-FINAL-14Nov2018-WMS.pdf

Complications

Respiratory insufficiency and failure are major life-threatening complications of COPD. The acuity of the onset and the severity of respiratory failure depend on baseline pulmonary function, pulse oximetry or arterial blood gas values, comorbid conditions, and the severity of other complications of COPD. Respiratory insufficiency and failure may be chronic (with severe COPD) or acute (with severe bronchospasm or pneumonia in a patient with severe COPD). Acute respiratory insufficiency and failure may necessitate ventilatory support until other acute complications, such as infection, can be treated. (See Chapter 19 for the management of the patient requiring ventilatory support.) Other complications of COPD include pneumonia, chronic atelectasis, pneumothorax, and pulmonary arterial hypertension (cor pulmonale).

Medical Management

Therapeutic strategies for the patient with COPD include promoting smoking cessation as appropriate, providing supplemental oxygen therapy as indicated, prescribing medications, and managing exacerbations. Some patients may

benefit from surgical interventions; whereas others with advanced COPD may benefit from palliative care.

Risk Reduction

For patients with stable disease, treatment aims to reduce risk and symptoms. The major risk factor associated with COPD is environmental exposure and it is modifiable. The most important environmental exposure is smoking. In 2017, over 34 million people in the United States reported that they were active smokers (CDC, 2018b). Smoking kills more than 480,000 people each year and costs the nation more than \$300 billion in health care expenses and lost productivity annually (CDC, 2019a; CDC, 2019b). Smoking cessation is the single most cost-effective intervention to reduce the risk of developing COPD and to stop its progression (GOLD, 2019). However, smoking cessation is difficult to achieve and even more difficult to sustain in the long term. Factors associated with continued smoking vary among patients and may include the strength of the nicotine addiction, continued exposure to smoking-associated stimuli (at work or in social settings), stress, depression, and habit.

Because multiple factors are associated with continued smoking, successful cessation often requires multiple strategies. Health care providers should promote cessation by explaining the risks of smoking and personalizing the “at-risk” message to the patient. After giving a strong warning about smoking, health care providers should work with the patient to set a definite “quit date.” Referral to a smoking cessation program may be helpful. Follow-up within 3 to 5 days after the quit date to review progress and to address any problems is associated with an increased rate of success; this should be repeated as needed. Continued reinforcement with a modality that is individualized to the patient and the patient’s lifestyle (e.g., telephone calls, texting, e-mail, or clinic visits) is beneficial. Relapses should be analyzed, and the patient and health care provider should jointly identify possible solutions to prevent future backsliding. It is important to emphasize successes rather than failures. Nicotine replacement—a first-line pharmacotherapy that reliably increases long-term smoking abstinence rates—comes in a variety of forms (gum, inhaler, nasal spray, transdermal patch, sublingual tablet, or lozenge). Bupropion SR and nortriptyline, both antidepressants, may also increase long-term quit rates. Other pharmacologic agents include the antihypertensive agent clonidine; however, its side effects limit its use. Varenicline, a nicotinic acetylcholine receptor partial agonist, may assist in smoking cessation (GOLD, 2019). Patients who are not appropriate candidates for such pharmacotherapy include those with medical contraindications, light smokers (fewer than 10 cigarettes per day), pregnant women, and adolescent smokers.

Smoking cessation can begin in a variety of health care settings—outpatient clinic, nursing center, pulmonary rehabilitation center, community, hospital, and in the home. Regardless of the setting, nurses have the opportunity to

educate patients about the risks of smoking and the benefits of smoking cessation. Various materials, resources, and programs developed by several organizations (e.g., AHRQ, CDC, National Cancer Institute, American Lung Association, American Cancer Society) are available to assist with this effort.

General Principles of Oxygen Therapy

Oxygen therapy is the administration of oxygen at a concentration greater than that found in the environmental atmosphere. At sea level, the concentration of oxygen in room air is 21%. The goal of oxygen therapy is to provide adequate transport of oxygen in the blood while decreasing the work of breathing and reducing stress on the myocardium.

Oxygen transport to tissues depends on factors such as cardiac output, arterial oxygen content, concentration of hemoglobin, and metabolic requirements. These factors must be kept in mind when oxygen therapy is considered for use in all patients, regardless of underlying disorders.

Indications

A change in the patient's respiratory rate or pattern may be one of the earliest indicators of the need for oxygen therapy. These changes may result from hypoxemia or hypoxia. **Hypoxemia**, a decrease in the arterial oxygen tension in the blood, is manifested by changes in mental status (progressing through impaired judgment, agitation, disorientation, confusion, lethargy, and coma), dyspnea, increase in blood pressure, changes in heart rate, arrhythmias, central cyanosis (late sign), diaphoresis, and cool extremities. Hypoxemia usually leads to **hypoxia**, a decrease in oxygen supply to the tissues and cells that can also be caused by problems outside the respiratory system. Severe hypoxia can be life-threatening.

The signs and symptoms signaling the need for supplemental oxygen may depend on how suddenly this need develops. With rapidly developing hypoxia, changes occur in the central nervous system because the neurologic centers are very sensitive to oxygen deprivation. The clinical picture may resemble that of alcohol intoxication, with the patient exhibiting lack of coordination and impaired judgment. With long-standing hypoxia (as seen in patients with COPD as well as in patients with chronic heart failure), fatigue, drowsiness, apathy, inattentiveness, and delayed reaction time may occur. The need for oxygen is assessed by arterial blood gas analysis, pulse oximetry, and clinical evaluation.

Complications

Oxygen is a medication, and except in emergency situations it is given only when prescribed by a health care provider. As with other medications, the nurse administers oxygen with caution and carefully assesses its effects on each patient.

In general, a patient with any type of respiratory disorder is given oxygen therapy only to increase the partial pressure of arterial oxygen (PaO_2) back to the patient's normal baseline, which may vary from 60 to 95 mm Hg. In terms of the oxyhemoglobin dissociation curve (see [Chapter 17](#)), arterial hemoglobin at these levels is 80% to 98% saturated with oxygen; higher **fraction of inspired oxygen (FiO_2)** flow values add no further significant amounts of oxygen to the red blood cells or plasma. Instead of helping, increased amounts of oxygen may produce toxic effects on the lungs and central nervous system or may depress ventilation, which is a particularly lethal adverse effect in patients with COPD (see later discussion).

It is important to observe for subtle indicators of inadequate oxygenation when oxygen is given by any method. Therefore, the nurse assesses the patient frequently for confusion, restlessness progressing to lethargy, diaphoresis, pallor, tachycardia, tachypnea, and hypertension. Intermittent or continuous pulse oximetry is used to monitor oxygen levels.

Oxygen toxicity may occur when too high concentration of oxygen is given for an extended period (generally longer than 24 hours) (Kacmarek, Stoller, & Heuer, 2017). It is caused by overproduction of oxygen free radicals, which are by-products of cell metabolism. These free radicals then mediate a severe inflammatory response that can severely damage the alveolar capillary membrane leading to pulmonary edema and progressing to cell death. Clinical manifestations of oxygen toxicity causing lung damage are similar to acute respiratory distress syndrome (ARDS) (see [Chapter 19](#)).

Signs and symptoms of oxygen toxicity include substernal discomfort, paresthesias, dyspnea, restlessness, fatigue, malaise, progressive respiratory difficulty, refractory hypoxemia, alveolar atelectasis, and alveolar infiltrates evident on chest x-rays.

Using the lowest amount of oxygen needed to maintain an acceptable PaO_2 level and treating the underlying condition aids in the prevention of oxygen toxicity (Kacmarek et al., 2017).

An additional adverse effect of the administration of high concentrations of oxygen (greater than 50%) to patients who are sedated and breathing small tidal volumes of air (volume of air inspired and expired with each breath) is absorption atelectasis. Normally, 79% of room air is comprised of nitrogen. During inhalation, nitrogen, in addition to other gases, fills the alveoli and helps keep the alveoli open. With the administration of high concentrations of oxygen, nitrogen is diluted and replaced with oxygen. Oxygen in the alveoli is absorbed quickly into the bloodstream and not replaced rapidly enough in the alveoli to maintain patency. The alveoli collapse, causing atelectasis (Kacmarek et al., 2017).

Because oxygen supports combustion, there is always a danger of fire when it is used. It is important to post "No Smoking" signs when oxygen is in use. Oxygen therapy equipment is also a potential source of bacterial

contamination; therefore, the nurse (or respiratory therapist) changes the tubing according to infection prevention policy, manufacturer's recommendations, and the type of oxygen delivery equipment.



Gerontologic Considerations

The respiratory system changes throughout the aging process, and it is important for nurses to be aware of these changes when assessing older adult patients who are receiving oxygen therapy. As the respiratory muscles weaken and the large bronchi and alveoli become enlarged, the available surface area of the lungs decreases, resulting in reduced ventilation and respiratory gas exchange. The number of functional cilia is also reduced, decreasing ciliary action and the cough reflex. As a result of osteoporosis and calcification of the costal cartilages, chest wall compliance is decreased. Patients may display increased chest rigidity and respiratory rate and decreased PaO_2 and lung expansion. The older adult is at risk for aspiration and infection related to these changes. In addition, patient education regarding adequate nutrition is essential because appropriate dietary intake can help diminish the excess buildup of carbon dioxide and maintain optimal respiratory functioning (Meiner & Yeager, 2019).

Methods of Oxygen Administration



Oxygen is dispensed from a cylinder or a piped-in system. A reduction gauge is necessary to reduce the pressure to a working level, and a flow meter regulates the flow of oxygen in liters per minute (L/min). When oxygen is used at high flow rates, it should be moistened by passing it through a humidification system to prevent it from drying the mucous membranes of the respiratory tract.

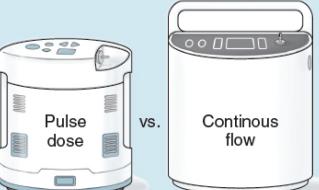
The use of oxygen concentrators is another means of providing varying amounts of oxygen, especially in the home setting. These devices are relatively portable, easy to operate, and cost-effective but require more maintenance than tank or liquid systems. These models can deliver oxygen flows from 1 to 10 L/min and provide an FiO_2 of about 40% (Cairo, 2018).

Many different oxygen devices are used (Table 20-2). The amount of oxygen delivered is expressed as a percentage concentration (e.g., 70%). The appropriate form of oxygen therapy is best determined by arterial blood gas levels (see Chapter 10), which indicate the patient's oxygenation status.

TABLE 20-2 Oxygen Administration Devices

Device	Suggested Flow Rate (L/min)	O ₂ Percentage Setting	Advantages	Disadvantages
Low-Flow Systems				
Cannula (nasal and reservoir)	1–2 3–5 6	24–28 32–40 44	Lightweight, comfortable, inexpensive, continuous use with meals and activity	Easily dislodged, from nares, skin breakdown over ears or nares, nasal mucosal and/or pharyngeal mucosal drying, air swallowing, variable FiO ₂
Nasal (oropharyngeal) catheter	1–6	24–44	Inexpensive, does not require a tracheostomy	Nasal mucosa irritation; catheter should be changed frequently to alternate nostril
Mask, simple	5–8	40–60	Simple to use, inexpensive	Poorly fitting, variable FiO ₂ , must remove to eat
Mask, partial rebreathing	8–11	50–75	Moderate O ₂ concentration	Warm, poorly fitting, must remove to eat

	10–15	80–95	High O ₂ concentration	Poorly fitting, must remove to eat
Mask, nonrebreathing				
High-Flow Systems				
	4–6	24, 26, 28	Provides low levels of supplemental O ₂	Must remove to eat
	6–8	30, 35, 40	Precise FiO ₂ , additional humidity available	
Mask, Venturi				
	1/4–4	60–100	More comfortable than other high-flow systems, concealed by clothing, less oxygen liters per minute needed than nasal cannula	Requires frequent and regular cleaning, requires surgical intervention, with associated risk for surgical complications
Transtracheal oxygen catheter				
	8–10	28–100	Good humidity, accurate FiO ₂	Uncomfortable for some
Mask, aerosol				

	8–10	28–100	Good humidity, comfortable, fairly accurate FiO_2	Requires surgery to place; needs cleaning and suctioning to maintain patency of airway
	8–10	28–100	Same as tracheostomy collar	Heavy with tubing; no need for surgery for placement
	8–10	28–100	Good humidity, fairly accurate FiO_2	Bulky and cumbersome
Oxygen-Conserving Devices				
	vs.	10–40 mL/breath	Deliver O_2 only on inspiration, conserve 50–75% of O_2 used	Must carefully evaluate function individually
Pulse dose (or demand)				

Oxygen delivery systems are classified as low-flow systems (variable performance) or high-flow systems (fixed performance). Low-flow systems contribute partially to the inspired gas the patient breathes, which means that the patient breathes some room air along with the oxygen. These systems do not provide a constant or precise concentration of inspired oxygen. The amount of inspired oxygen changes as the patient's breathing changes. High-flow systems provide the total inspired air. A specific percentage of oxygen is delivered independent of the patient's breathing. High-flow systems are indicated for patients who require a constant and precise amount of oxygen (Cairo, 2018).

A nasal cannula is used when the patient requires a low to medium concentration of oxygen for which precise accuracy is not essential. This method allows the patient to move about in bed, talk, cough, and eat without interrupting oxygen flow. Although a nasal cannula can deliver up to 6 L/min, flow rates in excess of 4 L/min may lead to swallowing of air or may cause irritation and drying of the nasal and pharyngeal mucosa.

A reservoir cannula stores oxygen in a thin membrane during exhalation. When the patient's inspiration exceeds the flow rate into the cannula, the patient receives additional gas from the reservoir membrane. This reduces oxygen use because the patient can achieve adequate oxygenation with a lower flow rate than what would be used with a nasal cannula. The patient must exhale through the nose to reopen the reservoir. Any condition, such as pursed lipped breathing, that prevents nasal exhalation would limit the effectiveness of the device.

The nasal (oropharyngeal) catheter delivers low to moderate concentrations of oxygen and is rarely used. This method of delivering low-flow oxygen is usually reserved for use in special procedures, such as those that examine the patient's airways and lungs (bronchoscopy). When used during long procedures, the catheter should be changed frequently (e.g., every 8 hours), alternating nostrils to prevent nasal irritation and infection.

When oxygen is given via cannula or catheter, the percentage of oxygen reaching the lungs varies with the depth, rate, and technique of respirations. Anatomic occlusions in the nasal cavity, swollen nasal mucosa, and mouth breathing are examples of conditions that would alter the amount of gas the patient inhales.

Oxygen masks come in several forms. Each is used for different purposes (see [Table 20-2](#)). *Simple masks*, low-flow design, are used to administer low to moderate concentrations of oxygen. The body of the mask itself gathers and stores oxygen between breaths. The patient exhales directly through openings or ports in the body of the mask. If oxygen flow ceases, the patient can draw air in through these openings around the mask edges. Although widely used, these masks cannot be used for controlled oxygen concentrations and must be adjusted for proper fit. They should not press too tightly against the skin, because this can cause a sense of claustrophobia as well as skin breakdown; adjustable elastic bands are provided to ensure comfort and security.

Partial rebreathing masks have a reservoir bag that must remain inflated during both inspiration and expiration. The nurse adjusts the oxygen flow to ensure that the bag does not collapse during inhalation. A moderate concentration of oxygen can be delivered because both the mask and the bag serve as reservoirs for oxygen. Oxygen enters the mask through small-bore tubing that connects at the junction of the mask and bag. As the patient inhales, gas is drawn from the mask, from the bag, and potentially from room air through the exhalation ports. As the patient exhales, the first third of the

exhalation fills the reservoir bag. This is mainly dead space and does not participate in gas exchange in the lungs. Therefore, it has a high oxygen concentration. The remainder of the exhaled gas is vented through the exhalation ports. The actual percentage of oxygen delivered is influenced by the patient's ventilatory pattern (Kacmarek et al., 2017).

Nonrebreathing masks are similar in design to partial rebreathing masks except that they have additional valves. A one-way valve located between the reservoir bag and the base of the mask allows gas from the reservoir bag to enter the mask on inhalation but prevents gas in the mask from flowing back into the reservoir bag during exhalation. One-way valves located at the exhalation ports prevent room air from entering the mask during inhalation. They also allow the patient's exhaled gases to exit the mask on exhalation. As with the partial rebreathing mask, it is important to adjust the oxygen flow so that the reservoir bag does not completely collapse on inspiration. In theory, if the nonrebreathing mask fits the patient snugly and both side exhalation ports have one-way valves, it is possible for the patient to receive 100% oxygen, making the nonrebreathing mask a high-flow oxygen system. However, because it is difficult to get an exact fit from the mask on every patient, and some nonrebreathing masks have only one one-way exhalation valves, it is almost impossible to ensure 100% oxygen delivery, making it a low-flow oxygen system.

The *Venturi mask* is the most reliable and accurate method for delivering precise concentrations of oxygen through noninvasive means. The mask is constructed in a way that allows a constant flow of room air blended with a fixed flow of oxygen. It is used primarily for patients with COPD because it can accurately provide appropriate levels of supplemental oxygen, thus avoiding the risk of suppressing the hypoxic drive.

The Venturi mask uses the Bernoulli principle of air entrainment (trapping the air like a vacuum), which provides a high airflow with controlled oxygen enrichment. For each liter of oxygen that passes through a jet orifice, a fixed proportion of room air is entrained. Varying the size of the jet orifice and adjusting the flow of oxygen can deliver a precise volume of oxygen. Excess gas leaves the mask through the two exhalation ports, carrying with it the exhaled carbon dioxide. This method allows a constant oxygen concentration to be inhaled regardless of the depth or rate of respiration.

The mask should fit snugly enough to prevent oxygen from flowing into the patient's eyes. The nurse checks the patient's skin for irritation. It is necessary to remove the mask so that the patient can eat, drink, and take medications, at which time supplemental oxygen is provided through a nasal cannula.



Concept Mastery Alert

Oxygen delivery systems are classified as either low- or high-flow systems. Whereas a low-flow oxygen delivery system may imprecisely deliver high concentrations of oxygen (e.g., up to 100% via a nonrebreathing mask), the Venturi mask, which is a high-flow system, is specifically designed to deliver precise but lower concentrations of oxygen (less than 30% oxygen).

The *transtracheal oxygen catheter* requires minor surgery to insert a catheter through a small incision directly into the trachea. It is indicated for patients with chronic oxygen therapy needs. These catheters are more comfortable, less dependent on breathing patterns, and less obvious than other oxygen delivery methods. Because no oxygen is lost into the surrounding environment, the patient achieves adequate oxygenation at lower rates, making this method less expensive and more efficient.

Other oxygen devices include *aerosol masks*, *tracheostomy collars* (see Table 20-2), *T-pieces*, and *face tents*, all of which are used with aerosol devices (nebulizers) that can be adjusted for oxygen concentrations from 28% to 100% (0.28 to 1.00). If the gas mixture flow falls below patient demand, room air is pulled in, diluting the concentration. The aerosol mist must be available for the patient during the entire inspiratory phase.

Specific Considerations for the Patient with COPD Receiving Oxygen Therapy

Oxygen therapy can be given as long-term continuous therapy, during exercise, or to prevent acute dyspnea during an exacerbation (see later discussion). The goal of supplemental oxygen therapy in the patient with COPD is to increase the baseline resting partial pressure of arterial oxygen (PaO_2) to at least 60 mm Hg at sea level, which corresponds with an arterial oxygen saturation (SaO_2) of 90% (GOLD, 2019). Long-term oxygen therapy (more than 15 hours per day) has also been shown to improve quality of life, reduce pulmonary arterial pressure and dyspnea, and improve survival (GOLD, 2019). Long-term oxygen therapy is usually introduced in very severe COPD, and indications generally include a PaO_2 of 55 mm Hg or less or SaO_2 at or below 88% (GOLD, 2019). Other indications for long-term oxygen therapy include evidence of tissue hypoxia and organ damage such as cor pulmonale, secondary polycythemia, edema from right-sided heart failure, or impaired mental status (GOLD, 2019). For patients with exercise-induced hypoxemia, oxygen supplementation during exercise may improve dyspnea but will not diminish breathlessness in daily life (GOLD, 2019). Patients who are hypoxic while awake are likely to be so during sleep. Therefore, nighttime oxygen therapy is recommended as well, and the prescription for oxygen therapy is for continuous, 24-hour use. Intermittent oxygen therapy is indicated for patients who **desaturate** (i.e., experience a precipitous drop in hemoglobin molecule saturation with oxygen) only during activities of daily living, exercise, or sleep.

The main objective in treating patients with hypoxemia and hypercapnia is to give sufficient oxygen to improve oxygenation. Patients with COPD who require oxygen may have respiratory failure that is caused primarily by a ventilation–perfusion mismatch. These patients respond to oxygen therapy and should be treated to keep the resting oxygen saturation at or above 90%, which is associated with a PaO₂ of 60 mm Hg or higher (GOLD, 2019). Nursing assessments of a patient with COPD on supplemental oxygen must include monitoring the respiratory rate and the oxygen saturation as measured by pulse oximetry (SpO₂) so that the patient has an adequate oxygen saturation (90%) on the lowest liter flow of oxygen (GOLD, 2019).

Administering too much oxygen can result in the retention of carbon dioxide. The high O₂ levels can then suppress CO₂ chemoreceptors, which in turn would depress the respiratory drive and disrupt ventilation–perfusion balance (Kacmarek et al., 2017). The resulting increased O₂ tension in the alveoli causes a ventilation–perfusion mismatch that presents as hypercapnia. Monitoring and assessment are essential in the care of patients with COPD on supplemental oxygen due to complications of oxygen supplementation. Although pulse oximetry is helpful in assessing response to oxygen therapy, it does not assess PaCO₂ levels. A SaO₂ of 88% or less warrants further evaluation with arterial blood gas analysis (GOLD, 2019). The nurse must evaluate for other factors and medications which could further decrease the respiratory drive—neurologic impairment, fluid and electrolyte issues, and opioids or sedatives.



