

Pathophysiology: The Respiratory System

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Faculty

Jane C. Norman, RN, MSN, CNE, PhD, received her undergraduate education at the University of Tennessee, Knoxville campus. There she completed a double major in Sociology and English. She completed an Associate of Science in Nursing at the University of Tennessee, Nashville campus and began her nursing career at Vanderbilt University Medical Center. Jane received her Masters in Medical-Surgical Nursing from Vanderbilt University. In 1978, she took her first faculty position and served as program director for an associate degree program. In 1982, she received her PhD in Higher Education Administration from Peabody College of Vanderbilt University. In 1988, Dr. Norman took a position at Tennessee State University. There she has achieved tenure and full professor status. She is a member of Sigma Theta Tau National Nursing Honors Society. In 2005, she began her current position as Director of the Masters of Science in Nursing Program.

Faculty Disclosure

Contributing faculty, Jane C. Norman, RN, MSN, CNE, PhD, has disclosed no relevant financial relationship with any product manufacturer or service provider mentioned.

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The division planner and director have disclosed no relevant financial relationship with any product manufacturer or service provider mentioned.

Audience

This course is designed for nurses working in critical care and general and specialty medical-surgical units in which patients with multiple organ system problems are found.

Accreditations & Approvals



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Course Objective

As health care becomes more complex, it is essential that the theoretical concepts of the basis of illness (pathophysiology) be well understood. The purpose of this course is to reinforce the scientific rationales for the interventions nurses perform and the decisions nurses make as patients move through the ever-changing struggle with their respiratory illness.

Learning Objectives

Upon completion of this course, you should be able to:

1. Identify the key structures and functional inter-relationships in the respiratory system.
2. Describe the components and functions of pulmonary circulation.
3. Discuss the pathophysiologic and environmental influences and effects on the respiratory system.
4. Outline the role of subjective data in completing a full nursing assessment of the respiratory system.
5. Describe objective data compiled during a nursing assessment of the respiratory system.
6. Identify diagnostic tests used in the identification and classification of respiratory diseases.
7. Outline the nursing diagnoses, planning, and management of conditions related to respiratory dysfunction.
8. Discuss clinical manifestations of infectious diseases of the upper respiratory system.
9. Review signs and symptoms of upper respiratory neoplasms and related nursing actions.
10. Describe the common causes, appearances, and treatment of traumatic disorders of the upper respiratory disorders.
11. Analyze the presentation and nursing management of occupational lung diseases.
12. Evaluate pathologic causes and manifestations of disorders of the lower respiratory tract.
13. Discuss the pathophysiology and clinical manifestations of traumatic respiratory disorders.
14. Outline the concepts and information the nurse should provide for the patient during the health teaching and discharge planning process after respiratory surgery.
15. Describe key concepts related to caring for patients who receive thoracic surgery.



Sections marked with this symbol include evidence-based practice recommendations. The level of evidence and/or strength of recommendation, as provided by the evidence-based source, are also included so you may determine the validity or relevance of the information. These sections may be used in conjunction with the course material for better application to your daily practice.

INTRODUCTION

Respiratory diseases are among the most common long-term conditions affecting patients in the United States, and the identification, assessment, diagnosis, and treatment of most respiratory diseases is an essential component of patient care. Socioeconomics, ethnicity, age, and gender have a significant effect on both the development of respiratory disease and its outcome. In addition, the impact of respiratory disease on patients, families, health services, and society is significant. When caring for patients with respiratory illness, there are key nursing skills involved in interpreting diagnostic testing, identifying comorbidities, and effectively managing care.

Respiratory disease affects patients of all ages. It also brings specific challenges in the diagnosis and treatment of various groups including children, some occupational and ethnic groups, those with social and mental health conditions, and those nearing the end of life. This course is designed to broaden the nurse's understanding of the pathophysiology of respiratory illness by exploring causes, alterations and physiologic adaptations, manifestations, and resolution of disease states. Pathophysiologic symptoms and signs are described in relation to the patient's clinical presentation, so the nurse can monitor physical changes and relate them directly to the illness process. Appropriate diagnostic tests and treatments for each problem are included, along with the nurse's responsibilities for patient teaching.

THE RESPIRATORY SYSTEM IN HEALTH AND ILLNESS: STRUCTURAL AND FUNCTIONAL INTER-RELATIONSHIPS

Every cell in the body requires oxygen to carry out its metabolic functions. Likewise, every cell in the body must rid itself of carbon dioxide (CO₂), a waste product of cellular metabolism. The process of transporting oxygen to the cells and removing CO₂ is called respiration. Any disease or trauma that interferes with respiration injures body cells. The body can survive without food for weeks and without water for days; without oxygen, it dies within minutes.

Respiration involves two major body systems: the cardiovascular system and the respiratory system, both regulated by the nervous system. Oxygen and CO₂ are conveyed to and from tissues and organs by the cardiovascular system. The respiratory system delivers oxygen from the atmosphere to the bloodstream and delivers CO₂ from the blood to the atmosphere. This gas exchange takes place in specialized structures of the lungs.

Although the respiratory airways and the anatomic structures where gas exchange takes place are continuous, their components are classified anatomically and functionally as belonging to either the upper or lower respiratory tracts. The muscles of the chest wall and diaphragm also participate in respiration.

THE UPPER RESPIRATORY TRACT

The upper respiratory tract is primarily an air delivery system. It warms, moistens, and filters inspired atmospheric air on its way to the lungs. Structures of the upper respiratory tract also expel foreign matter and excess secretions from the system. The principal structures of the upper respiratory tract are the nose, the paranasal sinuses, the pharynx, and the larynx.

The Nose

Air enters the system first through the nares or nostrils into the nasal fossae. The nasal septum separates the two fossae. The nose is composed of both bone and cartilage, and its interior surface has ridges called turbinates. The ridged configuration increases the effective surface of the nasal mucosa. An extensive bed of capillaries transfers body heat to the inspired air. Because of this rich vascularity, bleeding from injured nasal tissue can be profuse.

Mucus secreted by the membrane that lines the nose helps humidify inspired air, which attains a relative humidity of more than 90% as it passes through the nares. Hairs that line the nose filter out large foreign particles, and a sticky mucus secreted by the serous glands in the mucosa traps finer dirt, dust, and micro-organisms. Hairlike structures of the mucous membrane called cilia constantly propel trapped particles toward the pharynx, from which they can be expelled by sneezing or coughing [1; 2].

In addition to its respiratory functions, the nose is the organ of olfaction. Sensory receptors sensitive to various odors are concentrated in the roof of the nasal fossae. Along with the paranasal sinuses, the nose functions as a resonance chamber for phonation; if the mucosa of these structures becomes edematous or clogged with secretions, a flat, non-resonant sound occurs [2].

The Paranasal Sinuses

The paranasal sinuses are air-filled cavities within bony structures adjacent to the nasal cavity. These sinuses—the ethmoid, frontal, sphenoid, and maxillary sinuses—drain through the nasal cavity. All are lined with ciliated columnar epithelium that is continuous with the lining of the nose. Because the mucosa is continuous, infection in the nasal passages can readily spread to the sinuses.

The paranasal sinuses have a variety of functions, including lightening the weight of the head, humidifying and heating inhaled air, increasing the resonance of speech, and serving as an insulate to help protect vital structures in the event of facial trauma [3; 4]. Like all structures of the upper respiratory tract, the sinuses can trap foreign matter and, by ciliary movement, expel it [5].

The Pharynx

The pharynx begins at the base of the skull and ends opposite the lowest cartilaginous rings of the larynx. Its three sections, from superior to inferior, are the nasopharynx, the oropharynx, and the laryngopharynx. The nasopharynx contains the adenoids (paired lymphatic structures) and the Eustachian tubes, which maintain appropriate air pressure within the middle ear. Functional Eustachian tubes are essential for hearing and crucial to the mechanism by which the body maintains balance.

Air and food both enter the body through the oropharynx. The palatine tonsils, which are composed of lymphatic tissue, are located in the oropharynx. The laryngopharynx contains the lingual tonsils and the epiglottis, a small flap of tissue that covers the larynx during swallowing to prevent food or liquid from being aspirated into the lower airway [6; 7].

The lining of the pharynx, like the lining of the structures that precede it, consists of mucous membrane that traps foreign particles and humidifies and warms the inspired air. The lymphatic tissue of the tonsils also traps micro-organisms and disposes of them by phagocytes before they can continue further in the respiratory tract, another line of defense against infection [7].

THE LOWER RESPIRATORY TRACT

The lower respiratory tract consists of the trachea, the bronchi and their branches, and the various structures of the lungs, which are protected by the chest wall. The structures of the trachea and bronchi are best visualized as an inverted tree. The tracheobronchial tree is composed of a main “trunk” (the trachea) that bifurcates into two major branches (the right and left primary bronchi). These divide in turn into secondary and then tertiary bronchi, which branch again and again into “twigs” (the bronchioles). At the tiny outermost tips of the “twigs” are the respiratory bronchioles, from which air passes through alveolar ducts into the alveoli, the “leaves” where gas exchange actually takes place [6; 8].

The Trachea

The air passage of the trachea, or windpipe, is kept open by C-shaped cartilaginous rings in the tracheal wall. The mucus-bathed ciliary epithelium that lines the trachea sweeps foreign material up into the pharynx, where the cough reflex expels it. The trachea, like the upper respiratory passages, warms and humidifies inspired air.

The Bronchi and Bronchioles

The left primary bronchus exits from the trachea at a more acute angle than the right bronchus. Because of the obtuse angle, foreign material is more often aspirated into the right lung than the left. The cellular structure of the bronchial lining at this point is similar to that of the trachea.

The bronchi contain sensory receptors of the parasympathetic and sympathetic nervous systems. If these nerve endings are stimulated (for example, by an allergen), impulses transmitted to the respiratory centers of the brain by cranial nerves initiate constriction of the bronchi, the secretion of mucus, and/or the cough reflex.

The right primary bronchus divides into three secondary bronchi that supply the three lobes (superior, middle, and inferior) of the right lung. The left bronchus bifurcates, each segment going to one of the two lobes of the left lung.

The primary bronchi, like the trachea, are supported by partial rings of cartilage. As the airways become narrower, the proportion of smooth muscle to cartilage increases and the number of serous glands lining the bronchiolar walls decreases. At approximately the point where a bronchiole narrows to 1 mm in diameter, the walls are entirely surrounded by smooth muscle. Thus, when the muscles of the bronchioles spasm, as in an asthma attack, the lack of cartilaginous support causes air passages to collapse and breathing becomes extremely difficult.

The terminal bronchioles mark the end of the air conduction system and open into the respiratory bronchioles. Each of these in turn branches into several alveolar ducts, which open into grapelike clusters of air-filled sacs called alveoli. The respiratory bronchioles, alveolar ducts, and alveoli form the terminal respiratory units of the lungs, called acini [6].

The Lungs

The lungs are paired structures that lie in the thoracic cavity on either side of the mediastinum. The bases of the lungs rest on the diaphragm. As noted, the right lung has three lobes; the left has two. The lobes are further subdivided into smaller bronchopulmonary segments. This segmental structure makes it possible to remove a relatively small portion of the lung if surgical resection is necessary [9].

The lungs lie free within the pleural cavities of the thorax, except at the hilus on the medial surface. The bronchi and blood vessels enter and exit through the hilus, and the sternum forms the anterior border of the thorax. The lateral boundaries of the thorax are composed of the twelve ribs, or costae, which are attached to the sternum by the costal cartilages anteriorly and the vertebral column posteriorly. This bony thoracic cage protects the vital structures within the mediastinum and the fragile, spongy tissue of the lungs. The ability of the lungs to stretch to accommodate increases in volume is termed compliance [9].

The diaphragm is an important muscle of respiration and separates the thorax from the abdominal cavity. Each half of the diaphragm is innervated by a phrenic nerve. An injury to one of the phrenic nerves results in a unilateral diaphragmatic paralysis with elevation of half of the diaphragm [10; 11].

The Pleura

The visceral pleura covering the lungs is continuous with the parietal pleura, which lines the thoracic cavity. Both pleurae are formed of serous membrane that secretes pleural fluid into the extremely narrow pleural cavity between the two layers. This fluid lubricates the two layers, reducing friction as the lungs and thorax move during respiration. The pleural fluid also couples the parietal and visceral pleurae and the structures to which they are attached [9]. Inflammation of the pleural membrane (pleurisy) causes the membrane to become dry and fibrous. The ensuing friction makes breathing painful.

Intrapleural Pressure

Because of changes that occur when breathing begins after birth, air pressure within the pleural cavity (intrapleural pressure) is lower than air pressure within the lungs (intrapulmonary pressure). This lower pressure keeps the lung expanded because of its tendency to be drawn toward the area of subatmospheric pressure. If the lung or chest wall is punctured, air rushes into the area of lower pressure—the pleural space—destroying the vacuum that keeps the lung expanded. In severe injury, the amount of air entering the intrapleural space may be sufficient to cause equalization of intrapleural pressure and atmospheric pressure. The result is collapse of the lung on the affected side [6; 11].

THE PULMONARY CIRCULATION

The lungs have a dual blood supply: the tracheobronchial circulation and the pulmonary circulation. The right and left bronchial arteries branch from the descending aorta and supply blood to the trachea and bronchi to the level of the respiratory bronchioles. The terminal respiratory units of the lungs are nourished via the pulmonary circulation.

The pulmonary circulation is where oxygenation of blood occurs. The entire output of the right ventricle leaves the heart via the pulmonary artery, which divides into the right and left pulmonary arteries. This poorly oxygenated blood circulates through the capillaries of the alveoli, where gas exchange takes place. Oxygenated blood is then returned to the left atrium via the pulmonary veins [6; 11].

The Alveoli and Gas Exchange

Each terminal bronchiole supplies its own unit of several alveoli, called the acinus. Essentially, each alveolus is a tiny air space enclosed by a thin wall (the alveolar septum) that consists of a network of pulmonary capillaries held together by connective-tissue fibers and lined with squamous epithelium that contains secretory cells. The tissue of an adult lung contains more than 300 million alveoli [12].

The secretory glands of the alveolar wall produce pulmonary surfactant, which reduces the surface tension of the pleural fluid. If surface tension were to pull alveolar walls together, expansion of the lungs during inspiration would be hindered, and the alveoli would tend to collapse during expiration. Pulmonary surfactant also contains macrophages that destroy foreign material that has passed through the upper-airway defenses [13; 14].

Within the alveoli, air is separated from blood by the respiratory membrane, which is formed by the basement membrane of the alveolar and capillary epithelia. This membrane is less than 1-mm thick, and gases move across it in accordance with the principle of diffusion. Dyspnea is a symptom of an increasing capillary wedge pressure [12].

The venous blood returning from the tissues is high in CO₂ and low in oxygen; the air in the alveolar space is higher in oxygen and lower in CO₂ than the blood. Under normal conditions, the approximate partial pressures of oxygen in the alveoli and the capillaries are 105 mm Hg and 40 mm Hg, respectively. The partial pressure of CO₂ is 45 mm Hg in the capillaries and 35 mm Hg in the alveoli.

In essence, gas exchange depends on adequate flow of blood (perfusion) and adequate flow of air (ventilation) to and from alveoli [9]. For efficient gas exchange, a large number of capillaries must be in contact with the inspired air. The many-sectioned structure of lung tissue normally provides maximum capillary surface. If alveolar septa are destroyed by a disease process, however, and alveoli coalesce, the surface available for diffusion is reduced. In addition, if the alveolar membrane becomes fibrous and thickened by scarring, diffusion will be impeded.

Pulmonary blood flow must also be normal for efficient gas exchange. If an embolus obstructs blood flow to a portion of the lung, gas exchange will be impaired. In addition, alveoli must be in normal condition. If alveoli are filled with inflammatory exudates from infection, air cannot reach the respiratory membrane.

THE PROCESS OF VENTILATION

Ventilation is the exchange of air between the atmosphere and the alveoli. At rest and at sea level, intrapulmonary pressure and atmospheric pressure are equal—760 mm Hg. During inspiration, the muscles of the diaphragm and the intercostal muscles contract, lowering the diaphragm and raising the rib cage. The volume of the intrathoracic space expands and intrapleural and intrapulmonary pressures decrease, until the intrapulmonary pressure is lower than atmospheric pressure. Air moves along the concentration gradient (from higher concentration to lower) into the upper respiratory tract, through the tracheobronchial tree, and

into the alveolar tissue of the lungs. Air moves into the lungs until intrapulmonary pressure and atmospheric pressure are equal.

Neuronal receptors sensitive to stretch respond to the expansion of the thoracic cage, stimulating a rebound action of the muscles and connective-tissue fibers of the lungs. The ribs become more vertical and the diaphragm rises, causing intrapulmonary pressure to rise above atmospheric pressure. Air moves passively out of the lungs along the reversed concentration gradients, carrying out CO₂ (and other waste gases) that have been exchanged for oxygen from the inspired air. This expiration continues until the intrapulmonary pressure is again lower than atmospheric pressure, and the cycle begins again [15].

During normal inspiration, most of the work is accomplished by the diaphragm, with some participation by the intercostal muscles. Movement of the rib cage may be barely perceptible during quiet respiration, as during sleep. As exertion increases, oxygen demand increases proportionately, and the intercostal muscles are called upon to an increasing extent. During forced or labored respiration, additional chest muscles and even abdominal muscles are employed in moving the thoracic cage [15].

MECHANISMS OF RESPIRATORY CONTROL

The rate and extent of inspiration and expiration are governed by nervous pathways that respond to various stimuli that signal increased or diminished oxygen requirements or CO₂ levels. Requirements are greater during exertion and least during sleep. Like other mechanisms vital to survival, respiration proceeds without conscious control [1; 2].

Cerebral control of the respiratory mechanisms is believed to be centered in the pons and the medulla oblongata, both located in the brain stem. The apneustic and pneumotaxic centers of the pons apparently control and modify the activities of the medulla center through stimulation and inhibition, respectively. The cerebral centers receive impulses

from a wide array of nerve endings, some sensitive to chemical stimuli and some to mechanical stimuli. Certain chemicals that accumulate in muscle tissue during exertion initiate impulse sequences that increase the respiration rate. If circulating CO₂ increases, hydrogen ions increase and pH decreases; these chemical changes stimulate neurologic pathways that ultimately effect increases in both the rate and depth of ventilation. Fear or anxiety initiate response mechanisms that increase both heart rate and respirations to prepare the body for “fight or flight.” Chemoreceptors in the aortic arch and the bifurcation of the internal and external carotid arteries detect changes in oxygen content of the blood and send impulses via neuronal networks to the respiratory centers to increase the ventilation rate as required [2].

Clearly, then, there are many prerequisites for normal respiration. The muscles of respiration must be capable of normal movement, and the chest wall must be mobile. The neurologic pathways and centers affecting respiration must be intact and functional. Any number of alterations in the internal or external environment may adversely affect respiratory functions [2].

THE COUGH REFLEX

The cough reflex is initiated when a foreign substance (e.g., a dust particle) irritates specialized nerve endings within the larynx, trachea, or major bronchi. Nerve impulses are sent to contract muscles that close the vocal cords and simultaneously contract abdominal muscle and muscle fibers within the respiratory tract itself. Air pressure builds up in the lower airways, and when the vocal cords reopen, a sudden rush of air carries mucus and foreign matter up to be expectorated. Because the vocal cords are crucial to the cough reflex, persons whose larynxes have been removed cannot cough and thus are deprived of an important defense against airway obstruction.

PATHOPHYSIOLOGIC INFLUENCES AND EFFECTS

The basic abnormalities of oxygen-CO₂ exchange are hypoventilation, diffusion impairment, and ventilation-perfusion inequality, including shunt.

HYPOVENTILATION

Ventilation below the level needed to maintain normal arterial CO₂ tension is called hypoventilation. If a patient is hypoventilating, arterial blood levels of CO₂ will be above normal (hypercapnia or hypercarbia), because alveolar ventilation is not keeping pace with body metabolism. As arterial CO₂ rises, the partial pressure of arterial oxygen (PO₂) falls; this condition is called hypoxemia. Although hypercapnia is caused only by hypoventilation, hypoxemia may be caused by several other conditions as well [5].

Hypoventilation is related to many conditions; airway obstruction is one of the most common. The upper airway, especially the pharynx and larynx, may be obstructed by inflamed, edematous mucosal linings or by hypertrophic tonsils or adenoids. Alternatively, polyps, tumors, or foreign bodies may partially block the airway. Impairment of the lower respiratory tract or the alveoli can have even more serious effects. Retained secretions, mucosal edema, and bronchospasm can narrow or collapse some or all of the airways. Obstructive diseases such as emphysema cause hypoventilation because they impair air flow [5].

Functional alterations in the central nervous system, as well as neuromuscular or skeletal abnormalities, can also play a part in hypoventilation. Hypoventilation may also occur as a consequence of immobility or inappropriate positioning for extended periods.

DIFFUSION IMPAIRMENT

As discussed, oxygen and CO₂ molecules are transported between the alveolar air spaces and the capillary beds of the alveolar septum by diffusion. The effectiveness of the diffusion process is influenced by the condition of the alveolar and capillary epithelia, the interstitial fluid, and the erythrocyte membrane, as well as by the secretion of pulmonary surfactant. However, there is a wide margin of safety. Because blood in the alveolar capillaries can reach the gas tension levels prevalent in the alveolar space, approximately one-third of the time it remains there. Diffusion can be reduced for some time before abnormalities become apparent [15; 16].

Significant diffusion abnormalities can interfere with the passage of inspired oxygen from the alveoli into the blood. Because CO₂ diffuses readily, the partial pressure of CO₂ is generally unaffected by diffusion impairment. Hypoxemia may lead to hyperventilation, however, and this, rather than diffusion impairment itself, may lower partial pressure of CO₂ (PCO₂) [15; 16].

Any condition that thickens the alveolar septum can impair diffusion. For example, metastatic carcinoma may invade the interstitial spaces. Pulmonary edema hampers oxygen diffusion because of the increased amount of fluid in the alveoli and the interstitial spaces. If the amount of functioning lung tissue is reduced because of emphysema, pneumonectomy, or tumor growth, diffusion will also be impaired [17].

In the early stages of diffusion impairment, hypoxemia may occur only during exertion. As the condition progresses, hypoxemia and related symptoms (e.g., dyspnea, restlessness, tachycardia) may occur even when the patient is resting.

VENTILATION-PERFUSION ABNORMALITIES

Efficient exchange of CO₂ for oxygen requires equality of alveolar ventilation and perfusion. Slight imbalances occur in healthy individuals, but excessive ventilation-perfusion imbalances are the most common causes of hypoxemia. Such abnormalities may be classified as [18]:

- Normal ventilation to no perfusion
- No ventilation to normal perfusion
- No ventilation to no perfusion

Normal Ventilation to No Perfusion (Dead Space Unit)

Without perfusion, gas exchange cannot take place. This condition is called wasted ventilation, because ventilation of the alveoli brings about no exchange of CO₂ for oxygen. Conditions related to wasted ventilation include a decrease in total blood volume (in hemorrhage or dehydration), pulmonary embolism, and chronic obstructive pulmonary disease (COPD). Emphysema may also destroy both alveoli and capillaries within portions of the lungs, so neither ventilation nor perfusion can take place. If large areas of the lungs are affected by wasted ventilation, hypoxemia and hypercapnia with related respiratory acidosis can occur [18].

No Ventilation to Normal Perfusion (Shunt Unit)

In shunting, the alveolus is perfused but not ventilated (wasted perfusion). Any pathologic condition that obstructs the alveoli can lead to a low ventilation-to-perfusion ratio. For example, a patient who is in pain from upper abdominal surgery may take shallow breaths, resulting in atelectasis. Then unoxygenated blood from the collapsed area mixes with oxygenated blood from the unaffected areas, lowering the level of oxygen in the arterial blood. In addition, insufficient CO₂ is eliminated. Arterial hypoxemia occurs, but hypercapnia may not occur unless the lungs are severely compromised [18].

No Ventilation to No Perfusion (Silent Unit)

Conditions leading to diminished or absent ventilation of some alveolar units include pneumonia, atelectasis, pulmonary edema, and COPD. Conditions leading to diminished or absent perfusion of some alveolar units include compression of intrathoracic blood vessels by a neoplasm; occlusion of blood vessel by emboli or thrombi; and collapse of blood vessels because of decreased perfusion pressure, shock, or hypotension. The severity of patient symptoms depends on the extent of alveolar units involved [18].

RELATED SYSTEM INFLUENCES AND EFFECTS

In addition to abnormalities of the lungs and upper respiratory structures, physiologic processes involving other body systems can adversely affect respiratory functions. Conversely, because oxygen is a primary need of every body cell, dysfunction of the respiratory systems can have extensive repercussions in any body system. The two body systems closely related to respiratory function are the neurologic and cardiovascular systems [19].

NEUROLOGIC SYSTEM

The neurologic system regulates normal ventilation, and the cerebral cortex can consciously control respiration. As such, drugs or disease processes affecting the nervous system will inevitably affect respiration to some extent. Anesthetic agents are a major example of drugs having respiratory side effects. Infections, tumors, diseases of the peripheral nervous system (e.g., Guillain-Barré syndrome), and neuromuscular diseases (e.g., myasthenia gravis) may also affect respiration in various ways. The respiratory system may respond to these influences by hyperventilation, hypoventilation, a combination of the two (Cheyne-Stokes

respiration), or apnea. If the brain or spinal cord is damaged, respiratory function may be greatly impaired or even totally destroyed, depending on the location and severity of the damage [19; 20].

CARDIOVASCULAR SYSTEM

The heart not only moves blood to the pulmonary arteries for exchange of oxygen and CO₂ but also supplies oxygenated blood to the lung tissue itself. Consequently, functional alterations in the cardiovascular system affect respiratory function as well.

If severe hemorrhage depletes the volume of circulating blood, the supply of oxygen and nutrients for the airways and terminal respiratory units will also be diminished. The oxygen and nutrient deficit will be greater in pulmonary tissue because, even under normal conditions, pressure in the pulmonary circulation is lower than pressure in the systematic circulation. As the lungs are adjacent to the heart, little pressure is normally required for pumping blood to them [19].

Failure of the right side of the heart related to certain disease states may affect the volume of pulmonary blood circulation. Conversely, certain disorders of the respiratory system are closely related to right-sided heart failure. Left-sided heart failure also affects pulmonary function as a result of a backup of blood in the pulmonary vasculature and related pulmonary edema. If the volume of blood circulating either to or from the lungs is compromised for any reason, oxygen, CO₂, and acid-base abnormalities may occur [19; 21].

Oxygen obtained during gas exchange in the pulmonary circulation must combine with hemoglobin to be transported to the tissues. Normally, the circulation contains approximately 15 g of hemoglobin to carry about 20 mL of oxygen at any given time. If the hemoglobin concentration is less than normal (i.e., anemia), the capacity of the blood to transport oxygen will be reduced [18; 22].

OTHER RELATED SYSTEMS

Diseases and deformities of the skeletal system can also alter respiratory functioning, generally by restricting movement of the thoracic cage (e.g., scoliosis). Problems in the gastrointestinal tract (e.g., hiatal hernia) can interfere with lung expansion. Extreme obesity can restrict movement of the thoracic cage and place an abnormal load on the respiratory system by increasing the exertion required for ordinary activities [19].

Surgery of the gastrointestinal tract, especially procedures such as cholecystectomy that have a high abdominal incision, can be associated with pulmonary complications in the postoperative period. Pain at the surgical site inhibits adequate deep breathing and coughing, resulting in inadequate expansion of the lungs. Atelectasis or pneumonia can be the consequence [19].

