Emily gets sick so much faster than my other children. I guess the bronchopulmonary dysplasia and her tracheostomy make her more susceptible to infections. I really get concerned because she struggles so hard to breathe when she gets an infection. I have learned to suction and change her tracheostomy tube, but I’m afraid that one day her tracheostomy tube will get completely blocked. I just hope I remember all the things I’ve learned if that happens, and that the emergency medical personnel come quickly. —Father of Emily, 8 months old

**LEARNING OUTCOMES**

*After reading this chapter, you will be able to do the following:*

20.1 Describe unique characteristics of the pediatric respiratory system anatomy and physiology and apply that information to the care of children with respiratory conditions.

20.2 Contrast the different respiratory conditions and injuries that can cause respiratory distress in infants and children.

20.3 Explain the visual and auditory observations made to assess a child’s respiratory effort or work of breathing.

20.4 Assess the child’s respiratory status and analyze the need for oxygen supplementation.

20.5 Distinguish between conditions of the lower respiratory tract that cause illness in children.

20.6 Create a nursing care plan for a child with a common acute respiratory condition.

20.7 Develop a school-based nursing care plan for the child with asthma.

20.8 Perform a nursing assessment of the child with an acute lung injury.
KEY TERMS

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Cor pulmonale, 528
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Dysphonia, 519
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RESPIRATORY DISTRESS AND RESPIRATORY FAILURE

Many respiratory conditions associated with breathing difficulty can progress to respiratory distress. If the condition is not managed effectively, it can progress to respiratory failure. Foreign-body aspiration is a common cause of airway obstruction and respiratory distress.

Foreign-Body Aspiration

Foreign-body aspiration is the inhalation of any object (solid or liquid, food or non-food) into the respiratory tract. It is a major health threat for infants and young toddlers because of their increasing mobility and tendency to put objects into their mouths. Aspiration occurs most often during feeding and reaching activities, while crawling, or during playtime. However, aspiration may occur in children of any age. In 2007, 162 children less than 20 years of age died from foreign-body aspiration, and food aspiration caused 37% of these deaths. Nearly 75% of these children were younger than age 3 years (Levin & Smith, 2010).

Etiology and Pathophysiology

In infants over 6 months of age and young children, any number of small objects that enter the child’s mouth may cause aspiration. Partial and sometimes complete airway obstruction can occur. The severity of the obstruction depends on the size and composition of the object or substance and its location within the respiratory tract.

Most aspirated foreign bodies (AFBs) usually cause bronchial, not tracheal, obstruction. An object lodged high in the airway above the vocal cords is more easily removed by coughing or by back blows and chest thrusts. The right lung is the most common site of the AFB in the lower airway because of the sloped angle of its bronchus. Objects may migrate from higher to lower airway locations. An object may also move back up to the trachea, creating extreme respiratory difficulty. If the AFB is lodged in the trachea, it becomes life threatening.

Clinical Manifestations

In many cases the aspiration is unobserved. The child may have a sudden onset of choking, spasmodic coughing, shortness of breath, or dysphonia (muffled, hoarse, or absent voice sounds). These signs may be brief or may persist for several hours if the object drops below the trachea into one of the mainstem bronchi. Some children become asymptomatic after coughing for 15 to 30 minutes. The child may develop increased respiratory effort such as dyspnea (difficulty breathing), tachypnea, nasal flaring, and retractions. As respiratory distress progresses, the child may have a concentrated focus on breathing, an anxious expression, and an upright position with the neck extended. As hypoxia (lower than normal oxygen in the tissues) increases, behavior changes such as irritability and decreased responsiveness are seen.

If the AFB drops into the right bronchus and lower airway and is not removed, the child may present weeks later with a chronic cough, persistent or recurrent pneumonia, or a lung abscess.

Clinical Tip

Common items associated with foreign body aspiration and airway obstruction include the following:

- Foods such as nuts, popcorn, or small pieces of raw vegetables or hot dog
- Small loose toy parts, such as wheels, bells, or magnets
- Household items such as beads, safety pins, coins, buttons, or latex balloon pieces
The Respiratory System

ANATOMY AND PHYSIOLOGY

The respiratory system is composed of both the upper and lower airways. The upper airway, containing the nasopharynx and oropharynx, serves as the pathway for gases exchanged during ventilation, the movement of oxygen into the lungs and carbon dioxide out of the lungs. The larynx divides the upper and lower airways. The lower airways (trachea, bronchi, and bronchioles) serve as the pathway of gases to the alveoli in the lungs. The left lung is divided into two lobes, and the right lung is divided into three lobes. Alveolar sacs surrounded by capillaries are located at the end of the airways and are the site of gas exchange, where oxygen diffuses across the alveolocapillary membrane. Surfactant secreted by alveolar cells coats the inner surface of the alveolus to allow expansion during inspiration. The lung tissue surrounding the airways keeps them from collapsing as the oxygen moves in and carbon dioxide moves out during ventilation. The lungs are positioned in the thoracic cavity, where the ribs and muscles protect the lungs from injury.