Quality and Safety Nursing Alert

Oxygen therapy is variable in patients with COPD; its aim in COPD is to achieve an acceptable oxygen level without a fall in the pH (increasing hypercapnia).

Pharmacologic Therapy

Medication regimens used to manage COPD are based on disease severity. For grade I (mild) COPD, a short-acting bronchodilator may be prescribed. For grade II or III (moderate or severe) COPD, a short-acting bronchodilator and regular treatment with one or more long-acting bronchodilators may be used. For grade III or IV (severe or very severe) COPD, medication therapy includes regular treatment with long-acting bronchodilators and/or inhaled corticosteroids (ICSs) for repeated exacerbations.

Bronchodilators

Bronchodilators are key for symptom management in stable COPD (GOLD, 2019). The choice of bronchodilator depends on availability and individual response in terms of symptom relief and side effects. Long-acting bronchodilators are more convenient for patients to use, and combining bronchodilators with different durations of action and different mechanisms may optimize symptom management (GOLD, 2019). Long-acting bronchodilators are typically used for maintenance treatment for long-term symptom control. Short-acting bronchodilators are usually used for acute management of symptomatic flairs. Even patients who do not show a significant response to a short-acting bronchodilator test may benefit symptomatically from long-term bronchodilator treatment.

Bronchodilators relieve bronchospasm by improving expiratory flow through widening of the airways and promoting lung emptying with each breath. These medications alter smooth muscle tone and reduce airway obstruction by allowing increased oxygen distribution throughout the lungs and improving alveolar ventilation. Although regular use of bronchodilators that act primarily on the airway smooth muscle does not modify the decline of function or the prognosis of COPD, their use is central in the management of COPD (GOLD, 2019). These agents can be delivered through a pressurized metered-dose inhaler (pMDI), a dry-powder inhaler (DPI), by a small-volume nebulizer (SVN), or via the oral route in pill or liquid form. Bronchodilators are often given regularly throughout the day as well as on an as-needed basis. They may also be used prophylactically to prevent breathlessness by having the patient use them before participating in or completing an activity, such as eating or walking.

Several devices are available to deliver medication via the inhaled route. These may be categorized as pMDIs, DPIs, or SVN, as noted previously (Cairo, 2018; Gregory, Elliott, & Dunne, 2013). The choice of an inhaler device will depend on availability, cost, prescribing provider, insurance coverage, and the skills and ability of the patient (GOLD, 2019). Key aspects of each are described in [Table 20-3](#).

Both pMDIs and DPIs are small handheld devices that may be carried in a pocket or purse (Cairo, 2018; D'Urzo, Chapman, Donohue, et al., 2019). Attention to effective drug delivery and training in proper inhaler technique is essential when using a pMDI or DPI. A respiratory therapist is an excellent health care provider to consult on appropriate inhaler technique. **Pressurized metered-dose inhalers (pMDIs)** include conventional pMDIs or breath-actuated pMDIs; these may also feature spacer or valved-holding chambers (VHCs). They are pressurized devices that contain aerosolized powder of medications. A precise amount of medication is released with each activation of the pMDI canister. A spacer or VHC may also be indicated to enhance deposition of the medication in the lung and help the patient coordinate activation of the pMDI with inspiration. Spacers come in several designs, but

all are attached to the pMDI and have a mouthpiece on the opposite end ([Fig. 20-5](#)).

All pMDIs are designed so that they require coordination between the patient's inspiration and the mechanics of the inhaler. In contrast, **dry-powder inhalers (DPIs)** (see [Fig. 20-5](#)) rely solely on the patient's inspiration for medication delivery. While DPIs still require the user to press a lever or button to dispense the medication, these inhalers do not require the coordination necessary to administer pMDIs.

Because of the significant relationship between poor inhaler technique and lack of symptom control, issues that could affect proper inhaler use must be considered when assessing the effectiveness of these medications (GOLD, 2019). Conditions such as decreased hand–inhalation coordination, insufficient hand strength, and the inability to generate a sufficient inspiratory flow could impair the delivery of the medication, and thus, impair symptom control (D'Urzo et al., 2019). For example, patients with decreased hand–inhalation coordination could fail to exhale prior to administering pMDIs, which would prevent them from inhaling the proper amount of the medication. While DPIs minimize the need for hand–inhalation coordination, patients with severe COPD may not have the ability to generate a sufficient inspiratory flow necessary to deliver the proper dose (D'Urzo et al., 2019).

TABLE 20-3 Aerosol Delivery Devices

Devices/Drugs	Optimal Technique	Therapeutic Issues
Pressurized metered-dose inhaler (pMDI)	Actuation ^a during a slow (30 L/min or 3–5 s) deep inhalation, followed by 10-s breath-hold	Slow inhalation and coordination of actuation may be difficult for some patients. Patients may incorrectly stop inhalation at actuation. Deposition of 50–80% of actuated dose in the oropharynx. Mouth washing and spitting is effective in reducing the amount of drug swallowed and absorbed systemically
Beta-2-adrenergic agonists Corticosteroids Anticholinergics		
Breath-actuated pMDI Beta-2-adrenergic agonists	Tight seal around mouthpiece and slightly more rapid inhalation than standard pMDI (see above) followed by 10-s breath-hold	May be particularly useful for patients unable to coordinate inhalation and actuation. May also be useful for older patients. Patients may incorrectly stop inhalation at actuation. Cannot be used with currently available spacer/valved-holding chamber (VHC) devices
Spacer or VHC <i>(Note—this is an accessory to a pMDI)</i>	Slow (30 L/min or 3–5 s) deep inhalation, followed by 10-s breath-hold immediately following actuation. Actuate only once into spacer/VHC per inhalation. Rinse plastic VHCs once a month with low concentration of liquid household dishwashing detergent (1:5000 or 1–2 drops per cup of water) and let drip dry	Indicated for patients who have difficulty performing adequate pMDI technique. May be bulky. Simple tubes do not obviate coordinating actuation and inhalation. VHCs are preferred. Spacers or VHCs may increase delivery of inhalational corticosteroids to the lungs
Dry-powder inhaler (DPI) Beta-2-adrenergic agonists Corticosteroids Anticholinergics	Rapid (1–2 s) deep inhalation. Minimally effective inspiratory flow is device dependent	Dose is lost if patient exhales through device after actuating. Delivery may be greater or lesser than pMDIs, depending on device and technique. Delivery is more flow dependent in devices with highest internal resistance. Rapid inhalation promotes greater deposition in larger central airways. Mouth washing and spitting are effective in reducing amount of drug swallowed and absorbed systemically
Small-volume nebulizer (SVN) Beta-2-adrenergic agonists	Slow tidal breathing with occasional deep breaths. Tightly fitting facemask for those unable to use mouthpiece	Less dependent on patient's coordination and cooperation. May be expensive, time-consuming, and bulky; output depends on device and operating parameters (fill volume, driving gas flow);

Corticosteroids
Anticholinergics

internebulizer and intranebulizer output variances are significant. The use of a facemask reduces delivery to lungs by 50%. Choice of delivery system depends on resources, availability, and clinical judgment of clinician caring for patient.

There is potential for infections if device is not cleaned properly

^aActuation refers to release of dose of medication with inhalation.

Adapted from Cairo, J. M. (2018). *Mosby's respiratory care equipment* (10th ed.). St. Louis, MO: Elsevier Mosby.

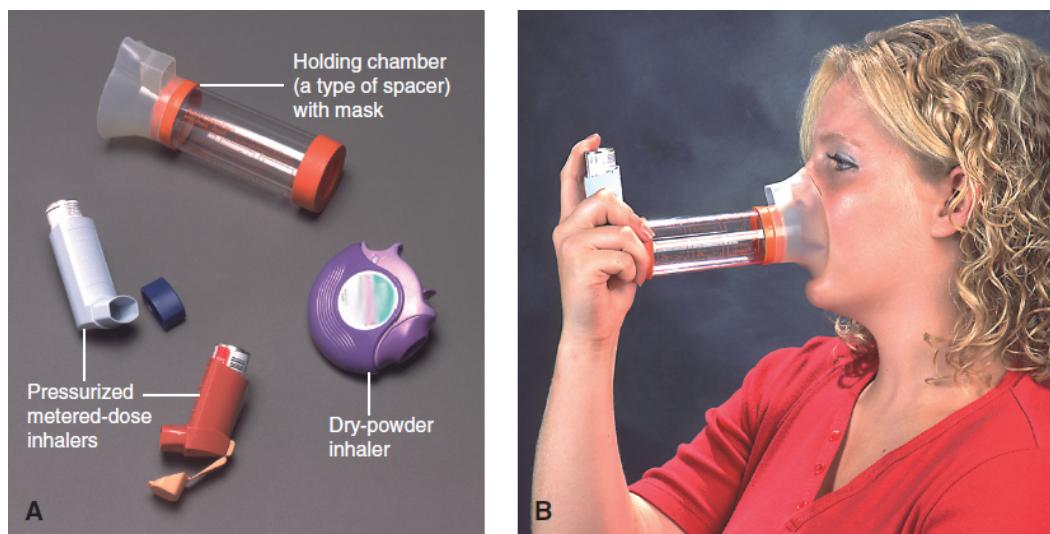


Figure 20-5 • A. Examples of pressurized metered-dose inhalers (pMDIs) and spacers and a dry-powder inhaler (DPI). **B.** A pressurized metered-dose inhaler and spacer in use.

The **small-volume nebulizer (SVN)** is a handheld apparatus that is easier to use than a pMDI or a DPI but lacks the convenience of these inhalers as it requires a power source in order to operate. Common SVN s include single-use pneumatic jet nebulizers with reservoir tubes, which are most commonly used in hospitals, and electronic nebulizers, which may be used in the home-based setting (Gregory et al., 2013). SVN s are commonly prescribed when patients are challenged with being able to administer their medications through either a pMDI or a DPI; some reasons why this might happen have been described previously (Cairo, 2018). The SVN may also be a preferred option to other inhalers because the nebulized particles in an SVN are smaller and can better penetrate the airways. Diaphragmatic breathing (see later discussion under “Breathing Retraining”) is a helpful technique to prepare for proper use of the SVN.

Several classes of bronchodilators are used that include beta-adrenergic agonists, muscarinic antagonists (anticholinergics) and combination agents. Beta-adrenergic agonists include short-acting beta-2-adrenergic agonists (SABAs) and long-acting beta-2 adrenergic agonists (LABAs). The anticholinergic agents include short-acting muscarinic antagonists (SAMAs) and long-acting muscarinic antagonists (LAMAs) (GOLD, 2018; GOLD, 2019). ICSs may also be combined with bronchodilators. These medications may be used in combination to optimize bronchodilation. LABA bronchodilators are more convenient for patient use as compared to short-acting beta₂-agonist bronchodilators. Examples of these medications are described in [Table 20-4](#).

Fixed dose combinations of LABAs and LAMAs have become the foundation for treating COPD (D'Urzo et al., 2019). Combining these classes of medications in one inhaler has synergistic effects, so that the dosages of each medication may be lesser than if they were each administered separately (i.e., as monotherapy), without diminishing their effectiveness (GOLD, 2019). Furthermore, combination therapy is associated with less adverse reactions and promotes proper medication administration by avoiding the use of multiple inhaler devices (GOLD, 2019).

Corticosteroids

Although inhaled and systemic corticosteroids may improve the symptoms of COPD, they do not slow the decline in lung function. A short trial course of oral corticosteroids may be prescribed for patients to determine whether pulmonary function improves and symptoms decrease. Long-term treatment with oral corticosteroids is not recommended in COPD and can cause steroid myopathy, leading to muscle weakness, decreased ability to function, and, in advanced disease, respiratory failure (GOLD, 2019). ICSs are frequently prescribed in COPD.

Treatment of COPD with combination long-term beta₂-agonists plus corticosteroids in one inhaler may improve lung function (GOLD, 2018). Examples of these medications include formoterol/budesonide, vilanterol/fluticasone furoate, and salmeterol/fluticasone.

Other Medications

Other pharmacologic treatments that may be used in COPD include alpha₁-antitrypsin augmentation therapy, antibiotic agents, mucolytic agents, antitussive agents, vasodilators, and opioids. Vaccines are also effective in that they prevent exacerbations by thwarting respiratory infections. For instance, influenza vaccines can reduce serious illness and death in patients with COPD (GOLD, 2019). It is recommended that people limit their risk through influenza vaccination and smoking cessation. Pneumococcal vaccination also

reduces the incidence of community-acquired pneumonia in the general older adult population (GOLD, 2019).

Management of Exacerbations

An exacerbation of COPD is defined as an event in the natural course of the disease characterized by acute changes (worsening) in the patient's respiratory symptoms beyond the normal day-to-day variations. An exacerbation also leads to change in medication (GOLD, 2019). During an exacerbation, there is increased dyspnea that is a result of amplified hyperinflation and air trapping (GOLD, 2019). Primary causes of an acute exacerbation are usually related to viral infections, particularly human rhinovirus (i.e., the common cold). However, bacterial infections and environmental factors have also been linked to the development of acute exacerbations (GOLD, 2019). Roflumilast may be used as a treatment to reduce the risk of exacerbations in patients with severe COPD associated with chronic bronchitis and a history of exacerbations. Roflumilast is a selective phosphodiesterase-4 (PDE4) inhibitor and is taken as a tablet once daily.

TABLE 20-4 Common Types of Bronchodilator Medications for Chronic Obstructive Pulmonary Disease

Class/Drug	Method of Administration			Duration of Action ^b
	Inhaler ^a	Nebulizer	Oral	
Beta-2-Adrenergic Agonist Agents				
albuterol	X	X	X	SABA
levalbuterol	X	X		SABA
terbutaline	X			SABA
arformoterol	X			LABA
formoterol	X			LABA
salmeterol	X			LABA
indacaterol	X			LABA
olodaterol	X			LABA
Anticholinergic Agents				
ipratropium bromide	X	X		SAMA
tiotropium bromide	X			LAMA
umeclidinium	X			LAMA
Combination Short-Acting Beta-2-Adrenergic Agonist and Anticholinergic Agent				
salbutamol/ipratropium	X			SABA/SAMA
Inhaled Corticosteroids (ICSs)				
beclomethasone dipropionate	X	X		
budesonide	X	X		
fluticasone propionate	X	X		
Combination Inhaled Corticosteroids and Long-Acting Beta-2-Adrenergic Agonist				
budesonide/formoterol	X			ICS/LABA
mometasone/formoterol	X			ICS/LABA
fluticasone/salmeterol	X			ICS/LABA
fluticasone furoate/vilanterol	X			ICS/LABA

^aInhaler may include pressurized metered-dose inhaler (pMDI) or dry-powder inhaler (DPI).

^bShort acting, 4–6 h; long acting, 12+ h.

ICS, inhaled corticosteroid; LABA, long-acting beta-2 adrenergic agonist; LAMA, long-acting muscarinic antagonist; SABA, short-acting beta-2 adrenergic agonist; SAMA, short-acting muscarinic antagonist.

Adapted from Global Initiative for Chronic Obstructive Lung Disease (GOLD). (2019). Global strategy for the diagnosis, management, and prevention of chronic obstructive pulmonary disease. Retrieved on 6/23/2019 at: www.goldcopd.org/wp-content/uploads/2018/11/GOLD-2019-v1.7-FINAL-14Nov2018-WMS.pdf

Treatment of an exacerbation requires identifying the primary cause (if possible) and administering the specific treatment. Optimization of bronchodilator medications is first-line therapy and involves identifying the best medication or combinations of medications taken on a regular schedule

for a specific patient. Depending on the signs and symptoms, corticosteroids, antibiotic agents, oxygen therapy, and intensive respiratory interventions may also be used. The GOLD (2019) guidelines provide indications for assessment, hospital admission, and possible critical-care admission for patients with exacerbations of COPD. Indications for hospitalization include marked increase in intensity of symptoms, severe underlying COPD, onset of new physical signs (e.g., the use of accessory muscles, paradoxical chest wall movement, worsening or new onset of central cyanosis, peripheral edema, signs of right heart failure, reduced alertness), failure to respond to initial medical management, older age, and insufficient home support. Patients requiring hospitalization for an exacerbation would exhibit severe dyspnea that does not respond adequately to initial therapy, confusion or lethargy, respiratory muscle fatigue, paradoxical chest wall movement, peripheral edema, worsening or new onset of central cyanosis, persistent or worsening hypoxemia, and the need for noninvasive or invasive assisted mechanical ventilation (GOLD, 2019). The outcome from an exacerbation of COPD is closely related to the development of respiratory acidosis, the presence of significant comorbidities, and the need for noninvasive or invasive positive pressure ventilatory support.

When the patient with an exacerbation of COPD arrives in an ED, the first line of treatment is supplemental oxygen therapy and rapid assessment to determine if the exacerbation is life-threatening (GOLD, 2019). A short-acting inhaled bronchodilator may be used to assess response to treatment. Oral or intravenous (IV) corticosteroids, in addition to bronchodilators, are recommended in the hospital management of a COPD exacerbation. The administration of antibiotics remains controversial, but in general, they should be administered when the patient has three cardinal symptoms of an exacerbation: increase in dyspnea, increase in sputum volume, and sputum purulence (GOLD, 2019).

Surgical Management

Surgical options might be appropriate for patients who do not demonstrate symptom improvement with nonsurgical therapies.

Bullectomy

A bullectomy is a surgical option for select patients with bullous emphysema. Bullae are enlarged airspaces that do not contribute to ventilation but occupy space in the thorax; these areas may be surgically excised. These bullae compress areas of the lung and may impair gas exchange. Bullectomy may help reduce dyspnea and improve lung function. It can be performed via a video-assisted thoracoscope or a limited thoracotomy incision (GOLD, 2019).

Lung Volume Reduction Surgery

Treatment options for patients with advanced or end-stage COPD (grade IV) with a primary emphysematous component are limited, although lung volume reduction surgery is a palliative surgical option. This includes patients with homogenous disease or disease that is focused in one area and not widespread throughout the lungs. Lung volume reduction surgery involves the removal of a portion of the diseased lung parenchyma. This reduces hyperinflation and allows the functional tissue to expand, resulting in improved elastic recoil of the lung and improved chest wall and diaphragmatic mechanics. This type of surgery does not cure the disease but may improve health status, exercise tolerance, and the patient's overall quality of life (GOLD, 2019).

Bronchoscopic lung volume reduction therapies are under investigation in clinical research protocols. These bronchoscopic procedures were developed to collapse areas of emphysematous lung and thus improve aeration of the functional lung tissue. Techniques include endobronchial placement of a one-way valve that allows air and mucus to exit the treated area but does not allow air to reenter. Another technique achieves biologic lung volume reduction through bronchoscopic instillation of nitinol coils into the airway of the hyperinflated lung tissue of patients with advanced emphysema. Because air can no longer enter the airway, the lung tissue beyond the sealed airway collapses over time. Patients receiving this procedure reported increased quality of life. However, there is insufficient evidence to determine the benefit–risk ratios, cost-effectiveness, and possible roles of these procedures in care of the patient with severe emphysema (GOLD, 2019).

Lung Transplantation

Lung transplantation is a viable option for definitive surgical treatment of severe COPD in select patients. It has been shown to improve quality of life and functional capacity in some patients with COPD. Limited not only by the shortage of donor organs, it is also a costly procedure with financial implications for months to years because of complications and the need for costly immunosuppressive medication regimens (GOLD, 2019).

Pulmonary Rehabilitation

Pulmonary rehabilitation, one of the most cost-effective treatment strategies, is a holistic intervention aimed at improving physical and psychological health of patients with COPD (GOLD, 2019). The primary goals of rehabilitation are to reduce symptoms, improve quality of life, and increase physical and emotional participation in everyday activities (GOLD, 2019). The benefits of this therapy include improvement of exercise capacity, reduction in the perceived intensity of breathlessness, improvement in health-related quality of life, reduction in the number of hospitalizations and days in the hospital, and reduction in the anxiety and depression associated with COPD (GOLD, 2019). Pulmonary rehabilitation services are multidisciplinary and include assessment, education,

smoking cessation, physical reconditioning, nutritional counseling, skills training, and psychological support. Patients are taught methods to alleviate symptoms. Breathing exercises, as well as retraining and exercise programs, are used to improve functional status.

Pulmonary rehabilitation is appropriate for most patients with COPD, particularly those with moderate or severe COPD (GOLD, 2019). Optimum benefits are achieved in programs that are 6 to 8 weeks in length (GOLD, 2019). Programs vary in duration and may be conducted in inpatient, outpatient, or home settings. Program selection depends on the patient's physical, functional, and psychosocial status; insurance coverage; availability of programs; and preference. Pulmonary rehabilitation may also be used therapeutically in other disorders besides COPD, including asthma, CF, lung cancer, interstitial lung disease, thoracic surgery, and lung transplantation. Despite their proven efficacy, comprehensive programs for patients with moderate to severe COPD are covered by Medicare only for those who meet specific criteria.



Patient Education

Nurses play a key role in identifying potential candidates for pulmonary rehabilitation and in facilitating and reinforcing the material learned in the rehabilitation program. Not all patients have access to a formal rehabilitation program. However, nurses can be instrumental in educating patients and families as well as facilitating specific services, such as respiratory therapy education, physical therapy for exercise and breathing retraining, occupational therapy for conserving energy during activities of daily living, and nutritional counseling. Patient education is a major component of pulmonary rehabilitation and includes a broad variety of topics. (See [Chart 20-3](#), Nursing Research Profile: Managing Anxiety among Patients with Advanced COPD.)