PSYCHOSOCIAL/LIFESTYLE INFLUENCES AND EFFECTS

Long-term impairment of respiratory function has serious effects on patients and their families. An acute respiratory infection or chest injury can severely incapacitate an individual, but after the infection is controlled or the injury healed, the patient can usually resume daily activities. Cancer of the respiratory system, on the other hand, is a progressive disease, often with a poor prognosis. Chronic disabling respiratory disorders of long duration, such as COPD, also have far-reaching psychosocial effects. These long-term disabilities have become more prevalent as the U.S. population has aged and as once-deadly acute infectious diseases have become more easily managed. Similarly, attention to environmental hazards that can lead to long-term pathologic changes in the respiratory system, such as smoking, has increased.

SMOKING

More than 480,000 Americans die prematurely each year from disorders related to smoking; millions of others lead restricted lives because of pulmonary damage and cardiovascular impairment [23]. The chemical agents in tobacco smoke reduce and eventually destroy ciliary movement in the bronchial mucosa, making the lungs more susceptible to infection. The hot smoke dries and inflames the delicate tissues of the mouth, larynx, trachea, and lungs. Carbon monoxide in cigarette smoke combines with hemoglobin more readily than oxygen; this competition reduces the amount of oxygen available to body tissues. Nicotine is a vasoconstrictor, and vasoconstriction also reduces oxygen supply. Sensors in the blood and the tissues thus signal the heart to beat faster to make up the deficit. Perhaps most well known, tar in cigarette smoke cause cancerous lesions in the lungs [24].

ENVIRONMENTAL ALLERGENS AND POLLUTION

Airborne allergens can cause or aggravate respiratory disease. The most common respiratory disease associated with allergens is extrinsic asthma, which can affect children and adults. Such well-known and widespread environmental allergens as ragweed pollen and animal dander are related to allergic rhinitis [25].

Pollution of the air by industrial and agricultural chemicals can increase the severity of numerous respiratory conditions, including long-term obstructive disorders. Individuals who have such conditions may have to change their residence or stay indoors when pollution levels are high. Although increasing public awareness of pollution hazards has stimulated efforts by government and industry to reduce the quantity of pollutants released into the air, new technology is needed and much remains to be done [25].

OCCUPATIONAL AND ECONOMIC FACTORS

Occupation is a significant factor in the development of some respiratory disorders. “Black lung disease,” which affects coal miners, is a well-publicized example; asbestosis is another. Solvents in paints and varnishes have also been implicated in respiratory disorders, not only among factory workers and professional painters, but among hobbyists as well. A timely question about recent craft or hobby projects can yield a valuable diagnostic clue about respiratory ailments. Clerks in dry cleaning establishments and beauticians exposed to permanent wave solutions (ammonia) and hair dyes may also develop respiratory abnormalities [25].

Existing respiratory problems can be made worse by exposure to chemical pollutants at work. The trend toward tightly insulated buildings to conserve energy has raised concerns about chemical pollution in office environments that formerly were relatively hazard free. By being alert to occupational information in the patient’s history, the nurse can help identify individuals at risk and can counsel patients with respiratory disorders about possible hazards in their working environments [25].

SOCIAL FACTORS

A disease that affects an activity as fundamental as breathing necessarily influences all aspects of the patient’s life, from intimate relationships to casual social contacts. Fear, anxiety, and anger related to symptoms and restrictions of activity place added burdens on an already compromised respiratory system and on personal relationships. Tensions rise, and depression is common.

If work activities are restricted, an individual may see his/her position and value in his/her family and community as being threatened or destroyed. When sports or hobbies are abandoned because they require more energy than the damaged respiratory system can supply, the social relationships accompanying these activities are also lost [25].

NURSING ASSESSMENT: ESTABLISHING THE DATA BASE

SUBJECTIVE DATA

Patients with disorders of the upper and lower airway may describe a variety of symptoms. These symptoms vary primarily with the location and severity of the disorder.

Principle Symptoms

Airway Problems

A common symptom in patients with respiratory disorders is difficult breathing, or dyspnea. Dyspnea is more often caused by disorders of the lower respiratory tract, such as COPD and carcinoma of the lung, than of the upper respiratory tract. However, occlusion of the upper airway by inflammation or obstruction by a foreign body or tumor may also result in dyspnea. Metabolic acidosis causes deep and labored breathing (Kussmaul breathing). Patients should be asked whether they are short of breath during rest or exertion and what factors aggravate and alleviate the symptoms, if present.

Another common symptom of respiratory disorders is a cough. Cough can result from irritation or from retained secretions that obstruct part of the airway. Causative disorders in the upper airway include sinusitis (leading to postnasal drip) and infections of the pharynx; causative disorders in the lower respiratory tract include bronchitis, bronchiectasis, and pneumonia. The patient should be asked whether the cough is productive or nonproductive. If the cough is productive, ask about the color, amount, odor, and consistency of the sputum. Inquire also about precipitating factors and the frequency of the cough.

Bronchospasm, retained secretions, edema, and obstruction by foreign objects can result in complaints of wheezing. This may be the chief concern of patients with asthma or allergic rhinitis. The patient should be questioned about the frequency of wheezing and any precipitating factors [26].

Chest Pain

Patients with respiratory dysfunction often describe sensations of pain and tenderness. Discomfort in the upper airway can result from an infection such as rhinitis, sinusitis, or pharyngitis. Trauma to the head and neck area can also cause pain in the upper respiratory tract. Although chest pain is not uncommon for patients with respiratory dysfunction, it can also result from cardiovascular, gastrointestinal, hepatic-biliary, genitourinary, and musculoskeletal disorders. Stress, anxiety, and panic can also contribute to chest pain. A careful history and physical examination are necessary to determine the origin of the pain so proper interventions can be carried out. Some disorders that cause chest pain, such as myocardial infarction or a punctured lung, can be fatal if not treated appropriately and promptly [27].

Voice Change

Having determined that chest pain does not stem from a disorder demanding immediate intervention, ask whether the patient has experienced any voice change. This symptom can be caused by infections of the pharynx, vocal nodules, laryngeal paralysis, and laryngeal tumors. Laryngeal paralysis results from damage to the recurrent or superior laryngeal nerve or the vagus nerve (e.g., due to bronchogenic carcinoma or an aortic aneurysm). Ask the patient how long ago the voice change occurred and whether it is associated with pain when speaking or swallowing.

Dysphagia

Dysphagia, defined as a decrease in a patient's ability to swallow, drink, and eat, may result from disorders such as pharyngitis, infectious mononucleosis, peritonsillar abscess, and tumors of the oropharynx and laryngopharynx. If present, ask patients how long they have experienced this symptom, if they experience pain when attempting to swallow, and if a sensation of choking or gagging occurs. Whether any difficulty has significantly affected nutritional intake should also be assessed [27].

Fatigue

Patients with respiratory illness may also complain of generalized feelings of malaise and fatigue. This may result from respiratory infections or other conditions that alter the normal levels of oxygen and CO₂ in the body. Neoplastic disorders also cause fatigue from increased metabolic demands. Furthermore, fatigue may result in patients using respiratory accessory muscles to breathe.

Weight Change

It is important to determine whether patients with respiratory disease have had a weight change. Weight loss may be the result from a neoplastic process or COPD. A weight gain may indicate fluid retention secondary to pulmonary edema or congestive heart failure. Ask how much weight was lost or gained, over what period of time, and whether the patient's appetite increased or decreased during the change.

Other General Symptoms

Many disorders of the respiratory tract may lead to an alteration in CO₂ and oxygen levels in the blood. This imbalance may manifest itself as respiratory acidosis or alkalosis. Patients in an acidotic state may complain of headache, double vision, weakness, drowsiness, and difficulty in breathing. These symptoms may result from hypoxia and/or hypercapnia. Patients who are in an alkalotic state may report they are dizzy and have a tingling sensation in the fingers and toes; these subjective complaints are the result of hypercapnia [28].

Tobacco Use

It is crucial to obtain a detailed smoking and tobacco use history from the patient. Cigars, pipes, and chewing tobacco should be included along with cigarettes. Smoking has been implicated as a risk factor in the development of lung cancer, cancer of the head and neck, and COPD. Smoking also aggravates upper respiratory symptoms such as rhinorrhea, sinusitis, and pharyngitis, because it damages the cilia and mucous membranes. The longer a person has smoked and the greater the

number of cigarettes, the greater the risk of developing respiratory disorders. Patients who smoke should be asked how many cigarettes they smoke each day, what brand and type, and how long they have been smoking (i.e., age at initiation). Patients who have stopped smoking should be asked the date they quit in addition to the previous questions. The patient's smoking history is recorded in pack years, which is calculated as the number of packs (i.e., 20 cigarettes) per day multiplied by the number of years they smoked. For example, a patient who has smoked two packs per day for 10 years has a 20 pack-year smoking history [28].

Patients should also be asked if they use chewing tobacco, as this has been implicated as a factor in the development of cancers of the mouth, larynx, throat, and esophagus. How long the patient has chewed tobacco and how frequently it is used should be noted.

Alcohol Use

An excessive use of alcohol has been implicated as a predisposing factor in the development of tuberculosis, pneumonia, and cancers of the mouth, larynx, throat, esophagus, and liver. Patients should be questioned specifically about what they drink, how much per day, and how long they have been drinking. Patients may minimize their drinking, so a careful, sensitive, nonjudgmental approach is needed when asking questions related to alcohol intake [28].

Past Health History

A thorough history of past respiratory, face, neck, and thoracic problems should be obtained. This includes history of maxillofacial trauma or rib fractures, scoliosis or thoracic deformity, a positive tuberculosis skin test or abnormal chest x-ray, and respiratory complications following general anesthesia or surgery. A history of any of these could contribute to the current health problem of the patient [28].

Allergy and Medication History

The patient should also be questioned about any history of allergies, which can cause sinusitis, allergic rhinitis, and asthma. If the patient has a history of allergies, ask how long the allergic symptoms have been present, what the symptoms are (e.g., difficulty breathing, rhinitis), if allergy testing been done, if specific allergens have been identified, if the patient is receiving immunotherapy, and what specific medications relieve the symptoms.

Patients should be asked to list all medications they are taking (including over-the-counter medications and herbal supplements) and why. Note if patients are using medications as prescribed and if they seem to provide the desired effects [28]. Drug allergies should also be ascertained.

Occupational and Travel History

Because exposure to certain chemical agents and other irritants can result in respiratory disorders, a thorough occupational history should be obtained. Patients should be asked if they work or have ever worked in a job that exposed them to chemical fumes, dust, smoke, or asbestos or in an environment with people who smoke. The specifics of the work environment (e.g., recirculated air) should be noted. The patient's recent travel history is also important, because some infectious diseases affecting the respiratory system are endemic to certain geographic regions [28].

Family History

Information should be gathered on respiratory problems in relatives. Any family history of allergies, asthma, chronic bronchitis, emphysema, tuberculosis, or malignancy should be documented. Whether the patient grew up in a smoking household or currently lives with a smoker should be noted. It is also important to know if anyone in the home or in the family has symptoms like the patient's [28].

OBJECTIVE DATA**Physical Assessment**

When performing a physical assessment of patients suspected of having a respiratory disorder, nurses use the skills of inspection, palpation, percussion, and auscultation.

Inspection

Inspection of the nose may reveal polyps, tumors, enlarged turbinates, a foreign body, secretions, or a combination of these. The size and shape of the nose should be noted. An alteration in its shape may be the result of trauma or a tumor in or near the nose. Characteristics of the nasal mucosa and the appearance of the nasal septum are important. The mucosa may be swollen, reddened, and/or covered with secretions. Patients with allergic rhinitis often have pale nasal mucosa rather than the usual pink. Most adults have some degree of nasal septal deviation, but any deviation that narrows or blocks the nasal airway should be noted [29].

The characteristics of the nasal secretions should be assessed. They may be watery, mucoid, mucopurulent, purulent, or bloody. Watery discharge is usually of viral origin, while secretions that are mucoid or mucopurulent may result from inflammation, an acute bacterial rhinitis, or allergic rhinitis. Purulent discharge is usually of bacterial origin. Blood may drain from the nares because of irritation or trauma.

The appearance of the inferior and middle turbinates should be assessed. Tissue overlying the turbinates may become hypertrophied in conditions such as chronic allergic rhinitis. Sinusitis may result in a decrease in transillumination of the frontal and maxillary sinuses. Skin over these areas may also appear reddened in the presence of an infection [30].

Structures of the oropharynx may be enlarged, reddened, and/or covered with secretions. The color of the oral mucosa should be noted. White patches or spots on the mucous membrane of the cheek or tongue (leukoplakia) may indicate a premalignant lesion. Inflammation and secretions are often present with infections such as pharyngitis. Bleeding, restrictions, or distortion of the area may be from a neoplasm of the oropharynx or an infection. Inspect the uvula, fauces, and pharyngeal tonsils as part of the examination. These areas may be distorted in disorders such as peritonsillar abscess, infectious mononucleosis, and tumors of the pharynx [30]. Enlarged lymph nodes in the neck may be the result of common upper respiratory infections, mononucleosis, lymphoma, or metastatic cancer.

Inspection of the chest may reveal thoracic deformities such as kyphoscoliosis or an increased anteroposterior diameter (i.e., “barrel chest”). Kyphoscoliosis reduces thoracic movement and limits lung expansion. “Barrel chest” is a common finding in patients with COPD. Asymmetrical chest expansion can result from trauma (e.g., pneumothorax, hemothorax, flail chest). General overall appearance, such as facial expression, posture, and ease of movement, should also be assessed. Patients with COPD may have to sit up or lean forward in a chair in order to breathe [30].

Examination of sputum may reveal thick, tenacious secretions; mucus plugs; or purulent, bloody, or blood-tinged sputum (hemoptysis). Secretions that are yellow-green or foul smelling may indicate an infection. Sputum that is pink or rust-colored may indicate bleeding, which can result from irritation, infection, or neoplasm.

The pattern and character of respirations should be observed, including the rate and depth of breathing. Labored breathing may be marked by nasal flaring, the use of neck and accessory chest muscles, asymmetry of chest expansion, and/or an increase in respiratory rate. This occurs in conditions such as airway obstruction, COPD, and mediastinal shift. Pursed-lip breathing (a slow, relaxed expiration against pursed lips) is characteristic of patients with emphysema and prevents collapse of small bronchioles and reduces the amount of trapped air. Chest trauma may result in subcutaneous emphysema (air under the skin), which can compromise the airway [30].

When inspecting patients with respiratory disorders, also observe for signs of respiratory acidosis, respiratory alkalosis, and hypoxemia. Disorders that can lead to acidosis include COPD, pneumonia, or respiratory depression due to trauma or medications/illicit drugs. Clinical manifestations of respiratory acidosis or hypercapnia include confusion, drowsiness, dizziness, tetany, and asterixis. Tachycardia and dysrhythmias may be present. Late signs of hypercapnia are convulsions and coma [30].

Respiratory alkalosis occurs in conditions that may lead to hyperventilation, including brain injury, central nervous system tumors, gram-negative sepsis, acute asthma attacks, and extreme anxiety. Manifestations of respiratory alkalosis are related to stimulation of the nervous system. The nurse may observe muscle spasms in these patients, including carpopedal spasm—contractions of the hands and feet. Severe spasms can progress to tetany or continuous muscle contractions. Diaphoresis and cardiac dysrhythmias may occur. The patient will be tachypneic and may lose consciousness [30].

When the respiratory system is affected by disease, the ability to deliver oxygen to the tissues may become impaired, resulting in hypoxia (inadequate tissue oxygen) or hypoxemia (inadequate blood oxygen levels). Conditions that limit the volume of

air entering the lungs result in inadequate amounts of available oxygen at the alveolar level. Disorders leading to hypoxia or hypoxemia include restrictive lung diseases (such as pulmonary fibrosis, occupational lung disease, and sarcoidosis), obstructive lung diseases (such as asthma, chronic bronchitis, and emphysema), and occasionally morbid obesity. Any disorder that lowers the oxygen-carrying capacity of the hemoglobin in the blood will also produce tissue hypoxia [30].

The symptoms manifested by acute hypoxia are reflected in the neurologic, cardiovascular, and respiratory systems. Deprivation of oxygen to the brain causes signs of restlessness, irritability, and mental confusion. Effects on the cardiovascular system include tachycardia, hypertension, and cardiac dysrhythmias. Manifestations of chronic hypoxia include exercise intolerance, a general feeling of fatigue, and clubbing of the fingers [30].

Palpation

Palpation of structures of the upper respiratory tract may reveal swelling due to neoplasms or an infection. Palpate the areas over the frontal and maxillary sinuses. With sinusitis, this may elicit complaints of tenderness or pressure. The neck should also be palpated for the presence of enlarged lymph nodes.

Fluid-filled or solid structures transmit vibrations better than structures filled with air. With palpation over the chest, vocal fremitus will be increased with excessive secretions, tumors, or pneumonia. A decrease in vocal fremitus is present in pleural effusion, because it slows the transmission of sound.

Crepitus may be palpated in cases of subcutaneous emphysemas; touching the area results in a crackling sensation. Intercostal bulging may be noted in a patient who has lung abscesses, tumors, or rib fractures. A deviation of the trachea may be palpated in conditions such as tension pneumothorax and neck masses [30].

Percussion

Percussion of the chest produces sounds that can help locate abnormalities in the lungs. The sound heard over normal lung tissue is called resonance. Hyper-resonance is noted when air trapping occurs, as in emphysema or a pneumothorax. Dullness may be heard in the presence of a small pleural effusion, atelectasis, or hemothorax. Flatness (the same sound transmitted with percussion over the thigh) may be heard with massive consolidation or a large pleural effusion. Consolidation refers to an area of the lung that has become more dense either because air is not reaching the alveoli or because the alveoli are filled with fluid or secretions. When fluid is present in the frontal or maxillary sinuses, as in sinusitis, percussion over the sinus produces a dull sound.

Auscultation

Auscultation of the lungs is performed to determine the presence or absence of abnormal breath sounds. Bronchial/tracheal, bronchovesicular, and vesicular breath sounds are normal respiratory sounds in certain areas of the lungs. However, auscultation of these sounds in areas where they are not normally heard may indicate pathology. For example, the presence of bronchial or tracheal sounds over the periphery of the lung may be an indication of atelectasis or consolidation. Although soft rustling (vesicular) sounds heard primarily during inspiration over the peripheral lung fields are normal, decreased vesicular sounds may be present in early pneumonia or emphysema [30].

Adventitious or abnormal breath sounds may also be heard during auscultation. These can include fine-to-medium rales, medium-to-coarse rales, rhonchi, wheezing, crackles, and friction rubs. Crackles are the result of air flowing through moisture in lung passages. Fine-to-medium rales may indicate pneumonia, while medium-to-coarse rales are heard in bronchitis, pneumonia, bronchiectasis, emphysema, and pleural effusion.

Wheezing may be noted in patients with asthma or COPD. Rhonchi indicate an obstructive mass or secretions in the large airways. A friction rub is described as “grating after coughing” and may be heard in patients with pneumonia, lung cancer, pleurisy, or tuberculosis [30].

DIAGNOSTIC STUDIES

Pulmonary Function Tests

Pulmonary function tests measure the functional ability of the lungs. More specifically, they:

- Provide objective evidence of the presence, type, and degree of lung abnormality
- Monitor the course of a disease process over time
- Evaluate the effectiveness of various interventions on breathing function
- Help determine the risk of respiratory complications or surgical procedures

Spirometry

In routine pulmonary function studies, the patient's lung size and breathing ability are compared with values for healthy individuals who are similar to the patient in age, sex, height, and race. The spirometer is the primary instrument used in this test. Spirometry provides an easy and inexpensive method to measure lung volume with relatively little risk to the patient. Several different types of spirometers are used to measure lung volumes [31; 32].



EVIDENCE-BASED
PRACTICE
RECOMMENDATION

The Department of Veterans Affairs and the Department of Defense recommend that spirometry, demonstrating airflow obstruction, be used to confirm all initial diagnoses of COPD.

(<https://www.healthquality.va.gov/guidelines/CD/copd/VADoDCOPDCPG2014.pdf>.
Last accessed August 10, 2020.)

Level of Evidence: Consensus Statement and/or Expert Opinion

Pulmonary function study results can show a restriction, an obstruction, or a combination of these states. Disease conditions that commonly result in a restriction of airflow include certain neuromuscular disorders (e.g., myasthenia gravis), thoracic deformities (e.g., kyphoscoliosis), restrictions to lung expansion (e.g., pneumothorax, fibrosis), or infiltrative diseases (e.g., tuberculosis, lung cancer). These restrictive conditions cause a reduction in lung compliance, decreasing chest expansion and the volume of air inspired and expired. Disorders that result in pathologic changes of the airways or alveoli obstruct airflow into and out of the lungs. These include chronic bronchitis, emphysema, asthma, and bronchiectasis [31].

Spirometry is able to measure tidal volume, inspiratory reserve volume, and expiratory reserve volume. Tidal volume is the amount of air inspired and expired with each normal breath. The normal value is approximately 500 mL. Inspiratory reserve volume is the additional volume of air that can be inspired beyond the normal tidal volume. It amounts to approximately 3,000 mL. Expiratory reserve volume is the volume of air that can be forcefully expired at the end of the normal tidal expiration. This is about 1,100 mL in healthy individuals. Residual volume consists of the amount of air that remains in the lungs after a forceful expiration. This usually equals about 1,200 mL.

When discussing the pulmonary cycle, it is often helpful to consider two or more of the pulmonary volumes together. These combinations are referred to as pulmonary capacities. Inspiratory capacity is the volume of air that a person can inspire from a resting level. This equals the tidal volume plus the inspiratory reserve volume, and typically amounts to about 3,500 mL. Vital capacity is the maximum volume of air that can be exhaled forcefully from the lungs following a maximal inspiration. This is equal to the inspiratory reserve volume, the expiratory reserve volume, and the tidal volume, and should total about 4,600 mL. Total lung capacity refers to the maximum volume to which the lungs

can be expanded with the greatest possible inspiratory effort. It equals the vital capacity plus the residual volume and is approximately 5,900 mL [21; 33].

Pulmonary volumes are measured in time intervals. Forced vital capacity (also referred to as forced expiratory volume) is the maximum pulmonary volume the patient has for ventilation. The patient inhales the maximum amount of air and then forcefully exhales as fast as possible. The amount of air the patient can forcefully exhale within a specific time period is calculated. The usual time periods are one, two, and three seconds. A healthy individual can usually exhale approximately 75% of vital capacity in one second and 100% by three seconds.

Minute respiratory volume is the amount of air moved into the respiratory passages each minute. This consists of the tidal volume multiplied by the respiratory rate. The normal finding is approximately 6 L/minute [21; 33].

To allay anxieties, patients should be told how spirometry tests will be conducted and what will be expected of them. It is important to explain that pulmonary tests are not painful or harmful. Some patients may need to be reassured that the degree of exertion necessary to complete the test will not cause injury to their lungs. Others may fear their lungs will burst or that they will be unable to catch their breath. Explain the technique and equipment to patients in terms they can understand. This will aid in lowering patient anxiety and increasing cooperation. Patients should be told their noses will be clamped intermittently and they will be asked to breathe in and out through a mouthpiece connected to a machine. It is important that patients understand that accurate results can be obtained only by following instructions carefully. Because gastric distention may impair ability to expand the lungs, tests should be performed before meals. Medications that may alter respiratory function, such as bronchodilators, should be withheld unless otherwise indicated by the physician [30].

Before the test, the patient is asked to loosen any constricting clothing that might interfere with chest expansion. The patient may be either sitting or standing. The patient should be told to seal both lips around the mouthpiece and keep the nose clip on to prevent air leakage. The patient is then asked to breathe as normally as possible through the spirometer; the next step is not initiated until he or she is comfortable with breathing normally on the machine. At the completion of four or five normal breaths, the patient is told to breathe in as much air as possible, to fill the lungs far more than usual, and then to blow out all the air from the lungs. The volumes breathed in and out are the measures, along with the time needed for expiration.

Gas Dilution Methods

Functional residual capacity cannot be calculated using simple spirometry; a method of gas dilution is used to obtain this value. Functional residual capacity is the volume of air remaining in the lungs after a normal expiration. It equals the expiratory reserve volume plus the residual volume and is approximately 2,300 mL in healthy adults. After this value is obtained, the residual volume can be calculated.

Gas dilution methods include the helium dilution and nitrogen washout techniques. With the nitrogen washout technique, after a normal expiration, the person changes from breathing normal air to breathing 100% oxygen for several minutes. This serves to remove (wash out) all of the nitrogen into the expired air (as dry atmospheric air contains approximately 78% nitrogen and 21% oxygen). By determining how much nitrogen was in the expired air, the amount of air in the lungs at the beginning of the test can be calculated. This value is the functional residual capacity. Residual volume may then be calculated by subtracting the expiratory reserve volume from the functional residual capacity [21].

Another technique is the helium dilution method. This consists of the use of a spirometer filled with a solution of helium and oxygen. The patient takes normal breaths, and the difference in helium concentration before and after the test is used to calculate the patient's functional residual capacity.

Lung Plethysmography

In some cases, a specialist may order lung plethysmography in order to assess patients with upper respiratory problems. This test consists of the patient sitting in a small, air-tight room (also referred to as a "body box") and blowing into a mouthpiece in both the open and closed positions.

X-Rays

Chest X-Ray

Chest x-ray, one of the most common procedures used to evaluate the lungs, is part of the evaluation of most patients suspected of having pulmonary disease, except during pregnancy. The evaluation should include a posteroanterior view and at least one lateral film.

In posteroanterior views, the upright position is used because the diaphragm is lower and the lungs are larger. The patient is asked to take a deep breath and hold it for a few seconds while an x-ray beam is projected from the back to the front of the patient. Individuals who are very ill, infants, and young children are usually x-rayed lying down in the supine or anteroposterior position [33].

Lateral views add information about areas of the lungs that cannot be viewed well in the posteroanterior position, such as the anterior part of the lung close to the mediastinum. A lateral film is always taken whenever chest disease is suspected or for patients older than 40 years of age. Oblique views are beneficial in delineating pulmonary or mediastinal masses or lesions and pleural effusion that may not be well-demonstrated on posteroanterior or lateral views [33].

The lateral decubitus view is used to detect a small amount of free pleural fluid, pneumothorax, cavitations, or lung abscess. This view is taken with the patient in the side-lying position. The x-ray beam is aimed parallel to the floor and the area of concern is positioned closest to the film. Lordotic views are also taken to better evaluate the apical portions of the lungs, to assist in recognizing collapse of the middle lobe, and to determine if a lesion is anterior or posterior. Abnormal findings evident on chest x-ray include areas of density (potentially related to atelectasis, pneumonia, or pneumothorax), hypersecretion, masses, and increased vascular marking [33].



According to the American College of Radiology, despite inconsistent data regarding the sensitivity of chest radiographs for bacterial pneumonia, it still plays a role as the primary modality for making or excluding the diagnosis

of bacterial pneumonia in patients presenting with acute respiratory illness.

(<https://acsearch.acr.org/docs/69446/Narrative>. Last accessed August 10, 2020.)

Level of Evidence: Expert Opinion/Consensus Statement

Paranasal Sinus Films

Patients suspected of having sinusitis may benefit from evaluation with paranasal sinus films. X-ray examination of the paranasal sinuses may also be employed for patients with head trauma and those suspected of having sinus neoplasm.

Traditional x-ray assessment of the paranasal sinuses often necessitates a series of different views, typically Caldwell's view, Water's view, lateral view, submentovertical view, and right and left oblique orbital views.

An area of density on x-ray film may indicate a foreign body, stone, cyst, polyp, or osteoma in the paranasal sinus. Osteolysis (abnormal resorption or absorption of bone) may be evident. In the absence of disease, the mucosal lining of the sinuses

does not show up on x-ray films. An infection of the sinus may be evident if it causes edema of the mucosal lining. Clouding of the sinus may indicate edema or accumulated fluid. When fluid is present but does not fill the entire cavity, an air-fluid level may be seen. Fluid may be present as the result of sinusitis or hemorrhage secondary to trauma.