The intercostal muscles work with the diaphragm to perform the work of breathing. The diaphragm is a muscle that separates the abdominal and thoracic cavity contents. When the diaphragm contracts, it creates negative pressure that increases the thoracic volume and pulls air into the lungs. The lungs and chest wall have the ability to expand during inspiration (compliance) and then to recoil or return to the resting state with expiration. The work of breathing is tied to the muscular effort required for ventilation, which can be increased in cases of disorders that increase the stiffness of the lungs or obstruct the airways.

The respiratory center in the brain controls respiration, sending impulses to the respiratory muscles to contract and relax. Breathing is usually involuntary, because the nervous system automatically adjusts the ventilatory rate and volume to maintain normal gas exchange (Brashers, 2010b). Chemoreceptors monitor the pH, PaCO₂, and PaO₂ in the arterial blood and send signals to the respiratory center to increase ventilation in cases of arterial hypoxemia. Effective gas exchange requires a near even distribution of ventilation and perfusion (oxygenated blood flow to all portions of the lungs). As oxygen diffuses across the alveolocapillary membrane, it dissolves in the plasma and the resulting pressure (PaO₂) helps bind the oxygen to the hemoglobin molecules where it is then transported to the cells for metabolism. Carbon dioxide produced by cellular metabolism is dissolved in the plasma (PCO₂) and/or as bicarbonate and travels back to the lungs where it diffuses across the alveolocapillary membrane (Brashers, 2010b).

FOCUS ON

PEDIATRIC DIFFERENCES

The child’s respiratory tract constantly grows and changes until about 12 years of age. The young child’s neck is shorter than an adult’s, resulting in airway structures that are closer together.

Upper Airway Differences

The child’s airway is shorter and narrower than an adult’s. These differences create a greater potential for obstruction (see As Children Grow: Airway Development). The infant’s airway diameter is approximately 4 mm, about the width of a drinking straw, in contrast to the adult’s airway diameter of 20 mm. The child’s little finger is a good estimate for the child’s tracheal diameter and can be used for a quick assessment of airway size. The trachea primarily increases in length rather than diameter during the first 5 years of life.

The tracheal division of the right and left bronchi is higher in a child’s airway and at a different angle than the adult’s (see As Children Grow: Trachea Position). The cartilage that supports the trachea is more flexible, and the airway may be compressed if the head and neck are not appropriately positioned. The child’s narrower airway causes a greater increase in airway resistance (the effort or force needed to move oxygen through the trachea to the lungs) in any condition causing airway inflammation or edema (see Pathophysiology Illustrated: Airway Diameter).

Newborns are obligatory nose breathers, breathing only through the mouth when crying. The coordination of mouth breathing is controlled by maturing neurologic pathways, and infants up to 2 to 3 months of age do not automatically open the mouth to breathe when the nose is obstructed. It is important to keep the newborn’s nose patent for breathing and eating.

Lower Airway Differences

The tracheobronchial tree is complete in the full-term newborn, but the child’s lower airway is constantly growing. At 24 weeks gestation, no lung sacs have developed, but by 32 weeks’ gestation, lung sacs have developed and have begun to differentiate into alveoli (Smith, McKay, van Asperen, et al., 2010). Full-term newborns have 25 million alveoli at birth, but they are not fully developed. Alveoli begin increasing in size and complexity after 8 years of age, and the number of alveoli increases to 300 million by adulthood (Brashers, 2010b).

The bronchi and bronchioles are lined with smooth muscle. By 5 months of age an infant has enough smooth muscle bundles to react to irritants by bronchospasm and muscle contraction.

Children under 6 years of age use the diaphragm to breathe because the intercostal muscles are immature. By 6 years of age the child uses the intercostal muscles more effectively. The ribs are primarily cartilage and very flexible. In cases of respiratory distress, the negative pressure caused by the diaphragm
movement causes the chest wall to be drawn inward, causing retentions (see Pathophysiology Illustrated: Retraction Sites).

Children consume more oxygen than adults because of their higher metabolic rate. This rate of oxygen consumption increases when the child is in respiratory distress. The child also has fewer muscle glycogen reserves, leading to more rapid muscle fatigue when accessory muscles must be used for breathing (Gott & Froh, 2010).