Depending on the length and setting of the educational program, topics may include normal anatomy and physiology of the lung, pathophysiology and changes with COPD, medications and home oxygen therapy, nutrition, respiratory therapy treatments, symptom alleviation, smoking cessation, sexuality and COPD, coping with chronic disease, communicating with the health care team, and planning for the future (advance directives, living wills, informed decision making about health care alternatives). Education, including that relating to smoking cessation, should be incorporated into all aspects of care for COPD and in many settings (primary providers' offices, clinics, hospitals, home and community health care settings, and comprehensive rehabilitation programs).

Nutritional Therapy

Nutritional assessment and counseling are important for patients with COPD. Nutritional status is reflected in severity of symptoms, degree of disability, and prognosis. Significant weight loss is often a major problem; however, excessive weight can also be problematic, although it occurs less often. Most patients with COPD have difficulty gaining and maintaining weight. A thorough assessment of caloric needs and counseling about meal planning and supplementation is part of the rehabilitation process. Continual monitoring of weight and interventions as necessary are important parts of the care of patients with COPD.

Chart 20-3



NURSING RESEARCH PROFILE

Managing Anxiety among Patients with Advanced COPD

Bove, D. G., Midtgård, G., Kaldan, D., et al. (2017). Home-based COPD psychoeducation: A qualitative study of the patients' experiences. *Journal of Psychosomatic Research*, 98, 71–77.

Purpose

This study was a nested posttrial qualitative study conducted in the context of a randomized controlled trial (RCT), *Efficacy of a Minimal Home-Based Psychoeducative Intervention in Patients with Advanced COPD*. Quantitative results from the RCT found that the nurse-led home-based intervention significantly reduced anxiety and increased mastery of dyspneic symptoms in patients with advanced COPD. The purpose of this qualitative study was to explore whether patients with advanced COPD who received this intervention found the intervention meaningful and applicable to their everyday lives.

Design

This qualitative study utilized the Interpretive Description methodology and collected data from 20 participants enrolled in the RCT. The participants accepted an invitation for the qualitative interview and signed informed consent to participate in the study. With one exception, all participants were interviewed at home. Interviews were conducted by researchers who did not previously meet the participants. All interviews were recorded and transcribed for data analysis.

Findings

Transcribed interviews revealed three main themes: (1) Making anxiety visible makes it manageable and provides relief; (2) Anxiety management is about getting control of cognitions; and (3) Being alone with anxiety and dyspnea. The first theme centered on recognition of anxiety as an aspect of COPD; nonetheless, participants expressed difficulty in talking about anxiety with relatives. Some participants felt that their spouses were annoyed when they talked about anxiety and dyspnea. They validated the usefulness of patient education materials that gave legitimacy to the problems they struggled with on a daily basis. The second theme focused on anxiety management and revealed that participants believed they had to deal with their anxiety privately. The behavioral cognitive intervention gave them the freedom to verbalize their thoughts and worries, especially thoughts of death and the dying process. The third theme revolved around feelings of isolation associated with anxiety and dyspnea. Participants verbalized that the psychoeducation intervention helped them establish a sense of control and self-preservation despite feeling alone during acute episodes.

Nursing Implications

This study validated that the nurse-led psychoeducation intervention that decreased anxiety and improved dyspneic symptoms among patients with advanced COPD also had the favorable effect of being perceived as meaningful and helpful to these participants. Participants in this study felt better equipped to manage their anxiety and dyspnea after having received the intervention, and found it valuable. They expressed relief that the intervention was focused upon their anxieties. These findings illustrate the importance of acknowledging and assessing anxiety during dyspneic episodes among patients with COPD. Legitimizing the anxiety experienced by patients with advanced COPD can establish a solid foundation for providing education to them and their spouses on the disease process and help them understand what to expect as the disease progresses. Increasing their knowledge on COPD and disease management will help them feel a sense of control that in turn could help diminish feelings of anxiety. Moreover, including family members in patient education could diminish feelings of isolation, which in turn will help decrease anxiety and ultimately improve disease management.

Palliative Care

Palliative care is integral for the patient with advanced COPD. Unfortunately, palliative care is often not considered until the disease is far advanced. The overall goals of palliative care are to manage symptoms and improve the quality of life for patients and families with advanced disease (GOLD, 2019). Areas addressed in palliative care include effective and empathetic communication with patients and families; close attention to pain, dyspnea, panic, anxiety, depression and other symptoms; psychosocial, spiritual and bereavement support; and coordination of the wide range of medical and social services required with this disease (GOLD, 2019). Palliative, hospice care, and end-of-life care are fundamental components of treatment for patients with advanced COPD (GOLD, 2019) (see [Chapter 13](#)).

Nursing Management



An overview of the nursing care of the patient with COPD is provided in [Chart 20-4](#). Additional nursing considerations with regard to assessing the patient with COPD and promoting optimal nursing and collaborative outcomes are specified as follows.

Assessing the Patient

Assessment involves obtaining information about current symptoms as well as previous disease manifestations. See [Chart 20-2](#) for sample questions that may be used to obtain a clear history of the disease process. In addition to the history, the nurse reviews the results of diagnostic tests.

Achieving Airway Clearance

Bronchospasm, which occurs in many pulmonary diseases, reduces the caliber of the small bronchi and may cause dyspnea, static secretions, and infection. Bronchospasm can sometimes be detected on auscultation with a stethoscope when wheezing or diminished breath sounds are heard. Increased mucus production, along with decreased mucociliary action, contributes to further reduction in the caliber of the bronchi and results in decreased airflow and decreased gas exchange. This is further aggravated by the loss of lung elasticity that occurs with COPD (GOLD, 2019). These changes in the airway require that the nurse monitor the patient for dyspnea and hypoxemia. The relief of bronchospasm is confirmed by measuring improvement in expiratory flow rates and volumes (the force of expiration, how long it takes to exhale, and the amount of air exhaled) as well as by assessing the dyspnea and making sure that it has lessened.

Chart 20-4



PLAN OF NURSING CARE

Care of the Patient with Chronic Obstructive Pulmonary Disease

Nursing Diagnosis: Impaired gas exchange and impaired airway clearance due to chronic inhalation of toxins

Goal: Improvement in gas exchange

Nursing Interventions	Rationale	Expected Outcomes
<p>1. Evaluate current smoking status, educate regarding smoking cessation, and facilitate efforts to quit.</p> <p>a. Evaluate current smoking habits of patient and family.</p> <p>b. Educate regarding hazards of smoking and relationship to COPD.</p> <p>c. Evaluate previous smoking cessation attempts.</p> <p>d. Provide educational materials.</p> <p>e. Refer to a smoking cessation program or resource.</p> <p>2. Evaluate current exposure to occupational toxins or pollutants and indoor/outdoor pollution.</p> <p>a. Emphasize primary prevention to occupational exposures. This</p>	<p>1. Smoking causes permanent damage to the lungs and diminishes the lungs' protective mechanisms. Airflow is obstructed, secretions are increased, and lung capacity is reduced. Continued smoking increases morbidity and mortality in COPD and is also a risk factor for lung cancer.</p> <p>2. Chronic inhalation of both indoor and outdoor toxins causes damage to the airways and impairs gas exchange.</p>	<ul style="list-style-type: none"> Identifies hazards of cigarette smoking Identifies resources for smoking cessation, if appropriate Enrolls in smoking cessation program, if appropriate Reports success in stopping smoking Verbalizes types of inhaled toxins Minimizes or eliminates exposures Monitors public announcements regarding air quality and minimizes or eliminates exposures during episodes of severe pollution

is best achieved by elimination or reduction in exposures in the workplace.

- b. Educate regarding types of indoor and outdoor air pollution (e.g., biomass fuel burned for cooking and heating in poorly ventilated buildings, outdoor air pollution).
- c. Advise patient to monitor public announcements regarding air quality.

Nursing Diagnosis: Impaired gas exchange associated with ventilation–perfusion inequality

Goal: Improvement in gas exchange

Nursing Interventions	Rationale	Expected Outcomes
<ol style="list-style-type: none">1. Administer bronchodilators as prescribed.<ol style="list-style-type: none">a. Inhalation is the preferred route. Observe for side effects: tachycardia, arrhythmias, central nervous system excitation, nausea, and vomiting.	<ol style="list-style-type: none">1. Bronchodilators dilate the airways. The medication dosage is carefully adjusted for each patient, in accordance with clinical response.	<ul style="list-style-type: none">• Verbalizes need for bronchodilators and for taking them as prescribed• Evidences minimal side effects; heart rate near normal, absence of arrhythmias,

	c. Assess for correct technique of pressurized metered-dose inhaler (pMDI), dry-powder inhaler (DPI), or small-volume nebulizer (SVN) administration.	normal mentation
2.	Evaluate effectiveness of pMDI, DPI, or SVN treatments.	<ul style="list-style-type: none"> Combining medication with aerosolized bronchodilators is typically used to control bronchoconstriction in an acute exacerbation. Generally, however, the pMDI with spacer is the preferred route (less cost and time to treatment).
a.	Assess for decreased shortness of breath, decreased wheezing or crackles, loosened secretions, and decreased anxiety.	<ul style="list-style-type: none"> These techniques improve ventilation by opening airways to facilitate clearing the airways of sputum. Gas exchange is improved, and fatigue is minimized.
b.	Ensure that treatment is given before meals to avoid nausea and to reduce fatigue that accompanies eating.	<ul style="list-style-type: none"> Oxygen will correct the hypoxemia. Careful observation of the liter flow or the percentage given and its effect on the patient is important. These patients generally require low-flow oxygen rates of 1–2 L/min. Monitor and titrate to achieve desired PaO₂. Periodic arterial blood gases and pulse oximetry help evaluate adequacy of oxygenation. Smoking may
3.	Instruct and encourage patient in diaphragmatic breathing and effective coughing.	
4.	Administer oxygen by the method prescribed.	
a.	Explain rationale and	

- importance to patient.
- b. Evaluate effectiveness; observe for signs of hypoxemia. Notify primary provider if restlessness, anxiety, somnolence, cyanosis, or tachycardia is present.
- c. Analyze arterial blood gases and compare with baseline values. When arterial puncture is performed and a blood sample is obtained, hold puncture site for 5 minutes to prevent arterial bleeding and development of ecchymoses.
- d. Initiate pulse oximetry to monitor oxygen saturation.
- e. Explain that no smoking is permitted by patient or visitors while oxygen is in use.
- render pulse oximetry inaccurate because the carbon monoxide from cigarette smoke also saturates hemoglobin.

Nursing Diagnosis: Impaired airway clearance associated with bronchoconstriction, increased mucus production, ineffective cough, bronchopulmonary infection, and other complications

Goal: Achievement of airway clearance

Nursing Interventions	Rationale	Expected Outcomes
<ol style="list-style-type: none"> 1. Adequately hydrate the patient. 2. Instruct in and encourage the use of diaphragmatic breathing and coughing techniques. 3. Assist in administering pMDI, DPI, or SVN. 4. If indicated, perform postural drainage with percussion and vibration in the morning and at night as prescribed. 5. Instruct patient to avoid bronchial irritants such as cigarette smoke, aerosols, extremes of temperature, and fumes. 6. Educate about early signs of infection that are to be reported to the primary provider immediately: <ol style="list-style-type: none"> a. Increased sputum production 	<ol style="list-style-type: none"> 1. Systemic hydration keeps secretions moist and easier to expectorate. Fluids must be given with caution if right- or left-sided heart failure is present. 2. These techniques help to improve ventilation and mobilize secretions without causing breathlessness and fatigue. 3. This ensures adequate delivery of medication to the airways. 4. This uses gravity to help raise secretions so they can be more easily expectorated or suctioned. 5. Bronchial irritants cause bronchoconstriction and increased mucus production, which then interfere with airway clearance. 6. Minor respiratory infections that are of no consequence to the person with normal lungs can produce fatal disturbances in the lungs of the person with COPD. Early 	<ul style="list-style-type: none"> • Verbalizes need to drink fluids • Demonstrates diaphragmatic breathing and coughing • Performs postural drainage correctly • Coughing is minimized • Does not smoke • Verbalizes that pollens, fumes, gases, dusts, and extremes of temperature and humidity are irritants to be avoided • Identifies signs of early infection • Is free of infection (no fever, no change in sputum, lessening of dyspnea) • Verbalizes need to notify primary provider at the earliest sign of infection • Verbalizes need to stay away from crowds or people with

b. Change in color of sputum	recognition is crucial.	colds in flu season
c. Increased thickness of sputum	7. Antibiotics may be prescribed to prevent or treat infection.	• Discusses flu and pneumonia vaccines with clinician to help prevent infection
d. Increased shortness of breath, tightness in chest, or fatigue	8. Patients with respiratory conditions are prone to respiratory infections and are encouraged to be immunized.	
e. Increased coughing		
f. Fever or chills		
7. Administer antibiotics as prescribed.		
8. Encourage patient to be immunized against influenza and <i>Streptococcus pneumoniae</i> .		

Nursing Diagnosis: Impaired breathing associated with shortness of breath, mucus, bronchoconstriction, and airway irritants

Goal: Improvement in breathing pattern

Nursing Interventions	Rationale	Expected Outcomes
1. Instruct patient in diaphragmatic and pursed-lip breathing.	1. This helps patient prolong expiration time and decreases air trapping. With these techniques, patient will breathe more efficiently and effectively.	• Practices pursed-lip and diaphragmatic breathing and uses them when short of breath and with activity
2. Encourage alternating activity with rest periods. Encourage patient to make some decisions (bath, shaving) about care based on tolerance level.	2. Pacing activities permits patient to perform activities without excessive distress. 3. This strengthens and conditions the respiratory muscles.	• Shows signs of decreased respiratory effort and paces activities • Uses inspiratory

3. Encourage the use of an inspiratory muscle trainer if prescribed.
- muscle trainer as prescribed

Nursing Diagnosis: Impaired ability to manage regime associated with fatigue secondary to increased work of breathing and insufficient ventilation and oxygenation

Goal: Independence in health management activities

Nursing Interventions	Rationale	Expected Outcomes
<p>1. Educate patient to coordinate diaphragmatic breathing with activity (e.g., walking, bending).</p> <p>2. Encourage patient to begin to bathe self, dress self, walk, and drink fluids. Discuss energy conservation measures.</p> <p>3. Educate patient about postural drainage if appropriate.</p>	<p>1. This will encourage the patient to be more active and to avoid excessive fatigue or dyspnea during activity.</p> <p>2. As condition resolves, patient will be able to do more but needs to be encouraged to avoid increasing dependence.</p> <p>3. This encourages patient to become involved in own care and prepares patient to manage at home.</p>	<ul style="list-style-type: none"> • Uses controlled breathing while bathing, bending, and walking • Paces activities of daily living to alternate with rest periods to reduce fatigue and dyspnea • Describes energy conservation strategies • Performs same self-care activities as before • Performs postural drainage correctly

Nursing Diagnosis: Activity intolerance due to fatigue, hypoxemia, and impaired breathing

Goal: Improvement in activity tolerance

Nursing Interventions	Rationale	Expected Outcomes
<ol style="list-style-type: none">1. Support patient in establishing a regular regimen of exercise using treadmill and exercise bicycle, walking, or other appropriate exercises, such as mall walking.<ol style="list-style-type: none">a. Assess the patient's current level of functioning, and develop exercise plan based on baseline functional status.b. Suggest consultation with a physical therapist or pulmonary rehabilitation program to determine an exercise program specific to the patient's capability. Have portable oxygen unit available if oxygen is prescribed for exercise.1. Muscles that are deconditioned consume more oxygen and place an additional burden on the lungs. Through regular, graded exercise, these muscle groups become more conditioned, and the patient can do more without getting as short of breath. Graded exercise breaks the cycle of debilitation.		<ul style="list-style-type: none">• Performs activities with less shortness of breath• Verbalizes need to exercise daily and demonstrates an exercise plan to be carried out at home• Walks and gradually increases walking time and distance to improve physical condition• Exercises both upper and lower body muscle groups

Nursing Diagnosis: Difficulty coping associated with reduced socialization, anxiety, depression, lower activity level, and the inability to work

Goal: Attainment of an optimal level of coping

Nursing Interventions	Rationale	Expected Outcomes
<ol style="list-style-type: none">1. Help the patient develop realistic goals.2. Encourage activity to level of symptom tolerance.3. Educate the patient about relaxation techniques or provide a relaxation recording on audiotape, CD, or digital audio available on smartphones or tablets.4. Enroll patient in pulmonary rehabilitation program where available.	<ol style="list-style-type: none">1. Developing realistic goals will promote a sense of hope and accomplishment rather than defeat and hopelessness.2. Activity reduces tension and decreases degree of dyspnea as patient becomes conditioned.3. Relaxation reduces stress, anxiety, and dyspnea and helps patient to cope with disability.4. Pulmonary rehabilitation programs have been shown to promote a subjective improvement in a patient's status and self-esteem as well as increased exercise tolerance and decreased hospitalizations.	<ul style="list-style-type: none">• Expresses interest in the future• Participates in the discharge plan• Discusses activities or methods that can be performed to ease shortness of breath• Uses relaxation techniques appropriately• Expresses interest in a pulmonary rehabilitation program

Nursing Diagnosis: Lack of knowledge about self-management to be performed at home

Goal: Adherence to therapeutic program and home care

Nursing Interventions	Rationale	Expected Outcomes
<ol style="list-style-type: none"> 1. Help patient identify/develop short- and long-term goals. <ol style="list-style-type: none"> a. Educate the patient about disease, medications, procedures, and how and when to seek help. b. Refer patient to pulmonary rehabilitation. 2. Give strong message to stop smoking. Discuss smoking cessation strategies. Provide information about resource groups (e.g., SmokEnders, American Cancer Society, American Lung Association). 	<ol style="list-style-type: none"> 1. Patient needs to be a partner in developing the plan of care and needs to know what to expect. Education about COPD is one of the most important aspects of care; it will prepare the patient to live and cope with the COPD and improve quality of life. 2. Smoking causes permanent damage to the lung and diminishes the lungs' protective mechanisms. Airflow is obstructed, and lung capacity is reduced. Smoking increases morbidity and mortality and is also a risk factor for lung cancer. 	<ul style="list-style-type: none"> • Understands disease and what affects it • Verbalizes the need to preserve existing lung function by adhering to the prescribed program • Understands purposes and proper administration of medications • Stops smoking or enrolls in a smoking cessation program • Identifies when and whom to call for assistance

Collaborative Problem: Atelectasis

Goal: Absence of atelectasis on x-ray and physical examination

Nursing Interventions	Rationale	Expected Outcomes
<ol style="list-style-type: none"> 1. Monitor respiratory status, including rate and pattern of respirations, breath sounds, 	<ol style="list-style-type: none"> 1. A change in respiratory status, including tachypnea, dyspnea, and diminished or absent 	<ul style="list-style-type: none"> • Normal (baseline for patient) respiratory

<p>signs and symptoms of respiratory distress, and pulse oximetry.</p> <p>2. Instruct in and encourage diaphragmatic breathing and effective coughing techniques.</p> <p>3. Promote the use of lung expansion techniques (e.g., deep breathing exercises, incentive spirometry) as prescribed.</p>	<p>breath sounds, may indicate atelectasis.</p> <p>2. These techniques improve ventilation and lung expansion and ideally improve gas exchange.</p> <p>3. Deep breathing exercises and incentive spirometry promote maximal lung expansion.</p>	<p>rate and pattern</p> <ul style="list-style-type: none"> Normal breath sounds for patient Demonstrates diaphragmatic breathing and effective coughing Performs deep breathing exercises, incentive spirometry as prescribed Pulse oximetry ≥90%
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Collaborative Problem: Pneumothorax

Goal: Absence of signs and symptoms of pneumothorax

Nursing Interventions	Rationale	Expected Outcomes
<p>1. Monitor respiratory status, including rate and pattern of respirations, symmetry of chest wall movement, breath sounds, signs and symptoms of respiratory distress, and pulse oximetry.</p> <p>2. Assess pulse.</p> <p>3. Assess for chest pain and precipitating factors.</p>	<p>1. Dyspnea, tachypnea, tachycardia, acute pleuritic chest pain, tracheal deviation away from the affected side, absence of breath sounds on the affected side, and decreased tactile fremitus may indicate pneumothorax.</p> <p>2. Tachycardia is associated with pneumothorax and anxiety.</p> <p>3. Pain may accompany pneumothorax.</p>	<ul style="list-style-type: none"> Normal respiratory rate and pattern for patient Normal breath sounds bilaterally Normal pulse for patient Normal tactile fremitus Absence of pain Tracheal position is midline Pulse oximetry ≥90%

4. Palpate for tracheal deviation/shift away from the affected side.	4. Early detection of pneumothorax and prompt intervention will prevent other serious complications.	• Maintains normal oxygen saturation and arterial blood gas measurements
5. Monitor pulse oximetry and, if indicated, arterial blood gases.	5. Recognition of deterioration in respiratory function will prevent serious complications.	• Exhibits no hypoxemia and hypercapnia (or returns to baseline values)
6. Administer supplemental oxygen therapy, as indicated.	6. Oxygen will correct hypoxemia; administer it with caution.	• Absence of pain
7. Administer analgesic agents, as indicated, for chest pain.	7. Pain interferes with deep breathing, resulting in decreased lung expansion.	• Symmetric chest wall movement
8. Assist with chest tube insertion and use pleural drainage system, as prescribed.	8. Removal of air from the pleural space will re-expand the lung.	• Lungs fully expanded bilaterally on chest x-ray

Collaborative Problem: Respiratory failure

Goal: Absence of signs and symptoms of respiratory failure; no evidence of respiratory failure on laboratory tests

Nursing Interventions	Rationale	Expected Outcomes
1. Monitor respiratory status, including rate and pattern of respirations, breath sounds, and signs and symptoms of acute respiratory distress.	1. Early recognition of deterioration in respiratory function will avert further complications, such as respiratory failure, severe hypoxemia, and hypercapnia.	• Normal respiratory rate and pattern for patient with no acute distress
2. Monitor pulse oximetry and arterial blood gases.	2. Recognition of changes in oxygenation and acid-base balance will guide in correcting and	• Recognizes symptoms of hypoxemia and hypercapnia • Maintains normal arterial blood

<p>3. Administer supplemental oxygen and initiate mechanisms for mechanical ventilation, as prescribed.</p>	<p>3. preventing complications.</p> <p>3. Acute respiratory failure is a medical emergency. Hypoxemia is a hallmark sign. Administration of oxygen therapy and mechanical ventilation (if indicated) are critical to survival.</p>	<p>gases/pulse oximetry or returns to baseline values</p>
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Collaborative Problem: Pulmonary arterial hypertension

Goal: Absence of evidence of pulmonary arterial hypertension on physical examination or laboratory tests

Nursing Interventions	Rationale	Expected Outcomes
<p>1. Monitor respiratory status, including rate and pattern of respirations, breath sounds, pulse oximetry, and signs and symptoms of acute respiratory distress.</p> <p>2. Assess for signs and symptoms of right-sided heart failure, including peripheral edema, ascites, distended neck veins, crackles, and heart murmur.</p> <p>3. Administer oxygen therapy, as prescribed.</p>	<p>1. Dyspnea is the primary symptom of pulmonary arterial hypertension. Other symptoms include fatigue, angina, near-syncope, edema, and palpitations.</p> <p>2. Right-sided heart failure is a common clinical manifestation of pulmonary arterial hypertension due to increased right ventricular workload.</p> <p>3. Continuous oxygen therapy is a major component of management of pulmonary arterial hypertension; it prevents hypoxemia, thereby reducing pulmonary vascular constriction</p>	<ul style="list-style-type: none"> • Normal respiratory rate and pattern for patient • Exhibits no signs and symptoms of right-sided failure • Maintains baseline pulse oximetry values and arterial blood gases

(resistance)
secondary
hypoxemia.
to

Diminishing the quantity and viscosity of sputum can clear the airway and improve pulmonary ventilation and gas exchange. All pulmonary irritants should be eliminated or reduced, particularly cigarette smoke, which is the most persistent source of pulmonary irritation. The nurse instructs the patient in directed or controlled coughing, which is more effective and reduces the fatigue associated with undirected forceful coughing. Directed coughing consists of a slow, maximal inspiration followed by breath-holding for several seconds and then two or three coughs. “Huff” coughing may also be effective. The technique consists of one or two forced exhalations (huffs) from low to medium lung volumes with the glottis open.