Facial Films

The traditional x-ray examination to detect injury after maxillofacial trauma consists of the four views, with the addition of the panorex view of the mandible. This shows the entire mandible fairly well in one view so that breaks in the bones and edema of tissues may be seen. If the patient has severe maxillofacial trauma, the nurse will need to provide emotional support in addition to technical skill maintaining a patent airway and closely monitoring vital signs.

Nursing Implications

The x-ray procedure should be explained in terms that the patient can understand. In a chest x-ray, a beam passes through the body to a film. The films obtained will provide the radiologist with information about the structure and function of the lungs. Patients may have misconceptions about the physiologic effects of exposure to diagnostic radiation. Allow the patient to verbalize these fears and then provide correct information. If the patient is pregnant, x-rays are avoided unless absolutely necessary. If critical illness of a pregnant woman necessitates a chest x-ray, the abdomen is protected with a lead shield [30].

When patients are acutely ill, portable chest x-rays may be necessary. The quality of a chest film taken with a portable x-ray is not as good as the film taken in the radiology department, because the patient and equipment cannot be positioned for the best view. To increase the quality of these films, the patient should be sitting completely upright. Visitors and other staff members should be asked to leave the immediate area, and personnel who must remain in the room should be protected by lead aprons. A pregnant nurse or visitor should never be exposed to x-rays [21].

If sinus x-ray is necessary, patients should be told that films will be taken from different views, and that the process will not cause them much, if any, discomfort. Patients will be asked to hold the head in certain positions against the x-ray plate. The nurse might find it helpful to compare the process to a chest x-ray, as many patients have had that experience [21].

Lung Scans

A lung scan may be classified as either a perfusion scan or a ventilation scan; usually, both types are done together. To obtain a perfusion scan, radioactive dye is administered intravenously. When the dye is injected, the patient should be supine and breathing normally to produce a uniform distribution of radioactive particles in the pulmonary capillary bed. The scan may begin immediately after injection of the dye. Anterior, posterior, both lateral views, and both posterior oblique views are obtained. An x-ray of the lung may be obtained at the same time so comparisons can be made [33].

Ventilation scans are usually performed using radioactive tracer gas or mist. The patient should be sitting or supine. Patients will usually wear a tightly fitting facial mask that allows them to breathe radioactive gas for a few minutes. Depending on the type of gas, patients may need only to breathe through a nasal cannula.

Ventilation and perfusion scanning are used most often to diagnose pulmonary embolism, but they may also be used in the work-up of lung cancer, COPD, pulmonary edema, and pulmonary infections. Unlike most pulmonary function tests, the lung scan can measure regional lung functions. This makes possible the diagnosis of pulmonary diseases at an earlier stage, before other parameters of respiratory function become impaired [33].

Nursing Implications

When preparing patients for lung scans, the first step is to explain the purpose of the test (to determine if all of the patient's lung tissue has adequate circulation and if air is reaching areas as it should).

Patients should know they will receive radioactive dye IV for a perfusion scan. Any history of an allergic reaction to dye used in diagnostic tests should be documented and brought to the attention of the physician. The nurse should stress that patients should try to relax and breathe normally during the test. Patients should be told that a machine will move over the chest to obtain different views of the lungs. A conventional chest x-ray may also be taken at that time [30].

Patients should be informed that during a ventilation scan they will be asked to breathe a mixture of gases through a mask or nasal cannula so the air flowing in and out of their lungs can be traced. Inhalation of this gaseous mixture should not cause them discomfort.

Arterial Blood Gas Analysis

Arterial blood is collected for analysis of pH, PCO₂, PO₂, oxygen saturation, bicarbonate level, and base excess. These values show how well the patient's lungs are delivering oxygen to the bloodstream and eliminating the waste products of cellular metabolism [34].

pH

The normal pH of arterial blood is 7.35 to 7.45. Values less than 7.35 indicate acidemia, while those greater than 7.45 are indicative of alkalemia. The normal pH range is maintained primarily by two buffers: carbonic acid and bicarbonate [34].

The normal ratio of carbonic acid to bicarbonate (1:20) must be maintained; otherwise, the pH will not be within the normal range. The lungs control the carbonic acid level by selectively retaining or ventilating CO₂, which combines with water to form the carbonic acid's hydrogen ion. The bicarbonate portion of the balance is controlled by the kidneys, which excrete either alkaline or acidic urine [35].

The normal range of PCO_2 in the arterial blood is 35 to 45 mm Hg. A PCO_2 level greater than 45 mm Hg may be indicative of compensated metabolic alkalosis or hypoventilation, which results in respiratory acidosis. A PCO_2 value less than 35 mm Hg may arise from compensatory metabolic acidosis or hyperventilation, which can result in respiratory alkalosis [34; 35].

The normal pressure of PO_2 in arterial blood is 80 to 100 mm Hg. This value has no direct bearing on the pH, but it is an important indication of whether adequate oxygen is available for cellular metabolism. A PO_2 elevation may be seen in patients who are receiving a high-liter flow of oxygen. Prolonged elevations in PO_2 levels can result in damage to the pulmonary tissue [34; 35].

Oxygen Saturation

The extent of oxygen saturation (the amount of hemoglobin combined with oxygen) is expressed as a percentage of the blood's capacity for full saturation. The normal value is 95% to 98% in arterial blood [34; 35].

Bicarbonate Ion

The negative ion of bicarbonate is normally present in arterial blood at a value of 22–26 mEq/L. A lower value is indicative of metabolic acidosis or compensation for respiratory alkalosis. A value greater than 26 mEq/L is indicative of metabolic alkalosis or compensated respiratory acidosis [34; 35].

Base Excess

The base excess represents an increase or a decrease in the total amount of buffer bases available. The normal range is -2 to +2 mEq/L in arterial blood. This value is considered a more reliable indication of the true metabolic makeup of an acid-base disturbance than the bicarbonate value. As with the other measures, an increase indicates metabolic alkalosis or compensated respiratory acidosis; a decrease indicates metabolic acidosis or compensated respiratory alkalosis [34; 35].

Nursing Implications

For arterial blood gas tests, the patient should be advised that a small amount of blood will be obtained from an artery to determine how well the lungs are functioning. Equipment necessary includes a heparinized syringe, an alcohol swab, and a piece of gauze. Many facilities use prepared syringes with dry electrolyte-balanced heparin. Heparinization may also be achieved “in house” by drawing up 0.5 mL of heparin (1:1,000) into the syringe and wetting the entire barrel by moving the plunger up and down. Excess heparin is ejected, leaving the syringe free of air bubbles, and the needle filled with heparin. This will prevent clotting of the blood sample [30].

Common sites for obtaining an arterial blood gas sample are the radial, brachial, and femoral arteries. The puncture site should be thoroughly cleansed with alcohol or an antiseptic solution. The location of the artery is ascertained by palpation of the pulse. A sterile 5-mL heparinized syringe fitted with a wide-bore needle (20 to 21 gauge) will allow the easy flow of blood into the syringe. However, a smaller gauge needle results in less trauma to the artery.

Cultures

A culture involves growing bacteria or other micro-organisms from a specimen of blood or material obtained in an aseptic manner or using sterile technique. The specimen is placed in an environment that promotes the growth of organisms. When the micro-organisms increase, laboratory personnel can isolate and identify the pathogen. Sensitivity studies may also be done to determine which antimicrobial drug is effective against the organism to help guide drug therapy.

Specimens are examined in stained and unstained direct smears. The most frequent staining test is Gram stain, which distinguishes among bacteria with similar morphology by classifying them as gram-negative or gram-positive. Some organisms, such as mycobacteria, cannot be stained using this method and require acid-fast staining techniques [1; 10].

Nursing Implications

Obtaining a nose or throat culture rarely causes the patient discomfort, but the patient should be told that a cotton swab will be inserted into the nose or throat to obtain a specimen. The purpose of obtaining the specimen—to identify organisms present and susceptibility to specific drugs—should be explained.

For cultures from the nares, the swab should be introduced as far back as possible (without bending) and rotated gently. Cultures from the pharynx are obtained while avoiding touching the tongue or teeth, which would result in contamination. Depress the tongue with a tongue blade, and swab the interior wall of the pharynx below the level of the uvula. The swab should be rotated over any involved or inflamed areas. The specimen collected on the swab should be placed in the appropriate container and taken to the laboratory as soon as possible to prevent drying.

Sputum cultures are often indicated for patients with suspected respiratory disease. Other culture specimens (e.g., from abscesses in the lungs) are obtained during bronchoscopy [29; 36].

Sputum Cytology

Sputum cytology involves the detailed examination of the cellular structures of sputum. This is primarily done to assist in the identification of malignant cells in individuals suspected of having lung cancer.

Nursing Implications

The optimal time to obtain a sputum specimen is early in the morning. The first sputum expectorated will contain secretions that have pooled in the patient's lungs during the night, giving a more productive sample. To decrease contamination of the sputum, the patient should rinse out the mouth without swallowing, brush the teeth, or both.

For a true sputum sample (not saliva), the patient should take several deep breaths and then cough forcefully. Respiratory secretions are more easily expelled if the patient is well-hydrated and breathes humidified air.

If the patient is not able to produce a sputum sample, it can be obtained by postural drainage, inhalation of cold steam or nebulized vapor, or suctioning. If suctioning is used, a sputum collection trap is used to obtain a sterile sample. When cultures are being obtained, the specimens should be collected in sterile containers using sterile technique prior to beginning antibiotic therapy [33].

Skin Tests

Tuberculin Skin Testing

One way to perform tuberculosis screenings is to use the Mantoux method of skin testing [37]. The test indicates those who have been infected with the organism as soon as 2 to 10 weeks after exposure.



The World Health Organization recommends that household contacts and other close contacts of TB cases, people living with HIV, and current and former workers in workplaces with silica exposure should be systematically screened for active TB.

(<https://www.who.int/tb/tbscreening/en/>. Last accessed August 10, 2020.)

Strength of Recommendation/Level of Evidence:
Strong recommendation, low-quality evidence

With the Mantoux technique, 0.1 mL of purified protein derivative (PPD), containing 5 tuberculin units (TU), is injected intradermally into the volar or dorsal surface of the forearm. Using a 26- or 27-gauge needle, the tuberculin syringe should be held close to the skin so the needle hub touches it as the needle is inserted into the skin, with the bevel up. This decreases the needle angle at the skin surface and helps to ensure the fluid is injected just beneath the surface of the skin into the dermis to form a wheal, taking care not to inject subcutaneously.

The site of the injection should be circled with a pen and the location documented on the patient's medical record (in case the pen circle should wash off). Examine the site of the Mantoux intradermal injection within 48 to 72 hours of injection. Always use sufficient lighting to examine the area. Use a pen to outline the diameter of induration (firm-to-hard zone of elevation or swelling). The area of erythema is not measured, and erythema without induration is of no significance. Use a standard centimeter ruler or a clear plastic ruler that has been marked with circles of various diameters. Place the ruler over the outlined induration to measure its diameter. The presence and degree of induration is an indicator of prior tuberculosis infection and, to some extent, the probability of current active tuberculosis.

A reaction of <5 mm is negative. Reactions >10 mm are "positive." An intermediate reaction of 5–10 mm is suspicious for prior infection in high-risk persons.

In suspect cases, the significance of a negative tuberculin skin test can be further assessed by testing for anergy. A control test is done using antigens to which virtually all adults have been previously exposed to determine if there is any cellular immune response. The antigens most commonly used as controls are *Candida albicans*, *Trichophyton*, mumps virus, and tetanus. They are administered using the same Mantoux technique.

Two blood tests are also available for tuberculosis diagnosis (the QuantiFERON-TB Gold In-Tube and T-SPOT.TB tests), and these options have the advantages of being done in one patient visit with results available in 24 hours. As such, they are usually the preferred option for diagnosis (rather than screening).

Coccidioidomycosis Skin Testing

Skin testing for coccidioidomycosis, a respiratory fungal disease also known as Valley fever, can be performed with mycelium-derived antigen coccidioidin or the newer, more sensitive spherulin (produced from the parasitic spherule). The procedure for administering the test is similar to that

described for the Mantoux tuberculin test; the test is read in 24 to 48 hours [38]. A positive reaction (0.5 mm or more of induration) indicates past infection. This test becomes diagnostic only when conversion to positive occurs during the course of the clinical illness. A positive skin test indicates intact cell-mediated immunity. This immunity is frequently lost during the course of dissemination of the disease and means a poor prognosis. As with tuberculosis, blood testing may be preferred over skin testing for diagnostic purposes.

Immunoglobulins

Immunoglobulins are serum proteins, produced by lymphocytes and plasma cells, that function as antibodies in the body's immune defense system. Immunoglobulins can be separated for study by electrophoresis. The five main immunoglobulin serum proteins are IgG, IgA, IgM, IgI, and IgE. The levels of one or more immunoglobulin fractions may change in allergy, pneumonia, tuberculosis, and pulmonary fungal infections (e.g., coccidioidomycosis). For this test, only a blood sample is necessary [1].

Indirect Laryngoscopy

Indirect laryngoscopy allows the examiner to view the vocal cords and other laryngeal structures. Patients are usually positioned so they are sitting all the way back in the chair with the head and shoulders forward. Mirrors of different sizes can be used, depending on the amount of space between the tonsils. Various surgical procedures can be performed using indirect laryngoscopy if the patient is cooperative, including injection laryngoplasty (to treat unilateral vocal cord paralysis) and removal of vocal nodules [19].

Nursing Implications

Laryngoscopic examination is easier and more information is gained if the patient is relaxed and knows what to expect. Position the patient correctly and explain the importance of remaining in that position. It is helpful if patients know that they will be instructed to say "ah" or make other sounds while being examined [30].

If surgical procedures are performed using this approach, the patient is usually given a sedative. In this case, the nurse would assist the patient in maintaining the desired position. The nurse also assesses the patient for changes in appearance or vital signs and abnormal bleeding.

Direct Laryngoscopy

With direct laryngoscopy, the physician inserts a fiber-optic laryngoscope to view the larynx directly under magnification. A variety of types of instruments can be used. Microlaryngoscopic instruments with binocular magnification allow the physician to view changes that cannot be seen with indirect laryngoscopy.

Direct laryngoscopy is used to investigate signs and symptoms associated with the larynx (e.g., when a patient complains of hoarseness for more than two weeks) when indirect laryngoscopy shows no abnormality. In addition, direct laryngoscopy is frequently used for minor surgical procedures, such as biopsy of a growth on the larynx, removal of laryngeal polyps and vocal cord nodules, and removal of foreign bodies from the larynx. Trauma victims may require direct laryngoscopy to assess the extent and severity of injuries [19].

Nursing Implications

Direct laryngoscopy can be performed using either local or general anesthesia. Patients should be assured that they should not experience pain during the procedure and that the airway will be maintained throughout. Preoperative medications may be administered to help the patient relax if local anesthesia is employed. The patient should not drink or eat for several hours before the procedure, and any dentures should be removed.

After the procedure, the patient will be allowed to drink soon after waking up. If a local anesthetic was used, the nurse must ensure that the patient's gag reflex has returned and that he or she can swallow. A sore or irritated throat is not uncommon following laryngoscopy, but the patient should be observed for signs and symptoms of respiratory distress from laryngeal edema or spasm. After the removal of laryngeal polyps or vocal cord nod-

ules, the patient should rest the voice for several days. Clearing the throat and coughing should be avoided, if possible [30].

Bronchoscopy

Bronchoscopy is the direct viewing of the trachea and tracheobronchial tree by means of a standard or fiber-optic bronchoscope. The fiber-optic bronchoscope is a slender, flexible tube with mirrors and a light at the distal end. A brush, biopsy forceps, or catheter may be passed through the bronchoscope to obtain samples for cytologic examination.

The fiber-optic bronchoscope is most commonly used because it is small and flexible, allowing better visualization of the segmental and subsegmental bronchi. There is also less risk of trauma from intubations with this approach [19].

Bronchoscopy is performed with the patient sitting or supine, with the bronchoscope inserted either through the patient's nose or mouth [19]. Bronchoscopy is used in the diagnosis of such conditions as hemoptysis, lesions, masses, and abnormalities seen on chest x-ray. The procedure may also be used to treat lung abscesses, pneumonia, and aspiration; to debride mucosal eschar resulting from burns and other inhalation injuries; and to remove foreign bodies. Bronchoscopy can aid in removal of excessive tenacious secretions when nasotracheal suctioning is ineffective.

Nursing Implications

Bronchoscopy entails a certain amount of patient discomfort. The patient is likely to be anxious, not only about pain but also about the findings, especially if the procedure is being performed to assess suspected malignancy. Nurses should take time to explain the procedure and to answer any questions the patient may have and allay any anxieties based on misconceptions. Patients should be told that they will receive an intravenous sedative to help them relax and that a local anesthetic will be sprayed into the nose and mouth to suppress the gag reflex. This will produce the sensation of a dry mouth, swollen tongue, and swollen throat, and will make the patient unable to swallow. Patients should be reassured that they will be able to breathe during the procedure [30].

Following bronchoscopy, vital signs are monitored. Conscious patients are placed in a semi-Fowler's position; unconscious patients are positioned on their side with the head of the bed slightly elevated. An emesis basin should be provided and the patient instructed to expectorate secretions into the basin rather than swallowing them. Patients should be advised that clearing the throat or coughing could dislodge a clot and possibly cause hemorrhage. Watch for subcutaneous emphysema, which may indicate tracheal or bronchial perforation. Foods and fluids are restricted until the gag reflex returns. Hoarseness and a sore throat can be relieved by gargles and throat lozenges. Nurses should assess for any breathing difficulty (from laryngeal edema or laryngospasm), hemoptysis, symptoms of a pneumothorax, and bronchospasm.

Mediastinoscopy

With mediastinoscopy, an incision is made over the mediastinum and a scope inserted to explore the area. The mediastinum is the area in which the esophagus, trachea, great vessels, and heart are located. Mediastinoscopy is also used to obtain biopsies of lymph nodes or other masses, to determine the presence of lymphoma or lymph node metastases due to bronchogenic carcinoma, and to diagnose intrathoracic sarcoidosis. A common approach is through an incision in the suprasternal notch, which allows for endoscopic examination of the upper half of the mediastinum, including the proximal part of the major bronchi [1].

Nursing Implications

Mediastinoscopy can be performed under either local or general anesthesia. Patients should be advised that the procedure will leave a small incision and that the incision site might be somewhat sore for a few days. The patient should not eat or drink anything for several hours prior to the procedure. Patients are given a full explanation of the procedure and its purpose in terms they can understand. A signed consent is necessary [30].

Postoperative nursing care includes monitoring vital signs, observing for bleeding from the incision site, and alleviating discomfort by supportive measures or administering prescribed pain medication, as appropriate. The nurse should also observe the wound for signs and symptoms of infection. Possible complications, in addition to hemorrhage and wound infection, include right recurrent laryngeal nerve paralysis and esophageal perforation.

Bronchography

On a chest x-ray, a small portion of the bronchial tree beyond the first two major divisions is visible. To diagnose abnormalities of the smaller sections of the bronchial tree, bronchography may be performed. This diagnostic test begins with instillation of radiopaque contrast medium through a catheter into the lumen of the trachea and bronchial tree. Chest x-rays are then taken. Bronchography is primarily indicated for diagnosing bronchiectasis and ascertaining its location before surgical resection. Bronchography may also aid in diagnosing compression, obstruction, and presence of a foreign body or a lesion in the trachea or larger bronchi [1].

Nursing Implications

A full explanation of the procedure should be given, including informing patients that they will be placed in various positions to aid in distribution of the dye. Question the patient and also check the chart for known hypersensitivity to the dye used for the procedure. Proper visualization requires that the airways be as free of secretions as possible. To achieve this, bronchial drainage, nasotracheal suctioning, or both may be necessary. The patient should have nothing by mouth for several hours prior to the procedure [30].

After completion of the procedure, the patient's vital signs should be monitored. To facilitate removal of the contrast medium, deep breathing and sighing, postural drainage, and nasotracheal suctioning are usually necessary. Before allowing the patient to drink, check for return of the gag reflex by stimulating the posterior pharynx with a swab or tongue blade.

Thoracentesis

Thoracentesis, employed for years to aid in the identification of diseases involving the pleura, consists of the insertion of a needle into the intrapleural space to remove fluid. It may be done to obtain a specimen for diagnostic purposes or to remove fluid from a pleural effusion. After the selected area is cleaned, a local anesthetic is injected into the skin. The needle is then inserted and fluid aspirated. The amount, color, odor, and character of the fluid should be noted. The fluid may be described as serous, serosanguineous, or turbid. Serous fluid may be obtained from patients who have disorders of nontraumatic origin, including congestive heart failure, pleural effusion due to a malignancy, glaucomatous diseases, and disorders resulting in inflammation. Blood in the fluid is usually due to trauma to the lungs, but it may also be seen in patients with advanced malignancy. Turbid fluid in the intrapleural space is most commonly from an infection [1; 10]. Rarely, hyperalimentation solution may be present in the fluid. This occurs when a central venous line is placed (and the solution is infused) into the intrapleural space instead of the vena cava.

No more than 1,000–1,500 mL of fluid should be removed at any one time because of the danger of hypotension. The specimen is sent to the laboratory, where it is assessed for red blood cell count, white blood cell count with differential, protein, glucose, lactic acid, dehydrogenase, amylase, pH, cultures, bacteriologic stains, and pleural fluid cytology.

Nursing Implications

Although thoracentesis is a relatively simple procedure, it can be frightening to patients. The basic steps should be explained to the patient calmly and completely. Patients should be warned to expect a sensation of pressure or discomfort when the needle is inserted. In some cases, medication may be prescribed to calm a frightened patient [30].

Proper positioning of the patient is essential for the procedure. The patient should either be sitting and leaning over a bedside table or, if unable to sit, lying on his/her affected side with the ipsilateral arm over the head and access available to the midaxillary line. These positions give the patient support and stability and allow for elevation of the ribs. Patients should be encouraged to remain still to avoid trauma to the lung tissue. If the patient has a frequent cough, a cough suppressant may be administered to avoid excessive movement while the needle is in the intrapleural space.

A nurse will remain with the patient throughout the procedure to provide support and monitor vital signs. Complications of thoracentesis are relatively rare and include hemorrhage, pain, and pneumothorax. After the procedure, monitor the patient's vital signs and respiratory status to detect any adverse reactions. The insertion site should be observed for swelling that could result from bleeding into the area [10].

Lung Biopsy

Both open and closed approaches are used to obtain lung tissue for cytologic analysis and culture. Closed approaches include fine-needle aspiration, biopsy via a percutaneous cutting needle, and biopsy via fiber-optic bronchoscope. All closed procedures are done under local anesthesia with fluoroscopic guidance. Open biopsy requires a thoracotomy. This approach provides the largest volume of tissue, but general anesthesia is needed. Lung biopsy is indicated when the patient's diagnosis remains unclear despite a complete work-up [12; 32].

Nursing Implications

If only local anesthetic is used, patients should be told that the area will be numbed, but they will probably still feel some pressure or discomfort when the biopsy is taken. Patients may be asked not to eat or drink anything for a few hours prior to the procedure. When the biopsy is completed, observe the site for swelling or bleeding, and watch the patient for approximately 24 hours for any signs and symptoms of pneumothorax, air embolism, or hemorrhage [30].

NURSING DIAGNOSES, PLANNING, AND IMPLEMENTATION

Assessment of patients with respiratory dysfunction involves obtaining the history, conducting a physical examination, and reviewing the results of diagnostic studies. The three major nursing diagnoses are ineffective airway clearance, ineffective breathing pattern, and impaired gas exchange. Various nursing interventions may be implemented to address these diagnoses.

INEFFECTIVE AIRWAY CLEARANCE

The nursing diagnosis of ineffective airway clearance is frequently used. The degree may range from mild to severe and may be related to the upper or lower respiratory system or both. Patients may experience difficulty maintaining normal airflow into and out of the lungs because of structural obstruction, the presence of foreign bodies, or the presence of excessive tenacious nasal or bronchial secretions. For example, patients with acute rhinitis or sinusitis may have nasal and sinus secretions that make it difficult or impossible to breathe through the nose. The presence of nasal polyps or turbinates enlarged as a result of an allergic response will also decrease the airflow through the nasal passage. Inadequate draining of the paranasal sinuses can result in chronic infectious sinusitis that may necessitate surgical intervention. Secretions may be present in the oropharynx from postnasal drip or an infection such as pharyngitis or tonsillitis and may impair the patient's ability to swallow, speak, or breathe. These symptoms can also be caused by a tumor in the oropharynx or laryngopharynx that blocks the flow of sputum when the patient coughs. Enlargement of structures in the oropharynx (e.g., the tonsils) may also block attempts to expel sputum. Foreign bodies in the oropharynx or laryngopharynx may block the flow of secretions as well as the flow of air and can be fatal [26; 27].

COPD is a common cause of ineffective airway clearance in the lower respiratory system. Patients with COPD often have excessive pulmonary secretions and have difficulty expelling the sputum. Infections such as pneumonia may also cause the accumulation of excessive secretions in the lower respiratory system.

A variety of nursing interventions may be employed when the nursing diagnosis is ineffective airway clearance. The most useful include pursed-lip breathing, diaphragmatic breathing, postural drainage, and nasotracheal suctioning. In severe disorders, the patient may require intubation mechanical ventilation [26].

Pursed-Lip Breathing

Pursed-lip breathing—a slow, even expiration against pursed lips—prevents collapse of small bronchioles, reduces the amount of trapped air in the lungs, and promotes CO₂ elimination. To assume the proper lip position for pursed-lip breathing, have the patient in a sitting position pretend to blow out a candle. As noted, patients with emphysema can use pursed-lip breathing to maximize expiration.

Diaphragmatic Breathing

Diaphragmatic breathing (also known as abdominal breathing) facilitates maximum use of the diaphragm in breathing. This is particularly helpful for patients who have had thoracic surgery and those with COPD. Ask the patient in a sitting position to take a deep, slow breath through the nose, concentrating on maximum expansion of the abdomen. Place the patient's hand on the abdomen to feel it rise. Then, have the patient exhale slowly through pursed lips while contracting the abdominal muscles. The patient should place manual pressure on the abdomen during expiration. Use of this breathing pattern should be encouraged during daily activities so it becomes an automatic approach to breathing during periods of respiratory difficulty [27].

Postural Drainage

Postural drainage combines the force of gravity with normal ciliary action to move secretions from smaller to larger airways, where they can be removed by coughing or suctioning. The patient's lungs should be auscultated prior to postural drainage to determine which segments require drainage, and after drainage to determine effectiveness of the therapy. Postural drainage can be directed to any segment of the lung.

Percussion and vibrating techniques are often used with postural drainage. Percussion with a cupped hand helps loosen secretions and stimulate coughing. The patient should use diaphragmatic breathing during percussion. Vibration involves manual pressure on the chest using a vibrating movement of the hand during expiration. The loosening and mobilizing of mucous secretions are increased with vibration.

Percussion and vibration are directed to the specific lung segments involved. To loosen secretions in the right middle lobe, percuss over the anterior and lateral right chest from the midaxillary line to the sternum for about two minutes. Then, perform three to five vibrations over the same area during expiration only. The patient should cough after the procedure.

Extremely ill or elderly patients may not be able to tolerate some of the positions for postural drainage, particularly those with the head lower than the feet. Individual modifications of position will be necessary, based on the patient's condition. Postural drainage exercises should be scheduled before meals, because sputum will be minimal and the risk for vomiting and aspiration minimized. Postural drainage is generally done two to four times per day [26; 27].