Use the Assessment Guide: The Child with a Respiratory Condition on page 524 to perform a nursing assessment of the respiratory system. See Table 20–1 on page 523 for a list of diagnostic and laboratory tests used to evaluate respiratory conditions. See Appendix D for expected laboratory values and Appendix E for information about diagnostic procedures.

Pediatric respiratory conditions may occur as a primary problem or as a complication of nonrespiratory conditions. Respiratory problems may result from structural problems, functional problems, or a combination of both. Structural problems involve alterations in the size and shape of parts of the respiratory tract. Functional problems involve alterations in gas exchange and threats to the process of ventilation due to irritation by large particles and chemicals or infection. Alterations in other organ systems, especially the immune and neurologic systems, may also threaten respiratory function. See Chapter 19 for...
In children, the trachea is shorter and the angle of the right bronchus at bifurcation is more acute than in the adult. When you are resuscitating or suctioning, you must allow for these differences. Do you think that the angle of the right bronchus is significant in foreign-body aspiration? Why?

Bifurcation of trachea in children is at T3 level.

Right mainstem bronchus in children has a steeper slope than in adults.

Bifurcation in adults is at T6 level.

**Pathophysiology Illustrated**  
**Airway Diameter**

An infant’s airway diameter is approximately 4 mm, in contrast to the adult’s 20-mm airway diameter. An inflammatory process in the airway causes swelling that narrows the airway, and airway resistance increases. Note that swelling of 1 mm reduces the infant’s airway diameter to 2 mm, but the adult’s airway diameter is only narrowed to 18 mm. Air must move more quickly in the infant’s narrowed airway to get the needed amount of air into the lungs. The friction of the quickly moving air against the side of the airway increases airway resistance. The infant must use more effort to breathe and must breathe faster to get adequate oxygen.

Upper respiratory conditions such as otitis media, sinusitis, and pharyngitis.

Most respiratory problems in children produce mild symptoms, last a short time, and can be managed at home. Other respiratory problems are chronic and potentially life threatening. Respiratory conditions are a common cause of hospitalization in children between 1 and 9 years of age and a leading cause in children between 10 and 17 years of age (Agency for Healthcare Research and Quality, 2011). Some respiratory conditions are chronic and have a significant impact on the child’s growth and development.
Infants and young children have immature chest muscles and ribs of cartilage, which makes the chest wall very flexible. The negative pressure created by the downward movement of the diaphragm is increased in cases of respiratory distress, and the chest wall is pulled inward, causing retractions. Intercostal retractions are seen in mild respiratory distress. As respiratory distress severity increases, substernal and subcostal retractions are seen. In cases of severe distress, supraclavicular and suprasternal retractions occur as the accessory muscles (sternocleidomastoid and trapezius muscles) are used.

**Table 20–1**

<table>
<thead>
<tr>
<th>Diagnostic Procedures</th>
<th>Laboratory Tests</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bronchoscopy</td>
<td>Arterial blood gas analysis</td>
</tr>
<tr>
<td>Chest radiograph</td>
<td>Cultures</td>
</tr>
<tr>
<td>Polysomnography (sleep study)</td>
<td>Neonatal screening for cystic fibrosis</td>
</tr>
<tr>
<td>Pulse oximetry</td>
<td>Protein-purified derivative (PPD), the Mantoux test</td>
</tr>
<tr>
<td>Spirometry (pulmonary function tests)</td>
<td></td>
</tr>
<tr>
<td>Sweat chloride test</td>
<td></td>
</tr>
</tbody>
</table>

*See Appendix D and E for information about these diagnostic procedures and tests.*
Clinical therapy focuses on taking a careful history to determine whether aspiration could have occurred. Witnessed coughing, gagging, or choking associated with feeding or crawling on the floor may confirm the aspiration. Decreased breath sounds, stridor, and respiratory distress increase suspicion in the child without a witnessed aspiration. Because many aspirated objects are organic, only 15% of the objects are radiopaque (Srivastava, 2010) (Figure 20–1). A special radiograph, called a forced expiratory film, may show local hyperinflation (air trapping) and a mediastinal shift away from the affected side, abnormalities that an AFB may cause.

An object lodged in the trachea is life threatening. Back blows and chest thrusts or abdominal thrusts are used to remove an object from an obstructed airway. (See the Clinical Skills Manual.) Fluoroscopy and fiber-optic bronchoscopy may be used to identify, locate, and extract the AFB. The child may develop pneumonia if a foreign body is not recognized as a cause of respiratory distress (see page 538).

NURSING MANAGEMENT for the Child with Foreign-Body Aspiration

Nursing Assessment and Diagnosis

Physiologic Assessment

The child with an acute AFB will be in respiratory distress and requires constant monitoring. Perform the respiratory assessment following the guidelines given in Assessment Guide: The Child with a Respiratory Condition.