Chest physiotherapy (CPT), increased fluid intake, and bland aerosol mists (with normal saline solution or water) may be useful for some patients with COPD. The use of these measures must be based on the response and tolerance of each patient. **Chest physiotherapy (CPT)** includes postural drainage, chest percussion and vibration, and breathing retraining. The goals of CPT are consistent with improved airway clearance as they are to remove bronchial secretions, improve ventilation, and increase the efficiency of the respiratory muscles.

Postural Drainage (Segmented Bronchial Drainage)

Postural drainage allows the force of gravity to assist in the removal of bronchial secretions. The secretions drain from the affected bronchioles into the bronchi and trachea and are removed by coughing or suctioning. Because the patient usually sits in an upright position, secretions are likely to accumulate in the lower parts of the lungs. Several other positions ([Fig. 20-6](#)) are used so that the force of gravity helps move secretions from the smaller bronchial airways to the main bronchi and trachea. Each position contributes to effective drainage of a different lobe of the lungs; lower and middle lobe bronchi drain more effectively when the head is down, whereas the upper lobe bronchi drain more effectively when the head is up. The secretions then are removed by coughing.

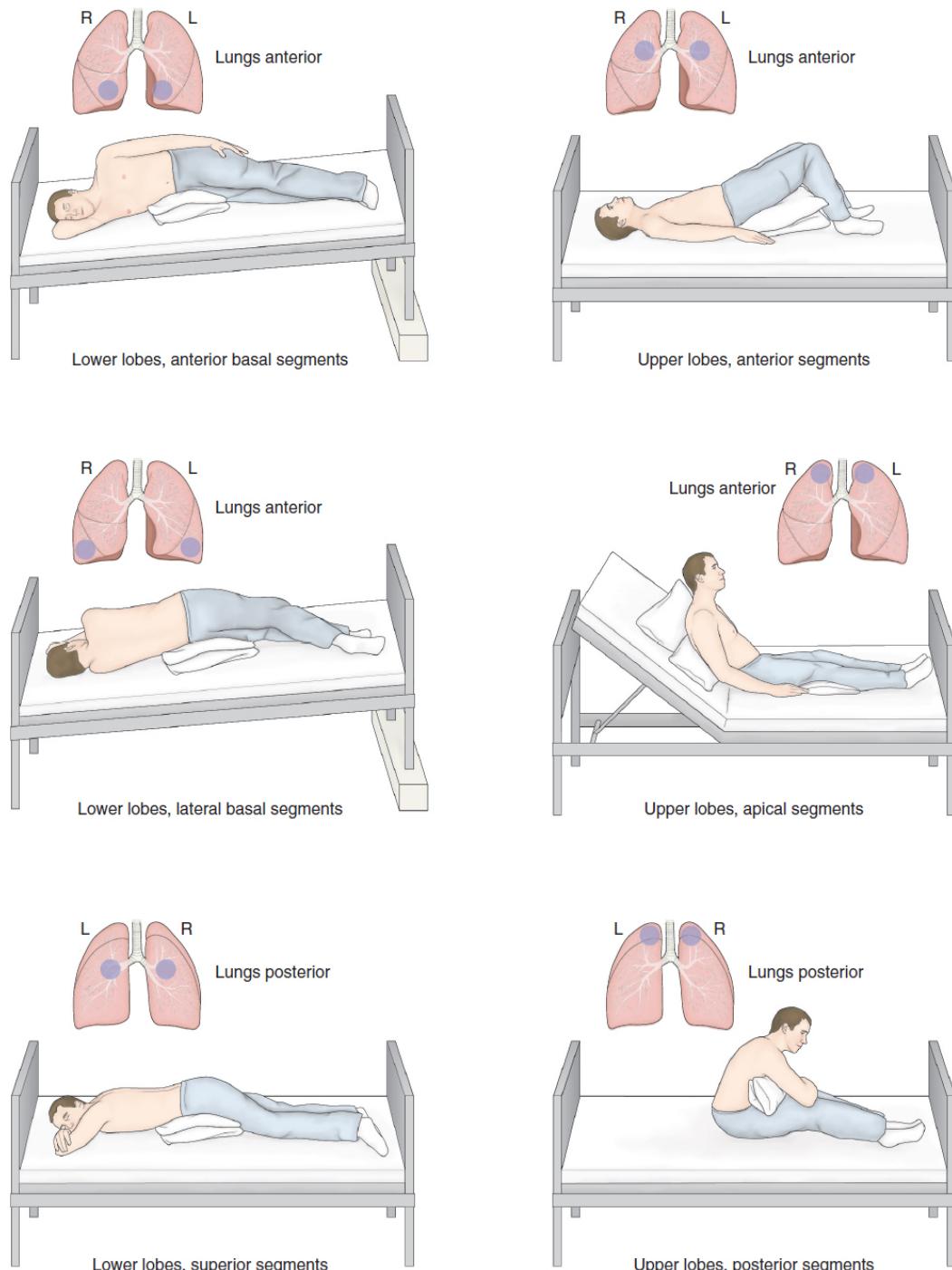


Figure 20-6 • Postural drainage positions and the areas of lung drained by each position.

The nurse should keep in mind the medical diagnosis, the lung lobes or segments involved, the cardiac status, and any structural deformities of the chest wall and spine. Auscultation of the chest before and after the procedure is used to identify the areas that need drainage and assess the effectiveness of

treatment. The nurse educates family members who will assist the patient at home to evaluate breath sounds before and after treatment. The nurse explores strategies that will enable the patient to assume the indicated positions at home. This may require the creative use of objects readily available at home, such as pillows, cushions, or cardboard boxes.

Postural drainage is usually performed two to four times daily, before meals (to prevent nausea, vomiting, and aspiration) and at bedtime. Prescribed bronchodilators, mucolytic agents, water, or saline may be nebulized and inhaled before postural drainage to dilate the bronchioles, reduce bronchospasm, decrease the thickness of mucus and sputum, and combat edema of the bronchial walls. The recommended sequence starts with positions to drain the lower lobes, followed by positions to drain the upper lobes.

The patient is made as comfortable as possible in each position and provided with an emesis basin, sputum cup, and paper tissues. The nurse instructs the patient to remain in each position for 10 to 15 minutes and to breathe in slowly through the nose and out slowly through pursed lips to help keep the airways open so that secretions can drain. If a position cannot be tolerated, the nurse helps the patient assume a modified position. When the patient changes position, instructions for how to cough and remove secretions are provided.

If the patient cannot cough, the nurse may need to suction the secretions mechanically. It also may be necessary to use chest percussion and vibration or a high-frequency chest wall oscillation (HFCWO) vest to loosen bronchial secretions and mucus plugs that adhere to the bronchioles and bronchi and to propel sputum in the direction of gravity drainage (see later discussion). If suctioning is required at home, the nurse instructs caregivers in safe suctioning technique and care of the suctioning equipment.

After the procedure, the nurse or family caregivers note the amount, color, viscosity, and character of the expelled sputum. The nurse evaluates the patient's skin color and pulse the first few times the procedure is performed. It may be necessary to administer oxygen during postural drainage.

If the sputum is foul smelling, postural drainage is performed in a room away from other patients or family members. Deodorizers may be used to counteract the odor. However, because aerosol sprays can cause bronchospasm and irritation, deodorizers should be used sparingly and with caution. After the procedure, the patient may find it refreshing to brush the teeth and use a mouthwash before resting.

Chest Percussion and Vibration

Thick secretions that are difficult to cough up may be loosened by percussing (tapping) and vibrating the chest or through the use of an HFCWO vest. Chest percussion and vibration help dislodge mucus adhering to the bronchioles and

bronchi. A scheduled program of coughing and clearing sputum, together with hydration, reduces the amount of sputum in most patients.

Chest percussion is carried out by cupping the hands and lightly striking the chest wall in a rhythmic fashion over the lung segment to be drained. The wrists are alternately flexed and extended so that the chest is cupped or clapped in a painless manner (Fig. 20-7). A soft cloth or towel may be placed over the segment of the chest that is being cupped to prevent skin irritation and redness from direct contact. Percussion, alternating with vibration, is performed for 3 to 5 minutes for each position. The patient uses diaphragmatic breathing during this procedure to promote relaxation (see later discussion on Breathing Retraining). As a precaution, percussion over chest drainage tubes and the sternum, spine, liver, kidneys, spleen, or breasts (in women) is avoided. Percussion is performed cautiously in older adult patients because of their increased incidence of osteoporosis and risk of rib fracture.

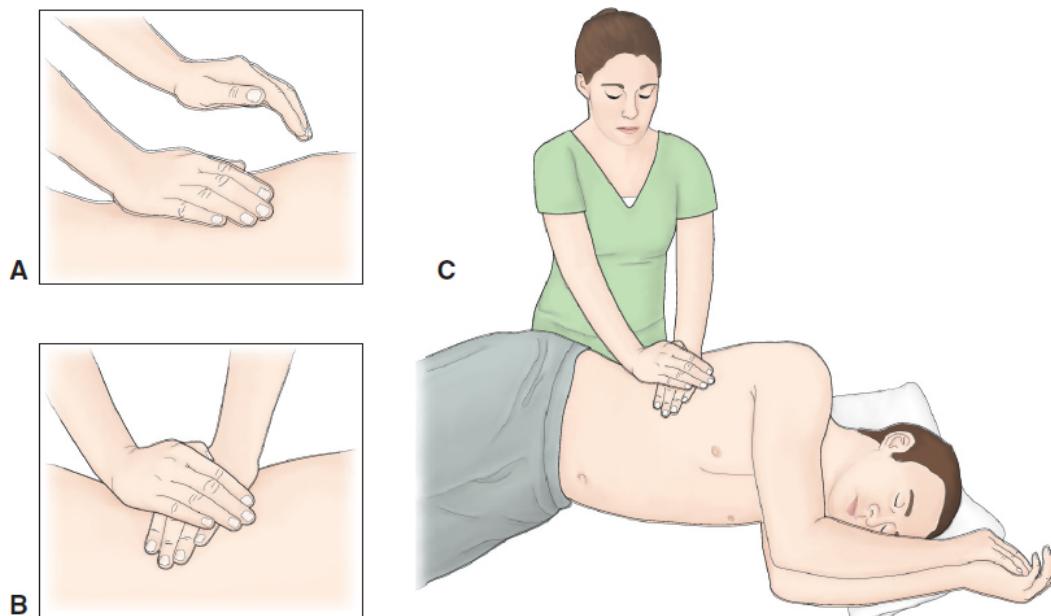


Figure 20-7 • Percussion and vibration. **A.** Proper hand position for percussion. **B.** Proper hand position for vibration. **C.** Proper technique for vibration. The wrists and elbows remain stiff; the vibrating motion is produced by the shoulder muscles.



Figure 20-8 • High-frequency chest wall oscillation (HFCWO) vest.
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Vibration is the technique of applying manual compression and tremor to the chest wall during the exhalation phase of respiration (see Fig. 20-7). This helps increase the velocity of the air expired from the small airways, thus freeing mucus. After three or four vibrations, the patient is encouraged to cough, contracting the abdominal muscles to increase the effectiveness of the cough.

The number of times the percussion and coughing cycle is repeated depends on the patient's tolerance and clinical response. The nurse evaluates breath sounds before and after application of these techniques.

An inflatable HFCWO vest (Fig. 20-8) may be used to provide chest therapy. The vest uses air pulses to compress the chest wall 8 to 18 times/sec, causing secretions to detach from the airway wall and enabling the patient to expel them by coughing. Patients prescribed vest therapy are generally more satisfied with this mode of treatment delivery than patients who receive manual CPT. Furthermore, research suggests that the vest is equally effective to manual CPT; however, the mode of therapy selected should consider the patient's specific needs and preferences (Hanlon, 2015; Powner, Nesmith, Kirkpatrick, et al., 2019). Technologic advances to the HFCWO vest include portable versions, the AffloVest® and Monarch®, which allow users to move about freely during therapy, thus improving patient adherence and satisfaction. In addition, CPT may also be delivered using specialized beds. These beds

feature programmable mattresses that deliver vibropercussion and may rotate the upper torso up to 45 degrees to help mobilize pulmonary secretions.

To increase the effectiveness of coughing, a flutter valve may be used, which is especially useful for patients who have CF (see later discussion). The **flutter valve** looks like a pipe but has a cap covering the bowl, which contains a steel ball. When the patient exhales actively into the device, movement of the ball causes pressure oscillations, thereby decreasing viscosity of the mucus, facilitating mucous clearance (Fig. 20-9).

When performing CPT, the nurse ensures that the patient is comfortable, is not wearing restrictive clothing, and has not just eaten. The nurse gives medication for pain, as prescribed, before applying the techniques of percussion and vibration, splints any incision, and provides pillows for support as needed. The positions are varied, but focus is placed on the affected areas. On completion of the treatment, the nurse assists the patient to assume a comfortable position.

If an HFCWO vest is being used, the patient may assume whatever position is most comfortable and may even continue to perform light activity during therapy, such as household chores (e.g., folding laundry) or engaging in hobbies (e.g., playing the guitar). The patient does not need to assume specific positions for the vest to be effective.

Treatment should be stopped if any of the following occur: increased pain, increased shortness of breath, weakness, lightheadedness, or hemoptysis. Therapy is indicated until the patient has normal respirations, can mobilize secretions, and has normal breath sounds, and until the chest x-ray findings are normal.

Nursing management of the patient using flutter valve therapy includes ensuring that the patient assumes the proper position, educating the patient on the technique for using the flutter valve, and setting realistic goals for the patient.

Improving Breathing Patterns

The breathing pattern of most people with COPD is shallow, rapid, and inefficient; the more severe the disease, the more inefficient the breathing pattern. Impaired breathing patterns and shortness of breath are due to the modified respiratory mechanics of the chest wall and lung resulting from **air trapping** (i.e., incomplete emptying of alveoli during expiration), ineffective diaphragmatic movement, airway obstruction, the metabolic cost of breathing, and stress. Breathing retraining may help improve breathing patterns. Training in diaphragmatic breathing reduces the respiratory rate, increases alveolar ventilation, and sometimes helps expel as much air as possible during expiration. Pursed-lip breathing helps slow expiration, prevent collapse of small airways, and control the rate and depth of respiration. It also promotes

relaxation, which allows patients to gain control of dyspnea and reduce feelings of panic.

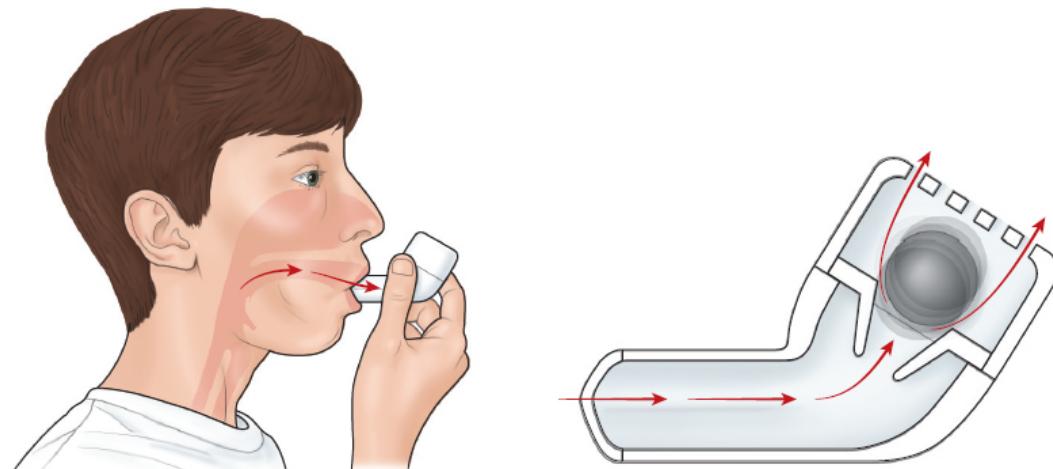


Figure 20-9 • The flutter valve is a handheld pipe-shaped device with a mouthpiece on one end, a perforated cover on the other end, and a steel ball on the inside. When the patient expires through this device, positive end pressure is enhanced, thus helping to clear respiratory secretions.

Chart 20-5  **PATIENT EDUCATION**

Breathing Exercises

General Instructions

The nurse instructs the patient to:

- Breathe slowly and rhythmically to exhale completely and empty the lungs completely.
- Inhale through the nose to filter, humidify, and warm the air before it enters the lungs.
- Breathe more slowly by prolonging the exhalation time when feeling out of breath.
- Keep the air moist with a humidifier.

Diaphragmatic Breathing

Goal: To use and strengthen the diaphragm during breathing

The nurse instructs the patient to:

- Place one hand on the abdomen (just below the ribs) and the other hand on the middle of the chest to increase the awareness of the position of the diaphragm and its function in breathing.
- Breathe in slowly and deeply through the nose, letting the abdomen protrude as far as possible.
- Breathe out through pursed lips while tightening (contracting) the abdominal muscles.
- Press firmly inward and upward on the abdomen while breathing out.
- Repeat for 1 min; follow with a rest period of 2 min.
- Gradually increase duration up to 5 min, several times a day (before meals and at bedtime).

Pursed-Lip Breathing

Goal: To prolong exhalation and increase airway pressure during expiration, thus reducing the amount of trapped air and the amount of airway resistance

The nurse instructs the patient to:

- Inhale through the nose while slowly counting to 3—the amount of time needed to say “Smell a rose.”
- Exhale slowly and evenly against pursed lips while tightening the abdominal muscles. (Pursing the lips increases intratracheal pressure; exhaling through the mouth offers less resistance to expired air.)
- Count to 7 slowly while prolonging expiration through pursed lips—the length of time to say “Blow out the candle.”
- While sitting in a chair:
Fold arms over the abdomen.

Inhale through the nose while counting to 3 slowly.

Bend forward and exhale slowly through pursed lips while counting to 7 slowly.

- While walking:
Inhale while walking two steps.
Exhale through pursed lips while walking four or five steps.

Breathing Retraining

Breathing retraining consists of exercises and breathing practices that are designed to achieve more efficient and controlled ventilation and to decrease the work of breathing. These exercises promote maximal alveolar inflation and muscle relaxation; relieve anxiety; eliminate ineffective, uncoordinated patterns of respiratory muscle activity; and slow the respiratory rate (Kacmarek et al., 2017). Slow, relaxed, rhythmic breathing also helps to control the anxiety that occurs with dyspnea. Specific breathing exercises include diaphragmatic and pursed-lip breathing ([Chart 20-5](#)).

Diaphragmatic breathing can become automatic with sufficient practice and concentration. Pursed-lip breathing, which improves oxygen transport, helps induce a slow, deep breathing pattern and assists the patient to control breathing, even during periods of stress. Breathing exercises should be practiced in several positions because air distribution and pulmonary circulation vary with the position of the chest.

Promoting Self-Care

As gas exchange, airway clearance, and the breathing pattern improve, the patient is encouraged to assume increasing participation in self-care activities. The patient is taught to coordinate diaphragmatic breathing with activities such as walking, bathing, bending, or climbing stairs. The patient should bathe, dress, and take short walks, resting as needed to avoid fatigue and excessive dyspnea. Fluids should always be readily available for the patient to promote adequate hydration. Patient education should address self-regulation of fluid intake. This could include the use of fluid diaries and using premeasured water containers to help patients become more cognizant of their fluid intake.