Nasotracheal Suctioning

Patients who are not intubated may require suctioning of the tracheobronchial tree. It is important to explain the procedure to the patient to allay anxiety and gain as much cooperation as possible. An explanation is important even if patients are unresponsive, because they may still be aware of activities.

The patient is positioned at a 45-degree angle (unless contraindicated). Patients should be hyperoxygenated before suctioning; if they are receiving oxygen, the flow rate is increased during the procedure. Nurses should limit suctioning to 5 to 10 seconds, and a rest period should be provided before repeating the procedure [26; 27].

Nasal Packing

Patients with epistaxis may have a nursing diagnosis of ineffective airway clearance. Some will have difficulty breathing because of the drainage of blood thorough the nasopharynx into the oropharynx. These patients may also have difficulty expectorating the blood and may swallow a significant amount, causing nausea and vomiting. Nasal packing (e.g., a balloon catheter) is inserted by the physician in an effort to control the bleeding.

Nasal packing may be either anterior, posterior, or both. When bleeding from the anterior portion of the nose cannot be controlled by either local application of vasoconstrictor drugs or cauterization, packing is inserted. Bleeding from the posterior portion of the nose is often more severe, and a posterior pack is inserted to control the bleeding. Patients with anterior nasal packing are often sent home; however, patients who require posterior packing may be admitted to the hospital for observation because of the risk of obstruction [29].

Patients sent home with nasal packing should be instructed to observe for bloody drainage. If bleeding begins and the gauze becomes blood soaked, the patient should call his or her physician immediately. When bleeding recurs, the patient is usually instructed to return to the office or hospital. Patients should also avoid tampering with or unnecessary touching of the packing or nose and should apply a lubricant around the nares to prevent drying and crusting of secretions and skin. Because mouth breathing is necessary, frequent oral hygiene should be given to prevent drying of the oral mucosa. Lubricants may be applied to the lips to prevent drying or cracking [36].

For patients with posterior packing, the posterior pharynx should be inspected often, with good lighting, to check for bleeding and to ensure that the packing has not moved. Misplacement of the packing into the oral pharynx could obstruct the upper airway. The patient should be told that swallowing may be difficult and will bring a sucking sensation in the back of the throat. Due to this, a liquid or soft diet is best tolerated [29].

Nurse and patient should be alert for renewed or increased bleeding, which can result in tachycardia and hypotension. Stools may be tarry if bleeding has lasted for a few days. These patients may also be prescribed prophylactic antibiotics to prevent sinus infection.

Nursing Evaluation

Nursing interventions related to excessive excretions in the respiratory system are successful when the patient can move air in and out of the upper and lower respiratory tracts without difficulty. Subjective and objective findings that verify these outcomes include a normal appearance (or a decrease in inflammation and swelling) of structures in the nose, oropharynx, and hypopharynx; absence of inflammation, redness, and tenderness over the paranasal sinuses; return of the patient's voice to normal; absence of purulent, tenacious discharge

or sputum; normal breath sounds on auscultation; absence of adventitious breath sounds; patient verbalization or verification that dysphasia, cough, headache, and/or sore throat have disappeared; and good skin turgor, with intake and output within acceptable limits. In addition, the patient's vital signs, chest x-ray, and arterial blood gas analysis should ideally be within normal limits [26; 27]. However, these expected outcomes may never be reached by some patients with respiratory disorders. For example, a patient with COPD will likely continue to have abnormal arterial blood gas values and a productive cough.

Patients with upper or lower respiratory tract infection may require education on actions to facilitate resolution of the infection and to prevent transmission. Signs that instruction was effective include observations that the patient has taken action to prevent the spread of infection (e.g., covering mouth and nose when coughing and sneezing); uses correct method of coughing and blowing nose; follows proper administration of decongestants/antihistamines; knows the benefits of and techniques for adequate hydration and humidification; correctly performs breathing exercises; and uses oxygen equipment appropriately. Family members and/or caregivers should also have an understanding of all information presented [26; 27].

INEFFECTIVE BREATHING PATTERN

Patients who have chest trauma, chest or abdominal pain, or pathology of the pulmonary tissue or who have undergone thoracic surgery are diagnosed as having an ineffective breathing pattern. Trauma to the thorax resulting in pneumothorax, hemothorax, flail chest, tension pneumothorax, or mediastinal shift may cause various abnormal breathing patterns leading to ineffective ventilation. When the condition prevents air from moving in and out of the lungs effectively, various signs of respiratory distress may be observed, such as dyspnea, cyanosis, or use of accessory muscles for breathing.

Patients experiencing pain in the chest or abdomen tend to “guard” by breathing as little as possible to avoid increasing the pain. This hypoventilation in turn leads to impaired gas exchange over a period of days.

Patients with pathology of the pulmonary tissue often show signs that they are having difficulty moving air in and out of their lungs. For example, patients with emphysema experience “air trapping” in the alveoli and have difficulty exhaling fully. These patients often lean forward and purse their lips to facilitate movement of air.

Patients with asthma or allergic reactions may experience bronchospasm and have difficulty ventilating. Wheezing can often be heard when the lungs of these patients are auscultated [26; 27].

Several nursing interventions may be employed when the nursing diagnosis is ineffective breathing pattern, including artificial airway (i.e., endotracheal, tracheotomy, or laryngectomy tube), chest tubes, and mechanical ventilation. These patients may also require deep breathing, coughing and breathing exercises, postural drainage, and nasotracheal suctioning if they are not intubated [27].

Incentive spirometry may be used to promote optimal breathing. With this approach, the patient is encouraged by visual feedback from a spirometer to execute sustained maximal inhalation. Patients usually perform 10 to 20 sustained deep breath exercises per hour until they can achieve their predicted inspiratory reserve volume. This method encourages voluntary deep breathing and reduces the risk of atelectasis and pulmonary consolidation.

Nursing Evaluation

Nursing interventions employed to improve the patient’s breathing pattern are successful when the lungs are aerated adequately. Findings verifying this outcome in patients who have experienced chest pain or trauma include normal breath sounds, normal chest x-ray, normal arterial blood gas values,

vital signs within normal limits, symmetrical chest expansion, and normal pulmonary function studies. When evaluating patients with a chest tube, note that the chest tube is in place, secured, and covered by a sterile dressing. The chest drainage collection receptacle should also be observed to see that it is functioning properly. If the patient is on a ventilator, the function of the ventilator should be monitored in addition to the condition of the patient [26].

Findings indicating that the nursing intervention for patients with pathophysiology of lung tissue has been successful include a return to baseline values for the arterial blood gas analysis, normal chest x-ray, and normal findings on pulmonary function studies. Improved lung sounds should be audible upon auscultation, and sputum production should decrease [26].

Respiratory disorders can significantly alter a patient’s ability to perform activities of daily living, as seen in many patients with COPD. The physiologic changes can result in stress and emotional turmoil for patients and family. With knowledgeable and caring nursing interventions, both patients and family members should be able to cope more effectively with limitations imposed by the respiratory disorder. Examples of effective coping behavior include active participation in developing the plan of care and performing activities of daily living. Expression of fears and anxieties related to the illness and its effects is an integral part of the coping process. Successful adaptation to the limitations imposed by the illness is evidenced by an interest in functioning at an optimal level. For some, this may mean adjusting to a change in occupation and/or a decrease in social activities [27].

Patients who require long-term management of their illness need to learn new techniques and skills. Instruction is successful if the patient and family members are able to incorporate learned health behaviors into their everyday life.

IMPAIRED GAS EXCHANGE

Any disorder of the respiratory system may result in a nursing diagnosis of impaired gas exchange, depending on the degree to which it interferes with ventilation and perfusion. This state, although abnormal, is “normal” for certain patients with respiratory disorders. For example, some patients with COPD have a higher PCO_2 and lower PO_2 than patients without a respiratory disorder. The diagnosis of impaired gas exchange may refer to three different abnormalities: respiratory acidosis, respiratory alkalosis, or hypoxia [26; 27].

Respiratory Acidosis (Hypercapnia)

Respiratory acidosis occurs when a disorder results in interference with gas exchange or decreases the amount of effective alveolar ventilation. The underlying cause of this abnormal state is always related to hypoventilation. Respiratory acidosis is observed in certain patients with COPD, pneumonia, or decreased respiratory function as a result of medication/illicit drugs or trauma. Patients in respiratory acidosis may exhibit confusion, drowsiness, headache, dizziness, tetany, asterixis, tachycardia, dysrhythmias, convulsions, and/or coma [34; 35].

Respiratory Alkalosis (Hypocapnia)

Respiratory alkalosis is the result of a low level of CO_2 or a high level of bicarbonate in the blood, usually due to hyperventilation. Any respiratory illness that leads to shortness of breath may result in this condition. Over time, hypocapnia may result in metabolic abnormalities (e.g., mild lactic acidosis), cardiac arrhythmias, and GI dysfunction.

Hypoxia

Disorders that limit the volume of air entering the lungs and produce hypoventilation result in inadequate amounts of available oxygen at the alveolar level and an impaired ability to deliver oxygen to the tissues, resulting in hypoxia. Conditions that can lead to hypoxia include restrictive lung diseases (e.g., pulmonary fibrosis), occupational lung diseases, and sarcoidosis. Hypoxia can also result from

obstructive lung diseases such as asthma, chronic bronchitis, and emphysema. Signs and symptoms of hypoxia are similar to those experienced by persons at high altitudes and include headache, restlessness, irritability, fatigue, tachycardia, hypertension, cardiac dysrhythmias, tachypnea, dyspnea, exercise intolerance, clubbing of the fingers, mental confusion, and coma. Treatment is to initiate oxygen therapy [34; 35].

Numerous nursing measures can be employed in an effort to improve the exchange of CO_2 and oxygen. These patients often require highly skilled nursing care with the assistance of mechanical ventilation. Other nursing measures that may be employed when caring for these patients include deep breathing and coughing exercises, administration of oxygen, postural drainage, and suctioning.

Nursing Evaluation

Nursing interventions for patients with gas exchange abnormalities focus on adequate oxygenation for cellular metabolism and return of arterial CO_2 levels to within the normal range [28].

When caring for the patient with hypoxia, nursing interventions are successful when there is improvement in cerebral, cardiovascular, and respiratory signs and symptoms, including an absence of (or decrease in) restlessness, irritability, impaired judgment, central cyanosis, diaphoresis, labored breathing, tachypnea, and tachycardia. Blood pressure and level of consciousness should return to the normal range for the patient, providing brain injury did not occur. Interpretation of arterial blood gas values will reveal a return to baseline normal PO_2 and oxygen saturation. A complete blood count will also show hemoglobin values within normal limits [28].

If the hypoxic state is a chronic condition, patients and caregivers will need to learn to cope effectively with the lowered oxygen level. For example, the patient and family may need to plan daily activities with adequate time for rest periods.

As with hypoxia, nursing measures for patients with hypercapnia and/or hypocapnia are successful if signs and symptoms of cerebral, cardiovascular, and respiratory impairment improve. This involves an absence of (or decrease in) confusion, drowsiness, headache, dizziness, tetany, muscle spasm/asterixis, tachycardia, and cardiac dysrhythmias. The patient will no longer experience convulsions, and the level of consciousness will improve or return to normal. Analysis of arterial blood gases will show a pH of 7.35 to 7.45 [39].

Patients with impaired gas exchange will require nursing measures to orient the patient and assist the family in coping with changes in cognition. Measures are considered successful if patients are able to provide their names, the date, the time, and the place. Family members and caregivers should have good knowledge of measures necessary to prevent the patient from self-injury [39].

DISORDERS OF THE UPPER RESPIRATORY SYSTEM

LARYNGEAL EDEMA

Edema of the laryngeal tissue may be acute or chronic. The rapidity of onset varies, depending on the underlying etiology and the response of the individual. Infections that involve the larynx may cause some degree of edema. Edema may also be related to irradiation of the neck, neoplastic diseases involving the larynx or adjacent region, or infections that alter the lymphatic drainage of the area. Laryngeal edema may also be secondary to iatrogenic injury in connection with intubation or surgical procedures. In some instances, edema occurs as a result of systemic diseases that alter capillary permeability or disturb the oncotic pressures of the plasma. Angioedema can develop as an allergic response of the tissues of the larynx. It can occur rapidly with an allergic reaction to inhalants, injected substances (including contrast media), transfusions, insect bites, foods, or medications [29].

Clinical Manifestations

The initial symptom of laryngeal edema is often hoarseness. As the condition progresses, the patient may lose the ability to speak. When inspected by indirect mirror laryngoscopy, the laryngeal structures and vocal cords may appear swollen. As obstruction becomes more severe, dyspnea, stridor, tachypnea, and cyanosis may occur. With the exception of angioedema, onset of the edema is usually gradual and involves structures other than the larynx. In the case of angioedema, symptoms and signs of laryngeal obstruction develop rapidly and the condition can progress to total obstruction and death [36].

Therapeutic Measures

Laryngeal edema is considered a medical emergency. For patients with angioedema, intravenous administration of epinephrine usually brings about rapid decrease in inflammation; corticosteroids may also be used. Tracheotomy or intubation may be required to maintain a patent airway, particularly in cases of acute onset. Laryngeal edema related to systemic disorders responds to treatments directed at the underlying condition. Serum protein and electrolyte levels may be monitored and corrected, if necessary [36].

Specific Nursing Measures

Nursing responsibilities involve obtaining a history from the patient of known allergies and documenting them in the nursing care plan and the patient's chart. Patients who have been intubated should be monitored for evidence of laryngeal edema. Emergency medications and a tracheotomy setup should be generally accessible.

FOREIGN BODY IN THE LARYNX

Foreign substances lodged in the throat may have been put into the mouth and accidentally displaced backward into the throat, or they may consist of large pieces of food or substances contained in food, such as bone. Many people hold objects in their mouths while working (e.g., pins, tacks, nails) and accidentally swallow or aspirate

them when distracted. Intoxicated individuals, or those taking sedative drugs, may aspirate gastric contents or food because their protective reflexes are impaired. People who talk while eating or eat hurriedly without chewing their food sufficiently are at increased risk, as are the elderly, patients with neurologic disorders, and those who may have poor dentition and cannot chew effectively [29; 36].

Clinical Manifestations

Any foreign body that becomes lodged in the larynx will impair respiration to some extent. If complete obstruction occurs, the victim will be unable to talk and may indicate choking by clutching the neck—the universal sign of choking. If the airway is incompletely obstructed, the victim will exhibit signs of respiratory distress; coughing, choking, or gagging indicates that some air is moving through the respiratory tract [36].

Therapeutic Measures

Total obstruction of the airway is an emergency; victims can sustain brain damage or even die in minutes if a patent airway is not restored. The Heimlich maneuver is recommended in this situation. If the maneuver is unsuccessful, a cricothyroidotomy should be performed. If the larynx is only partially blocked, endoscopic removal of the obstruction should be performed by direct laryngoscopy as soon as possible, as the object blocking the airway could shift and cause a total obstruction [36].

UPPER RESPIRATORY INFECTION

Upper respiratory infection encompasses infections of the nose and paranasal sinuses, nasopharynx, middle ear and Eustachian tube, pharynx, and larynx. Upper respiratory infections are among the most common infections and are responsible for 80% of all missed school days and 40% of lost workdays. In some cases, more severe disorders accompany upper respiratory infections. On occasion, an upper respiratory infection may spread to the lower respiratory tract [29].

Most of these infections are minor and self-limiting, but inflammation of the epiglottitis is considered an emergency because it can rapidly lead to total obstruction of the airway. This serious infection is most often caused by *Haemophilus influenzae* type B organism, but the infection has also been associated with *Staphylococcus aureus*, group A beta-hemolytic streptococcus, *Neisseria catarrhalis*, and *Streptococcus pneumoniae* [36].



EVIDENCE-BASED
PRACTICE
RECOMMENDATION

The Advisory Committee on Immunization Practices asserts that routine annual influenza vaccination is recommended for all persons 6 months of age and older.

(<https://www.cdc.gov/vaccines/hcp/acip-recs/vacc-specific/flu.html>. Last accessed

August 10, 2020.)

Level of Evidence: Consensus Statement and/or Expert Opinion

Clinical Manifestations of Epiglottitis

Typically, epiglottitis is manifested by sore throat of short duration (less than 12 hours) and rapidly increasing severity, pain in the area of the hyoid at the base of the tongue, significant dysphagia, and elevation of temperature that may reach 103 degrees F. Secretions may be so copious that the patient drools. Hoarseness is minimal, but the patient's voice may have a muffled quality. Respiratory obstruction becomes evident as the inflammation progresses. Although the enlarged, cherry red epiglottitis may be seen by means of indirect laryngoscopy, lateral x-rays of the neck taken with the patient in an upright position are a less hazardous means of diagnosis. Manipulation can aggravate edema, leading to sudden total occlusion of the airway. Cultures of blood and secretions may be used to isolate the causative organism. A leukocyte count of 18,000–24,000 cells/mcL is common [36].

Therapeutic Measures

The patient with epiglottitis should be hospitalized, because respiratory obstruction can rapidly occur. Restlessness, stridor, cyanosis, and retraction of the supraclavicular and intercostal spaces indicate a need for immediate tracheotomy. Antibiotic therapy appropriate to the organism identified by culture studies is prescribed and administered. Recovery usually follows 24 to 48 hours after treatment is initiated. Failure to recognize the seriousness of the disorder can lead to death in up to 20% of patients [29; 36].

NEOPLASMS OF THE LARYNX

Neoplasia of the upper respiratory tract can have diverse consequences. Benign tumors can have serious adverse effects related to expansion and obstruction; malignant neoplasms damage tissue by infiltration and metastasis. Any diagnosis of cancer is frightening to the patient, but neoplastic disease affecting the head and neck can be especially devastating psychologically because sensory functions (e.g., olfaction, vision) may be disturbed, and physical appearance may be seriously affected.

Although benign neoplasms of the larynx do occur, they are usually small, easily removed papillomas. Malignant laryngeal neoplasms may be classified according to locus of origin as:

- Glottic (arising from the larynx)
- Supraglottic (arising above the larynx)
- Subglottic (arising below the larynx)
- Transglottic

Glottic carcinoma is the most common and has the most favorable prognosis. Supraglottic lesions are more often associated with lymphatic metastasis and thus have a poorer prognosis. Subglottic lesions, the rarest of the four types, are less aggressive than supraglottic lesions but more so than glottic cancers. Transglottic cancer is highly invasive and tends to metastasize extensively [29]. Laryngeal cancer has a high rate of cure when detected early, but patients have consulted an average of three physicians about persistent hoarseness over a period of eight months by the time the condition is diagnosed [29].

Cigarette smoking and ingestion of alcohol are believed to be major factors in the development of laryngeal cancer. Environmental pollution (particularly air pollution), occupational exposure to radiation, and chronic pharyngeal infection have also been implicated. Although laryngeal carcinoma predominantly affects men 50 to 70 years of age, the incidence in women has been rising [36].

Clinical Manifestations

The most common symptom of benign laryngeal neoplasm is hoarseness, sometimes accompanied by dysphasia if the lesion is large. Other symptoms of laryngeal carcinoma vary according to the type of lesion [29].

Glottic Carcinoma

With glottic carcinoma, hoarseness occurs early in the course of the disorder. Pain may be felt in the latter stages, as are dyspnea and inability to speak (aphonia) [29].

Supraglottic Carcinoma

Hoarseness is uncommon with supraglottic carcinoma. Patients may report a sensation of “something in the throat” or a change in voice quality. The throat may burn when hot or acidic liquid is ingested. The patient may notice a lump in the neck, which may be the reason for consulting a healthcare provider. Pain unrelated to ulceration may occur, as may referred otalgia. Later symptoms include pain, hoarseness, and dyspnea related to obstruction of the airway [29].

Subglottic and Transglottic Carcinomas

In subglottic carcinoma, dyspnea may be the initial reported symptom; hoarseness is rare. Transglottic tumors have invaded various sections of the larynx; thus, a variety of symptoms described for the other types may occur. Lesions involving one of both vocal cords may be seen by indirect mirror laryngoscopy; supraglottic lesions are more likely to ulcerate than glottic lesions. Visualization of the subglottic area requires direct laryngoscopy.

Cervical nodes may be palpable if the lesion has metastasized. X-ray examinations will aid in determining the extent of the disease, and biopsy specimens may be removed under local or general anesthesia [29].

Therapeutic Measures

A radical neck dissection may be necessary in conjunction with total or supraglottic laryngectomy, but partial laryngectomy has the most favorable prognosis. In cases of localized carcinomas involving only one vocal cord, radiation therapy may be effective and will have less effect on voice quality than surgical excision. Radiotherapy is least effective with advanced lesions because the level of irradiation required to destroy the neoplasm causes damage to the surrounding tissues. Adjuvant chemotherapy may be employed in an attempt to shrink the tumor and eradicate micrometastases [29; 36].

TRAUMATIC DISORDERS

Trauma of the head and neck may be related to motor vehicle accidents, abuse or assaults, falls, sports activities, or occupational accidents. Trauma to the head and neck is a leading cause of morbidity and mortality in the United States. Such trauma is serious, as it can lead to sensory impairment, permanent disability, disfigurement, and death [29; 40; 41].

Maxillofacial trauma may cause extensive damage to soft tissue, bone, and cartilage. Because the nose protrudes from the center of the face, it is injured more frequently than other areas of the body. Maxillofacial trauma is related to some kind of direct blow [36; 40; 41].

Laryngotracheal trauma may be classified as open or closed and may be accompanied by neural and vascular trauma of the head and neck. Fracture of the cervical spine commonly co-occurs with this kind of injury.

Automobile accidents in which an individual is thrown against the steering wheel or dashboard at a high rate of speed are the most common cause of blunt laryngotracheal trauma. Penetrating injuries are often caused by sharp objects (e.g., stab wounds). Iatrogenic laryngeal injury can occur in relation to endoscopy, endotracheal intubation, or tracheotomy; improper endoscopic technique can dislocate the larynx or tear the laryngeal mucosa. Pressure exerted by the cuff of an endotracheal or tracheostomy tube against the arytenoid cartilage may result in formation of scar tissue (arytenoid stenosis), although this occurs less frequently with the introduction of low-pressure cuffs [36; 40; 41].

General Nursing Implications

Patients with facial, skull, or neck fractures require surgical intervention to reduce, stabilize, and immobilize the injured part. Proper nursing care of these patients can greatly facilitate healing and help avoid complications. Many head and neck injuries have psychologic consequences related to changed appearance and an inability to carry out normal activities. Patients with such injuries can benefit from instructions and support during recovery and rehabilitation [36]. In addition, nurses working in the community should advocate for safety features such as automobile seat belts and helmets while riding bicycles and motorcycles.

Assessment

Patients with upper respiratory trauma should be assessed for possible damage to the cervical spine prior to any manipulation, except emergency life-saving measures, to prevent additional neurologic damage. Assessment of cranial nerves II through X should be performed. Visual disturbances such as diplopia or decreased acuity may occur. Alteration in sensation may range from pain to hypoesthesia [36; 40; 41]. Symptoms of a fat embolus include petechial hemorrhages on the thorax.

Inspection for hemorrhage and drainage should be routine; edema and ecchymosis may occur in relation to profuse bleeding. Drainage from the nares should be evaluated for the presence of cerebrospinal fluid (CSF), which is transparent,

contains glucose, and dries as a yellow, halo-like ring and does not crust as do other types of secretions. Lacerations may be noted, with foreign debris in the wound or surrounding area. The patient may experience difficulty swallowing or speaking [30; 40; 41].

Nursing Intervention

It is important that cardiopulmonary function is maintained post-trauma. The oral cavity should be inspected, and dried blood, tooth fragments, bone splinters, and other foreign matter should be removed by suction. A tracheotomy tray should be readily available, and the nurse should be prepared to assist with intubation or tracheotomy [28].

Patients should be positioned to reduce edema and avoid asphyxiation. Elevating the head of the bed, if not otherwise contraindicated, helps decrease edema of the head and neck; application of ice is helpful during the first 24 hours after injury, with warm applications used thereafter to promote vasodilation. Blood transfusions and intravenous fluids may be given [28].

Wound care should be meticulous. This may involve cleansing and application of antimicrobial ointments. Dressings may be necessary, depending on the nature of the injury. The nurse should continually observe for signs of infection [28].

Adequate nutritional intake is crucial to healing. Depending on the patient's ability to eat, a liquid diet or intravenous fluids may be used initially. If the nature of the injury permits, nasogastric feedings may be administered. A baseline weight should be obtained upon admission, so nutritional status can be monitored.

Patients should be encouraged to take part in self-care to the maximum extent possible; doing so helps them re-establish a sense of control over their lives. Emotional support is of utmost importance for these patients, who may face long-term rehabilitation and major changes in appearance and lifestyle. Patients with disfiguring injuries may appreciate receiving information about plastic surgery [42].

DISORDERS OF THE LOWER RESPIRATORY SYSTEM

Problems of the lower respiratory tract constitute a major concern in patient care. These disorders can range from a minor bout of acute bronchitis to major life-threatening conditions such as respiratory failure. Many lower respiratory system disorders are chronic and debilitating, making it necessary for patients and their families to make long-term adjustments in lifestyle. Patients admitted to a hospital with other debilitating conditions frequently develop respiratory difficulties in the form of atelectasis, retained secretions, and pneumonia. A majority of these are preventable with good medical and nursing care.

Interpersonal nursing intervention skills are also required. Dysfunction of the lower respiratory system can arouse many disturbing feelings and concerns, including anxiety, helplessness, fear, despair, and depression. Air hunger is a primal drive—stronger even than hunger and thirst. Nurses should be equipped to deal with the problems these feelings produce and assist patients and their families to cope.

OCCUPATIONAL LUNG DISEASES (PNEUMOCONIOSES)

Occupational lung diseases result from exposure to offending respiratory agents in the workplace. The pathogenic agents can be classified as mineral (inorganic) fibers or dusts, organic fibers and dusts, or irritant gases and chemicals [29].

Pneumoconioses are lung diseases resulting from inhalation of inorganic dusts. Silicosis, asbestosis, and coal workers' pneumoconiosis fall into this category.

Clinical Manifestations

The clinical manifestations of various pneumoconioses are similar, and all can lead to pulmonary fibrosis. This condition causes the lungs to become stiff and non-elastic, reducing lung volume. The development of a thickened pulmonary membrane can interfere with gas exchange [29; 36].

Silicosis

Silicosis may occur in various forms. The most common is chronic or classic silicosis, which occurs in individuals who have inhaled relatively low concentrations of dust over long periods (i.e., 10 to 20 years). Initially, the accumulated dust and tissue reaction result in the development of scattered nodules throughout the lungs and shortness of breath upon exertion. Over time, silicosis may become more serious, resulting in increased shortness of breath, cough, and sputum production. In complicated silicosis, fibrosis of the lung occurs, leading to restriction in lung function and right-sided heart failure. Respiratory impairment is severe.

Those with silicosis may also develop tuberculosis and/or Caplan syndrome, characterized by rheumatoid arthritis and concomitant fibrotic lesions. Acute silicosis, most commonly due to exposure to high concentrations of silica dust (as with sand blasting), is a rapidly progressive disease leading to severe disability and high mortality within five years of diagnosis [29; 36].

Asbestosis

Asbestosis is a diffuse interstitial fibrosis of the lungs resulting from the impact and deposition of asbestos fibers on the alveolar walls. As the fibrosis becomes widespread, the elasticity and compliance of the lung are reduced. Fibrosis results in a thickening of the alveolar walls and interstitial space, which in turn reduces the oxygen diffusion to the pulmonary capillary bed. Pulmonary function studies show a reduced forced vital capacity. X-rays reveal linear opacities, especially in the lower lung fields. Unfortunately, there are few physical symptoms and signs until the disease is relatively advanced. Individuals may seek help for a productive cough, shortness of breath, and/or weight loss. Asbestosis has no cure and is associated with a high mortality rate.