If management of secretions is a problem and some type of postural drainage or airway clearance maneuver is to be performed at home, the nurse or respiratory therapist instructs and supervises the patient before discharge or in an outpatient setting.

Improving Activity Tolerance

People with COPD have decreased exercise tolerance during specific periods of the day, especially in the morning on arising, because bronchial secretions have collected in the lungs during the night while the patient was lying down. The patient may have difficulty bathing or dressing and may become fatigued. Activities that require the arms to be supported above the level of the thorax may produce fatigue or respiratory distress but may be tolerated better after the

patient has been up and moving around for an hour or more. The nurse can help the patient reduce these limitations by planning self-care activities and determining the best times for bathing, dressing, and other daily activities.

Patients with COPD of all grades may benefit from exercise training programs. These benefits may include increased exercise tolerance and decreased dyspnea and fatigue (GOLD, 2019). Physical conditioning techniques include breathing exercises and general exercises intended to conserve energy and increase pulmonary ventilation. Graded exercises and physical conditioning programs using treadmills, stationary bicycles, and measured level walks can improve symptoms and increase work capacity and exercise tolerance. Any physical activity that can be performed regularly is helpful. Walking aids may be beneficial (GOLD, 2019). Lightweight portable oxygen systems are available for ambulatory patients who require oxygen therapy during physical activity. Education is focused on rehabilitative therapies to promote independence in executing activities of daily living. These may include pacing activities throughout the day or using supportive devices to decrease energy expenditure. The nurse evaluates the patient's activity tolerance and limitations and uses education strategies to promote independent activities of daily living. Other health care professionals (rehabilitation therapist, occupational therapist, physical therapist) may be consulted as additional resources.

Encouraging Effective Coping

Any factor that interferes with normal breathing quite naturally induces anxiety, depression, and changes in behavior. Constant shortness of breath and fatigue may make the patient irritable and apprehensive to the point of panic. Restricted activity (and reversal of family roles due to loss of employment), the frustration of having to work to breathe, and the realization that the disease is prolonged and unrelenting may cause the patient to become angry, depressed, and anxious. Sexual function may be compromised, which also diminishes self-esteem. The nurse should provide education and support to spouses or significant others and families, because the caregiver role in end-stage COPD can be challenging.

Monitoring and Managing Potential Complications

The nurse must assess for various complications of COPD, such as life-threatening respiratory insufficiency and failure, as well as respiratory infection and chronic atelectasis, which may increase the risk of respiratory failure. The nurse monitors for cognitive changes (personality and behavioral changes, memory impairment), increasing dyspnea, tachypnea, and tachycardia, which may indicate increasing hypoxemia and impending respiratory failure.

The nurse monitors pulse oximetry values to assess the patient's need for oxygen and administers supplemental oxygen as prescribed. The nurse also instructs the patient about signs and symptoms of respiratory infection that may worsen hypoxemia and reports changes in the patient's physical and cognitive status to the primary provider.

Bronchopulmonary infections must be controlled to diminish inflammatory edema and to permit recovery of normal ciliary action. Minor respiratory infections that are of no consequence to people with normal lungs can be life-threatening to people with COPD. Infection compromises lung function and is a common cause of respiratory failure in people with COPD. In COPD, infection may be accompanied by subtle changes. The nurse instructs the patient to report any signs of infection, such as a fever or change in sputum color, character, consistency, or amount. Any worsening of symptoms (increased tightness of the chest, increased dyspnea, fatigue) also suggests pneumonia and must be reported. Viral infections are hazardous to the patient because they are often followed by pneumonia caused by bacterial organisms, such as *Streptococcus pneumoniae*, *Moraxella catarrhalis*, and *Haemophilus influenzae* (Bartlett & Sethi, 2018).

To prevent pneumonia, the nurse encourages the patient with COPD to be immunized against influenza and pneumococcal pneumonia, because the patient is prone to respiratory infection. In addition, because each patient reacts differently to external exposures (significant air pollution, high or low temperatures, high humidity, strong smells), the nurse must assess the patient's actual and potential triggers that cause bronchospasm so that avoidance or a treatment plan can be established.

Pneumothorax is a potential complication of COPD and can be life-threatening in patients with COPD who have minimal pulmonary reserve. Patients with severe emphysematous changes can develop large bullae, which may rupture and cause a pneumothorax. Development of a pneumothorax may be spontaneous or related to an activity such as severe coughing or large intrathoracic pressure changes. If a rapid onset of shortness of breath occurs, the nurse should quickly evaluate the patient for potential pneumothorax by assessing the symmetry of chest movement, differences in breath sounds, and a decrease in pulse oximetry.

Over time, pulmonary hypertension may occur as a result of chronic hypoxemia, which causes the pulmonary arteries to constrict and leads to this complication. Pulmonary hypertension may be prevented by maintaining adequate oxygenation through an adequate hemoglobin level, improved ventilation-perfusion of the lungs, or continuous administration of supplemental oxygen (if needed).

Promoting Home, Community-Based, and Transitional Care

Referral for home, community-based, or transitional care is important. These referrals assess the patient's home environment in relation to their physical and psychological status and the patient's ability to adhere to a prescribed therapeutic regimen. These assessments include evaluating the patient's ability to cope with changes in lifestyle and physical status so that their medical management can be tailored to their specific needs. Once home care is set up, the visits provide an opportunity to reinforce the information and activities learned in the inpatient or outpatient pulmonary rehabilitation program and to have the patient and family demonstrate correct administration of medications and oxygen, if indicated, and performance of exercises. If the patient does not have access to a formal pulmonary rehabilitation program, the nurse provides the education and breathing retraining necessary to optimize the patient's functional status.



Educating Patients About Self-Care

When providing education about self-management, the nurse must assess the knowledge of patients and family members about self-care and the therapeutic regimen. The nurse should also consider whether they are comfortable with this knowledge. Familiarity with potential side effects of prescribed medications is essential. In addition, patients and family members need to learn the early signs and symptoms of infection and other complications so that they seek appropriate health care promptly. Nurses are key in promoting smoking cessation and educating patients about its importance. Patients diagnosed with COPD who continue to smoke must be encouraged and assisted to quit.

A major area of patient education involves setting and accepting realistic short-term and long-range goals. If the COPD is mild (e.g., grade I), the objectives of treatment are to increase exercise tolerance and prevent further loss of pulmonary function. If the COPD is severe (e.g., grade III), the objectives are to preserve current pulmonary function and relieve symptoms as much as possible. It is important to plan and share the goals and expectations of treatment with the patient. Both the patient and the care provider need patience to achieve these goals.

Chart 20-6 PATIENT EDUCATION



Use of Pressurized Metered-Dose Inhaler (pMDI)

The nurse instructs the patient to:

- Remove the cap and hold the inhaler upright.
- Shake the inhaler.
- Sit upright or stand upright. Breathe out slowly and all the way.
- Use one of two techniques: open- or closed-mouth technique.
 - *Open-mouth technique*
 - Place the pMDI 2 finger widths away from lips.
 - With mouth open and tongue flat, tilt outlet of the pMDI so that it is pointed toward the upper back of the mouth.
 - Actuate the pMDI and begin to breathe in slowly. Breathe slowly and deeply through the mouth and try to hold breath for 10 s.
 - *Closed-mouth technique*
 - Place the pMDI between the teeth and make sure the tongue is flat under the mouthpiece and does not block pMDI.
 - Seal lips around mouthpiece and actuate the pMDI. Breathe in slowly through the mouth and try to hold breath for 10 s.
- Repeat puffs as directed, allowing 1 min between puffs. There is no need to wait for other medications.
- Apply the cap to the pMDI for storage.
- After inhalation, rinse mouth with water when using a corticosteroid-containing pMDI.

The pMDI mouthpiece should be cleaned on a regular basis as should the nozzle of the canister based on the manufacturer's recommendations. As there are many types of inhalers, it is important to follow the manufacturer's instructions for use and care of the inhaler.

Adapted from Cairo, J. M. (2018). *Mosby's respiratory care equipment* (10th ed.). St. Louis, MO: Elsevier Mosby.

The nurse instructs the patient to avoid extremes of heat and cold. Heat increases the body temperature, thereby raising oxygen requirements, and cold tends to promote bronchospasm. Air pollutants such as fumes, smoke, dust, and even talcum, lint, and aerosol sprays may initiate bronchospasm. High altitudes aggravate hypoxemia.

A patient with COPD should adopt a lifestyle of moderate activity, ideally in a climate with minimal shifts in temperature and humidity. As much as possible, the patient should avoid emotional disturbances and stressful situations that might trigger a coughing episode. Self-management also includes getting sufficient rest and sleep. The medication regimen can be quite complex; patients receiving aerosol medications by a pMDI or other type of inhaler may be particularly challenged. The nurse must review educational

information and have the patient demonstrate correct pMDI use before discharge, during follow-up visits to a caregiver's office or clinic, and during home visits ([Chart 20-6](#)).

Smoking cessation goes hand in hand with lifestyle changes, and reinforcing the patient's efforts is a key nursing activity. Smoking cessation is the single most important therapeutic intervention for patients with COPD. There are many strategies, including prevention, cessation with or without oral or topical patch medications, and behavior modification techniques.

At times, the patient will need oxygen at home. The nurse instructs the patient or family in the methods for administering oxygen safely and informs the patient and family that oxygen is available in gas, liquid, and concentrated forms. The gas and liquid forms come in portable devices so that the patient can leave home while receiving oxygen therapy. Humidity must be provided while oxygen is used (except with portable devices) to counteract the dry, irritating effects of compressed oxygen on the airway ([Chart 20-7](#)). To help the patient adhere to the oxygen prescription, the nurse explains the proper flow rate and required number of hours for oxygen use as well as the dangers of arbitrary changes in flow rate or duration of therapy. The nurse also reassures the patient that oxygen is not "addictive" and explains the need for regular evaluations of blood oxygenation by pulse oximetry or arterial blood gas analysis.

Chart 20-7



HOME CARE CHECKLIST

Oxygen Therapy

At the completion of education, the patient and/or caregiver will be able to:

- State proper care of and administration of oxygen to patient.
- State primary provider's prescription for oxygen and the manner in which it is to be used.
- Indicate when a humidifier should be used.
- Identify signs and symptoms indicating the need for change in oxygen therapy.
- Describe precautions and safety measures to be used when oxygen is in use:
 - Know NOT to smoke or be around people who are smoking while using oxygen.
 - Post "No Smoking—Oxygen in Use" signs on doors.
 - Notify local fire department and electric company of oxygen use in home.
 - Never use paint thinners, cleaning fluids, gasoline, aerosol sprays, and other flammable materials while using oxygen.
 - Keep all methods of oxygen delivery at least 15 feet away from matches, candles, gas stove, or other source of flame, and 5 feet away from television, radio, and other appliances.
 - Keep oxygen tank out of direct sunlight.
 - When traveling in automobile, place oxygen tank on floor behind front seat.
 - If traveling by airplane, notify air carrier of need for oxygen at least 2 wks in advance.
- State how and when to place an order for more oxygen.
- Maintain and use equipment properly:
 - Identify when a portable oxygen delivery device should be used.
 - Demonstrate safe and appropriate use of and how to change from one oxygen delivery system to another (e.g., from oxygen concentrator to portable oxygen delivery).
 - Demonstrate correct adjustment of prescribed flow rate.
 - Describe how to clean and when to replace oxygen tubing.
 - Identify causes of malfunction of equipment and when to call for the replacement of equipment.
 - Describe the importance of determining that all electrical outlets are working properly.

Resources

See [Chapter 2, Chart 2-6](#) for additional information related to durable medical equipment, adaptive equipment, and mobility skills.

Numerous educational materials are available to assist nurses in educating patients with COPD (see Resources at the end of the chapter).

Continuing and Transitional Care

Home visits by a nurse or respiratory therapist may be arranged based on the patient's status and needs. It is important to assess the patient's home environment, the patient's physical and psychological status, and the need for further education. The nurse reinforces educational points on how to use oxygen safely and effectively, including fire safety tips. To maintain a consistent quality of care and to maximize the patient's financial reimbursement for home oxygen therapy, the nurse ensures that the prescription given by the primary provider includes the diagnosis, the prescribed oxygen flow, and conditions for use (e.g., continuous use, nighttime use only). Because oxygen is a medication, the nurse reminds the patient receiving long-term oxygen therapy and the family about the importance of keeping follow-up appointments with the patient's primary provider. The patient is instructed to see the primary provider every 6 months or more often, if indicated. Arterial blood gas measurements and laboratory tests are repeated annually or more often if the patient's condition changes.

The nurse directs patients to community resources, such as pulmonary rehabilitation programs and smoking cessation programs, to help improve patients' ability to cope with their chronic condition and the therapeutic regimen and to provide a sense of worth, hope, and well-being. In addition, the nurse reminds the patient and family about the importance of participating in general health promotion activities and health screening.

Patients with COPD have indicated that information about their end-of-life needs is limited. Areas to discuss regarding end-of-life care may include symptom management, quality of life, satisfaction with care, information/communication, use of care professionals, use of differing care facilities, hospital admission, and place of death. It is crucial that patients know what to expect as the disease progresses. In addition, they should have information about their role in decisions regarding aggressiveness of care near the end of life and access to specialists who may help them and their families. As the disease course progresses, a holistic assessment of physical and psychological needs should be undertaken at each hospitalization, clinic visit, or home visit. This helps gauge the patient's assessment of the progression of the disease and its impact on quality of life and guides planning for future interventions and management (see [Chapter 13](#) for additional information).

Bronchiectasis

Bronchiectasis is a chronic, irreversible dilation of the bronchi and bronchioles that results from destruction of muscles and elastic connective tissue. Numerous factors can induce or contribute to the development of bronchiectasis. Some of these include recurrent respiratory infections, CF, rheumatic and other systemic diseases, primary ciliary dysfunction, tuberculosis, or immune deficiency disorders (Barker, King, & Hollingsworth, 2019). Between 340,000 and 522,000 adults were living with non-CF bronchiectasis in 2013, estimates show (Weycker, Hansen, & Seifer, 2017). The increased prevalence of bronchiectasis, with an annual growth rate of 8% since 2001, may be attributed to advances in the technology for diagnosing the disease (GOLD, 2019). Bronchiectasis, a disease process separate from COPD, is often a comorbidity with COPD (GOLD, 2019). Bronchiectasis and sinusitis are the major respiratory manifestations of CF (discussed later in this chapter) (Barker et al., 2019).

Pathophysiology

The inflammatory process associated with pulmonary infections damages the bronchial wall, causing a loss of its supporting structure and resulting in thick sputum that ultimately obstructs the bronchi. The walls become permanently distended and distorted, impairing mucociliary clearance. In saccular bronchiectasis, each dilated peribronchial tube amounts to a lung abscess, the exudate of which drains freely through the bronchus. Bronchiectasis is usually localized, affecting a segment or lobe of a lung, most frequently the lower lobes.

The retention of secretions and subsequent obstruction ultimately cause the alveoli distal to the obstruction to collapse (atelectasis). Inflammatory scarring or fibrosis replaces functioning lung tissue. In time, the patient develops respiratory insufficiency with reduced vital capacity, decreased ventilation, and an increased ratio of residual volume to total lung capacity. There is impairment in the match of ventilation to perfusion (ventilation-perfusion imbalance) and hypoxemia.

Clinical Manifestations

Characteristic symptoms of bronchiectasis include chronic cough and the production of purulent sputum in copious amounts. Many patients with this disease have hemoptysis. Clubbing of the fingers is also common because of respiratory insufficiency. Patients usually have repeated episodes of pulmonary infection.

Assessment and Diagnostic Findings

Bronchiectasis is not readily diagnosed because the symptoms can be mistaken for those of chronic bronchitis. A definite sign is a prolonged history of productive, chronic cough, with sputum consistently negative for tubercle bacilli. The diagnosis is established by a CT scan, which reveals bronchial dilation. The advent of high-resolution CT scanning makes it possible to diagnose this disease during its earlier stages.

Medical Management

Treatment objectives are to promote bronchial drainage, to clear excessive secretions from the affected portion of the lungs, and to prevent or control infection and inflammation. Chest physiotherapy (CPT; see previous discussion) is essential for promoting airway drainage. Sometimes, mucopurulent sputum must be removed by bronchoscopy. Smoking cessation is important, because smoking impairs bronchial drainage by paralyzing ciliary action, increasing bronchial secretions, and causing inflammation of the mucous membranes, resulting in hyperplasia of the mucous glands.

Antibiotics are the cornerstone therapy for management of a bronchiectatic exacerbation. Antimicrobial therapy choice is based on the results of sensitivity studies on organisms cultured from sputum; however, empiric coverage (i.e., broad-spectrum antibiotics that are effective in treating commonly implicated pathogens) is often prescribed initially, pending results of sputum cultures. The most commonly implicated pathogens include *H. influenzae*, *M. catarrhalis*, *Staphylococcus aureus*, and *Pseudomonas aeruginosa* (Barker, Stoller, King, et al., 2018). Because infection with *P. aeruginosa* is associated with a greater rate of lung function deterioration, more aggressive oral or IV antibiotic therapy may be used for a longer duration. For patients with recurrent exacerbations (usually two or more during the past year), a low dose macrolide antibiotic may be used as preventative, ongoing therapy (Barker et al., 2018). In addition, patients should be vaccinated against influenza and pneumococcal pneumonia.

Secretion management is an issue for patients with bronchiectasis. Nebulized mucolytics may help to clear airway secretions. These drugs promote expectoration by breaking down the mucus blocking the airways. The administration of nebulized hypertonic saline also improves airway clearance by decreasing the viscosity of the mucus and improving the ability of secretions to move out of the airways. Bronchodilators might be prescribed to help open up the airways, thus enhancing the ability of the other medications (e.g., mucolytics, hypertonic saline) to mobilize secretions. These agents also allow a better passageway for the secretions to move through. Bronchodilators are typically administered at the beginning of each pulmonary treatment. Ensuring adequate hydration and employing CPT may also be of help in loosening and thinning secretions (Barker et al., 2018).

Surgical intervention, although used infrequently, may be indicated for patients who continue to expectorate large amounts of sputum and have repeated bouts of pneumonia and hemoptysis despite adherence to treatment regimens. The disease must involve only one or two areas of the lung that can be removed without producing respiratory insufficiency. The goals of surgical treatment are to conserve normal pulmonary tissue and to avoid infectious complications. Diseased tissue is removed, provided that postoperative lung function will be adequate. It may be necessary to remove a segment of a lobe (segmental resection), a lobe (lobectomy), or, rarely, an entire lung (pneumonectomy). Segmental resection is the removal of an anatomic subdivision of a pulmonary lobe. In select cases, video-assisted surgery (VATS) segmentectomy or lobectomy may be performed, which is associated with fewer complications and decreased length of stay. The chief advantage is that only diseased tissue is removed, and healthy lung tissue is conserved.

The surgery is preceded by a period of careful preparation. The objective is to obtain a dry (free of infection) tracheobronchial tree to prevent complications (atelectasis, pneumonia, bronchopleural fistula, and empyema). This is accomplished by postural drainage or, depending on the location, by direct suction through a bronchoscope. A course of antibacterial therapy may be prescribed. After surgery, care is the same as for any patient who has undergone chest surgery.

Nursing Management

Nursing management focuses on alleviating symptoms and helping patients clear pulmonary secretions. Patient education targets eliminating smoking and other factors that increase the production of mucus and hamper its removal. Patients and families are taught to perform postural drainage and to avoid exposure to people with upper respiratory or other infections. If the patient experiences fatigue and dyspnea, they are informed about strategies to conserve energy while maintaining as active a lifestyle as possible. The patient is educated about the early signs of respiratory infection and the progression of the disorder so that appropriate treatment can be implemented promptly. The presence of a large amount of mucus may decrease the patient's appetite and result in an inadequate dietary intake; therefore, the patient's nutritional status is assessed and strategies are implemented to ensure an adequate diet.

Asthma

Asthma is a heterogeneous disease, usually characterized by chronic airway inflammation (Global Initiative for Asthma [GINA], 2019a). This chronic inflammatory disease of the airways causes airway hyperresponsiveness,

mucosal edema, and mucus production. This inflammation ultimately leads to recurrent episodes of asthma symptoms: cough, chest tightness, wheezing, and dyspnea (Fig. 20-10). In the United States, asthma affects approximately 19 million adults and accounted for approximately 3564 deaths in 2017 (CDC, 2017b; Kochanek, Murphy, Xu, et al., 2019). Of these adults, 35.2% have intermittent severity and 64.8% have persistent severity of asthma symptoms (CDC, 2015). Nearly 10% of all ED visits are related to asthma (CDC, 2018c). Although asthma is the most common chronic disease of childhood, it can occur at any age. For most patients, asthma is a disruptive disease, affecting school and work attendance, occupational choices, physical activity, and general quality of life.

Physiology/Pathophysiology

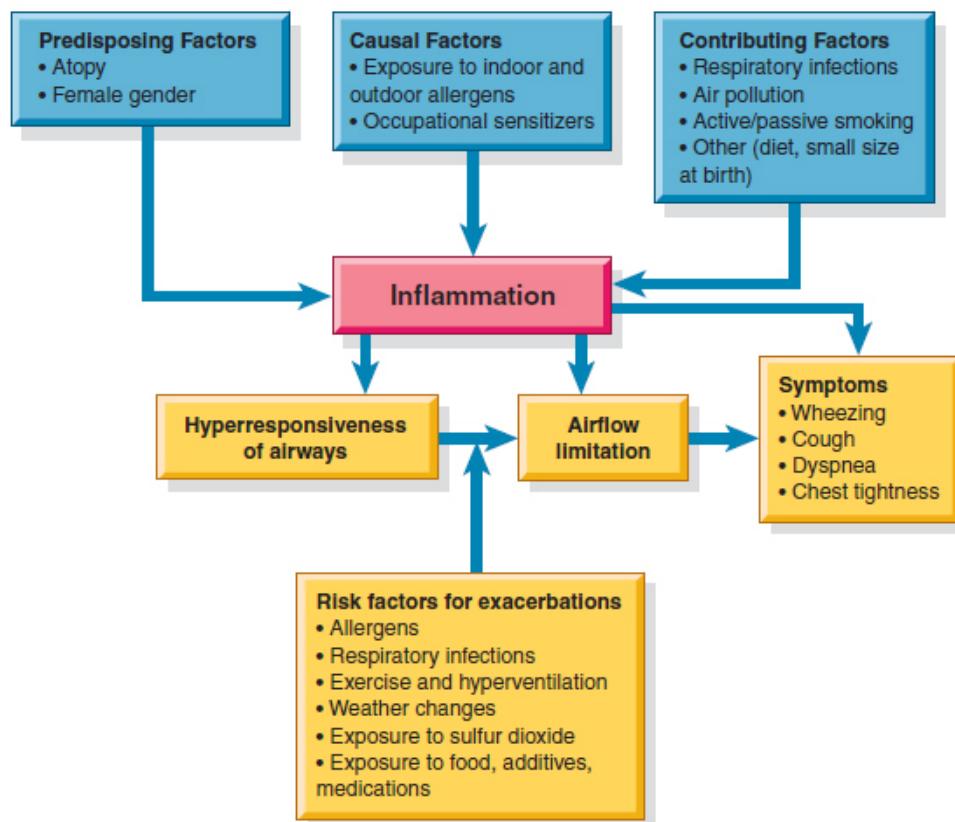


Figure 20-10 • Pathophysiology of asthma. Adapted from materials developed for the Global Initiative for Asthma (2019). Global strategy for asthma management and prevention. Available at: www.ginasthma.org

Twenty-one percent of patients with asthma smoke, even though cigarette smoke is known to trigger an attack, while nearly 17% of people without asthma smoke (CDC, 2015). Asthma–COPD overlap refers to patients who

have clinical presentations of both conditions (Papi, Brightling, Pedersen, et al., 2018). Smokers are at higher risk for having asthma–COPD overlap (Papi et al., 2018).

Despite increased knowledge regarding the pathology of asthma and the development of improved medications and management plans, the death rate from the disease continues to rise. Ethnic and racial disparities affect morbidity and mortality in asthma, particularly for African American and Hispanic/Latino American urban populations (Sullivan, Ghushchyan, Kavati, et al., 2019). Contributing to these disparities are epidemiologic considerations and risk factors that include genetic and molecular aspects; inner-city environments; limited community assets; health care access/delivery/and quality; and insufficient health insurance coverage.

Unlike other obstructive lung diseases, asthma is largely reversible, either spontaneously or with treatment. Patients with asthma may experience symptom-free periods alternating with acute exacerbations that last from minutes to hours or days.

Allergy is the strongest predisposing factor for asthma. Chronic exposure to airway irritants or allergens also increases the risk of asthma. Common allergens can be seasonal (e.g., grass, tree, weed pollens) or perennial (e.g., mold, dust, roaches, animal dander). Common triggers for asthma symptoms and exacerbations include airway irritants (e.g., air pollutants, cold, heat, weather changes, strong odors or perfumes, smoke, occupational exposure), foods (e.g., shellfish, nuts), exercise, stress, hormonal factors, medications, viral respiratory tract infections, and gastroesophageal reflux. Most people who have asthma are sensitive to a variety of triggers.

Pathophysiology

The underlying pathology in asthma is reversible diffuse airway inflammation that leads to long-term airway narrowing. This narrowing, which is exacerbated by various changes in the airway, includes bronchoconstriction, airway edema, airway hyperresponsiveness, and airway remodeling (Papi et al., 2018). The interaction of these factors determines the clinical manifestations and severity of asthma (GINA, 2019a). Over the course of a lifetime, the impact of increasing pathophysiologic changes and environmental susceptibility lead to an irreversible disease process.

Asthma is a complex disease process that involves numerous inflammatory and structural cells as well as mediators that lead to the disorder's effects. Mast cells, macrophages, T lymphocytes, neutrophils, and eosinophils all play a key role in the inflammation of asthma. When activated, mast cells release several chemicals called *mediators*. These chemicals, which include histamine, bradykinin, prostanoids, cytokines, leukotrienes, and other mediators, perpetuate the inflammatory response, causing increased blood flow,

vasoconstriction, fluid leak from the vasculature, attraction of white blood cells to the area, mucus secretion, and bronchoconstriction (Kacmarek et al., 2017; McCance & Huether, 2019).

During acute exacerbations of asthma, bronchial smooth muscle contraction or bronchoconstriction occurs quickly to narrow the airway in response to an exposure. Acute bronchoconstriction due to allergens results from an immunoglobulin E (IgE)-dependent release of mediators from mast cells; these mediators include histamine, tryptase, leukotrienes, and prostaglandins that directly contract the airway. In addition, alpha- and beta-2-adrenergic receptors of the sympathetic nervous system located in the bronchi play a role. When the alpha-adrenergic receptors are stimulated, bronchoconstriction occurs. The balance between alpha- and beta-2-adrenergic receptors is controlled primarily by cyclic 3',5'-adenosine monophosphate (cyclic AMP). Beta-2-adrenergic stimulation results in increased levels of cyclic AMP, which inhibits the release of chemical mediators and causes bronchodilation.

As asthma becomes more persistent, the inflammation progresses and other factors may be involved in airflow limitation. These include airway edema, mucus hypersecretion, and the formation of mucus plugs. In addition, airway “remodeling” (i.e., structural changes) may occur in response to chronic inflammation, causing further airway narrowing.

Clinical Manifestations

The three most common symptoms of asthma are cough, dyspnea, and wheezing. In some instances, cough may be the only symptom. An asthma attack often occurs at night or early in the morning, possibly because of circadian variations that influence airway receptor thresholds.

An asthma exacerbation may begin abruptly but most frequently is preceded by increasing symptoms over the previous few days. There is cough, with or without mucus production. At times, the mucus is so tightly wedged in the narrowed airway that the patient cannot cough it up. There may be generalized wheezing (the sound of airflow through narrowed airways), first on expiration and then possibly during inspiration as well. Generalized chest tightness and dyspnea occur. Expiration requires effort and becomes prolonged. As the exacerbation progresses, diaphoresis, tachycardia, and a widened pulse pressure may occur along with hypoxemia and central cyanosis (a late sign of poor oxygenation). Severe, life-threatening hypoxemia can occur in asthma but is relatively uncommon. The hypoxemia is secondary to a ventilation-perfusion mismatch and readily responds to supplemental oxygenation.

Symptoms of exercise-induced asthma include maximal symptoms during exercise, absence of nocturnal symptoms, and sometimes only a description of a “choking” sensation during exercise.

Assessment and Diagnostic Findings

To establish the diagnosis, the clinician must determine that episodic symptoms of airflow obstruction are present, airflow is at least partially reversible, and other causes have been excluded. A positive family history and environmental factors, including seasonal changes, high pollen counts, mold, pet dander, climate changes (particularly cold air), and air pollution, are primarily associated with asthma. In addition, asthma is associated with a variety of foods, compounds, and occupation-related chemicals. Comorbid conditions that may accompany asthma include viral infections, gastroesophageal reflux disease, drug-induced asthma, and allergic bronchopulmonary aspergillosis. Other possible allergic reactions that may accompany asthma include eczema, rashes, and temporary edema. Questions in the assessment that may help to evaluate the patient's asthma control include:

- Have your symptoms awakened you at night or in the early morning?
- Have you needed your quick-acting relief medication more than usual?
- Have you needed unscheduled care for your asthma—a call to the primary provider's office, office visit, ED?
- Have your symptoms impacted your normal activities at school/work/sports?

During acute episodes, sputum and blood tests may disclose eosinophilia (elevated levels of eosinophils). Serum levels of IgE may be elevated if allergy is present. Arterial blood gas analysis and pulse oximetry reveal hypoxemia during acute attacks. Initially, hypocapnia and respiratory alkalosis are present. As the patient's condition worsens and they become more fatigued, the PaCO₂ may increase. Because carbon dioxide is 20 times more diffusible than oxygen, it is rare for PaCO₂ to be normal or elevated in a person who is breathing very rapidly.



Quality and Safety Nursing Alert

Normal PaCO₂ during an asthma attack may be a signal of impending respiratory failure.

During an exacerbation, the FEV₁ and FVC are markedly decreased but improve with bronchodilator administration (demonstrating reversibility). Pulmonary function is usually normal between exacerbations. The occurrence of a severe, continuous reaction is referred to as status asthmaticus and is considered life-threatening (see later discussion).

Asthma severity is considered in the selection of the initial type, amount, and schedule of treatments (GINA, 2019a). Disease severity is classified by current impairment and future risk of adverse events. Impairment is defined by the following factors: nighttime awakenings, the need for short-acting bronchodilators for symptom relief, work/school days missed, ability to engage in normal activities, and quality of life. Lung function is evaluated by spirometry. Assessment of risk of future adverse events is evaluated by numbers of exacerbations, the need for ED care or hospitalizations in the past year, demographic data (gender, ethnicity, nonuse of prescribed ICS therapy, existing smoking), psychosocial factors and attitudes, and beliefs about taking medication (GINA, 2019a).

Prevention

Patients with recurrent asthma should undergo testing to identify the substances that precipitate the symptoms. Possible causes are dust, dust mites, roaches, certain types of cloth, pets, horses, detergents, soaps, certain foods, molds, and pollens. If the attacks are seasonal, pollens can be strongly suspected. Patients are instructed to avoid the causative agents whenever possible. Knowledge is the key to quality asthma care. Evaluation of impairment and risk are primary methods that help ensure control.

Occupational asthma refers to asthma induced by exposure in the work environment to dusts, vapors, or fumes, with or without a preexisting diagnosis of asthma. An estimated 5% to 20% of new asthma cases in the United States are related to workplace exposures (GINA, 2019a). Work-related asthma should be part of the differential diagnosis of every case of adult-onset asthma. A detailed work history evaluation is key to identifying occupational asthma. Immediate treatment is aimed at removing or decreasing the exposure in the patient's environment and following the patient on an ongoing basis. Standard asthma medications may be prescribed to minimize bronchoconstriction and airway inflammation. In certain cases, patients may be impaired or disabled from the disease. Compensation systems are in place to protect a worker; however, these systems are often slow and complex to navigate.

Complications

Complications of asthma may include status asthmaticus, respiratory failure, pneumonia, and atelectasis. Airway obstruction, particularly during acute asthmatic episodes, often results in hypoxemia, requiring the administration of oxygen and the monitoring of pulse oximetry and arterial blood gases. Fluids are given because people with asthma are frequently dehydrated from diaphoresis and insensible fluid loss with hyperventilation.

Medical Management

Primary treatment focuses on preventing impairment of lung function, minimizing symptoms, and preventing exacerbations (Papi et al., 2018). GINA (2019a) recommendations are based on the concept of severity and control of asthma along with the domains of reducing impairment and reducing risk as keys to improving care. Asthma control is assessed by symptom management and future risk of adverse outcomes (GOLD, 2019). In an acute situation, symptom control includes using immediate intervention to diminish bronchoconstriction, which prevents increased anxiety resulting from progressive dyspnea. Uncontrolled anxiety could aggravate the situation and ultimately worsen dyspnea. Poor symptom control increases the risk of exacerbations (GINA, 2019a).

Pharmacologic Therapy

There are two general classes of asthma medications: quick-relief medications for immediate treatment of asthma symptoms and exacerbations and long-acting medications to achieve and maintain control of persistent asthma ([Tables 20-5](#) and [20-6](#)). Because the underlying pathology of asthma is inflammation, control of persistent asthma is accomplished primarily with regular use of anti-inflammatory medications. The route of choice for administration of these medications is a pMDI or other type of inhaler, because it allows for localized administration within the lungs (see [Chart 20-6](#) and [Table 20-3](#)).

Quick-Relief Medications

Short-acting beta-2-adrenergic agonists (SABAs) (e.g., albuterol, levalbuterol, pirbuterol) are the medications of choice for relief of acute symptoms and prevention of exercise-induced asthma. They are used to relax smooth muscle.

Anticholinergics (e.g., ipratropium) inhibit muscarinic cholinergic receptors and reduce intrinsic vagal tone of the airway. These may be used in patients who do not tolerate short-acting beta-2-adrenergic agonists.

TABLE 20-5 Quick-Relief Medications for Treatment of Asthma

Medication	Indications/Mechanisms	Potential Adverse Effects	Nursing Considerations
Inhaled Short-Acting Beta-2 Adrenergic Agonists			
albuterol levalbuterol HFA metaproterenol sulfate	<i>Indications</i> Relief of acute symptoms; quick-relief medication <i>Mechanisms</i> Bronchodilation; binds to the beta-2 adrenergic receptor, producing smooth muscle relaxation and decreased bronchoconstriction	Tachycardia, muscle tremor, hypokalemia, increased lactic acid, headache, and hyperglycemia. Inhaled route causes few systematic adverse effects. Patients with preexisting cardiovascular disease, especially older adults, may have adverse cardiovascular reactions with inhaled therapy Lack of effect or need for regular use indicates inadequate asthma control	Instruct patient in correct use of inhaled agents and how to evaluate amount of remaining medication in pressurized metered-dose inhaler. Recommend periodic cleaning of device. Inform patient about possible adverse effects and need to inform primary provider about increased use of medication to control symptoms.
Anticholinergics			
ipratropium	<i>Indications</i> Relief of acute bronchospasm <i>Mechanisms</i> Bronchodilation; inhibition of muscarinic cholinergic receptors Reduction in vagal tone of airways May decrease mucous gland secretion	Dryness of mouth and respiratory secretions; may cause increased wheezing in some patients Does not block exercise-induced bronchospasm Is not effective in long-term control of asthma	Instruct patient in correct use of inhaled agents. Ensure adequate fluid intake. Assess patient for hypersensitivity to atropine, soybeans, peanuts; glaucoma; prostatic hypertrophy.
Corticosteroids			
Systemic methylprednisolone prednisolone	<i>Indications</i> For short-term (3–10 d) “burst;” to gain prompt	Blood glucose abnormalities, increased	Explain to patient that action is often rapid in

prednisone	<p>control of inadequately controlled persistent asthma</p> <p>For moderate or severe exacerbations to prevent progression of exacerbation, reverse inflammation, speed recovery, and reduce rate of relapse</p> <p><i>Mechanisms</i></p> <p>Anti-inflammatory; block reaction to allergen and reduce hyperresponsiveness; inhibit cytokine production, adhesion protein activation, and inflammatory cell migration and activation; reverses beta-2 receptor downregulation</p>	<p>appetite, fluid retention, weight gain, mood alteration, hypertension, peptic ulcer, insomnia</p> <p>Consideration must be given to comorbidities that may be worsened by systemic corticosteroids</p>	<p>onset, although resolution of symptoms may take 3–10 d.</p> <p>Instruct patient about possible side effects and the importance of taking the medication as prescribed.</p> <p>If the patient is taking multiple doses a day, administering the last dose prior to 2 PM (when possible) may help to prevent sleep disturbances.</p>
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HFA, hydrofluoroalkane.

Adapted from Global Initiative for Asthma (GINA) (2019b). Pocket guide for asthma management. Retrieved on 7/01/2019 at: www.ginasthma.org/wp-content/uploads/2019/04/GINA-2019-main-Pocket-Guide-wms.pdf

TABLE 20-6 Long-Term Medications for Treatment of Asthma (Controller Medications)

Medication	Dosage Information	Indications/Mechanisms	Potential Adverse Effects	Nursing Considerations
Inhaled Corticosteroids beclomethasone dipropionate budesonide ciclesonide flunisolide fluticasone mometasone furoate		<p><i>Indications</i> Long-term prevention of symptoms; suppression, control, and reversal of inflammation Reduce need for oral corticosteroid</p> <p><i>Mechanisms</i> Anti-inflammatory; block late reaction to allergen and reduce airway hyperresponsiveness Inhibit cytokine production, adhesion protein activation, and inflammatory cell migration and activation; reverse beta-2 receptor downregulation; inhibit microvascular leakage</p>	<p>Cough, dysphonia, oral thrush (candidiasis), headache</p> <p>In high doses, systemic effects may occur (e.g., adrenal suppression, osteoporosis, skin thinning, easy bruising)</p>	<p>Instruct patient in correct use of pMDI and use of spacer/holding chamber devices.</p> <p>Instruct patient to rinse mouth after inhalation to reduce local side effects.</p>

Systemic Corticosteroids methylprednisolone prednisolone prednisone	Indications For prevention of symptoms in severe persistent asthma: suppression, control, and reversal of inflammation Mechanisms Same as inhaled corticosteroids	Long-Term Use: adrenal axis suppression, growth suppression, dermal thinning, hypertension, diabetes, Cushing's syndrome, cataracts, muscle weakness, and, in rare instances, impaired immune function, insomnia Consideration should be given to comorbidities that could be worsened by systemic corticosteroids	Instruct patient about possible side effects and the importance of taking the medication as prescribed (usually a single dose in the morning daily or on an alternate-day schedule, which may produce less adrenal suppression). If the patient is taking multiple doses a day, administering the last dose prior to 2 PM (when possible) may help to prevent sleep disturbances.
Long-Acting Beta-2 Adrenergic Agonists Inhaled salmeterol formoterol Oral albuterol sustained release	Indications Long-term prevention of symptoms, added to ICS Prevention of exercise-induced bronchospasm Mechanisms Bronchodilation; smooth muscle relaxation following adenylate cyclase activation and increase in cAMP, producing functional antagonism of bronchoconstriction Compared to SABA, salmeterol (but not formoterol) has slower onset of action (15–30 min). Both salmeterol and formoterol have longer duration (>12 h) compared to SABA	Should not be used to treat acute symptoms or exacerbations Decreased protection against exercise-induced bronchospasm may occur with regular use Tachycardia, muscle tremor, hypokalemia, ECG changes with overdose. A diminished bronchoprotective effect may occur within 1 wk of chronic therapy. Potential risk of uncommon, severe, life-threatening, or fatal exacerbation	Reinforce to patient that these medications should <i>not</i> be used to treat acute asthma symptoms or exacerbations. Instruct patient about correct use of pMDI or aerolizer inhaler.
Phosphodiesterase Inhibitors theophylline sustained-release tablets and capsules	Indications Long-term control and prevention of symptoms in mild persistent asthma or as adjunctive with ICS, in moderate or persistent asthma Mechanisms Bronchodilation; smooth muscle relaxation from phosphodiesterase inhibition and possibly adenosine antagonism May affect eosinophilic infiltration into bronchial mucosa as well as decreased T-lymphocyte numbers in epithelium Increases diaphragm contractility and mucociliary clearance	Dose-related acute toxicities include tachycardia, nausea and vomiting, tachyarrhythmias (SVT), central nervous system stimulation, headache, seizures, hematemesis, hyperglycemia, and hypokalemia Adverse effects at usual therapeutic doses include insomnia, gastric upset, aggravation of ulcer or reflux, and difficulty in urination in older males who have prostatism Not generally recommended for exacerbations. There is minimal evidence for added benefit to optimal doses of SABA	Maintain steady-state serum concentrations between 5 and 15 mcg/mL. Be aware that absorption and metabolism may be affected by numerous factors that can produce significant changes in steady-state serum theophylline concentrations. Instruct patient to discontinue if toxicity occurs. Serum concentration monitoring is mandatory. Inform patient about the importance of blood tests to monitor serum concentration. Instruct patient to check with primary provider before taking any new medication.

Combined Medication (Corticosteroid/Long-Acting Beta-2 Adrenergic Agonist)			
fluticasone/ salmeterol	Lowest dose of DPI or HFA used for patients whose asthma is not controlled on low- to medium-dose ICS Higher doses of DPI or HFA used for patients whose asthma is not con- trolled on medium- to high-dose ICS	DPI 100 mcg/50 mcg 250 mcg/50 mcg 500 mcg/50 mcg HFA 45 mcg/21 mcg 115 mcg/21 mcg 230 mcg/21 mcg	
budesonide/ formoterol fluticasone furoate/vilanterol mometasone/ formoterol	Lower dose used for patients who have asthma not con- trolled on low- to medium-dose ICS Higher dose used for patients who have asthma not con- trolled on medium- to high-dose ICS Used if asthma not controlled on long- term asthma control medication.	HFA pMDI 80 mcg/4.5 mcg 160 mcg/4.5 mcg 100 mcg/25 mcg 200 mcg/25 mcg 100 mcg/5 mcg 200 mcg/5 mcg	Do not use with other long- acting beta-agonist drugs
Leukotriene Modifiers			
Leukotriene Receptor Antagonists montelukast Available in tablets and granules		Mechanism Selective competitive inhibitor of CysLT1 receptor Indications Long-term control and prevention of symptoms in mild persistent asthma for patients ≥ 1 year of age May also be used with ICS as combination therapy in moderate persistent asthma Long-term control and prevention of symptoms in mild persistent asthma; may also be used with ICS as combination therapy in moderate persistent asthma	May attenuate EIB in some patients, but less effective than ICS therapy LTRA + LABA should not be used as a substitute for ICS + LABA. Headache, dizziness, upper respiratory infections, pharyngitis, sinusitis
zafirlukast Available in tablets		Cases of reversible hepatitis have been reported along with rare cases of irreversible hepatic failure resulting in death and liver transplantation	Instruct patient to take at least 1 h before meals or 2 h after meals. Inform patient that zafirlukast can inhibit the metabolism of warfarin. INRs should be monitored if patient is taking both zafirlukast and montelukast. Instruct patients to discontinue use if they experience signs and symptoms of liver dysfunction (right upper quadrant pain, pruritus, lethargy, jaundice, nausea), and to notify their primary provider.
5-Lipoxygenase Inhibitor zileuton		Mechanism Inhibits the production of leukotrienes from arachidonic acid, both LTB and the cysteinyl leukotrienes Indications Long-term control and prevention of symptoms in mild persistent asthma for patients May be used with ICS as combination therapy in moderate persistent asthma in patients	Elevation of liver enzymes has been reported. Limited case reports of reversible hepatitis and hyperbilirubinemia Inform patient that zileuton can inhibit the metabolism of warfarin and theophylline. Therefore, the doses of these medications should be monitored accordingly. Educate patient about the importance of monitoring medication levels and tests of liver function.