Lung cancer is also associated with all types of asbestos inhalation. Malignant mesothelioma, a cancer that usually affects the pleura, is a significant cause of death among high-risk workers (e.g., dock workers) [29; 36].

Coal Workers' Pneumoconiosis

Coal workers' pneumoconiosis results from the inhalation and accumulation of coal dust in the lungs, also known by the name "black lung disease." Simple coal workers' pneumoconiosis is not complicated by other lung conditions and causes no symptoms or respiratory difficulty. A small percentage of patients develop progressive massive fibrosis with large lesions consisting of fibrous tissue, coal dust, and central cavitation. Patients may produce thick, black sputum and suffer from shortness of breath and dyspnea. X-ray reveals large opacities, and pulmonary function studies indicate an obstructive deficit. The large-mass lesions may eventually lead to pulmonary hypertension, cor pulmonale, and death from congestive heart failure [29; 36].

Therapeutic Measures

Thorough patient history, pulmonary function studies, and chest x-ray assist in the assessment and diagnosis of pneumoconioses. Therapeutic measures are supportive rather than curative. Superimposed respiratory tract infections are treated with antibiotics. Antituberculosis medications are administered if tuberculosis develops, and bronchodilators may be beneficial when there is evidence of a reversible obstructive component [29; 36].

Oxygen therapy may be necessary for individuals with low PO_2 levels; however, administering O_2 at too high a flow rate may depress the patient's stimulus to breathe. Cardiotonic drugs may be prescribed if the cardiovascular system has been affected. Bronchial hygiene measures, such as deep breathing, coughing, and postural drainage, are often indicated [36].

Specific Nursing Measures

Nursing management of patients with pneumoconioses is generally supportive. It is important to stress the importance of avoiding further exposure to the harmful agent(s) and other irritating substances, including cigarette smoke. Answering patient questions, describing the disease process, and explaining treatments will empower patients to be involved in their own care.

Even in the face of serious disease, many people will be reticent to leave their occupation, especially after years of commitment and specialized training. Others, unable to leave a geographic area and with responsibility for a family, will feel their options are limited. Some may choose to stay in a job even though it interferes with their health. If nurses acknowledge the reality of the patient's situation, health teaching efforts may be more readily accepted [36].

ACUTE RESPIRATORY DISTRESS SYNDROME

Acute respiratory distress syndrome (ARDS) is a pathophysiologic state best recognized in patients with no previous underlying lung disease who experience a sudden, catastrophic, often multisystem insult that leads to the development of severe dyspnea, hypoxemia, loss of pulmonary compliance, and noncardiogenic pulmonary edema. ARDS is not a clearly defined disease, but is rather an umbrella term for a group of conditions of different etiology having similar manifestations. Many factors can lead to the development of ARDS, including major insults such as shock, multisystem trauma, aspiration, overwhelming systemic infections (sepsis), drug overdose, and inhaled toxic substances. ARDS has also been called shock lung, white lung, Da Nang lung, adult hyaline membrane disease, stiff lung syndrome, and wet lung.

Estimates of the incidence of ARDS in the United States range from 64.2 to 78.9 cases per 100,000 persons [43]. Twenty-five percent of ARDS cases are initially classified as mild and 75% as moderate or severe. Approximately one-third of mild cases progress to moderate or severe disease. The mortality rate of ARDS is commensurate to the severity of disease—27% for mild disease, 32% for moderate disease, and 45% for severe disease [43].

Clinical Manifestations

There is often a latent period of 12 to 48 hours between the initial injury or insult and the development of ARDS. The pathophysiology is the result of diffuse damage to either side of the alveolar-capillary membrane. Whether the initial damage is alveolar or capillary, the result is an increase in vascular permeability with edema and hemorrhage. Fluid and red blood cells leak into the interstitial space and the alveoli. The resulting pulmonary edema leads to decreased lung volume and impaired oxygenation. The presence of fluid in the alveoli causes a decrease in surfactant activity, leading to an increased tendency of the alveoli to collapse. In alveoli that are collapsed or filled with edema fluid, little or no ventilation can take place. Because oxygen-poor blood is still perfused to these non-ventilated alveoli, the result is an abnormally low ventilation-to-perfusion ratio, with an increased right-to-left intrapulmonary shunt. This is responsible for the severe hypoxemia associated with ARDS that is refractory to increases in inspired oxygen concentrations [39].

Therapeutic Measures

Prevention and early identification are key, and the first step is identifying patients who are at risk for developing ARDS. These patients should be closely monitored for early signs of abnormal lung functioning so preventive measures can be instituted. Treatment of ARDS requires that the patient's ventilation be supported and adequate inspired oxygen be delivered to correct the life-threatening hypoxemia [39].

After ARDS has been diagnosed, nursing care becomes complex. The patient's airway requires suctioning and postural drainage, and proper management of the endotracheal or tracheostomy tube is necessary. Close attention should be paid to arterial blood gas values and fluid balance. Daily weights and accurate intake and output records are important. Electrolyte imbalances should be assessed and addressed as necessary [39].

The cardiovascular system may be affected by the various therapeutic interventions. Measurements of central venous pressure, pulmonary artery pressure, and pulmonary capillary wedge pressure are frequently made in the intensive care setting. Because these patients are acutely ill, they and their families require emotional support [39].

ACUTE TRACHEOBRONCHITIS

Of all infectious diseases, lung infections are the most common life-threatening diseases, accounting for significant morbidity and mortality. A variety of organisms (e.g., viruses, bacteria, fungi) can cause respiratory infections. One such infection is acute tracheobronchitis, a condition involving inflammation of the trachea, bronchi, or both. Although it is usually the result of an infection, it can also be due to an irritant or allergic reaction. Symptoms include cough, wheezing, and sore throat.

Therapeutic Measures

Treatment focuses on palliation of symptoms, because the condition is generally self-limited and resolves relatively quickly. In some cases, antibiotics are prescribed to prevent infection spreading through the respiratory tract into the larger bronchi [44].

ACUTE BRONCHITIS

Acute bronchitis is primarily an infection of the larger bronchi in patients whose airways are otherwise normal. This infection is most commonly viral in etiology and usually starts as an extension of an upper respiratory infection.

Clinical Manifestations

The major symptoms of acute bronchitis include cough, a burning substernal sensation (often aggravated by a deep breath), and sputum production. As the infection progresses, sputum becomes mucoid or purulent. The patient may or may not have an elevated temperature. Malaise, muscle aches, and headache are common. Chest auscultation reveals rales, rhonchi, and wheezes. The disease is self-limiting, and the duration depends on the underlying causative organism. Smoking tends to prolong and aggravate the condition [44].

Therapeutic Measures

Treatment of acute bronchitis is aimed at relieving the symptoms. Bed rest, hot or cold steam inhalation, and intermittent positive pressure breathing will loosen secretions so they can be more easily expectorated. Antipyretics (e.g., aspirin) may be ordered if temperature is elevated; expectorants or antitussives may be necessary to loosen secretions or to quiet a chronic, nonproductive cough. Lozenges may be used to soothe an irritated throat. Antibiotics are not routinely given unless sputum cultures identify a bacterial infection [44].

In more debilitated patients who have a poor cough reflex, suctioning may be necessary. Increased fluid intake of at least 2–3 L/day should be encouraged (unless contraindicated) to help prevent dehydration and to keep respiratory tract secretions more easily expectorated. Nutritional management should include light meals that are easily tolerated and digested to meet caloric needs [42].

PNEUMONIA

Pneumonia is an infection of the lower respiratory tract that is usually accompanied by cough, fever, malaise, and chest x-ray abnormalities. Sputum production, dyspnea, hypoxia, and hemoptysis may be present in some individuals with pneumonia, depending on the causative organism. The disease is further classified as community-acquired, health-care-associated, or hospital-acquired according to how and where it was contracted.

The Infectious Diseases Society of America (IDSA) defines community-acquired pneumonia (CAP) as an acute infection of the pulmonary parenchyma frequently associated with at least two symptoms of active infection occurring in individuals who have not been hospitalized or resided in a long-term care facility for 14 days before the onset of symptoms [45]. In most cases of CAP, diagnosis is made by history and physical examination; identification of the etiologic agent is not always necessary. The most clear-cut indication for extensive diagnostic testing is in the critically ill patient with CAP [46]. Although the list of organisms causing CAP is long and increasing, relatively few organisms are responsible for most cases of pneumonia [46].

Hospital-acquired pneumonia (HAP) is defined as any pneumonia in a patient who has been hospitalized 48 hours prior to onset of symptoms and that was not incubating prior to admission [47]. Ventilator-associated pneumonia (VAP) refers to a pneumonia that develops at least 48 hours after intubation and the initiation of mechanical ventilation. An additional subtype of pneumonia is healthcare-associated pneumonia (HCAP), which refers to pneumonia in patients who are not hospitalized but have had contact with the healthcare system. Guidelines for patients with HCAP were previously included with those for HAP and VAP due to patients' contact with the healthcare system and the presumed high risk of multidrug-resistant pathogens. However, recommendations specific to HCAP were removed from the updated 2016 IDSA guidelines for the management of HAP and VAP due to increasing evidence that patients defined as having HCAP are not necessarily at high risk for multidrug-resistant pathogens. Although interaction with the healthcare system potentially puts patients at risk for these pathogens, underlying patient characteristics are important independent determinants of risk [47].

As stated, multidrug-resistant bacterial pathogens are very often a cause of HAP and VAP. Pathogens responsible for multidrug-resistant pneumonias can include *Pseudomonas aeruginosa*, *Acinetobacter* spp., and methicillin-resistant *Staphylococcus aureus* (MRSA).

Aspiration pneumonia is an infectious process caused by inhalation of oropharyngeal secretions that are colonized with bacteria. Aspiration pneumonia is distinct from aspiration pneumonitis (caused by the inhalation of sterile gastric contents), but the syndromes can overlap. This type of pneumonia is a major cause of morbidity and mortality in both nursing home residents and hospitalized patients [48].

Atypical pneumonia is a term used to refer to pneumonia caused by bacteria and nonbacterial organisms that do not share characteristics commonly found in patients with pneumonia. Causative agents include *Legionella* spp., *Mycoplasma pneumoniae*, *Chlamydia* spp., and *Coxiella burnetii* [47].

The most common cause of bacterial pneumonia is the gram-positive bacterium *Streptococcus pneumoniae*, estimated to be the cause of 20% to 60% of pneumonia cases [49]. Possible gram-negative infective organisms include *Haemophilus influenzae*, *Klebsiella pneumoniae*, and *Moraxella catarrhalis*. *K. pneumoniae* infections are more commonly diagnosed when there is co-existent alcoholism [45; 47]. *S. aureus* and *H. influenzae* infections often occur after a primary influenza infection. *M. catarrhalis*, an organism not thought to be pathogenic, is most commonly found in those with chronic lung conditions, such as COPD [50]. It is also found in patients with diabetes, who are taking steroids, or who have other underlying chronic lung conditions or malignancy [50].

Another organism known to cause pneumonia is *Legionella pneumophila*. This organism was first implicated in 1976 after 182 people became ill in Philadelphia while attending an American Legion convention [51]. The organism is a gram-negative bacillus that survives in water and soil. Infection with the organism is acquired through inhalation of aerosolized droplets, making air-conditioning ventilating systems an obvious reservoir.

Potential atypical and nonbacterial organisms responsible for pneumonia include *M. pneumoniae*, *Chlamydia pneumoniae* (the Taiwan acute respiratory [TWAR] strain), and multiple viruses. Mycoplasma organisms lack cell walls and cannot be stained and visualized by conventional methods. Infection with these organisms usually causes disease in younger individuals and follows a milder course than that seen in patients with bacterial pneumonia. Chlamydial infection also manifests as a mild infection spread from person to person by aerosolized droplet secretions.

Pneumonia remains one of the leading causes of morbidity and mortality in the United States, especially in older adults and in those with underlying chronic disease. It is the leading cause of death from infectious disease and the eighth most common cause of death overall in the United States (along with influenza) [52]. It is estimated that 4 million episodes of pneumonia are diagnosed in the United States every year, with a total of 30 million days of disability [53; 54]. The World Health Organization (WHO) estimates that 54 million people die from pneumonia every year, with a bimodal distribution of mortality, with peaks in children younger than 5 years of age and adults older than 75 years of age [55]. Worldwide, pneumonia killed an estimated 808,694 children younger than 5 years of age in 2017, with the majority of these deaths occurring in South Asia and sub-Saharan Africa [56]. These are surprising statistics given the advent of broad-spectrum antibiotics, a multivalent pneumococcal vaccine, and sophisticated hospital care.

The elderly have the highest rates of CAP in the United States [57; 58; 59]. Aging is associated with a variety of declines in immune function (immune senescence) and prevalent comorbidities. As a result, the elderly constitute the largest immunocompromised population in the United States, putting them at risk for new infectious agents. Pathogens that are not typical causative agents of pneumonia must be considered as possible etiologic agents in the elderly. As a result, older

adults are more likely to have CAP caused by a resistant organism or tuberculosis and to require hospital admission [60].

Therapeutic Measures

The successful treatment of pneumonia depends on the correct empiric antibiotic selection and knowledge of its proven effectiveness in vivo. A working knowledge of the organisms that most commonly infect different age-groups and the habits or characteristics that put an individual at risk for specific etiologic agents is essential. Polyvalent pneumococcal vaccine can be used to prevent the development of pneumococcal pneumonia, providing protection for at least three years against 23 serotypes causing 75% of this type of pneumonia [61].

Antipyretics and analgesics such as acetylsalicylic acid or acetaminophen may be given. Narcotics may be required if chest pain is severe; codeine is most frequently given. Expectorants are given to reduce the viscosity of pulmonary secretions; terpin hydrate may be given orally or acetylcysteine by nebulization. Antitussives may be ordered to treat nonproductive cough [62; 63].

Patients with more severe disease may require bed rest or hospitalization. Intermittent positive pressure breathing along with other pulmonary hygiene measures, such as postural drainage, may be ordered. Supplemental oxygen may be necessary if PO₂ levels become too low. Hospitalized patients may receive intravenous fluids to replace fluid and electrolyte loss caused by an elevated temperature, increased cellular metabolism, tachypnea, and diaphoresis. Between 3 and 4 L of fluid per day are required unless contraindicated. If the patient is unable to eat, nasogastric feedings or hyperalimentation may be ordered. If respiratory failure occurs, intubation and mechanical ventilation are required. Depending on the infectious agent, patients may have to be placed in respiratory isolation. If a pleural effusion develops, a thoracentesis may be performed [33].

Specific Nursing Measures

Although the etiology and signs/symptoms of pneumonias vary, the overall nursing care is similar. Care for hospitalized patients should be organized to allow periods of uninterrupted rest combined with turning, range of motion exercises, coughing, and deep breathing at least every two hours. Postural drainage measures may also be needed. If patients are not able to expectorate secretions effectively, tracheal suctioning may be required [64].

Careful monitoring and assessment of respirations is necessary to identify improvements or deteriorations in the patient's condition. Nurses should remain alert to potential pulmonary complications of pneumonia, including pleurisy, pleural effusion, empyema, lung abscess, and pulmonary edema (which may lead to respiratory failure). Monitoring for systemic complications (e.g., septicemia, septic shock, meningitis, endocarditis, renal and liver involvement) is also important to ensure early recognition and treatment [65].

Because sputum specimens play an important part in identifying the causative organism, efforts should be made to collect an adequate sample. Tracheal suctioning may be required for patients who cannot cough effectively. If the patient has an elevated temperature and is diaphoretic, tepid baths and frequent changes of bed linen are needed as comfort measures and to prevent chilling [66].

As noted, keeping the patient hydrated is important. In hospitalized patients, fluid intake should be closely monitored, and set amounts should be given for each shift. Urinary output is a good indicator of hydration. If patients can eat, good oral care may help to improve the appetite. Splinting the chest during coughing and deep breathing exercises will help to reduce chest pain.

Discharge planning involves reviewing medication actions and side effects with the patient and family. Patients with an underlying chronic debilitating condition should be advised of their increased susceptibility to respiratory tract infections and techniques to avoid infections that may lead to further pneumonia. If these measures are not at least attempted, the risk of recurrence is increased [64; 65].

Specific nursing measures should be employed to prevent aspiration. Patients with altered consciousness should be placed on their side with the foot of the bed elevated 6–9 inches unless contraindicated. The head of the bed should be elevated at least 30 degrees during and for one hour after feeding. Gag and cough reflexes should also be checked before feeding. Before administering a nasogastric feeding, check for proper placement of the tube in the stomach. Aspirate for stomach contents, and if 100 mL or more is withdrawn, hold the feeding and consult with the physician. The tube feeding should be administered slowly over 30 minutes. If tube feeding is continuous, the head of the bed should be kept elevated. Frequent oral care and removal of secretions that accumulate in the back of the throat will help to prevent the aspiration of organisms into the lower respiratory tract [66].

TUBERCULOSIS

TB, also historically called the “white plague” and “consumption,” is a disease that has plagued the citizens of nearly every nation in the world for centuries. It has produced acute, chronic, and latent diseases involving every organ in the body, although the lungs remain the primary site of infection. The disease is caused by a group of similar bacilli, most commonly *Mycobacterium tuberculosis*, which is often abbreviated as *M. tuberculosis* or as MTB.

In a global perspective, the effect of TB on the health and economy of the world is staggering. It has been estimated that 2 to 3 billion people worldwide have become infected with *M. tuberculosis* and are therefore at risk for developing active clinical disease within their lifetime. This represents more than one-third of the world's population. In 2018 alone, 10.0 million new cases of active clinical disease and 1.2 million deaths from TB-related causes were reported by the WHO [67]. TB ranks as a leading cause of death among individuals with HIV or acquired immune deficiency syndrome (AIDS) worldwide, and 251,000 TB deaths are among HIV-positive individuals [67].

In 2018, a total of 9,025 TB cases were reported in the United States, a 0.7% decline from the 2017 rate, continuing the decrease in incidence rates for more than 20 years [68]. This represents an incidence of 2.8 per 100,000 population. Incidence varied significantly among states, from 0.3 per 100,000 population in West Virginia to 8.5 per 100,000 in Alaska [68]. Overall, the incidence of TB remained the same from 2017 to 2018; however, the nation has not yet achieved the 2025 national target of less than 1.3 TB cases per 100,000. In 2018, 42 states reported incidences at or below the national average of 2.8 cases per 100,000 [68]. California, Florida, New York, and Texas combined account for more than half of all cases in the United States [68].

Clinical Manifestations

There are three stages of infection seen in persons with pulmonary TB: primary or initial infection; latent or dormant (asymptomatic) infection; and secondary or reactivation infection. All three must be considered and treated when patients present with TB-specific symptoms.

The early symptoms of active pulmonary TB are often so subtle as to be missed at first by most patients. Because of this, they will frequently have difficulty pinpointing exactly when their illness began. Some patients without obvious symptoms

are diagnosed solely by a routine chest x-ray. For those who do have symptoms, the most common manifestations are gradual onset and progression of fever, malaise, cough, anorexia, and weight loss. The fever is one that is not so high as to be noticed or to be disquieting. When the fever breaks during the early morning hours, it is often associated with "night sweats." Weight loss may result from the infectious process itself, or it can be a sign that malnutrition and depletion of immune reserves preceded, and to some extent caused, the infection.

Cough is generally nonproductive at first, then later productive of purulent sputum. With progressive cavitation in the lung, the patient develops hemoptysis. Bleeding results from the necrosing walls of cavitory lesions in the lungs or from the rupture of small venules in the walls of inflamed bronchi.

Chest pain, usually pleuritic in nature, arises from infection of the pleural surface and the resulting effusion. If there is extensive lung destruction, dyspnea will also occur, which eventually leads to respiratory failure and death.

Therapeutic Measures

With appropriate antibiotic treatment, TB can be cured in most people. Six drugs (isoniazid, rifampin, rifabutin [off-label], rifapentine, pyrazinamide, and ethambutol) are rated as first-line because they are frequently effective and have low toxicity for most patients with TB. A successful treatment outcome depends greatly on patient compliance with the prescribed combination of drugs. Patient noncompliance with the prescribed regimen may lead to failed resolution, early relapse, and the emergence of resistant strains. Successful treatment of drug-resistant TB is difficult and involves the use of less effective, potentially more toxic medications that must be administered for as long as two years. Even more severe is extensively drug-resistant TB, which is caused by a strain that resists even the second-line agents [69; 70].

In cases of ineffective breathing, the patient may have decreased lung volume and lung capacity due to the TB. Increased metabolism may also be a factor in patients with high fevers. Some patients may have a frequent productive cough and hemoptysis. These issues are defined by increased respiratory rate, the use of accessory muscles to breathe, retractions, diaphoresis, and tachycardia. The therapeutic interventions are to administer oxygen as necessary, push fluids and promote hydration to liquefy secretions, and maintain semi-Fowler's position to ease breathing.

Specific Nursing Measures

Patients with TB who require hospitalization are routinely placed in isolation in negative air pressure rooms, if available. Careful handling and disposal of secretions, the avoidance of direct face-to-face contact, and the use of respirators are recommended. The patient's room should be properly ventilated with non-recirculating air. Laminar flow or ultra-violet lighting will accomplish the same purpose as non-recirculating ventilation. Patients should be instructed to cover their nose and mouth when they cough or sneeze. Patients unable to cover their mouths should be masked when direct care is given. Within two weeks after chemotherapy is begun, the possibility of transmitting the disease is markedly reduced [71].

Because strict adherence to the medication schedule is required for effective treatment, patients should receive extensive education on prescribed medications and the need to continue taking medications for six to nine months. The importance of follow-up should be stressed, not only so progress can be monitored but also to check for possible side effects from the medications and to make sure drug resistance has not developed. Patients should be instructed to see a physician immediately if symptoms of TB recur or if they develop any medication side effects [65].

LUNG ABSCESS

A lung abscess is a circumscribed suppressive area of inflamed and infected lung parenchyma associated with central tissue necrosis. Communication with the bronchial tree results in the eventual expectoration of purulent material.

Single lung abscesses usually result from an inflammatory response to a bronchial obstruction. The aspiration of foreign material, such as food, gastric contents, or blood, can lead to obstruction. Benign or malignant tumors or large amounts of thick, sticky secretions can also obstruct an airway. Pneumonia, although not as common a cause of lung abscess formation, may be a causative factor in some cases. The organisms most frequently responsible for lung abscess formation are *S. aureus*, *K. pneumoniae*, some strains of mycobacteria, *Bacteroides* spp., and certain fungi and parasites, such as the lung fluke. Immunosuppressive therapy and alcohol abuse are predisposing factors in the development of lung abscesses [71].

Clinical Manifestations

The most common symptoms of lung abscess include fever, chills, malaise, anorexia, cough, and pleuritic chest pain. When the abscess ruptures into a bronchus, the cough is productive of copious amounts of purulent sputum, which may be foul smelling, bloody, and dark brown in color. Cavitory lesions that result from abscess formation are visible on chest x-ray. The prognosis of lung abscess, if not complicated by an underlying malignancy or other progressive lung disease, is generally good if the organism responsible is treated [71].

Therapeutic Measures

In cases of lung abscess of bacterial origin, standard therapy consists of clindamycin 600 mg IV every eight hours. Alternatives include penicillin, lincomycin, or erythromycin; in some cases, streptomycin or tetracycline may be added. Antibiotics are usually given for at least six weeks [21].

Bronchoscopy is indicated for removal of foreign matter that may be blocking a bronchus or to obtain a specimen for diagnostic purposes. Pulmonary hygiene measures, such as postural drainage and suctioning, may be ordered. Surgical drainage of an abscess by means of a thoracotomy or chest tube is rarely performed today but may be done if the abscess is resistant to antibiotic therapy or is larger than 6 cm in diameter [21].

Specific Nursing Measures

Nursing measures for patients with lung abscess include coughing and deep breathing exercises, tracheal suctioning, and postural drainage. Good oral hygiene in patients who are unconscious is important because bacterial growth in the oral cavity can worsen infections.

EMPHYEMA

Empyema is the accumulation of pus in the pleural space or a purulent pleural effusion. The use of antibiotics in the treatment of lung infections has greatly reduced the occurrence of empyema, but it can develop as a complication of a penetrating chest wound or thoracic surgery [71].

Clinical Manifestations

Fibrous adhesions between the lung and the chest wall can develop as part of the inflammatory process. Common symptoms include fever, pleuritic chest pain, dyspnea, and anorexia. Breath sounds are absent over the affected area, and there is dullness to percussion. There may be a productive cough; blood-stained sputum can result from the development of a bronchopleural fistula. The prognosis for individuals with empyema is good if it is properly and promptly treated with antibiotics and/or surgery [71].

Therapeutic and Nursing Measures

Antibiotic therapy is selected on the basis of Gram stain and culture and sensitivity reports. Surgery is also usually required. A thoracentesis is usually performed to make a definitive diagnosis. A chest tube is then inserted to drain the pleural space. Repeated needle aspirations may be performed in lieu of chest tube insertion [21].

Nurses should provide education and support to patients with empyema. Oral care should be conducted before and after meals. Because empyema is an infectious disease, it is crucial to maintain a clean environment and to teach patients proper cough/sneeze cover and disposal of used tissues.

HISTOPLASMOSIS

Fungal infections (mycoses) of the lungs are generally the result of infectious spores that are inhaled into the distal air spaces, where they multiply and cause an inflammatory response. The infection can then spread from the lungs to other organs, including the skin, bones, and the central nervous system. Many fungi can cause respiratory diseases, all of which have similar pathologic findings, symptomatology, and treatment. Coccidioidomycosis, histoplasmosis, and blastomycosis are three of the most common endemic fungal infections in the United States, with prevalence varying by region [71].

Histoplasmosis is caused by the dimorphic fungus *Histoplasma capsulatum*. It occurs worldwide, but in the United States, it is more prevalent in the Mississippi and Ohio River valleys. The organism flourishes in a temperate climate, and its growth is enhanced in soil that contains chicken, starling, or blackbird droppings or bat guano. The fungi become airborne and may be inhaled when the soil is disturbed; transmission from person to person does not occur [71].

Clinical Manifestations

After the spores of *H. capsulatum* are implanted in the lungs, they mature and rupture, releasing yeast forms of the organism. These yeast forms are surrounded and engulfed by macrophages, similar to the process seen with tuberculosis. Caseating granulomas form, and delayed hypersensitivity develops. Invariably, the organism invades the bloodstream, spreading to various organs, especially the liver and spleen. In most cases, the disease is self-limited. Histoplasmosis can be asymptomatic, acute, or chronic. Acute histoplasmosis is most common in infants and small children; acute his-

toplasmosis in adults is most often a reinfection with a large number of fungi. Symptoms include fever, chills, malaise, dry cough, and muscle aches. Pulmonary infiltrates plus hilar and mediastinal lymphadenopathy are visible on x-ray. Symptoms of this form of histoplasmosis usually persist for five to seven days. Lesions on the lung eventually calcify, leaving a so-called “buck shot” appearance. In some cases, a severe pneumonia results. Acute disseminated histoplasmosis is rare. Patients who are immunosuppressed and young children are more likely to develop this form of histoplasmosis [71].

Therapeutic Measures

A *Histoplasma* antigen skin test is available for diagnosis. However, skin testing is of limited value because of the high rate of false-positive and false-negative results. Serologic tests can be done, but they are often made positive by the histoplasmin skin test, so blood should be drawn prior to the skin test. The organism can be better identified from cultures of sputum, blood, urine, and tissue biopsy. No antifungal medication is required for primary histoplasmosis under most circumstances. However, in cases of chronic progressive pulmonary disease and acute disseminated disease, IV amphotericin B is recommended, followed by an extended course of itraconazole [23]. Surgery is rarely performed but may be done to resect compressing nodes, if necessary [21].

Specific Nursing Measures

Nursing care for patients with pulmonary mycoses focuses on explaining the disease and treatment and monitoring for potential side effects of treatment. Patients and their families may be apprehensive that the disease is contagious, so it is important to explain that person-to-person transmission does not occur.

Because the primary drug used in the treatment of histoplasmosis, amphotericin B, can cause kidney damage and other adverse effects (e.g., liver damage, severe chilling, hypotension), the administration of this medication should be monitored

closely. Patients should be questioned about any side effects experienced, and laboratory tests of hepatic and renal function may be ordered. The color and consistency of urine should also be monitored and urinary output measured. The patient's skin should be inspected in natural light to detect any jaundice [64; 65].

BRONCHIECTASIS

Bronchiectasis is a permanent abnormal dilation of one or more large bronchi caused by destruction of the elastic and muscular components of the bronchial wall. While the number of people developing bronchiectasis as a complication of severe pulmonary infection is decreasing, bronchiectasis remains a common complication of certain systemic disorders, particularly cystic fibrosis [71].

The basic disturbance in bronchiectasis is a congenital or acquired weakness of the bronchial wall. Anomalies of the bronchial system can lead to bronchiectasis by promoting infection in the involved airways. For example, immotile cilia syndrome, a genetic disorder causing immobility of cilia in the respiratory tract, leads to recurrent sinus and bronchial infections and eventually bronchiectasis. Certain hereditary immunodeficiency diseases are also frequently complicated by bronchiectasis because affected patients are predisposed to infections of the upper and lower airways [71]. Occasionally, bronchiectasis may follow the aspiration of corrosive chemicals or gastric fluid.

Most forms of bronchiectasis are associated with prolonged respiratory tract infections and bronchial obstruction. At times, it is difficult to determine whether the infections caused the bronchiectasis or if the infection is superimposed on an underlying congenital, hereditary, or local obstruction. Those most likely to develop bronchiectasis have disorders with diffuse airway involvement such as cystic fibrosis, bronchial asthma, chronic bronchitis, and ciliary immobility disorders [71].

Clinical Manifestations

The primary clinical feature of bronchiectasis is a chronic, loose cough that is usually productive of large amounts of mucopurulent, often foul-smelling sputum. Hemoptysis is a frequent occurrence, and recurrent bronchopulmonary infections are common. Patients may develop dyspnea, chronic malnutrition, fatigue, and anemia as the disease progresses.

Auscultation of the chest usually reveals rales. Chest x-ray may show chronic inflammatory changes, including recognizable dilations. Arterial blood gas values reveal a reduced PO₂ because of perfusion of poorly ventilated alveoli; PCO₂ is often normal. The prognosis of severe untreated bronchiectasis is generally poor, but the use of antibiotics has improved the outlook for this disease [71].

Therapeutic Measures

The cornerstone of treatment in bronchiectasis is daily bronchial hygiene with postural drainage, which usually has to be continued for life. Adequate hydration and humidification along with intermittent positive pressure breathing are necessary to assist in the liquefaction of bronchial secretions. Bronchodilators are indicated when bronchospasm compounds the problem [1; 10].

Antibiotic therapy is necessary if an infection develops in association with bronchiectasis. The choice of antibiotic is guided by results of sputum culture. However, prolonged use of antibiotics, especially multiple antibiotics, should be avoided. Treatment of accompanying sinusitis with decongestants and humidified air is also important [63; 72].

Specific Nursing Measures

Because bronchiectasis is a chronic condition, patients and their families will require instruction on long-term care, including how to perform deep breathing and coughing exercises and bronchial drainage. Adequate fluid intake and humidified air may also help. Patients should avoid exposure

to infectious diseases and other situations, such as smoke or heavy smog, that could aggravate their conditions.

Nutritional management should be stressed, because patients with bronchiectasis are often anorexic. A nutritious diet is necessary for patients' immune systems to ward off respiratory tract infections [36]. Good oral hygiene and adequate rest are also important. Bronchial hygiene measures before meal times may help reduce coughing and expectoration during eating. Patients should be encouraged to receive appropriate immunizations, particularly influenza and pneumococcal vaccines [42].

ASTHMA

Asthma is considered a chronic, albeit reversible, respiratory disorder. This inflammatory condition produces hyper-reactive and hyper-responsive airway and lungs, causing episodic, reversible airway obstruction through bronchospasms, increased mucus secretions, and mucosal edema [73; 74; 75]. The hyper-reactive lungs of patients with asthma are more sensitive than most individuals' and may become inflamed or edematous when exposed to irritants, such as cold air, animal dander, dust, tobacco smoke, or grass [74; 75]. The patient's immune system over-reacts to these irritants, constricting the airways and filling them with mucus; constricted airways interfere with the movement of air in and out of the lungs, making breathing difficult [74; 75].

Asthma is marked by recurrent episodes of wheezing, breathlessness, chest tightness, and/or coughing. Usually, these periods are associated with widespread but variable airflow obstruction followed by a period of relief, either spontaneously or in response to treatment [76]. Asthma has many puzzling aspects, and its symptoms may wax and wane, especially seasonally [74]. Unlike other respiratory diseases, such as COPD and emphysema, in which air trapping and hyperinflation of the lungs also occur, asthma is reversible with the use of proper medications and therapies. Long-term lung tissue damage can occur when asthma attacks occur frequently or when the disorder is poorly controlled.

Permanent damage would require many instances of severe attacks. In children, whose lungs are still developing, the risk of long-term damage is greater.

In 2016, an estimated 339 million people worldwide had asthma. Most asthma-related deaths occur in low and lower-middle income countries. According to the World Health Organization, there were 417,918 deaths due to asthma worldwide in 2016 [77].

The global increase in asthma incidence and its impact on public health are also evidenced in the United States. In 2018, it was estimated that 7.7% of Americans (approximately 24.7 million people) had asthma [78]. The number of individuals diagnosed with asthma increased from 7.3% in 2001 to 7.9% in 2017 [79]. As of 2018, current asthma prevalence in the United States is 7.7% (19.2 million) among adults and 7.5% (5.5 million) among children [80].

The cause of the proliferation of asthma in the last few decades is not yet known, although some have attributed the rise to environmental factors and expansion of the condition's diagnostic criteria. The National Health Survey questions, from which most of the statistics on asthma prevalence are obtained, changed slightly after 1997, causing a shift in how the condition and associated statistics were reported [81; 82]. In 2001, the CDC introduced a more precise measurement of asthma. Since then, the trend has remained stable at historically high levels [82].

Clinical Manifestations

There are essentially five key elements of an asthma attack: muscle spasm, excess mucus, coughing, wheezing, and fatigue. While not all five elements are present for all patients, they are the most common physical manifestations of an episodic attack of the condition and should be evaluated and treated urgently.

Muscle Spasm

In response to irritation and immune response, muscles on the outer layer of the bronchi contract, causing a bronchospasm. Tightened muscles restrict the movement of air. Depending on the degree of airway narrowing, which differs for each patient and with the severity of the attack, the characteristic breathing difficulty, chest tightness, wheezing, and coughing will follow [74].

Excess Mucus

Inflammation can produce excess mucus as a protective mechanism. During an asthma attack, glands secrete excessive amounts of thick mucus to compensate for the increased amount of irritants or allergens. The excess mucus clumps together in the airways, further narrowing the bronchial tubes by partially blocking the passageway and hindering breathing. This increased amount of mucus can also form plugs that clog very small airways. During an asthma episode, some patients attempt to clear their airways by coughing up what seems to be a mucus plug. However, patients may produce many plugs; consequently, they may have a continuous, irritating hacking cough. If left untreated, mucus plugs can prolong asthma episodes and increase the risk of infection [74].

Coughing

When secretions become too thick for cilia to handle, the system responds by coughing to remove the unwanted substance. Dry coughs in patients with asthma are generally the product of extra-thick mucus plugs or bronchioles so blocked that the mucus cannot be removed or moved through. Nasal and sinus drainage, a common symptom of allergies, may also irritate airways and produce a nagging, unproductive cough [74]. If a patient has been mouth breathing, the airways may become dry and have decreased elasticity, making it more difficult to clear them. If this is the case, the patient should be encouraged to take frequent sips of water or isotonic fluids (e.g., electrolyte replacement drinks).

Wheezing

Wheezing is considered to be a trademark of asthma, but it is not a definite indicator. The wheezing sound associated with asthma results from a forceful rush of air pushing through narrowed, constricted airway lumens. The surge of air causes vibrations that make the wheezing sound. In some cases, airways can be so constricted that the air flowing past a blockage is not sufficient to produce a wheeze. In very severe attacks, the absence of wheezing is a worrisome sign.

It is important to note that patients with severe asthma have acute airway inflammation during an episode, and patients with chronic asthma have continuous symptoms of airway inflammation, which can eventually destroy airway tissue and alter lung function. Prolonged inflammation may result in permanent obstruction as a result of alteration of the bronchial walls. Unfortunately, after this change occurs, the airways may not respond to treatment as quickly or at all. This is why it is important to use medication to reduce airway inflammation, subsequently preventing permanent obstruction [74].

Fatigue

Breathing with asthma can fatigue the body. As exhalation is blocked and air is trapped in the lungs, more force is required to maintain adequate oxygen supply. To aid in exhalation, accessory muscles become involved, which can deplete the body of energy. Untreated asthma can produce severe degrees of fatigue for the patient, and this can become a critical situation warranting immediate intervention [74]. Lethargy, decreased response time, and weakness are all late signs of fatigue.

Therapeutic Measures

The treatment of asthma is generally divided into one of two categories: short- or long-term management. Short-term treatments are used only in the case of an asthma attack for immediate relief from the devastating symptoms. The focus of treatment for stable asthma is long-term prevention, planning

ahead for emergencies, and being alert to increased symptoms [74]. Asthma may be controlled with early, accurate diagnosis and a treatment plan that involves a patient's, and perhaps an entire family's, active participation.

When considering pharmacologic treatment of asthma, the dosage, timing, and type of medication should be tailored to individual needs. Optimal treatment should include methods to reverse air-flow barriers, stop symptoms from occurring, prevent serious attacks and need for emergency care and hospitalization, keep asthma from interfering with activities of daily living, minimize side effects, and control symptoms with the least amount of medication [74]. As with the approach to management, medication therapy generally adheres to two possible uses: to relieve symptoms quickly with the use of bronchodilators or to reduce chronic airway inflammation with anti-inflammatory medications, preventing asthma from recurring in the future.



EVIDENCE-BASED
PRACTICE
RECOMMENDATION

In patients with severe allergic asthma, the American Thoracic Society and the European Respiratory Society suggest a therapeutic trial of omalizumab both in adults and in children.

(<https://www.thoracic.org/statements/resources/allergy-asthma/Severe-Asthma-CPG-ERJ.pdf>. Last accessed August 10, 2020.)

Strength of Recommendation/Level of Evidence:
Conditional recommendation, low quality evidence

Asthma exacerbations can be frightening experiences for both patients and their caregivers, especially the first time an attack occurs. A thorough explanation of all the treatments administered will better educate patients for future attacks and prepare them for future treatment.

Specific Nursing Measures

Although patients may have been through the experience many times, each asthma attack generates the fear of dying. To help allay the feeling of suffocation, patients may prefer not to be closed

in (e.g., by bedside curtains). A quiet environment with as few interruptions as possible should be maintained. Patients should be protected from drafts and chills; wet linen from diaphoresis should be changed quickly.

Because shortness of breath interferes with the ability to talk, patients should not be fatigued further by taking an in-depth history or asking nonessential questions. Needed information can often be obtained more easily from family members [36].

Fluid intake and output should be monitored; unless contraindicated, patients should receive 3–4 L per day. The nutritional intake of patients with asthma can be severely hampered if shortness of breath makes them unable to eat. It may be necessary to monitor food and fluid intake and provide or recommend high-nutrient liquid supplements.

Breathing exercises along with bronchial drainage are important aspects of care. These exercises can help reduce the amount of residual volume of air in the lungs during an attack, and bronchial drainage can help to prevent the buildup of secretions [29; 36; 83]. Suctioning may be required if secretions cannot be expectorated. The sputum expectorate should be observed and charted for amount, consistency, odor, and color [29; 36].

Respiratory and cardiac assessment is an ongoing responsibility, as is careful monitoring of arterial blood gas values and pulmonary function studies. Cardiac dysrhythmias, tachycardia, tremors, nervousness, nausea, and headache are possible adverse effects from the beta-adrenergic stimulants as well as from aminophylline and theophylline. Sudden absence of wheezing indicates a progression to respiratory failure [29; 36].

Because asthma is a chronic condition, patients, their families, and significant others require instructions in its cause, care, and treatment. If possible, help patients to identify precipitating factors (triggers) in the development of their attacks and take measures to avoid them. Environmental irritants, such as cigarette smoke, aerosol sprays, overly dry air, and extremes in temperatures, should

be avoided. Patients should be encouraged to seek medical care at the first sign of a respiratory tract infection, tonsillitis, or sinusitis [29; 36].

Patients with asthma should be encouraged to maintain as active and as normal a life as possible. Sufficient rest is important, as fatigue may make it more difficult for these patients to handle daily stress.

Patients should be aware of the nature, proper administration, and effects of the medications they are taking. Propranolol should not be given to patients with asthma because of its potential to cause bronchoconstriction. Antihistamines and decongestants should be avoided because of the tendency to dry airway secretions, making expectoration difficult [72].

CHRONIC OBSTRUCTIVE PULMONARY DISEASE

COPD is as a common preventable disease characterized by airflow limitation that is usually progressive and is associated with an abnormal inflammatory response in the airways and the lung to inhaled noxious particles or gases. Exacerbations and comorbidities contribute to the overall severity in individual patients [84]. Clinically and pathologically, COPD is comprised of two overlapping disease processes: chronic bronchitis and emphysema.

Chronic bronchitis is defined as a cough with sputum production on most days for at least three months of a year for two consecutive years [85]. Patients with chronic bronchitis have a characteristic hyperplasia and hypertrophy of the goblet cells and mucous glands of the airway, leading to excessive mucus secretion narrowing the airways, which results in repeated cough with sputum. The airway walls are infiltrated with inflammatory cells, and persistent inflammation results in thickening of the wall and airway narrowing. Progression of chronic bronchitis results in fibrosis and squamous metaplasia, which limits airflow [86]. Chronic bronchitis is a recurrent and irreversible condition, which differentiates it from acute bronchitis. Acute

bronchitis is an inflammation of the large bronchi in the lungs typically caused by viruses or bacteria that may last several days or weeks [87].

Emphysema is an enlargement of the air spaces distal to the terminal bronchioles, with destruction of their walls [85]. The destruction of air space walls reduces elastic recoil and the surface area available for the exchange of oxygen and CO₂ during breathing. These airways can collapse, leading to further limitation in airflow. Emphysema can be classified by location as panacinar/panlobular and centriacinar/centrilobular [88].

Panacinar emphysema results in enlargement of respiratory bronchiole to alveoli and includes entire respiratory acini. It usually involves all lung fields, particularly the bases and anterior margins of the lungs. This type of emphysema is common in individuals with alpha-1 antitrypsin deficiency.

Centriacinar emphysema predominantly occurs in the upper lobes, resulting in enlargement of the respiratory bronchiole (i.e., the proximal and central part of the acinus); however, the distal acinus and alveoli are unaffected. This type of emphysema is common in smokers. Emphysema can also be classified as distal acinar emphysema, irregular emphysema, or congenital lobar emphysema (CLE). Distal acinar emphysema preferentially involves the distal airway structures, alveolar ducts, and alveolar sacs. CLE is a rare congenital disorder characterized by hyperinflation of one or more of the pulmonary lobes. Irregular emphysema is a fibrotic form of the disease that shows no consistent relationship to any portion of the acinus. Scarring is very common in patients with irregular emphysema.

Clinical Manifestations

The cardinal signs and symptoms of COPD are chronic cough, sputum production, breathlessness (shortness of breath and dyspnea), and limited exercise tolerance. Other common signs that may be present in COPD include:

- Tachypnea
- Pursed lips breathing
- Prolonged expiration phase of breathing (compared with inspiration)
- Active use of neck muscles during breathing
- Increased resonance of the chest (by percussion) caused by hyperaeration and emphysematous change
- Increased anteroposterior diameter of the chest (“barrel chest”)

In established and late-stage disease, systemic complications can develop, including skeletal muscle wasting and weakness, poor exercise capacity, weight loss, depression and anxiety, osteoporosis, cor pulmonale, and polycythemia.

Treatment Measures

The management of stable COPD is characterized by a stepwise increase in treatment guided by the overall health and clinical status of the patient and the severity of the disease. Pharmacotherapy is used to both control and prevent COPD symptoms. Effective treatment will reduce the frequency and severity of COPD exacerbations, increase exercise capacity, and improve overall health status. Currently, there is no medication for COPD that can prevent the long-term deterioration in lung function that is the hallmark of the disease. However, there are many drugs that can improve symptoms and provide relief to the patient, including bronchodilators (i.e., beta₂-agonists, muscarinic antagonists, and methylxanthines), corticosteroids, and phosphodiesterase-4 inhibitors. Each individual responds differently to treatment and will experience a varying degree of side effects. Careful monitoring is required to ensure that the goal of treatment is met.

Influenza and pneumococcal vaccines are effective in preventing some of the infections that cause COPD exacerbations and should be administered to all patients with COPD. Pulmonary rehabilitation is a multidisciplinary and comprehensive intervention that is individually tailored for patients with COPD. Its principal goals are to:

- Reduce COPD symptoms
- Optimize physical and emotional status
- Reduce healthcare costs by controlling and reversing various dysfunctions (reducing the need for hospitalization)
- Improve overall quality of life
- Improve activities of daily living

Pulmonary rehabilitation can address nonpulmonary conditions that are not addressed by the medical management of COPD, including:

- Muscle weakness and wasting
- Exercise deconditioning
- Depression
- Relative social isolation
- Weight loss

Addressing and treating such problems can disrupt the “vicious circle” in COPD, leading to overall improvement in all aspects of COPD. Patients involved in pulmonary rehabilitation experience an 11% increase in peak oxygen consumption, an 18% increase in peak workload, and an 87% increase in endurance time [89].

Specific Nursing Measures

Patients with chronic lung conditions like COPD may feel angry, depressed, or anxious over their condition and its effect on their life. It is important that patients understand which aspects of their condition are reversible, such as accumulation of secretions and bronchospasm, and which are not. The potential for reversibility is greatest in treating chronic bronchitis and least in treating emphysema [29].



The American College of Chest Physicians and the Canadian Thoracic Society suggest including smoking cessation counseling and treatment using best practices as a component of a comprehensive clinical strategy to prevent acute exacerbations of COPD.

(<https://europemc.org/article/med/25321320>.
Last accessed August 10, 2020.)

Strength of Recommendation/Level of Evidence:
2C (Weak recommendation, low- or very-low-quality evidence)

Patients with COPD should be instructed to take steps to avoid respiratory tract infections and to contact their physician if they become ill. Patients should also avoid exposure to irritants and high pollution levels.

Bronchial hygiene is an important aspect of patient teaching. Topics should include effective cough technique, breathing exercises, and pursed lip breathing to promote CO₂ elimination. Bronchial drainage may be necessary to facilitate the expectoration of secretions and reduce bronchospasm; an intermittent positive pressure breathing machine may be ordered for use at home. Saline and medications such as isoetharine may be added to the nebulizer to loosen secretions and reduce bronchospasm. Steam inhalation may also be helpful [29].

Continuous home oxygen therapy may be required if the patient's PO₂ level is low. Because those with COPD may have a hypoxic drive to breathe, continuous low-flow oxygen therapy should be carefully monitored with regular arterial blood gas levels. Patients and caregivers should be instructed to use only the flow of oxygen ordered by the physician and not to increase the flow [36].

Signs and symptoms of hypoxia and hypercapnia (e.g., shortness of breath, restlessness, lethargy, headache, confusion) should be reviewed with the patient and family members and/or caregivers, as these symptoms may signify impending respiratory failure. Patients should weigh themselves daily, because a significant weight gain in a short period could indicate fluid retention from right-sided heart failure.

Hydration is an important aspect of COPD care, because water helps to liquefy secretions in the lungs. Unless contraindicated, patients should be instructed to drink 8 to 10 glasses of fluids daily. Coffee and tea have a diuretic effect and should not be counted as fluid intake [36].

High-calorie meals are necessary for patients with COPD who are underweight and undernourished. Small, frequent meals may be more easily tolerated by those who are short of breath; eating large meals requires more energy to consume and digest. Salt-restricted diets may be necessary for those with right-sided heart failure. Foods high in potassium are important for patients taking diuretics. Teaching materials and handouts are available through the American Lung Association [42].

ACUTE RESPIRATORY FAILURE

Acute respiratory failure is defined as the sudden inability of the respiratory system and the heart to maintain adequate arterial oxygenation and CO₂ elimination. The marked increases in CO₂ levels associated with acute respiratory failure depress the central nervous system, leading to symptoms of drowsiness, muscle twitching, a gradual loss of consciousness, and coma. Clinical manifestations of hypoxemia affect the nervous system first, because it is most sensitive to oxygen deprivation. The four most common signs of acute respiratory failure are restlessness, headache, confusion, and tachycardia [44].

Treatment Measures

If necessary, bronchodilators such as aminophylline may be used in the treatment of respiratory failure to decrease edema of the airways and bronchospasm. Corticosteroids may be administered to reduce bronchial inflammation and bronchospasm. Antibiotics may also be necessary if underlying infection is present. Cardiac medications are given if cardiac failure or dysrhythmias occur. Sodium bicarbonate is administered if respiratory acidosis is present [44].

Acute respiratory failure can be a medical emergency requiring lifesaving measures such as intubation and mechanical ventilation. Three general indications for endotracheal intubation and mechanical ventilation are unconsciousness, copious secretions that cannot be cleared by coughing, and severe hypoxemia or respiratory acidosis that does not respond promptly to other measures [39; 44].

Specific Nursing Measures

Patients with respiratory failure should be carefully observed for signs and symptoms of hypoxia and hypercapnia. Individuals who are difficult to arouse from sleep or irritable may be exhibiting signs of hypercapnia. Besides monitoring respiratory status, the patient's cardiac status should also be assessed; hypoxia, hypercapnia, and acidosis can lead to cardiac dysrhythmias and depressed myocardial contractility. Serum electrolyte values also require close monitoring [39].

Healthcare professionals should be alert to the possibility of CO₂ narcosis, especially in those with COPD. This condition occurs when the level of CO₂ in the arterial blood becomes so elevated that it no longer provides a stimulus to breathe. This can lead to respiratory arrest [39].

Bronchial hygiene instruction is necessary. If patients cannot clear secretions effectively, tracheobronchial suctioning may be necessary. Psychologic support is also important. Many of the lifesaving measures employed in the treatment of acute respiratory failure can cause anxiety and fear.

LUNG CANCERS

Lung cancer is the second most common cancer affecting both men and women in the United States, accounting for an estimated 12.5% of all new cancer diagnoses [90; 91]. Although it has been linked primarily to smoking and environmental factors, this disease can affect patients regardless of their occupation or lifestyle. Within the general diagnosis of lung cancer, there are several types, each with its own clinical course and prognosis.

There are two main categories of lung cancer: small cell lung cancer (SCLC) and non-small cell lung cancer (NSCLC). NSCLC accounts for approximately 85% of all lung cancers and is further divided into two types: non-squamous carcinoma (this includes adenocarcinoma, large cell carcinoma, and other cell types) and squamous cell (epidermoid) carcinoma, each with distinct histologic and clinical characteristics [92; 93; 94; 95]. It is important that healthcare professionals understand these differences as they care for patients with the diagnosis of lung carcinoma.

Clinical Manifestations

Lung cancer rarely gives an early indication of its presence. It may be detected accidentally, when viewing a routine chest x-ray, or it may be suspected by symptoms presented by the patient.

One of the most common symptoms experienced by patients with lung cancer is cough, which occurs when the airways become irritated (as from smoking) [91; 93; 96]. Those patients who have a cough related to their smoking may recognize a change in the type of cough but are not as likely to realize the significance of that change, particularly if the change occurs slowly over decades [96]. The cough may be more frequent, more irritating, of a different tone, or may feel as if it is arising from a different site than a normal cough. A cough that has always been dry may suddenly become productive as the obstructed bronchus develops an infection [91; 96; 97]. Persistent wheezing that occurs in one location in a smoker may also indicate lung cancer [96; 97].



EVIDENCE-BASED
PRACTICE
RECOMMENDATION

According to the American College of Chest Physicians, all patients with lung cancer who have troublesome cough without a treatable cause should be prescribed opioids to suppress the cough.

([https://journal.chestnet.org/article/S0012-3692\(13\)60305-0/fulltext](https://journal.chestnet.org/article/S0012-3692(13)60305-0/fulltext). Last accessed August 10, 2020.)

Strength of Recommendation: 1B (Strong recommendation based on moderate evidence that the benefits outweigh the risks/burdens)

Pain that arises from lung abscess or tumor is often difficult to describe. It may not be severe, if present at all. With metastasis to the chest wall or lymph nodes, the patient may feel some tightness or a constant ache, which may be mistaken for a pulled muscle related to coughing. When a tumor invades the brachial plexus, there is usually pain in the arm and shoulder. Pain that originates in the chest wall may worsen with deep breathing or coughing [96; 97; 98].

Therapeutic Measures

After the tissue type has been confirmed and the stage has been determined, treatment options may be discussed with the patient and the patient's family. It is critical that all healthcare professionals thoroughly understand each type of treatment in order to answer questions posed by the patient and family as they work through the decision-making process. Patients commonly ask about the quality of life that can be anticipated after the treatment decision has been made. The components of treatment, such as discomfort, pain, nausea, hospitalization, and loss of time with friends and family, should all be weighed against the possibility of a longer life. The course of treatment is ultimately the patient's decision, and it is helpful to answer questions and provide acceptance no matter what choice is made.

Surgery is a frequent and logical choice for removing a cancer. Many patients respond to their diagnosis with comments indicating that they want the cancer removed from their body immediately. While this is not always an option, it is the best choice for many patients with early-stage disease [92; 99]. In general, the type of surgery performed depends upon the extent of the disease [92].

The patient with NSCLC may receive chemotherapy in combination with radiation and/or surgery, as determined by the stage of the disease and the patient's overall health status [100]. Research has indicated that adjunctive chemotherapy, in addition to surgery, radical radiotherapy, or supportive care, is effective in improving overall survival rates and disease-related symptoms [100].

Radiation therapy is defined as the use of ionizing radiation to kill cancer cells. It is usually considered local therapy because it treats only the cells at which the radiation is directed; however, systemic radiation therapy, or introduction of radioactive material (i.e., radiopharmaceuticals) into the circulatory system, is also available. When healthy cells surrounding the cancerous lesion are exposed to radiation, they may also be destroyed; however, they are better able to repair DNA damage than are cancer cells. Radiation treatments may be administered intravenously or orally, whichever is determined most effective to treat the specific tumor type and magnitude [101; 102].

Aside from these modalities, several alternative modalities, such as stem cell and bone marrow transplantation, are in clinical trials to determine their effectiveness in the treatment of lung cancer.

Specific Nursing Measures

Patient education is a crucial aspect of the care of those with lung cancer. Patients require an understanding of the various diagnostic procedures, therapeutic interventions, and associated side effects [103].

One of the primary concerns voiced by patients who are given a diagnosis of cancer is that they will be in severe pain. Some patients are so certain their diagnosis equates to suffering that they are willing to forego treatment that would prolong their life. It is vital that patients and their families be assured that pain, if experienced, will be relieved effectively.