Immunomodulators			
<i>IgE-Inhibiting IgG monoclonal antibody</i>	Dose is given either every 2 or 4 wks and depends on the patient's body weight and IgE level before therapy	Indications Long-term control and prevention of symptoms with moderate or severe persistent allergic asthma inadequately controlled with ICS	Anaphylaxis has been reported in 0.2% of treated patients Pain, bruising, and skin reactions (itching, redness, stinging) at injection sites
omalizumab Given by subcutaneous injection	A maximum of 150 mg can be given in 1 injection Medication needs to be stored under refrigeration at 2°–8°C (35.6°–46.4°F)	Mechanisms Monoclonal antibody that binds to circulating IgE, preventing it from binding to the high-affinity receptors on basophils and mast cells	It is unknown if patients will develop significant antibody titers to the drug with long-term administration
<i>Interleukin-5 Receptor (IL-5R) Antagonists</i> mepolizumab reslizumab benralizumab Mepolizumab and benralizumab are given by subcutaneous injection. Reslizumab is given by intravenous infusion.		Indications Long-term control and prevention of symptoms in patients with severe persistent asthma of eosinophilic phenotype. Mepolizumab and benralizumab are approved for adolescents and adults ≥ 12 years of age, and reslizumab is approved for adults ≥ 18 years of age	Monitor patients for allergic reactions or anaphylaxis following administration. Be prepared to initiate emergency treatment if anaphylaxis occurs. Instruct patient about signs and symptoms that indicate allergic reaction and immediate action to take. Remind patient to continue to take other medications prescribed for treatment of asthma.
<i>Interleukin-4 (Receptor Alpha (IL-4Ra) Antagonist</i> dupilumab Given by subcutaneous injection		Mechanisms Monoclonal antibodies that decrease production and survival of eosinophils by binding to and inhibiting IL-5R. However, the specific mechanism in which these agents exert their effects in asthma has not been definitively established	Ensure the patient understands appropriate administration technique to minimize administration and dosing errors and to optimize patient safety. Note that dose and frequency of administration of biologics may be influenced by various factors such as weight, blood work, or the need for titration. Education is key to adherence and it is important to confirm patient knowledge and understanding.

cyclic AMP; cyclic 3',5'-adenosine monophosphate; CysLT1, cysteinyl leukotriene receptor 1; DPI, dry-powder inhaler; ECC, electrocardiogram; EIB, exercise-induced bronchospasm; HFA, hydrofluorocarbons; ICS, inhaled corticosteroid; IgE, immunoglobulin E; IgG, immunoglobulin G; INR, international normalized ratio; LABA, long-acting beta-2 adrenergic agonist; LTB, leukotriene B; LTRA, leukotriene receptor antagonist; pMDI, pressurized metered-dose inhaler; SABA, short-acting beta-2 adrenergic agonist; SVT, supraventricular tachycardia.

Adapted from Ferguson, G. T., Stoller, J. K., & Hollingsworth, H. (2019). Management of severe, chronic, obstructive pulmonary disease. *UpToDate*. Retrieved on 7/30/2019 at: www.uptodate.com/contents/management-of-stable-chronic-obstructive-pulmonary-disease; Global Initiative for Asthma (GINA). (2019b). Pocket guide for asthma management. Retrieved on 7/01/2019 at: www.ginasthma.org/wp-content/uploads/2019/04/GINA-2019-main-Pocket-Guide-wms.pdf; Wenzel, S., Bochner, B. S., & Hollingsworth, H. (2019). Treatment of severe asthma in adolescents and adults. *UpToDate*. Retrieved on 7/30/2019 at: www.uptodate.com/contents/treatment-of-severe-asthma-in-adolescents-and-adults

The combination medication ipratropium bromide and albuterol sulfate is used for quick relief of asthma symptoms and acute exacerbations. This medication is administered using a small-volume nebulizer (SVN; discussed previously).

Long-Acting Control Medications

Corticosteroids are the most potent and effective anti-inflammatory medications currently available. They are broadly effective in alleviating symptoms, improving airway function, and decreasing peak flow variability.

Initially, an inhaled form is used. All patients should rinse their mouth with water (and should not swallow the rinse) after administration of ICSs to prevent thrush, a common complication associated with the use of these drugs. However, those who lack the coordination to ensure proper administration technique should use a spacer. This will reduce medication deposition within the mouth and further reduce the risk of thrush. A systemic preparation may be used to gain rapid control of the disease; to manage severe, persistent asthma; to treat moderate to severe exacerbations; to accelerate recovery; and to prevent recurrence.

Long-acting beta-2 adrenergic agonists (LABAs) are used with anti-inflammatory medications to control asthma symptoms, particularly those that occur during the night. These agents are also effective in the prevention of exercise-induced asthma. LABAs are not indicated for immediate relief of symptoms. Salmeterol and formoterol have duration of bronchodilation of at least 12 hours. They are used with other medications in long-term control of asthma.

Leukotriene modifiers (inhibitors), or *antileukotrienes*, are a class of medications that include montelukast, zafirlukast, and zileuton. Leukotrienes, which are synthesized from membrane phospholipids through a cascade of enzymes, are potent bronchoconstrictors that also dilate blood vessels and alter permeability. Leukotriene inhibitors act either by interfering with leukotriene synthesis or by blocking the receptors where leukotrienes exert their action. They may provide an alternative to ICSs for mild persistent asthma, or they may be added to a regimen of ICSs in more severe asthma to attain further control.

Phosphodiesterase inhibitors cause bronchodilation and act as mild anti-inflammatory agents by influencing epinephrine release. Theophylline is used as an add-on agent and in conjunction with inhaled steroids; however, it is not as effective in treating asthma as the medications previously discussed. Theophylline should be used with reservation because it has the potential to cause many drug interactions and its higher risk of side effects (GOLD, 2019).

Immunomodulators prevent binding of IgE to the high-affinity receptors of basophils and mast cells. The U.S. Food and Drug Administration (FDA) approved five biologic immunomodulators for the treatment of asthma (omalizumab, mepolizumab, reslizumab, benralizumab, and dupilumab) and several others are in development. Medications in this class are add-on treatments used when patients experience poor symptom control on high-dose inhaled corticosteroids with a LABA (ICS-LABA). These immunomodulators are monoclonal antibodies that are derived from biologic sources and are therefore sometimes referred to as biologics. They help with symptom control by interfering with the inflammatory response that is associated with acute asthmatic episodes (Krings, McGregor, Bacharier, et al., 2019). Cost and patient preference for route of administration must be considered when adding

on this treatment (GOLD, 2019). Biologics are either administered subcutaneously or intravenously.

Management of Exacerbations

Asthma exacerbations are best managed by early treatment and education, including the use of written action plans as part of any overall effort to educate patients about self-management techniques, especially those with moderate or severe persistent asthma or with a history of severe exacerbations (GINA, 2019a). GINA (2019a) recommends using an ICS treatment for the prevention of exacerbations in adults. Short-acting beta-2-adrenergic agonist medications are used at the time of the exacerbation for prompt relief of airflow obstruction. Systemic corticosteroids may be necessary to decrease airway inflammation in patients who fail to respond to inhaled beta-adrenergic medications. In some patients, oxygen supplementation may be required to relieve hypoxemia associated with moderate to severe exacerbations. In addition, response to treatment may be monitored by serial measurements of lung function. Patients with persistent symptoms and/or exacerbations may benefit from routinely using ICS-LABA to improve symptom management and prevent the occurrence of exacerbations.

Evidence from clinical trials suggests that antibiotic therapy, whether given routinely or when suspicion of bacterial infection is low, is not beneficial for asthma exacerbations (GINA, 2019a). Antibiotics may be appropriate in the treatment of acute asthma exacerbations in patients who have symptoms of a respiratory infection (e.g., fever and purulent sputum, evidence of pneumonia, suspected bacterial sinusitis).

Despite insufficient data supporting or refuting the benefits of using a written asthma action plan as compared to medical management alone, it is recommended to use a written asthma action plan to educate patients about self-management ([Fig. 20-11](#)). Plans can be based on either symptoms or peak flow measurements. They should focus on daily management as well as the recognition and handling of worsening symptoms. Patient self-management and early recognition of problems lead to more efficient communication with health care providers about asthma exacerbations (GINA, 2019a).

Peak Flow Monitoring

Peak flow meters measure the highest airflow during a forced expiration ([Fig. 20-12](#)). Daily peak flow monitoring is recommended for patients who meet one or more of the following criteria: have moderate or severe persistent asthma, have poor perception of changes in airflow or worsening symptoms, have unexplained response to environmental or occupational exposures, or at the discretion of the clinician and patient (GINA, 2019a). Peak flow

monitoring helps measure asthma severity and, when added to symptom monitoring, indicates the current degree of asthma control.

The patient is instructed in the proper technique (Chart 20-8), particularly about using maximal effort; peak flows are monitored for 2 or 3 weeks after receipt of optimal asthma therapy. Then, the patient's "personal best" value is measured. The green (80% to 100% of personal best), yellow (60% to 80%), and red (less than 60%) zones are determined, and specific actions are delineated for each zone, enabling the patient to monitor and manipulate their own therapy after careful instruction (GINA, 2019a).

Asthma Action Plan			
For: _____ Doctor: _____ Date: _____ Doctor's Phone Number _____ Hospital/Emergency Department Phone Number _____			
GREEN ZONE Doing Well <input type="checkbox"/> No cough, wheeze, chest tightness, or shortness of breath during the day or night <input type="checkbox"/> Can do usual activities And, if a peak flow meter is used, Peak flow: more than _____ (80% or more of my best peak flow) My best peak flow is: _____			
Take these long-term-control medicines each day (include an anti-inflammatory). Medicine _____ How much to take _____ When to take it _____			
Identify and avoid and control the things that make your asthma worse, like (list here): _____ _____ _____			
Before exercise, if prescribed, take: <input type="checkbox"/> 2 or <input type="checkbox"/> 4 puffs _____ 5 to 60 minutes before exercise			
YELLOW ZONE Asthma Is Getting Worse <input type="checkbox"/> Cough, wheeze, chest tightness, or shortness of breath, or <input type="checkbox"/> Waking at night due to asthma, or <input type="checkbox"/> Can do some, but not all, usual activities -Or- Peak flow: _____ to _____ (50% to 79% of my best peak flow)			
First: Add: quick-relief medicine—and keep taking your GREEN ZONE medicine.  <input type="checkbox"/> 2 or <input type="checkbox"/> 4 puffs, every 20 minutes for up to 1 hour (short-acting beta ₂ -agonist) <input type="checkbox"/> Nebulizer, once If applicable, remove yourself from the thing that made your asthma worse. If your symptoms (and peak flow, if used) return to GREEN ZONE after 1 hour of above treatment: Continue monitoring to be sure you stay in the green zone. -Or- If your symptoms (and peak flow, if used) do not return to GREEN ZONE after 1 hour of above treatment: <input type="checkbox"/> Take: _____ <input type="checkbox"/> 2 or <input type="checkbox"/> 4 puffs or <input type="checkbox"/> Nebulizer (short-acting beta ₂ -agonist) <input type="checkbox"/> Add: _____ mg per day For _____ (3-10) days (oral corticosteroid) <input type="checkbox"/> Call the doctor: _____, <input type="checkbox"/> before/ <input type="checkbox"/> within _____ hours after taking the oral corticosteroid. (phone)			
RED ZONE Medical Alert! <input type="checkbox"/> Very short of breath, or <input type="checkbox"/> Quick-relief medicines have not helped, or <input type="checkbox"/> Cannot do usual activities, or <input type="checkbox"/> Symptoms are same or get worse after 24 hours in Yellow Zone -Or- Peak flow: less than _____ (50% of my best peak flow)			
Take this medicine: <input type="checkbox"/> _____ <input type="checkbox"/> 4 or <input type="checkbox"/> 6 puffs or <input type="checkbox"/> Nebulizer (short-acting beta ₂ -agonist) <input type="checkbox"/> _____ mg (oral corticosteroid) Then call your doctor NOW. Go to the hospital or call an ambulance if: <input type="checkbox"/> You are still in the red zone after 15 minutes AND <input type="checkbox"/> You have not reached your doctor.			
DANGER SIGNS <input type="checkbox"/> Trouble walking and talking due to shortness of breath  <input type="checkbox"/> Take <input type="checkbox"/> 4 or <input type="checkbox"/> 6 puffs of your quick-relief medicine AND <input type="checkbox"/> Lips or fingernails are blue <input type="checkbox"/> Go to the hospital or call for an ambulance _____ NOW! (phone)			

Figure 20-11 • Asthma action plan. Adapted from National Heart, Lung, and Blood Institute (NHLBI). (2012). Asthma care quick reference: Diagnosing and managing asthma. NIH Publication No. 12-5075. Revised September 2012.



Figure 20-12 • Peak flow meters measure the highest volume of airflow during a forced expiration. The patient takes a deep breath and places lips around the mouthpiece (**A**), and then exhales hard and fast (**B**). Volume may be measured in color-coded zones: the green zone signifies 80% to 100% of personal best; yellow, 60% to 80%; and red, less than 60%. If peak flow falls below the red zone, the patient should take the appropriate actions prescribed by the patient's primary provider.

Chart 20-8 HOME CARE CHECKLIST

Use of Peak Flow Meter in Asthma Management

At the completion of education, the patient and/or caregiver will be able to:

- Describe the rationale for using a peak flow meter in asthma management.
- Explain how peak flow monitoring is used along with symptoms to determine severity of asthma.
- Demonstrate steps for using the peak flow meter correctly.
 1. Move the indicator to the bottom of the numbered scale.
 2. Stand up.
 3. Take a deep breath, and fill the lungs completely.
 4. Place mouthpiece in mouth, and close lips around mouthpiece. (Do not put tongue inside opening.)
 5. Blow out hard and fast with a single blow.
 6. Record the number achieved on the indicator. If patient coughs or a mistake is made in the process, do it again.
 7. Repeat steps 1–5 two more times, and write the highest number in the asthma diary.
- Explain how to determine the “personal best” peak flow reading.
- Describe the significance of the color zones for peak flow monitoring.
- Demonstrate how to clean the peak flow meter.
- Discuss how and when to contact the primary provider about changes or decreases in peak flow values.

GINA (2019a) recommends that peak flow monitoring be considered an adjunct to asthma management for patients with moderate to severe persistent asthma. Peak flow monitoring plans may enhance communication between the patient and health care providers and may increase the patient’s awareness of disease status and control.

Nursing Management

The immediate nursing care of patients with asthma depends on the severity of symptoms. The patient may be treated successfully as an outpatient if asthma symptoms are relatively mild or may require hospitalization and intensive care if symptoms are acute and severe. The patient and family are often frightened and anxious because of the patient’s dyspnea. Therefore, a calm approach is an important aspect of care. The nurse assesses the patient’s respiratory status by monitoring the severity of symptoms, breath sounds, peak flow, pulse oximetry, and vital signs.

The nurse generally performs the following interventions:

- Obtains a history of allergic reactions to medications before administering medications.
- Identifies medications the patient is taking.
- Administers medications as prescribed and monitors the patient's responses to those medications. These medications may include an antibiotic if the patient has an underlying respiratory infection.
- Administers fluids if the patient is dehydrated.

If the patient requires intubation because of acute respiratory failure, the nurse assists with the intubation procedure, continues close monitoring of the patient, and keeps the patient and family informed about procedures. (See [Chapter 19](#) for discussion of intubation and mechanical ventilation.)

Promoting Home, Community-Based, and Transitional Care

Implementation of basic asthma management principles at the community level is a major challenge. Strategies include education of health care providers, establishment of programs for asthma education (for patients and providers), the use of outpatient follow-up care for patients, and a focus on chronic management versus acute episodic care. Nurses are pivotal to achievement of these objectives.



Educating Patients About Self-Care

Patient education is a critical component of care for patients with asthma. Multiple inhalers, different types of inhalers, antiallergy therapy, antireflux medications, and avoidance measures are essential for long-term control. This complex therapy requires a partnership between the patient and the health care providers to determine the desired outcomes and to formulate a plan to achieve those outcomes. The patient then carries out daily therapy as part of self-care management, with input and guidance by their health care providers. Before a partnership can be established, the patient must understand the following:

- Nature of asthma as a chronic inflammatory disease
- Definitions of inflammation and bronchoconstriction
- Purpose and action of each medication
- Triggers to avoid and how to avoid them
- Proper inhalation technique
- How to perform peak flow monitoring (see [Chart 20-8](#))
- How to implement an asthma action plan (see [Fig. 20-11](#))
- When to seek assistance, and how to do so

An assortment of excellent educational materials is available from the National Heart, Lung, and Blood Institute and other sources (see Resources section at the end of the chapter). The nurse should obtain current educational materials for the patient based on the patient's diagnosis, causative factors, educational level, and cultural background. If a patient has a coexisting sensory impairment (i.e., vision loss or hearing impairment), materials should be provided in an alternative format.

Continuing and Transitional Care

Nurses who have contact with patients with asthma in any setting use the opportunity to assess the patient's respiratory status and ability to manage self-care to prevent serious exacerbations. Nurses emphasize adherence to the prescribed therapy, preventive measures, and the need to keep follow-up appointments with health care providers. Home visits to assess the home environment for allergens may be indicated for patients with recurrent exacerbations. Nurses refer patients to community support groups. In addition, nurses remind patients and families about the importance of health promotion strategies and recommended health screening.

Unfolding Patient Stories: Jennifer Hoffman • Part 1



Jennifer Hoffman is a 33-year-old woman diagnosed with asthma in childhood. She has come to the clinic multiple times over the last 2 mo complaining of continued symptoms. Her asthma action plan was adjusted by her primary provider last month. What measures can the nurse take to determine areas needing education reinforcement?

How can the nurse ensure that Jennifer is accurately following the prescribed asthma regimen and monitoring medication effectiveness? (Jennifer Hoffman's story continues in [Chapter 33](#).)

Care for Jennifer and other patients in a realistic virtual environment: **vSim** (thepoint.lww.com/vSimMedicalSurgical). Practice documenting these patients' care in DocuCare (thepoint.lww.com/DocuCareEHR).



Status Asthmaticus

An asthma exacerbation can range from mild to severe with potential respiratory arrest (GINA, 2019a). The term *status asthmaticus* is sometimes used to describe rapid onset, severe, and persistent asthma that does not

respond to conventional therapy. The attacks can occur with little or no warning and can progress rapidly to asphyxiation. Infection, anxiety, inhaler abuse, dehydration, increased adrenergic blockage, and nonspecific irritants may contribute to these episodes. An acute episode may be precipitated by hypersensitivity to medications, such as aspirin, beta-blockers, and nonsteroidal anti-inflammatory drugs (NSAIDs) (American Academy of Allergy, Asthma & Immunology [AAAAI], 2019; GOLD, 2019).

Pathophysiology

The basic characteristics of asthma (inflammation of bronchial mucosa, constriction of the bronchiolar smooth muscle, and thickened secretions) decrease the diameter of the bronchi and occur in status asthmaticus. The most common scenario is severe bronchospasm, with mucus plugging leading to asphyxia. A ventilation–perfusion abnormality results in hypoxemia. There is a reduced PaO_2 and initial respiratory alkalosis, with a decreased PaCO_2 and an increased pH. As status asthmaticus worsens, the PaCO_2 increases and the pH decreases, reflecting respiratory acidosis.

Clinical Manifestations

The clinical manifestations are the same as those seen in severe asthma; signs and symptoms include labored breathing, prolonged exhalation, distended neck veins, and wheezing. However, the extent of wheezing does not indicate the severity of the attack. As the obstruction worsens, the wheezing may disappear; this is frequently a sign of impending respiratory failure.

Assessment and Diagnostic Findings

The severity of an exacerbation may be evaluated by a general assessment of the patient (degree of breathlessness, ability to talk, positioning of patient, level of alertness or cognitive function), physical assessment (respiratory rate, the use of accessory muscles, presence of central cyanosis, auscultatory findings, pulse, and pulsus paradoxus), and laboratory evaluation (peak expiratory flow after a bronchodilator, PaO_2 and PaCO_2 , and pulse oximetry). Pulmonary function studies are the most accurate means of assessing an acute, severe airway obstruction, though not practical to obtain during this type of an emergent situation. Arterial blood gas measurement and/or pulse oximetry are obtained if the patient cannot perform pulmonary function maneuvers because of severe obstruction or fatigue, or if the patient does not respond to treatment. Respiratory alkalosis (low PaCO_2) is the most common early finding in patients with an ongoing asthma exacerbation and is due to hyperventilation. At this early stage, relatively fewer acinar units (i.e., pulmonary alveolar units

where gas exchange occurs) are obstructed/constricted compared to those that are functional, and hyperventilation occurs as part of the sympathetic response.



Quality and Safety Nursing Alert

In status asthmaticus, increasing PaCO₂ (to normal levels or levels indicating respiratory acidosis) is a danger sign signifying impending respiratory failure.