Nausea, vomiting, and weight loss are often linked to treatment with either radiation or chemotherapy but may occur solely from the cancer. For patients experiencing nausea, soda crackers and ginger ale may help settle their stomachs. For some patients, simply eliminating spicy foods or foods with strong odors may make a difference. Encouraging the family to eat with the patient and making it a social event can be helpful. Antiemetics taken regularly before meals can often relieve symptoms of nausea and vomiting. Simple counseling may be very helpful. Dietitians can suggest ways to increase the caloric content of simple foods without requiring the patient to eat a great deal more food. Adding dry milk powder to milk, ice cream, or puddings, for example, can substantially increase calorie intake.

Lung cancer generally does not have a good prognosis. As previously noted, many patients with lung cancer have metastases at the time of diagnosis, which decreases survival time. For these patients, dealing with impending death is a reality to be considered. This is not to say that patients should not be fighting the disease and, indeed, some do win the battle. Unfortunately, the overall five-year survival rate for lung cancer is only about 19% [91].

While patients with terminal lung cancer face psychologic and emotional anguish, it may also be a time for connection and personal growth [104; 105]. The time of life when lung cancer is diagnosed may be relevant to the degree of grace the patient exhibits. When occurring so as to interrupt plans of travel, marriage, child rearing, career, or other major events, the impact of cancer may be even more devastating to the patient and the patient's family. When hope begins to fade and

it becomes apparent that the end is approaching, changes will occur in the patient and the patient's family. Ideally, this is a time when they can realize how important they are to one another and express their feelings and wishes.

TRAUMATIC DISORDERS

Chest trauma results from penetrating or blunt trauma to the chest. Penetrating chest injuries, also referred to as “open chest” trauma, may be caused by gunshot wounds, stab wounds, and wounds from other penetrating objects. Blunt chest trauma—nonpenetrating injury to the chest—is primarily caused by traffic accidents, but other causes include falls, blasts, explosions, and assault. Blunt chest trauma is by far the most common type of injury to the chest. Chest injuries may involve the bony framework of the chest, the heart, the great vessels, the lungs, or a combination of these structures. Damage to the liver and spleen may also occur. Of all deaths resulting from trauma, approximately 75% involve chest injury [106; 107].

Trauma victims require close monitoring because the full extent of their injuries may not always be initially evident. When caring for a patient with chest trauma, remember the ABC(CC)s: airway, breathing, circulation, cervical spine, and consciousness [107].

Breathing in patients with chest trauma may be accompanied by pain, dyspnea, asymmetrical chest movement, paradoxical chest movement, a sucking sound, poor tidal volume, and/or symptoms of hypoxia or hypercapnia. Cyanosis may be a later manifestation. Circulation may be affected and may be detected by such signs as jugular venous distention, tachycardia, dysrhythmias, hypovolemic shock, and cardiogenic shock. It is always assumed that victims of chest trauma have suffered a spinal cord injury until x-rays prove otherwise. Patients with chest trauma may fall at any point on the spectrum between alert/oriented and comatose; if alert, they may be very apprehensive [106; 107].

If a patient with a penetrating chest wound has retained the instrument (e.g., knife), it should not be removed until he or she is in a position to be stabilized. In most situations, the object serves as a mechanical barrier for the lacerated vessels, and removing the instrument may result in hemorrhage.

The control of pain is important for all trauma patients. If analgesics are ordered, the nurse should monitor the patient for depressive respiratory side effects [106; 107; 108].

FLAIL CHEST

A flail chest occurs when multiple adjacent rib fractures and/or costosternal separations result in “floating” of a segment of the rib cage. It is the result of blunt trauma in which there is crushing injury to the chest [107].

Clinical Manifestations

A primary symptom of flail chest is the paradoxical motion of the chest wall during inspiration and expiration. Flail chest may also be accompanied by a pneumothorax, a hemothorax, or both. Mediastinal structures may shift toward the uninjured lung, compressing it and reducing the amount of ventilation the unaffected lung can provide. This mediastinal shift may also cause kinking and obstruction of major vessels. Patients complain of pain, often severe, that results in limited respiratory effort and an ineffective cough. Other manifestations include dyspnea, tachycardia, restlessness, and cyanosis [106; 107].

Therapeutic Measures

As a first-aid measure, the flail segment can initially be stabilized by exerting firm but gentle pressure on the segment with the palm of the hand. Supplemental oxygen and nerve blocks to decrease pain may also be employed. If the patient's ventilation becomes more severely compromised (i.e., hypoxemia and hypercapnia develop), the treatment of choice is intubation and mechanical ventilation. Mechanical ventilation is usually continued only until the patient can maintain adequate sponta-

neous ventilation. Closed chest drainage may be necessary if a pneumothorax or hemothorax is present [107].

Specific Nursing Measures

Coughing and deep breathing are imperative to prevent atelectasis and pneumonia. Suctioning may be required. The patient's level of pain should be assessed and the effects of analgesics monitored. Close observation of vital signs and level of consciousness is necessary [39].

PNEUMOTHORAX

A pneumothorax occurs when there is a leak of air into the pleural space, with resultant loss of the negative intrapleural pressure causing partial or total collapse of the lung. A pneumothorax may be open or closed. In an open pneumothorax, an injury creates an opening in the chest wall, allowing air to flow into the pleural cavity. The increased intrapleural pressure causes a partial or total collapse of the lung [106]. In closed pneumothorax, also called spontaneous pneumothorax, the chest wall remains intact and air enters the pleural space from the lung surface. A closed pneumothorax may be caused by blunt chest trauma, in which a fractured rib pierces the lung [107].

Clinical Manifestations

A patient with a pneumothorax may complain of pain with breathing and may also exhibit dyspnea, tachypnea, and unilateral diminished breath sounds. The respiratory movement on the affected side may be diminished or absent. With a tension pneumothorax, air enters the pleural cavity during inspiration but is unable to escape during expiration. With each inspiratory cycle, the amount of air increases, causing progressive compression of the lung. The high intrathoracic pressure on the affected side causes a shift of the mediastinum (along with the heart, trachea, esophagus, and great vessels) to the unaffected side. This mediastinal shift compresses the unaffected lung, further

decreasing ventilation. Distortion of the vena cava impairs venous return to the heart, with a resulting decrease in cardiac output. Symptoms include marked dyspnea, severe chest pain, restlessness, agitation, hypotension, and cyanosis [44].

Therapeutic Measures

Diagnosis of pneumothorax is confirmed by chest x-ray, which also shows the extent of lung collapse. Treatment of a pneumothorax involves the insertion of chest tubes in the pleural space to evacuate the air; a thoracentesis may be performed. If a tension pneumothorax has developed, emergency performance of a needle thoracotomy or insertion of a flutter valve or chest tube is done to relieve the life-threatening pressure in the pleural cavity [44; 108].

Specific Nursing Measures

Careful assessment of the respiratory and cardiac status of the patient with pneumothorax is imperative. Be on the alert for signs and symptoms of a tension pneumothorax.

Positioning the patient in a semi-Fowler's position may facilitate breathing. Deep breathing and coughing should be encouraged. In cases of penetrating injuries, the possibility of infection introduced by the penetrating object should be considered. Be prepared to assist the physician in a thoracotomy and insertion of chest tubes [39].

HEMOTHORAX

A hemothorax is defined as the accumulation of blood in the pleural space. It may result from either blunt or (more commonly) penetrating trauma to the chest. A hemothorax should be considered in severe blunt or decelerating accidents (e.g., motor vehicle accidents), which can result in ruptured intrathoracic vessels and cause aortic tears. Fractured ribs caused by blunt trauma are commonly responsible for lacerations leading to hemothorax [44; 108].

Clinical Manifestations

A hemothorax may result not only in respiratory and cardiac impairments, but also in hypovolemic shock if large amounts of blood are lost. The total accumulation of blood can range from less than 300 mL in a small hemothorax to more than 1,500 mL in a severe hemothorax. With a small hemothorax, the patient may be asymptomatic. With more severe bleeding, partial or total lung collapse may occur as blood accumulates in the pleural cavity. There may be increasing dyspnea, asymmetric chest movement, chest tightness, ecchymosis over the affected lung, and hemoptysis. Tachycardia, restlessness, hypotension, and hypovolemic shock may occur [44; 108].

Therapeutic and Specific Nursing Measures

Chest x-ray confirms the diagnosis of hemothorax. Patients with a small hemothorax often require no treatment, as the absorptive power of the pleura may resolve the problem. In symptomatic cases, a thoracentesis may be performed initially, but chest tube drainage is the most effective treatment. Replacement of lost blood volume is indicated, and a thoracotomy may be necessary in cases in which there is a large amount of recurrent bleeding. The nursing measures are comparable to those of pneumothorax. The emphasis is on monitoring for hypovolemic shock and carrying out fluid and blood replacement therapy [39].

CARBON MONOXIDE POISONING

Carbon monoxide is a toxic but colorless, odorless, tasteless, and initially non-irritating gas produced by the incomplete combustion of organic matter due to insufficient oxygen supply. It is often produced in domestic or industrial settings by motor vehicles that run on gasoline, diesel, methane, or other carbon-based fuels and from tools, gas heaters, and cooking equipment that are powered by carbon-based fuels such as propane and butane. Exposure at 100 ppm or greater can be dangerous to human health [44; 108].

Clinical Manifestations

Carbon monoxide mainly causes adverse effects in humans by combining with hemoglobin to form carboxyhemoglobin (HbCO_2) in the blood. This effectively reduces the oxygen-carrying capacity of the blood, leading to hypoxia. Myoglobin and HbCO_2 can revert to hemoglobin, but the recovery takes time because the HbCO_2 complex is fairly stable [44; 108].

Symptoms of mild acute poisoning include light-headedness, confusion, headache, vertigo, and flu-like symptoms; larger exposures can lead to significant toxicity of the central nervous system and heart and eventually loss of consciousness and death. Following acute poisoning, long-term sequelae often occur. Chronic exposure to low levels of carbon monoxide can lead to depression, confusion, and memory loss.

Therapeutic and Nursing Measures

Treatment of carbon monoxide poisoning largely consists of administering 100% oxygen or providing hyperbaric oxygen therapy, although the optimum treatment remains controversial. Oxygen increases the removal of carbon monoxide from hemoglobin, providing the body with normal levels of oxygen.

The prevention of carbon monoxide poisoning is a significant public health issue. Carbon monoxide poisoning is the most common type of fatal poisoning in many countries and has been used as a method to commit suicide. Domestic poisoning can be prevented by early detection with the use of household carbon monoxide detectors. Modern automobiles, even with electronically controlled combustion and catalytic converters, can still produce potentially lethal levels of carbon monoxide in an enclosed space or if the tailpipe is obstructed (e.g., by snow) [44; 108]. These risks should be relayed to the public.

RESPIRATORY SURGERY OF THE UPPER AIRWAY

Patients who undergo surgery of the respiratory system (and their families or caregivers) often require teaching, support, and encouragement to cope with the significant alterations in lifestyle that may result. To be effective, the healthcare professional who cares for these patients should blend technical competence with human sensitivity.

As with any surgery, these patients should be monitored for complications. Aspiration and postoperative bleeding should be considered. Patients having surgery of the upper airway show signs of postoperative hemorrhage by repeated swallowing attempts.

TRACHEOTOMY

Tracheotomy is performed to obtain a temporary opening into the trachea. If the trachea is sutured to make a permanent opening, it is a tracheostomy. This technique is performed to provide access for aspiration of the bronchial tree or to relieve upper airway obstruction. It may be employed when a patient is unable to cough effectively and expel secretions. Indications for a tracheotomy include [108]:

- Mechanical ventilation for more than 7 to 10 days
- An artificial airway is required but the patient is not a candidate for orotracheal or nasotracheal intubation (because of severe facial injuries)
- Weakness or critical illness making breathing difficult
- A neurologic disorder paralyzing the chest muscles and diaphragm
- An obstructed upper airway caused by a tumor of the trachea or pharynx

A tracheotomy is not recommended in an emergency; in these cases, a cricothyroidotomy should be performed [108].

Physiologic Implications

Possible complications of tracheotomy during the early postoperative period include hemorrhage, tear of the trachea, extra-tracheal intubation (i.e., placement of the tube anterior to the trachea in a false passage), and subcutaneous emphysema [108]. Some patients are unable to swallow effectively following tracheotomy (even when the cuff of the tracheostomy tube is deflated) and may require the placement of a nasogastric feeding tube. Patients often experience postoperative discomfort and pain requiring analgesics. Opioids should be avoided or administered at the lowest possible dose to prevent respiratory depression. Humidified air or supplementary oxygen is necessary to avoid irritation to the mucosal lining. Even so, an increase in mucus production is likely.

Nursing Implications

Patients undergoing tracheotomy should be prepared for the effects of the operation, particularly if a tracheostomy is created—breathing through the stoma in the neck and loss of ability to speak while the stoma is open. Nurses should frequently assess respiratory rate and breathing patterns.

Tracheal suctioning should be performed as needed, depending on the status of the patient. The need for suctioning is determined by auscultation of lung sounds, the degree of the patient's respiratory distress, arterial blood gas levels, and chest x-rays. Cleansing of the area around the stoma and the tracheostomy tube is necessary [29].

Discharge Teaching

Patients who have a tracheostomy will need to learn how to care for themselves at home. The patient and at least one family member should demonstrate competence at suctioning and cleansing the tube prior to discharge. Patients should be assured that accidental occlusion of the opening during sleep will awaken them. Water poses a risk, however; patients should be reminded to cover the stoma when bathing. Some experts advise against all water sports, while others indicate that patients can engage in certain water sports if cautious.

Drowning can occur rapidly, and patients should be extremely careful if they choose to engage in boating or fishing [29].

CRICOTHYROIDOTOMY

Cricothyroidotomy consists of the creation of an opening between the thyroid and cricoid cartilages into the trachea. Cricothyroidotomy is the procedure of choice in an emergency to establish an airway when orotracheal or nasotracheal intubation is not possible [108].

In many cases, cricothyroidotomy is done in the field or emergency department, often without the benefit of anesthesia. If the procedure is elective, local anesthesia is given. A short transverse incision is made in the neck immediately below the thyroid cartilage to expose the cricothyroid membrane. An incision is made through this membrane, and a small tracheostomy tube is inserted to establish the airway. If the patient requires intubation for more than a few days, the cricothyroidotomy should be converted to a standard tracheotomy. The implications for patient care are the same as for a tracheotomy [108].

LARYNGECTOMY

Laryngectomy is an option for some patients with laryngeal cancer. Partial laryngectomy using the laryngofissure approach is recommended for patients in whom the cancerous growth is limited. Partial laryngectomy approaches have the advantage of preserving the normal airway and the patient's ability to speak [108]. Total laryngectomy is appropriate for the removal of neoplasms too extensive to be removed by a partial or supraglottic laryngectomy [108].

Physiologic Implications

A total laryngectomy results in permanent changes in the patient's airway and speech. During ventilation, air enters through the tracheostoma instead of the nose, which results in anosmia and lack of humidification. Because taste depends on smell, patients may also experience a permanent alteration of their ability to taste. Potential complications include hemorrhage, nerve damage, fistula

formation, and carotid artery rupture. Mucus secretion is often copious after surgery, and the patient cannot cough effectively without a glottis to close to increase intrathoracic pressure. However, patients can still expel secretions (often forcefully) through the stoma. Patients can no longer blow their noses or use a straw when drinking; they may experience difficulty swallowing initially, but this usually subsides after healing. The change that affects individuals the most is loss of the ability to talk (with total laryngectomy only). Fear of being unable to communicate can cause anxiety and negatively impact quality of life [108].

Preoperative Care

Preoperative teaching should focus on the permanent alterations in breathing and communication. When planning preoperative counseling, consider individual differences [39]. Speech therapists, mental health professionals, and other allied healthcare providers should establish contact before the procedure is done.

Postoperative Care

In the postoperative period, priority should be given to maintaining a patent airway. The trachea should be suctioned to remove secretions, and humidified air or oxygen may be administered initially. Most surgeons prefer to have the patient wear a laryngectomy tube for one to two weeks or until the stoma maintains its size. After the tube has been permanently removed, the patient should wear a lightweight stoma covering or bib. This allows movement of air into and out of the stoma but prevents foreign particles from entering. Moistening the bib with sterile saline provides some humidification [39].

If thick secretions are a problem, the patient should be taught to instill a few drops of normal saline into the stoma, followed by suctioning. A mucous plug that obstructs the trachea can usually be removed by suctioning, which stimulates the patient to cough. If these measures are unsuccessful, the physician should be notified. Measures should be taken to promote wound healing and prevent infection [39].

Discharge Teaching

Patients should be advised that the stoma should be covered when bathing to avoid aspiration. A scarf or high collar can be worn for warmth and to prevent foreign-body aspiration. Patients should be encouraged to carry a wallet card or bracelet indicating that they have undergone a laryngectomy.

Most patients will return as outpatients for continued instruction and evaluation of the method they choose for voice production. In the early post-operative period, patients may rely on gesturing and/or writing. Other options for communication include esophageal speech, artificial speech aids, and surgical-prosthetic voice restorations. Multimedia resources and written material are available through organizations such as the American Cancer Society.

THORACIC SURGERY

Thoracic surgery refers to any surgical procedure involving the chest wall or any organ between the diaphragm and clavicles. A variety of incisions may be employed in thoracic surgery; the posterolateral and anterolateral approaches are used often in general thoracic surgery, whereas median sternotomy is employed for certain cardiothoracic procedures [108].

Opening the thorax disrupts the normal negative pressure in the intrapleural space. During surgery, the loss of negative intrapleural pressure is compensated for—the patient is intubated and mechanically ventilated. Chest tubes are placed prior to closure of the thorax to restore the negative intrapleural pressure and assist in re-expansion of the lungs. After most pulmonary resections, tubes are placed to allow for drainage of fluid and removal of air from the intrapleural space [108].

TYPES OF THORACIC SURGERY

Closed Tube Thoracotomy

Closed tube thoracotomy refers to percutaneous insertion of a chest tube into the intrapleural space to evacuate blood or other fluid caused by trauma, surgery, malignancy, or infection or to re-expand the lung in patients who have a pneumothorax with more than 10% collapse [108].

Chest tubes are removed when fluid drainage is less than 80–100 mL per day, when an air leak is no longer present, or when the tube is occluded. A chest x-ray is done after removal of a chest tube to evaluate lung expansion. The patient should be observed for symptoms and signs of a recurrent pneumothorax or hemothorax [108].

Open Thoracotomy

Open thoracotomy consists of opening the thorax for the purpose of inspecting, repairing, or removing tissue. It may be performed as an elective or emergency procedure. It has also been used when patients develop cardiac tamponade or other bleeding cardiopulmonary wounds. Emergency thoracotomy allows rapid access to perform open heart massage in an effort to maintain an adequate cardiac output [108].

Decortication

Decortication involves the removal of pathologically thickened pleura that restricts lung expansion [108]. If the intercostal space is fused, this procedure may be very difficult or impossible.

Lung Transplantation

Lung transplantation was developed for patients with end-stage pulmonary disease. Techniques have been developed to transplant one lung, both lungs, or the heart with both of the lungs [108]. Long-term immunosuppression is necessary to prevent rejection of the transplanted organ.

Pulmonary Resection

There are many different types of pulmonary resection, usually categorized by the location and/or extent of the resection. Pneumonectomy refers to the removal of a lung, and a radical pneumonectomy also includes the removal of anterior and posterior mediastinal lymph nodes [108]. Lobectomy is the removal of one lobe from either the right or left lung [108]. The removal of a portion of a lobe is referred to as a segmentectomy or wedge resection [108].

PHYSIOLOGIC IMPLICATIONS

Thoracic surgery is generally associated with some pain, the degree of which varies with the type of procedure. This often causes patients to guard the area and hyperventilate, which increases the risk for atelectasis (i.e., collapse of a section of the lung).

Other possible complications following thoracic surgery include hemorrhage, hypotension, infection, cardiac dysrhythmia, respiratory failure, pulmonary edema, subcutaneous emphysema, residual pleural space, persistent air leak, bronchopleural fistula, and emphysema [108]. With pulmonary resection, there is a permanent decrease in pulmonary function [108].

PREOPERATIVE CARE

Candidates for thoracic surgery usually undergo extensive evaluation to ensure they can withstand the stress of the procedure. In addition to routine preoperative tests, patients' nutritional status and cardiac, pulmonary, and adrenal function are assessed. The results of pulmonary function tests and arterial blood gas analyses allow evaluation of respiratory status. Aggressive measures may be employed in an attempt to improve the patient's nutritional or pulmonary status prior to surgery, including hyperalimentation or enteral (tube) feedings [39].

Family members should be included in preoperative preparation. All patients should be prepared to engage in breathing, walking, and shoulder exercises after surgery. Teaching the procedure for incentive spirometry should be included in preoperative care. Psychologic preparation of the patient and family may include a preoperative visit to the intensive care unit. Patients may have an endotracheal tube, pulmonary artery catheter (Swan-Ganz catheter), central venous pressure (CVP) line, arterial line, peripheral intravenous lines, chest tubes, and a urinary catheter inserted during surgery. Preoperative teaching about the function of tubes inserted during surgery is also helpful [39].

POSTOPERATIVE CARE

Arm and shoulder exercises prevent stiffening of the shoulder and loss of muscle strength. The patient should be taught (and should demonstrate) shoulder exercises and the proper technique for coughing and deep breathing. Patients should also be instructed to ask for analgesics if they are experiencing pain. Nursing goals for patients who have undergone thoracic surgery include maintenance of adequate cardiac output, promotion of optimal pulmonary ventilation, maintenance of normal fluid and electrolyte balance, relief from pain, promotion of optimal wound healing, promotion of recovery without residual dysfunction, and emotional support and encouragement [39].

Maintaining Adequate Cardiac Output

Immediately upon arrival from surgery, the patient's blood pressure should be obtained and electrodes fixed to the chest to facilitate continuous monitoring of the cardiac rhythm. CVP readings should be taken hourly. Pulmonary capillary wedge pressures may be ordered every one to two hours. A change in body temperature alters the metabolic requirement and, thus, affects the cardiac output. If the patient's temperature is greater than 102 degrees F (39 degrees C), an antipyretic is prescribed. If the temperature rises above 104 degrees F (40 degrees C), the patient is placed on a cooling pad [39].

Drainage from the chest tubes should be monitored hourly. During the immediate postoperative period, it is wise to note the amount every 15 minutes. Persistent drainage of more than 200 mL per hour may require re-exploration to achieve hemostasis. Patients should be encouraged to move their legs frequently while in bed to promote venous return to the heart and prevent the formation of clots [39].

Promoting Optimal Pulmonary Ventilation

After thoracic surgery, humidified oxygen is administered either by endotracheal tube or by mask to prevent hypoxia and to liquefy secretions. The patient's color, respiration, and other vital signs should be assessed and documented. Auscultate the chest for a full respiratory cycle at each placement point of the stethoscope to determine the respiratory quality of function. Frequent analysis of arterial blood gas levels may be necessary.

It is crucial to ensure that chest tubes remain in the intrapleural space, are patent, and are connected to a collection receptacle. As soon as the patient regains consciousness, encourage coughing and deep breathing every hour for the first 24 hours. Coughing is more effective if the patient is assisted to a sitting position with the feet elevated. The incision should be supported anteriorly and posteriorly during coughing to minimize pain [39].

The patient should change position every one to two hours. In general, it is recommended that patients who have undergone pneumonectomy not be turned to the nonoperative side to allow maximum ventilation of the remaining lung. Patients who undergo lobectomy or a segmental resection should be positioned so their operated side is up to facilitate expansion of the remaining tissue in the lung. After one or two days, these patients can usually be turned to either side. Patients who undergo other types of thoracic surgery can usually be turned from their back to either side [39].

Maintaining Normal Fluid and Electrolyte Balance

Weight should be measured daily post-thoracic surgery. Urine output is closely monitored and should amount to at least 30 mL per hour. It is important not to administer fluids too rapidly, as this can lead to complications such as pulmonary edema.

If the abdominal cavity was not entered during surgery, patients can take fluids by mouth as soon as they are alert. Patients should be encouraged to drink a minimum of 1.5–2 L each day unless contraindicated. The patient can usually be advanced to the prescribed diet by the third postoperative day [39].

Relief From Pain

An opioid analgesic such as meperidine or morphine is prescribed to be given every two to three hours, as needed, after surgery. However, caution should be used when administering opioid analgesics because they can lead to respiratory depression. Later, medications such as aspirin or acetaminophen should be sufficient to manage postoperative pain [39;65].

Promoting Recovery without Residual Dysfunction

Altered sensation around the surgical wound can last for months, and patients often avoid moving the arm on the affected side because of the discomfort it causes. To combat these factors, the patient should engage in regular arm and shoulder exercises, starting with passive range-of-motion exercises performed a few hours after surgery. Patients often require encouragement to carry out these exercises [39].

Emotional Support and Encouragement

The hospital environment, the presence of numerous tubes, and pain can be emotionally exhausting for patients. The patient and family members will require explanations and reassurances [39].

CONCLUSION

With knowledge of respiratory structure and function and the dynamic pathology that impedes normal function, nurses can readily provide quality and even lifesaving care. An appreciation of the underlying causes of respiratory signs and symptoms leads to quicker reporting of changes in the patient's condition. The nurse can also perform immediate interventions based on standing orders and recognition of the appropriate actions to provide safe, quality care. Understanding the pathophysiology of the respiratory system transforms technical care to professional care through the use of solid decision-making skills.

CASE STUDIES

ASTHMA

Patient A is a woman, 42 years of age, admitted to the critical care unit (CCU) for an acute asthmatic attack. For three weeks prior to admission, the patient had increasing difficulty with cough with thick, white sputum, shortness of breath, syncope episodes associated with wheezing, and intermittent fevers up to 101 degrees F (37.8 degrees C).

Patient A is married and has two children in college. Although she has no smoking history, she was forced to retire from her job four years ago because of her chronic obstructive lung disease.

Past Medical History

Patient A reports allergies to erythromycin and penicillin. She has a history of asthma precipitated by dust, pollens, fumes, and air pollution requiring multiple emergency department visits and hospital admissions over the past 10 years. She also reports thrombophlebitis and hypertensive syncope accompanied by seizure activity for one year.

Past surgical procedures include left brachial artery embolectomy done 4 years previously, right knee repair completed 10 years previously, remote hemorrhoidectomy, and remote tonsillectomy and adenoidectomy in childhood. She is currently taking sustained-release theophylline, prednisone, phenytoin, warfarin, terbutaline sulfate, and metered-dose inhaler.

Assessment and Diagnosis

Upon admittance to the CCU, a full physical exam is conducted (**Table 1**). An ECG is done and shows sinus tachycardia with incomplete right bundle branch block. Several laboratory tests are ordered, with the following results:

- White blood cell count: $9.5 \times 10^9/L$
- Hemoglobin: 18.2 g/dL
- Hematocrit: 53.2%

Based on the results of the assessment, Patient A is diagnosed with acute asthma attack.

Management

Patient A's ventilation and oxygenation are managed and monitored by arterial blood gas results. Pulmonary spirometry is also used to evaluate her progress, and there is marked improvement with a bronchodilator. Patient A is transferred out of the CCU on the fourth day and discharged on the seventh day.

Study Questions

1. Why is asthma considered an obstructive pulmonary disease?
2. What nursing interventions will help calm a hypoxic, agitated patient?
3. How do you recognize and treat asthma?
4. What should you think if a patient with acute asthma stops hyperventilating or has a normal CO_2 level?
5. The arterial blood gas level of a patient with asthma has changed from alkalotic to normal, and the patient seems to be sleeping. Is the patient ready to go home from the hospital?

PATIENT A'S PHYSICAL EXAM RESULTS	
Parameter	Findings
General appearance	Heavy-set, agitated, diaphoretic woman breathing with pursed lips Height: 5 feet 2 inches (157.5 cm) Weight: 187 pounds (85 kg)
Head and eyes	Normocephalic Pupils equal, round, reactive to light, accommodation
Ears	Tympanic membranes intact and clear
Neck	Supple, without masses or thyromegaly Jugular-vein distention to 7 cm while sitting up 45 degrees
Chest	Dyspnea with rib retractions Unable to complete a sentence without taking a breath Fair inspiratory effort A few diffuse inspiratory wheezes, marked expiratory wheezing
Abdomen	Rounded with active bowel sounds Soft and nontender to palpation
Extremities	Peripheral pulses full, equal, and without bruits
Genitourinary system	Within normal limits
Neurologic status	Oriented to person, place, and time Cranial nerves II–XII grossly intact Sensory and motor function intact
Cardiovascular system	Point of maximal impulse not palpable Heart sounds very difficult to hear Peripheral pulses present and thready Left radial pulse barely palpable
Vital Signs	
Blood pressure	100/60 mm Hg
Temperature	101° F
Heart rate	155 beats per minute
Respiratory rate	18 breaths per minute
Source: Author	

Table 1

COPD

Patient B, 69 years of age with advanced COPD, is admitted to the CCU for progressive respiratory distress. His respiratory status began deteriorating three months prior to admission following an upper respiratory tract infection. Since then, he has used oxygen at home, intermittently produced large amounts of purulent, non-bloody sputum, and lost 10 pounds. Patient B works as the owner of a movie theater and is involved in his Greek Orthodox church. He had been a heavy cigarette smoker and exposed to toxic chemicals during his working life.

Past Medical History

Patient B has a history of spring “hay fever” and rare asthma since puberty. For the past 18 years, he has had progressive emphysema with a reversible component. Two years previously, he was diagnosed with adenocarcinoma of the lung. He also reports an allergy to penicillin.

PATIENT B'S PHYSICAL EXAM RESULTS	
Parameter	Findings
General appearance	Thin, wasted, tired-looking man in acute respiratory distress Height: 5 feet 9 inches (175 cm) Weight: 152 pounds (69 kg)
Head and eyes	Normocephalic Pupils equal, round, reactive to light, accommodation Foul odor to breath
Ears	Tympanic membranes intact and clear
Neck	Supple, without masses or thyromegaly Jugular venous pulse not visualized
Chest	Increased anteroposterior diameter Decreased breath sounds in the right lower lobe posteriorly and anteriorly with scattered loud wheezes, rhonchi, and rales Prolonged expiratory time and rib retractions with dyspnea and tachypnea
Abdomen	Scaphoid, with several mature scars Bowel sounds active in all quadrants Soft, nontender without masses Lower liver edge palpable 2 cm below right costal margin
Extremities	Peripheral pulses full, equal, and without bruits Pitting edema (2+) noted on lower extremities and sacrum
Genitourinary system	Within normal limits
Neurologic status	Oriented to person, place, and time Cranial nerves II–XII grossly intact Sensory and motor function intact Patient fatigues quickly
Cardiovascular system	Sinus tachycardia Faint heart sounds Normal S1 and S2 with summation gallop Skin warm and moist
Vital Signs	
Blood pressure	140/100 mm Hg
Temperature	97.8° F
Heart rate	134 beats per minute
Respiratory rate	40 breaths per minute
Source: Author	

Table 2

At 12 years of age, Patient B underwent right inguinal herniorrhaphy. Sixteen years ago, he underwent gastrojejunal anastomosis, followed by right upper lobotomy requiring tracheotomy, and right upper lobotomy for benign organized pneumonitic process. Nine years previously, an appendectomy and repair of perforated sigmoid disarticulates with peritonitis were performed.

Assessment and Diagnosis

Upon admittance to the CCU, a full physical exam is conducted (**Table 2**). Complete blood count, electrolytes, and urinalysis are all within normal limits.

PATIENT B'S ARTERIAL BLOOD GAS RESULTS					
Time	O ₂	pH	PCO ₂	PaO ₂	CaO ₂
0 hours (admission)	2 L/minute	7.06	92.8	30	8.8
2 hours	4 L/minute	7.18	66.2	62	20.0
4 hours	6 L/minute	7.21	72.3	69	21.4
6 hours	4 L/minute	7.28	60.8	55	19.9
9 hours	4 L/minute	7.35	52.8	48	19.6
24 hours	4 L/minute	7.37	52.2	62	21.7
Discharge	2 L/minute	7.4	57.8	66	21.3
Source: Author					Table 3

Based on the results of the assessment, Patient B is diagnosed with:

- Acute respiratory failure
- COPD
- Adenocarcinoma of the lung

Management

Patient B is given aerosolized bronchodilators every one to two hours initially. An aminophylline infusion is administered as well. The frequency of the aerosol treatments is gradually reduced to every four hours, with supplemental oxygen administered by nasal cannula. Patient B's ventilation and oxygenation are managed and monitored by arterial blood gas results (**Table 3**).

The nurses work with a dietitian to provide small, frequent, high-calorie and high-protein meals. This approach, adapted to his anorexia, dyspnea, and previous gastric surgery, improves Patient B's nutritional status. Patient B is transferred out of the CCU on the second hospital day and discharged five days after admission.

One month after discharge, Patient B is readmitted in acute respiratory failure. He and his family decide no resuscitation should be performed, and he dies two days after readmission.

Study Questions

1. Discuss the etiology of COPD. What lifestyle restrictions does the patient face?
2. Describe the pathophysiology of Patient B's chronic respiratory failure. What changes occur when acute respiratory failure is superimposed?
3. According to the arterial blood gas results, was Patient B improved at discharge?
4. If it is not possible to achieve normal arterial blood gas levels in a patient with respiratory failure, what levels are considered acceptable?
5. Identify Patient B's nursing problems. What outcomes are appropriate for him in view of his end-stage respiratory failure?

Works Cited

1. West JB, Luks AM. *West's Respiratory Physiology: The Essentials*. 10th ed. Philadelphia, PA: Wolters Kluwer; 2016.
2. Des Jardins T. *Cardiopulmonary Anatomy & Physiology: Essentials for Respiratory Care*. 7th ed. Clifton Park, NY: Delmar Cengage Learning; 2020.
3. Dalgorf DM, Harvey RJ. Sinonasal anatomy and function. *Am J Rhinol Allergy*. 2013;27(Suppl 1):S3-S6.
4. Reddy UD, Dev B. Pictorial essay: anatomical variations of paranasal sinuses on multidetector computed tomography—how does it help FESS surgeons? *Indian J Radiol Imaging*. 2012;22(4):314-324.
5. Cloutier MM. *Respiratory Physiology*. 2nd ed. Philadelphia, PA: Mosby Elsevier; 2019.
6. Mitchell R, Kumar V, Abbas AK, Aster JC. *Pocket Companion to Robbins and Coltran Pathologic Basis of Disease*. 9th ed. Philadelphia, PA: Elsevier; 2017.
7. Nowak T, Handford AG. *Pathophysiology: Concepts and Applications for Health Care Professionals*. 3rd ed. New York, NY: McGraw Hill; 2003.
8. McCance KL, Huethe SE (eds). *Pathophysiology: The Biologic Basis for Disease in Adults and Children*. 8th ed. St. Louis, MO: Elsevier Mosby; 2019.
9. Dvorak AM, Monahan-Earley RA. *Diagnostic Ultrastructural Pathology: A Text-Atlas of Case Studies Emphasizing Respiratory and Nervous Systems*. New York, NY: CRC Press; 1992.
10. Ward JPT, Ward J, Leach RM. *The Respiratory System at a Glance*. 4th ed. Oxford: John Wiley & Son Ltd.; 2015.
11. Banasik JL. *Pathophysiology*. 6th ed. St. Louis, MO: Elsevier Mosby; 2019.
12. Galvagno SM. *Emergency Pathophysiology: Clinical Applications for Prehospital Care*. Jackson, WY: Teton NewMedia; 2013.
13. Davies A, Moores C. *The Respiratory System: Basic Science and Clinical Condition*. 2nd ed. London: Churchill Livingstone Elsevier; 2010.
14. Kaminsky D. *The Netter Collection of Medical Illustrations: Respiratory System*. 2nd ed. Philadelphia, PA: Elsevier Saunders; 2011.
15. Hall JE (ed). *Guyton and Hall Textbook of Medical Physiology*. 14th ed. Philadelphia, PA: Elsevier; 2021.
16. Brashers VL. *Clinical Applications of Pathophysiology: An Evidence-Based Approach*. 3rd ed. St. Louis, MO: Mosby; 2006.
17. Bullock BA, Henze RL. *Focus on Pathophysiology*. 4th ed. Philadelphia, PA: Lippincott Williams and Wilkins; 2010.
18. Browder Lazenby R. *Handbook of Pathophysiology*. 4th ed. Philadelphia, PA: Lippincott Williams and Wilkins; 2011.
19. Prentice Hall PTR. *The Respiratory System*. 3rd ed. New York, NY: Prentice Hall; 2013.
20. Kaliner MA, Barnes PJ, Kunkel GHH, Baraniuk JN (eds). *Neuropeptides in Respiratory Medicine*. New York, NY: Marcel Dekker, Inc.; 1994.
21. Bope ET, Kellerman RD. *Conn's Current Therapy 2020*. Philadelphia, PA: Elsevier; 2020.
22. Price SA, Wilson LM. *Pathophysiology: Clinical Concepts of Disease Processes*. 7th ed. St. Louis, MO: Mosby; 2014.
23. U.S. Department of Health and Human Services. *The Health Consequences of Smoking: 50 Years of Progress: A Report of the Surgeon General*. Atlanta, GA: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health; 2014.
24. Loke J (ed). *Pathophysiology and Treatment of Inhalation Injuries*. New York, NY: Marcel Dekker; 1988.
25. Buttaro Mahan T, Trybulski J, Polgar-Bailey P, Sandberg-Cook J. *Primary Care: A Collaborative Practice*. 5th ed. St. Louis, MO: Elsevier; 2017.
26. Ackley BJ, Ladwig GB, Makic MB, Martinez-Kratz M, Zanoliti M. *Nursing Diagnosis Handbook: An Evidence-Based Guide to Planning Care*. 12th ed. St. Louis, MO: Elsevier; 2019.
27. Ladwig GB, Ackley BJ, Makic MB. *Mosby's Guide to Nursing Diagnosis*. 6th ed. St. Louis, MO: Elsevier; 2020.
28. Gulanick M, Myers JL. *Nursing Care Plans: Diagnoses, Interventions and Outcomes*. 9th ed. St. Louis, MO: Elsevier; 2017.
29. Harding MM. *Medical-Surgical Nursing: Assessment and Management of Clinical Problems*. 11th ed. St. Louis, MO: Elsevier Mosby; 2020.
30. Fenske C, Dolan Watkins K, Saunders T, D'Amico DT, Barbarito C. *Health and Physical Assessment in Nursing*. 4th ed. St. Louis, MO: Pearson; 2019.
31. Davies A. *The Respiratory System: Systems of the Body Series*. New York, NY: Churchill Livingstone; 2003.
32. Schwartzstein RM, Parker MJ. *Respiratory Physiology: A Clinical Approach*. Philadelphia, PA: Lippincott Williams & Wilkins; 2006.
33. Domino FJ, Baldor RA, Golding J, Stephens MB. *The 5-Minute Clinical Consult Standard 2016*. Philadelphia, PA: Wolters Kluwer; 2015.
34. Lancraft T, Frierson F, Shuster C, Sun E. *Interactions: Exploring the Functions of the Human Body/Gas Exchange and pH Balance: The Respiratory System*. 2nd ed. John Wiley & Sons, Inc.; 2006.
35. Prange HD. *Respiratory Physiology: Understanding Gas Exchange*. New York, NY: Chapman and Hall; 1996.

36. LeMone P, Burke KM, Bauldoff G, Gubrud P. *Medical Surgical Nursing: Critical Thinking in Patient Care*. 6th ed. New York, NY: Pearson; 2014.
37. Centers for Disease Control and Prevention. Testing for TB Infection. Available at <https://www.cdc.gov/tb/topic/testing/tbtesttypes.htm>. Last accessed July 17, 2020.
38. Centers for Disease Control and Prevention. Fungal Diseases. Diagnosis and Testing for Valley Fever (Coccidioidomycosis). Available at <https://www.cdc.gov/fungal/diseases/coccidioidomycosis/diagnosis.html>. Last accessed July 17, 2020.
39. Saunorus Baird M. *Manual of Critical Care Nursing: Nursing Interventions and Collaborative Management*. 7th ed. St. Louis, MO: Elsevier; 2016.
40. Zane RD, Kosowsky JM. *Pocket Emergency Medicine*. 4th ed. Philadelphia, PA: Lippincott Williams & Wilkins; 2018.
41. Markovchick VJ, Pons PT, Bakes KA, Buchanan J. *Emergency Medicine Secrets*. 6th ed. Philadelphia, PA: Elsevier; 2016.
42. Nelms M, Sucher KP. *Nutrition Therapy and Pathophysiology*. 4th ed. Boston, MA: Cengage Learning; 2019.
43. Diamond M, Feliciano HLP, Sanghavi Devang, Mahapatra S. *Acute Repiratory Syndrome (ARDS)*. Treasure Island, FL: StatPearls Publishing; 2020.
44. Berg SM, Bittner EA. *Massachusetts General Hospital Review of Critical Care Medicine*. Philadelphia, PA: Lippincott Williams & Wilkins; 2014.
45. Mandell LA, Wunderlink RG, Anzuneto A, et al. Infectious Diseases Society of America/American Thoracic Society consensus guidelines on the management of community-acquired pneumonia in adults. *Clin Infect Dis*. 2007;19(44):S27-S72.
46. Metlay JP, Waterer GW, Long AC, et al. Diagnosis and treatment of adults with community-acquired pneumonia. An official clinical practice guideline of the American Thoracic Society and Infectious Diseases Society of America. *Am J Respir Crit Care Med*. 2019;200(7):e45-e67.
47. Management of adults with hospital-acquired, ventilator-associated pneumonia: 2016 clinical practice guidelines by the Infectious Diseases Society of America and the American Thoracic Society. *Clin Infectious Dis*. 2016;63:e61-e111.
48. Marik PE. Aspiration pneumonitis and aspiration pneumonia. *N Eng J Med*. 2001;344(9):665-671.
49. Jameson JL, Fauci AS, Kasper DL, Hauser S, Longo D, Loscalzo J (eds). *Harrison's Principles of Internal Medicine*. 20th ed. New York, NY: McGraw-Hill; 2018.
50. High KP. Pneumonia in older adults. New categories add complexity to diagnosis and care. *Postgrad Med*. 2005;118(4):18-28.
51. Garrett L. *The Coming Plague: Newly Emerging Diseases in a World Out of Balance*. New York, NY: Farrar, Straus, Giroux; 1994.
52. Heron M. Deaths: final data for 2017. *Nat Vital Stat Rep*. 2019;68(9):1-80.
53. Fagon JY, Chastre J, Hance AJ, Montravers P, Novara A, Gibert C. Nosocomial pneumonia in ventilated patients: a cohort study evaluating attributable mortality and hospital stay. *Am J Med*. 1993;94(3):281-288.
54. Huang SS, Johnson KM, Ray GT, et al. Healthcare utilization and cost of pneumococcal disease in the United States. *Vaccine*. 2011;29(18):3398-1412.
55. Ruuskanen O, Lahti E, Jennings LC, Murdoch DR. Viral pneumonia. *Lancet*. 2011;377(9773):1264-1275.
56. World Health Organization. Fact Sheets: Pneumonia. Available at <https://www.who.int/news-room/fact-sheets/detail/pneumonia>. Last accessed July 17, 2020.
57. File TM Jr, Marrie TJ. Burden of community-acquired pneumonia in North American adults. *Postgrad Med*. 2010;122(2):130-141.
58. Fung HB, Monteagudo-Chu MO. Community-acquired pneumonia in the elderly. *Am J Geriatr Pharmacother*. 2010;8(1):47-62.
59. Jackson ML, Neuzil KM, Thompson WW, et al. The burden of community-acquired pneumonia in seniors: results of a population-based study. *Clin Infect Dis*. 2004;39(11):1642-1650.
60. Stringer JR, Beard CB, Miller RF, Wakefield AE. A new name (*Pneumocystis jiroveci*) for pneumocystis from humans. *Emerg Infect Dis*. 2002;8(9):891-896.
61. Advisory Committee on Immunization Practices. Prevention of pneumococcal disease: recommendations of the Advisory Committee on Immunization Practices (ACIP). *MMWR*. 1997;46(RR8):1-24.
62. Spina D, Page CP, Metzger WJ, O'Connor BJ (eds). *Drugs for the Treatment of Respiratory Diseases*. Cambridge: Cambridge University Press; 2003.
63. DiPiro J, Yee G, Posey LM, Haines ST, Nolin TD, Ellingrod V. *Pharmacotherapy: A Pathophysiologic Approach*. 11th ed. New York, NY: McGraw-Hill Education; 2020.
64. Springhouse. *Nursing 2009 Student Drug Guide*. 10th ed. Springhouse, PA: Springhouse Corporation; 2010.
65. Wilson BA, Shannon M, Shields K. *Pearson Nurse's Drug Guide: 2020*. New York, NY: Pearson; 2019.
66. Huether SE, McCance KL. *Understanding Pathophysiology*. 6th ed. St. Louis, MO: Elsevier; 2017.
67. World Health Organization. Global Tuberculosis Report 2019. Available at https://www.who.int/tb/publications/global_report/en/. Last accessed July 17, 2020.

68. Centers for Disease Control and Prevention. Trends in Tuberculosis, 2018. Available at <https://www.cdc.gov/tb/publications/factsheets/statistics/tbtrends.htm>. Last accessed July 17, 2020.
69. Centers for Disease Control and Prevention. Fact Sheet: Extensively Drug-Resistant Tuberculosis (XDR-TB). Available at <https://www.cdc.gov/TB/publications/factsheets/drtb/xdrtb.htm>. Last accessed July 17, 2020.
70. Centers for Disease Control and Prevention. Public Health Investigation Seeks People Who May Have Been Exposed To Extensively Drug Resistant Tuberculosis (XDR-TB) Infected Person [Archive]. Available at <https://www.cdc.gov/media/transcripts/2007/t070529.htm>. Last accessed July 17, 2020.
71. Grossman S, Porth CM. *Porth's Pathophysiology: Concepts of Altered Health States*. 9th ed. Philadelphia, PA: Lippincott Williams and Wilkins; 2014.
72. Zerwekh J. *Mosby's Pharmacology Memory NoteCards: Visual, Mnemonic, and Memory Aids for Nurses*. 5th ed. St. Louis, MO: Elsevier; 2018.
73. Willis L. *Professional Guide to Diseases*. 11th ed. Ambler, PA: Lippincott Williams and Wilkins; 2019.
74. American Medical Association. *The American Medical Association Essential Guide to Asthma (Better Health for 2003)*. New York, NY: Pocket Books; 2000.
75. National Heart, Lung, and Blood Institute. Asthma. Available at <https://www.nhlbi.nih.gov/health-topics/asthma>. Last accessed July 17, 2020.
76. McMillan JA, DeAngelis CD, Feigin RD, Jones MD (eds). *Oski's Pediatrics: Principles and Practice*. 4th ed. Philadelphia, PA: Lippincott Williams and Wilkins; 2006.
77. World Health Organization. Fact Sheets: Asthma. Available at <https://www.who.int/news-room/fact-sheets/detail/asthma>. Last accessed July 17, 2020.
78. Centers for Disease Control and Prevention. Asthma: Data, Statistics, and Surveillance: Asthma Surveillance Data. Available at <https://www.cdc.gov/asthma/asthmadata.htm>. Last accessed July 8, 2020.
79. Centers for Disease Control and Prevention. Asthma: Data, Statistics, and Surveillance. Asthma Prevalence in the U.S. Available at <https://www.cdc.gov/asthma/asthmadata.htm>. Last accessed July 17, 2020.
80. Centers for Disease Control and Prevention. National Center for Health Statistics. Asthma. Available at <https://www.cdc.gov/nchs/fastats/asthma.htm>. Last accessed July 17, 2020.
81. Moorman JE, Zahran H, Truman BI, Molla MT. Current asthma prevalence—United States, 2006–2008. *MMWR*. 2011;60(1):84–86.
82. Centers for Disease Control and Prevention. State of Childhood Asthma, United States: 1980–2005. Available at <https://www.cdc.gov/nchs/pressroom/06facts/asthma1980-2005.htm>. Last accessed July 17, 2020.
83. Ehrman J, Gordon P, Visich P, Keteyian S. *Clinical Exercise Physiology*. 3rd ed. Champaign, IL: Human Kinetics; 2013.
84. Global Initiative for Chronic Obstructive Lung Disease. Global Strategy for the Diagnosis, Management, and Prevention of Chronic Obstructive Pulmonary Disease: 2018 Report. Available at https://goldcopd.org/wp-content/uploads/2017/11/GOLD-2018-v6.0-FINAL-revised-20-Nov_WMS.pdf. Last accessed July 17, 2020.
85. Wilkinson I, Raine T, Wiles K, Goodhart A, Hall C, O'Neill H. *Oxford Handbook of Clinical Medicine*. 10th ed. Oxford: Oxford University Press; 2017.
86. Feather A, Randall D, Waterhouse (eds). *Kumar and Clark's Clinical Medicine*. 10th ed. Edinburgh: Elsevier Saunders; 2020.
87. Wenzel RP, Fowler AA. Clinical practice: acute bronchitis. *N Engl J Med*. 2006;355(20):2125–2130.
88. Lodish H, Berk A, Kaiser CA, et al. *Molecular Cell Biology*. 8th ed. New York, NY: WH Freeman; 2016.
89. Troosters T, Casaburi R, Gosselink R, Decramer M. Pulmonary rehabilitation in chronic obstructive pulmonary disease. *Am J Respir Crit Care Med*. 2005;172(1):19–38.
90. Centers for Disease Control and Prevention. United States Cancer Statistics. Available at <https://www.cdc.gov/cancer/uscs/>. Last accessed July 17, 2020.
91. American Cancer Society. Cancer Facts and Figures: 2020. Available at <https://www.cancer.org/research/cancer-facts-statistics/all-cancer-facts-figures/cancer-facts-figures-2020.html>. Last accessed July 17, 2020.
92. National Comprehensive Cancer Network. NCCN Clinical Practice Guidelines in Oncology: Non-Small Cell Lung Cancer. Available at https://www.nccn.org/professionals/physician_gls/pdf/nscl.pdf. Last accessed July 17, 2020.
93. American Cancer Society. Lung Cancer: Small Cell Lung Cancer. Available at <https://www.cancer.org/cancer/lung-cancer.html>. Last accessed July 8, 2020.
94. Tan WW. Non-Small Cell Lung Cancer. Available at <https://emedicine.medscape.com/article/279960-overview>. Last accessed July 17, 2020.
95. MedlinePlus. Non-Small Cell Lung Cancer. Available at <https://medlineplus.gov/ency/article/007194.htm>. Last accessed July 17, 2020.
96. Merck Manual Professional Version. Available at <https://www.merckmanuals.com/professional>. Last accessed July 17, 2020.

97. Centers for Disease Control and Prevention. What Are the Symptoms of Lung Cancer? Available at https://www.cdc.gov/cancer/lung/basic_info/symptoms.htm. Last accessed July 17, 2020.
98. Johnston L. *Lung Cancer: Making Sense of Diagnosis, Treatment, and Options*. Sebastopol, CA: Patient Centered Guides; 2001.
99. Betticher DC. Adjuvant and neoadjuvant chemotherapy in NSCLC: a paradigm shift. *Lung Cancer*. 2005;50(Suppl 2):S9-S16.
100. National Cancer Institute. Non-Small Cell Lung Cancer Treatment (PDQ). Available at <https://www.cancer.gov/types/lung/hp/non-small-cell-lung-treatment-pdq>. Last accessed July 17, 2020.
101. Haas ML. Radiation therapy. In: *Cancer Source Book for Nurses*. 8th ed. Sudbury, MA: Jones and Barlett; 2004.
102. American Cancer Society. Radiation Therapy. Available at <https://www.cancer.org/content/cancer/en/treatment/treatments-and-side-effects/treatment-types/radiation.html>. Last accessed July 17, 2020.
103. Ferrell BR, Coyle N, Paice J (eds). *Oxford Textbook of Palliative Nursing*. 5th ed. Oxford: Oxford University Press; 2019.
104. McPhee SJ, Markowitz AJ. Psychological considerations, growth, and transcendence at the end of life: the art of the possible. *JAMA*. 2001;286(23):3002.
105. National Cancer Institute. Last Days of Life for Health Professionals (PDQ). Available at https://www.cancer.gov/about-cancer/advanced-cancer/caregivers/planning/last-days-hp-pdq#section/_1. Last accessed July 17, 2020.
106. Montgomery WW. *Surgery of the Upper Respiratory System*. Philadelphia, PA: Lippincott Williams & Wilkins; 1996.
107. Lumb AB. *Nunn's Applied Respiratory Physiology*. 8th ed. Philadelphia, PA: Elsevier; 2012.
108. Ali J, Summer W, Leritzky MG (eds). *Pulmonary Pathophysiology: A Clinical Approach*. 3rd ed. New York, NY: McGraw-Hill Medical; 2010.

Evidence-Based Practice Recommendations Citations

- Management of Chronic Obstructive Pulmonary Disease Working Group. VA/DoD *Clinical Practice Guideline for the Management of Chronic Obstructive Pulmonary Disease*. Washington, DC: Department of Veterans Affairs, Department of Defense; 2014. Available at <https://www.healthquality.va.gov/guidelines/CD/copd/VADoDCOPDCPG2014.pdf>. Last accessed August 10, 2020.
- Jokerst C, Chung JH, Ackman JB, et al. *ACR Appropriateness Criteria: Acute Respiratory Illness in Immunocompetent Patients*. Reston, VA: American College of Radiology; 2018. Available at <https://acsearch.acr.org/docs/69446/Narrative>. Last accessed August 10, 2020.
- World Health Organization. *Systematic Screening for Active Tuberculosis: Principles and Recommendations*. Geneva: World Health Organization; 2013. Available at <https://www.who.int/tb/tbscreening/en/>. Last accessed August 10, 2020.
- Advisory Committee for Immunization Practices. Influenza ACIP Vaccine Recommendations. Available at <https://www.cdc.gov/vaccines/hcp/acip-recs/vacc-specific/flu.html>. Last accessed August 10, 2020.
- Chung KF, Wenzel SE, Brozek JL, et al. International ERS/ATS guidelines on definition, evaluation and treatment of severe asthma. *Eur Respir J*. 2014;43(2):343-373. Available at <https://www.thoracic.org/statements/resources/allergy-asthma/Severe-Asthma-CPG-ERJ.pdf>. Last accessed August 10, 2020.
- Criner GJ, Bourbeau J, Diekemper RL, et al. Prevention of acute exacerbations of COPD: American College of Chest Physicians and Canadian Thoracic Society Guideline. *Chest*. 2015;147(4):894-942. Available at <https://europepmc.org/article/med/25321320>. Last accessed August 10, 2020.
- Simoff MJ, Lally B, Slade MG, et al. Symptom management in patients with lung cancer: diagnosis and management of lung cancer, 3rd ed.: American College of Chest Physicians evidence-based clinical practice guidelines. *Chest*. 2013;143(5 Suppl):e455S-e497S. Available at [https://journal.chestnet.org/article/S0012-3692\(13\)60305-0/fulltext](https://journal.chestnet.org/article/S0012-3692(13)60305-0/fulltext). Last accessed August 10, 2020.