Medical Management

Close monitoring of the patient and objective reevaluation for response to therapy are key in status asthmaticus. In the emergency setting, the patient is treated initially with a short-acting beta-2-adrenergic agonist and subsequently a short course of systemic corticosteroids, especially if the patient does not respond to the short-acting beta-2-adrenergic agonist. Corticosteroids are critical in the therapy of status asthmaticus and are used to decrease the intense airway inflammation and swelling. Inhaled short-acting beta-2-adrenergic agonists provide the most rapid relief from bronchospasm. A pMDI, with or without a spacer, may be used for administering the medications. However, more commonly, short-acting bronchodilators will be given via an SVN. A mouthpiece or facemask can be used and the bronchodilator is continuously given to the patient. The patient does not have to work to coordinate the breathing pattern, which can otherwise cause additional anxiety in this acute situation. The patient requires supplemental oxygen and IV fluids for hydration. Oxygen therapy is initiated to treat dyspnea, central cyanosis, and hypoxemia. High-flow supplemental oxygen is best delivered using a partial or complete non-rebreathing mask. Sedatives are contraindicated. Magnesium sulfate, a calcium antagonist, may be given to induce smooth muscle relaxation; the magnesium can relax smooth muscle and hence cause bronchodilation by competing with calcium at calcium-mediated smooth muscle-binding sites. IV magnesium sulfate is not recommended for routine use in asthma exacerbations; however, when given as a single 2-g infusion over 20 minutes, it may be helpful in treating patients who present with severely compromised pulmonary function, who have not responded to initial therapy, and with persistent hypoxemia (GINA, 2019a). Adverse effects of magnesium sulfate may include facial warmth, flushing, tingling, nausea, central nervous system depression, respiratory depression, and hypotension.

If there is no response to repeated treatments, hospitalization is required. Other criteria for hospitalization include poor pulmonary function test results and deteriorating blood gas levels (respiratory acidosis), which may indicate that the patient is tiring and will require mechanical ventilation. Most patients

do not need mechanical ventilation, but it is used for patients in respiratory failure, for those who tire and are too fatigued by the attempt to breathe, and for those whose condition does not respond to initial treatment.

For a very select group of patients with uncontrolled severe asthma, bronchial thermoplasty may be considered. Bronchial thermoplasty is the first nondrug therapy for the treatment of severe, uncontrolled asthma. It consists of controlled radiofrequency heating of the central airways through a bronchoscope. The thermal energy reduces the amount of smooth muscle involved in bronchospasm and potentially decreases the severity and frequency of symptoms. This therapy is invasive and relatively new; therefore, only select centers have the ability to perform this procedure, and it should only be considered in a select group of patients (GINA, 2019a).

Death from asthma is associated with several risk factors, including the following (GINA, 2019a):

- Past history of severe exacerbation (e.g., intubation or intensive care unit admission)
- Hospitalizations or emergency care visits for asthma within the past year
- Currently or having recently stopped using oral corticosteroids
- Not using ICSs
- Overuse of SABAs
- Concurrent psychiatric disease or psychosocial problems
- Poor adherence to written asthma action plan
- Poor adherence to medication regimen
- Presence of a food allergy

Nursing Management

The main focus of nursing management is to actively assess the airway and the patient's response to treatment. The nurse should be prepared for the next intervention if the patient does not respond to treatment.

The nurse vigilantly monitors the patient for the first 12 to 24 hours, or until the severe exacerbation resolves. The nurse also assesses the patient's skin turgor for signs of dehydration. Fluid intake is essential to combat dehydration, to loosen secretions, and to facilitate expectoration. Nurses administer IV fluids as prescribed, up to 3 to 4 L/day, unless contraindicated. Blood pressure and cardiac rhythm should be monitored continuously during the acute phase and until the patient stabilizes and responds to therapy. The patient's energy needs to be conserved, and his or her room should be quiet and free of respiratory irritants, including flowers, tobacco smoke, perfumes, or odors of cleaning agents. Nonallergenic pillows should be used. An asthma attack may also be precipitated or aggravated by exposure to latex if the patient has a latex

allergy; therefore, this type of hypersensitivity must be identified and latex-free products used, as warranted. Once the exacerbation is resolved, the factors that precipitated the exacerbation should be identified and strategies for their future avoidance implemented. In addition, the patient's medication plan should be reviewed.

Cystic Fibrosis

CF is the most common fatal autosomal recessive disease among Caucasians. It is less frequently found among Hispanic, Asian, and African Americans. A person must inherit a defective copy of the CF gene (one from each parent) to have CF. Each year, 1000 new cases of CF are diagnosed, and more than 75% of patients are diagnosed by 2 years of age (Cystic Fibrosis Foundation [CFF], 2019a). In 2010, over 50% of people with CF in the United States were diagnosed with newborn screening (Heltshe, Cogen, Ramos, et al., 2017). Approximately 30,000 children and adults in the United States have CF and half are over the age of 18. CF was once a fatal childhood disease; however, the median expected survival age is now 37 (National Institutes of Health, 2018). Furthermore, survival age is projected to rise to 57 years if the survival rate continues to improve 1.8% per year (Heltshe et al., 2017). The improved survival rate is due to advances in medical management and procedures such as lung transplantation. Now that the median survival age has increased to 37 years for patients with CF, issues that were not present in past generations have arisen. These issues include antibiotic resistance and the desire for patients with CF to have their own biologic children.

Although most patients are diagnosed by 2 years of age, this disease may not be diagnosed until later in life (CFF, 2019b). Respiratory symptoms are frequently the major manifestation of CF when it is diagnosed later in life. These patients will not demonstrate the classic symptoms of CF, which may potentially cause a diagnostic dilemma.

Pathophysiology

CF is caused by mutations or dysfunction in the protein cystic fibrosis transmembrane conductance regulator (CFTR), which normally transports chloride ions across epithelial cell membranes. Gene mutations affect transport of these ions, leading to CF, which is characterized by thick, viscous secretions in the lungs, pancreas, liver, intestine, and reproductive tract as well as increased salt content in sweat gland secretions. The most common mutation is ΔF508; however, researchers have identified more than 1700 mutations of the disease (CFF, 2019a). The numerous mutations of the CFTR gene create multiple variations in the presentation and progression of the disease.

The ability to detect the common mutations of this gene allows for routine screening for CF and the detection of carriers of the disease. Genetic counseling is an important part of health care for couples at risk (see [Chapter 6](#)). People who are heterozygous for CF (i.e., have one defective gene and one normal gene) do not have the disease but can be carriers and pass the defective gene on to their children. If both parents are carriers, their risk of having a child with CF is one in four (25%) with each pregnancy. Any biologic offspring of a patient with CF will have CF. Genetic testing should be offered to adults with a positive family history of CF and to partners of people with CF who are planning a pregnancy or seeking prenatal counseling. The hallmark pathology of CF is bronchial mucus plugging, inflammation, and eventual bronchiectasis. Commonly, the bronchiectasis begins in the upper lobes and progresses to involve all lobes.

Clinical Manifestations

The pulmonary manifestations of CF include a productive cough, wheezing, hyperinflation of the lung fields on chest x-ray, and pulmonary function test results consistent with obstructive disease of the airways. Chronic respiratory inflammation and infection are caused by impaired mucus clearance. Colonization of the airways with pathogenic bacteria usually occurs early in life. *S. aureus* and *H. influenzae* are common organisms during early childhood. As the disease progresses, *P. aeruginosa* is ultimately isolated from the sputum of most patients (Simon, Mallory, & Hoppin, 2019b). Upper respiratory manifestations of the disease include sinusitis and nasal polyps. Pulmonary complications of CF are the primary cause of morbidity and mortality in the United States (Simon, Mallory, & Hoppin, 2019a).

Nonpulmonary manifestations include gastrointestinal problems (e.g., pancreatic insufficiency, recurrent abdominal pain, biliary cirrhosis, vitamin deficiencies, recurrent pancreatitis, weight loss), CF-related diabetes, and genitourinary problems (male and female infertility). (See [Chapter 44](#) for a discussion of pancreatitis.)

Assessment and Diagnostic Findings

The diagnosis of CF requires a clinical picture consistent with the CF phenotype and laboratory evidence of CFTR dysfunction. Key assessment findings in adults include (Katkin, Mallory, & Hoppin, 2019):

- Chronic sinopulmonary disease as manifested by chronic cough and sputum production, persistent infection consistent with typical CF pathogens, and x-ray evidence of bronchiectasis and chronic sinusitis, often with nasal polyps

- Gastrointestinal tract and nutritional abnormalities (pancreatic insufficiency, recurrent pancreatitis, biliary cirrhosis and portal hypertension, CF-related diabetes)
- Male urogenital problems as manifested by congenital bilateral absence of the vas deferens; reduced female fertility

Medical Management

CF requires both acute and chronic therapy. Cornerstones of treatment include multimodal antibiotic regimens, airway clearance measures, bronchodilators, CFTR modulators, nutritional support, and exercise (Simon et al., 2019a). Multimodal antibiotic regimens use different types of antibiotics and routes (oral, inhaled, and IV) to help control, suppress, and treat exacerbation of bacterial infections. Airway clearance measures entail the use of the mucolytics (e.g., dornase alfa; see later discussion), inhaled hypertonic saline, and various pulmonary techniques that promote mucus expectoration.

Because chronic infection (viral and bacterial) of the airways occurs in CF, control of infections is essential to treatment. It is best to prevent viral infections. Administering viral influenza vaccinations is essential for CF patients. Due to the increased risk of viral influenza, some CF patients may benefit from prophylactic treatment with a neuraminidase inhibitor (e.g., zanamivir, oseltamivir) (Simon et al., 2019a).

Bacterial infection requires aggressive therapy to improve airway clearance and the use of antibiotics based on results of sputum cultures. The majority of patients are colonized with *P. aeruginosa*; however, *S. aureus*, methicillin-resistant *Staphylococcus aureus*, and *Burkholderia cepacia* complex are examples of other commonly found pathogens (Simon et al., 2019b).

Chronic infection with *P. aeruginosa* is an independent risk factor for accelerated loss of lung function and decreased survival (Simon et al., 2019b). *P. aeruginosa* is also common in CF exacerbations and new strains may develop with recurring infections leading to different antibiotic-resistance profiles (Simon et al., 2019b). As CF patients are living longer and experiencing more exacerbations, antibiotic resistance is becoming a serious concern and can affect life expectancy.

B. cepacia complex consists of different species of bacteria. Infection with *B. cepacia* complex, in general, is associated with poor outcomes in CF patients as a result of the bacteria's inherent antibiotic resistance. Infection with this complex may prevent a CF patient from becoming a lung transplant candidate (Hachem, 2019).

Routine cultures of respiratory secretions are used to identify organisms and guide antibiotic selection. Two IV antibiotics have been typically prescribed to treat a severe exacerbation of *P. aeruginosa*. Tobramycin, along with piperacillin-tazobactam, a third-generation cephalosporin (e.g., ceftizoxime,

ceftazidime), a carbapenem (e.g., meropenem, aztreonam) may be prescribed (Simon et al., 2019b). Three newer combination medications, ceftazidime and avibactam, meropenem and vaborbactam, and ceftolozane and tazobactam, unite commonly known antibiotics with a beta-lactamase inhibitor to counteract bacterial resistance. Dosing of antibiotics is determined on a case-by-case basis; some patients may require higher doses or an extended IV infusion. When methicillin-resistant *S. aureus* accompanies *P. aeruginosa*, vancomycin is administered in addition to dual IV antibiotic therapy (Simon et al., 2019b). Careful monitoring is always required to minimize any side effects of the antibiotics.

Maintenance oral antibiotic therapies are sometimes employed to help suppress infections caused by other common bacteria such as methicillin-sensitive *S. aureus*. These infections vary across patients and require individualized patient care. The antibiotic regimens used vary depending on the specific organism grown and severity of infection.

Inhaled antibiotics are mainly used to treat *P. aeruginosa*. Tobramycin is the first-line inhaled antibiotic choice but aztreonam can be used as an alternative treatment. Typically, these antibiotics are used on a 28-day on and 28-day off regimen. Patients with deteriorating lung function or recurrent exacerbations may use these antibiotics by rotating courses of inhaled tobramycin and aztreonam without implementing a 28-day off period (Simon, Mallory, & Hoppin, 2019c). Although there is no general consensus on the use of inhaled colistimethate sodium, this drug can be used with patients who do not respond well with the other inhaled antibiotics (Simon et al., 2019c).

Various pulmonary techniques are used to promote airway clearance through the expectoration of secretions. Examples include CPT with manual postural drainage; HFCWO; autogenic drainage (a combination of breathing techniques at different lung volume levels to move the secretions to where they can be huff-coughed out); and other devices that assist in airway clearance, such as masks that generate positive expiratory pressure (PEP masks) and flutter valves (devices that provide an oscillatory expiratory pressure pattern with PEP and assist with expectoration of secretions). It is important to assure that the patient is properly positioned when using the flutter valve and that the patient uses proper technique with this treatment.

Dornase alfa is a nebulized medication given to degrade the large amount of deoxyribonucleic acid (DNA) that accumulates within CF mucus. This agent helps decrease the viscosity of the sputum and promotes expectoration of secretions. It is recommended for patients with moderate to severe disease (severity of lung disease classification is based on predicted FEV₁ percentage). In addition, inhaled hypertonic saline may be used in the chronic treatment of CF. Inhalations increase hydration of the airway surface liquid in patients with CF and improve airway clearance.

Nebulized and IV antibiotics or a combination may be used to treat chronic colonization of the lung. Nebulization provides high intrapulmonary drug concentrations and minimal systemic absorption. Inhaled tobramycin or aztreonam have been shown to decrease the frequency of pulmonary exacerbations. Acute infections are treated with a variety of IV antibiotics. Such infections remain a major cause of mortality related to pulmonary exacerbations in adults with CF.

Other therapeutic measures may be necessary as well. Anti-inflammatory agents may be used to treat inflammatory response in the airways. There is insufficient evidence for the use of routine inhaled or oral corticosteroids (Simon et al., 2019b). IV corticosteroids are used during acute exacerbations and only for those patients with asthmalike symptoms (Simon et al., 2019b). Inhaled bronchodilators (e.g., salmeterol, tiotropium bromide) may be used in patients who have a significant bronchoconstrictive component; this is confirmed by spirometry before and after therapy is instituted (Simon et al., 2019c).

Pancreatic exocrine insufficiency occurs frequently in people with CF and requires oral pancreatic enzyme supplementation with meals (Katkin, Baker, & Baker, 2019). Given the fat malabsorption in CF and increased caloric needs due to the work of breathing, nutritional counseling and weight monitoring are extremely important. Supplements of fat-soluble vitamins A, D, E, and K are also used.

CFTR modulators are a class of drugs that help prevent the progression of CF (Simon et al., 2019c). These agents are novel in that they aim to address the cause of CF as opposed to treating symptoms. There are two classes of modulators used in treating CF: potentiators (help salt and water flow through the CFTR protein channel at the cell surface) and correctors (help the CFTR protein to form the right 3D shape so that it is able to move to the cell surface). The selection of the CFTR modulator depends on the patient's specific CFTR mutation and the patient's age (Simon et al., 2019a).

Ivacaftor, a potentiator, improves salt and water movement across the membrane (thus improving hydration and clearing of mucus from the airways). The drug does not correct the gene mutation; it only helps in the movement of salt and water across the membrane. Monotherapy of ivacaftor is approved for patients with CF who are 6 months of age and older (Simon et al., 2019c).

Although corrector drugs (e.g., lumacaftor, tezacaftor) help the CFTR protein reach the cell surface, they do not diminish CF symptoms because the proteins that do reach the cell surface are unable to improve the flow of salt and water across the cell membrane. This is why lumacaftor and tezacaftor are used in combination with ivacaftor. Combined, these drugs can modestly improve lung function and reduce CF exacerbations (Simon et al., 2019c). Lumacaftor-ivacaftor is approved for patients 2 years of age and older, but is only recommended for treating patients age 2 to 5. Tezacaftor-ivacaftor is the

preferred treatment for patients 6 years of age and older because it produces fewer side effects and drug–drug interactions than lumacaftor-ivacaftor (Simon et al., 2019c).

Currently, a triple combination of tezacaftor-ivacaftor with an additional CFTR corrector is being investigated for treating various CFTR mutations. One such medication, elexacaftor-tezacaftor-ivacaftor, completed phase 3 clinical trials and is being reviewed by the FDA to treat patients with CF age 12 years and older. This drug improves ΔF508 CFTR protein processing, trafficking, and function (Simon et al., 2019c). The goal of these new modulators is to improve the functionality of the CFTR and restore chloride transport at the cellular level, thus decreasing symptoms and complications related to the disease. These positive effects include less viscous mucus production, decreased exacerbation frequency, and improved nutrient absorption.

As the pulmonary deterioration advances, supplemental oxygen is used to treat the progressive hypoxemia that occurs with CF. It helps correct the hypoxemia and may minimize the complications seen with chronic hypoxemia (pulmonary hypertension). Lung transplantation is an option for a small, select population of patients with CF. A double-lung transplantation technique is used because of chronic infection of both lungs in end-stage CF. Because there is a long waiting list for lung transplants, many patients die while waiting for suitable lungs for transplantation.

Nursing Management

Nursing management is crucial to the interdisciplinary approach required for care of adults with CF. Nursing care includes helping patients manage pulmonary symptoms and prevent complications. Specific measures include strategies that promote removal of pulmonary secretions, CPT (including postural drainage, chest percussion, and vibration), and breathing exercises (which are implemented and taught to the patient and family when the patient is very young). The patient is reminded of the need to reduce risk factors associated with respiratory infections (e.g., exposure to crowds or to people with known infections). In addition, the patient is taught the early signs and symptoms of respiratory infection and disease progression that indicate the need to notify a primary provider.

The nurse emphasizes the importance of an adequate fluid and dietary intake to promote removal of secretions and to ensure an adequate nutritional status. Because CF is a lifelong disorder, patients often have learned to modify their daily activities to accommodate their symptoms and treatment modalities. As the disease progresses, periodic reassessment of the home environment may be warranted to identify modifications required to address changes in the patient's needs, increasing dyspnea and fatigue, and nonpulmonary symptoms.

As with any chronic disease, palliative care and end-of-life issues and concerns need to be addressed with the patient when warranted. For the patient whose disease is progressing and who is developing increasing hypoxemia, preferences for end-of-life care should be discussed, documented, and honored (see [Chapter 13](#)). Patients and family members require support as they face a shortened lifespan and an uncertain future (Tomaszek, Debska, Cepuch, et al., 2019).

CRITICAL THINKING EXERCISES

1 ipc A 55-year-old man presented to the ED with complaints of acute shortness of breath and difficulty breathing. SpO₂ on admission to the ED was 85% on room air. His admitting diagnosis was acute exacerbation of COPD. He was admitted to a general medicine unit, and arrived to his room on 4 L of O₂ via nasal cannula. During his admission assessment, the patient tells you that he works in the coal mines and his shift supervisor had to bring him to the hospital. He also states that he has a long history of smoking 1 to 2 packs of cigarettes per day and his attempts to quit have been unsuccessful. While conducting the assessment, you note that the patient has a productive cough and is becoming confused to time. What is your priority as you admit this patient? What information would you provide the primary provider? What tests might be ordered to help further evaluate the patient's condition? What information would you need to ask the patient to plan for a home discharge? What health care team members would you consult to plan for a home discharge?

2 pq A 20-year-old male with a history of asthma presents to the ED with severe shortness of breath and dyspnea at rest. He said he had a cold last week and was coughing up clear sputum. This morning he began expectorating yellow sputum and became increasingly short of breath. He used his rescue inhaler with little relief. Before he came to the ED, he used his rescue inhaler every half hour. Upon presentation to ED triage, his SpO₂ was 90% on room air, but is now 84% on room air. Physical examination reveals tachycardia at 136 bpm, cyanotic lips, and tachypnea at 30 breaths/min with signs of accessory muscle use. When asked about his asthma medications, he admits he only uses his prescribed daily inhaler once a day because it is too expensive. He also stated his primary provider gave him a breathing machine for medicine but he did not know how to use it. What is your priority of care? What evidence-based medical and nursing interventions would improve the patient's respiratory status? What educational needs does this patient have?

3 ebp A 25-year-old woman is hospitalized for CF. She was admitted for elevated temperature and weight loss. At the time of admission, she was not using oxygen therapy at home. She was working full-time in a department store prior to this exacerbation. She told the social worker yesterday that she is afraid she will have to quit her job and will lose her health insurance. Her husband, who is unemployed, is also dependent on her for health insurance. Today, she is unable to eat due to the severe dyspnea. Physical assessment reveals SpO₂ of 87% on 2 L of O₂ via nasal cannula, bilateral crackles with severely diminished breath sounds on the right, and expectoration of thick yellow sputum. What evidence-based

interventions might be used to alleviate her CF symptoms? Identify the criteria used to evaluate the strength of the evidence for these practices.

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Resources

- Agency for Healthcare Research and Quality (AHRQ), www.ahrq.gov
- Alpha-1 Foundation, www.alpha1.org
- American Academy of Allergy, Asthma & Immunology (AAAAI), www.aaaai.org
- American Association for Respiratory Care (AARC), www.aarc.org
- American Association of Cardiovascular and Pulmonary Rehabilitation (AACVPR), www.aacvpr.org
- American Cancer Society, www.cancer.org
- American College of Chest Physicians (ACCP), www.chestnet.org
- American Lung Association, www.lung.org
- American Thoracic Society (ATS), www.thoracic.org
- Centers for Disease Control and Prevention (CDC), www.cdc.gov
- COPD Foundation, www.copdfoundation.org
- Cystic Fibrosis Foundation, www.cff.org
- National Heart, Lung, and Blood Institute (NHLBI), www.nhlbi.nih.gov
- SmokEnders, www.smokenders.org
- U.S. Department of Health & Human Services (HHS), www.hhs.gov or healthfinder.gov