<table>
<thead>
<tr>
<th>Assessment Focus</th>
<th>Assessment Guidelines</th>
</tr>
</thead>
<tbody>
<tr>
<td>Position of comfort</td>
<td>■ Is the child comfortable lying down?</td>
</tr>
<tr>
<td></td>
<td>■ Does the child prefer to sit up or be in the tripod position (sitting forward with arms on knees for support and extending the neck)?</td>
</tr>
<tr>
<td>Vital signs</td>
<td>■ Assess the rate, depth, and ease of respirations. See Table 5–9 on page 137 for expected respiratory rate ranges by age.</td>
</tr>
<tr>
<td></td>
<td>■ Assess the pulse for rate and strength. See Table 5–11 on page 140 for expected heart rate ranges by age.</td>
</tr>
<tr>
<td>Lung auscultation</td>
<td>■ Are breath sounds bilateral, diminished, or absent?</td>
</tr>
<tr>
<td></td>
<td>■ Are adventitious sounds (wheezes, crackles, or rhonchi) present?</td>
</tr>
<tr>
<td>Respiratory effort (work of breathing)</td>
<td>■ Is stridor (an audible crow-like inspiratory and expiratory breath sound) or grunting with expiration heard?</td>
</tr>
<tr>
<td></td>
<td>■ Is breathing labored?</td>
</tr>
<tr>
<td></td>
<td>■ Are retractions (visible appearance of the chest being drawn in on inspiration) present or are accessory muscles used to breathe?</td>
</tr>
<tr>
<td></td>
<td>■ Is nasal flaring present?</td>
</tr>
<tr>
<td></td>
<td>■ Is tachypnea (abnormally rapid rate of respirations) present?</td>
</tr>
<tr>
<td></td>
<td>■ Can the child say a full sentence or is a breath needed every few words? Is the cry strong or weak?</td>
</tr>
<tr>
<td></td>
<td>■ Do the chest and abdomen rise simultaneously with inspiration or is paradoxical breathing present in which the chest and abdomen do not simultaneously rise?</td>
</tr>
<tr>
<td>Color</td>
<td>■ What is the color of the mucous membranes, skin, and nailbeds (pink, pale, mottled, cyanotic)?</td>
</tr>
<tr>
<td></td>
<td>■ Does crying improve or worsen the color?</td>
</tr>
<tr>
<td>Cough</td>
<td>■ Is the cough dry (nonproductive), wet (productive, mucousy), brassy (noisy, musical), or croupy (barking, seal-like)?</td>
</tr>
<tr>
<td></td>
<td>■ Is the coughing effort forceful or weak?</td>
</tr>
<tr>
<td>Behavior change</td>
<td>■ Is irritability, restlessness, or change in level of responsiveness present?</td>
</tr>
<tr>
<td>Family history</td>
<td>■ Is there a family history of asthma or cystic fibrosis?</td>
</tr>
</tbody>
</table>

*Refer to Chapter 5 for the assessment techniques mentioned in this table.
Anxiety (Child) related to difficulty breathing, unfamiliar surroundings, and procedures

Injury, Risk for related to small objects in environment

Planning and Implementation

Be prepared to perform back blows and chest thrusts for an infant or abdominal thrusts for the child with complete obstruction (see the Clinical Skills Manual [SKILLS]). When the child has a partial obstruction, remain with the child and have resuscitation equipment at the bedside. Permit the child to stay in a position of comfort. Avoid performing procedures that increase the child’s anxiety because sudden movements and increased respiratory efforts may cause the obstruction to move and completely obstruct the airway.

After the AFB is removed, the child is stabilized and observed for a few hours in a short-stay unit to ensure that there are no respiratory complications.

Discharge Planning and Home Care Teaching

Prevention of future aspirations is a major focus for nursing care. Educate the family on the child’s developmental characteristics and how to identify potential safety hazards in the home. Encourage the parents to learn rescue breathing, back blows, chest thrusts, or abdominal thrusts.

Evaluation

Expected outcomes of nursing care include the following:

- The child breathes spontaneously after removal of the foreign body.
- Parents complete a home safety check to prevent future aspiration incidents.

Respiratory Failure

Respiratory failure occurs when the body can no longer maintain effective gas exchange. Poor ventilation of the alveoli initiates the process that leads to respiratory failure. Hypoventilation occurs

Psychosocial Assessment

The unexpected and acute nature of the event creates anxiety for both parents and child. The child will be fearful because of difficulty breathing. Assess the family’s level of distress and coping ability.

Developmental Assessment

As the child’s condition stabilizes, observe how well the child’s abilities match the parents’ understanding of age-appropriate behaviors. See Chapters 7 and 8.

Common nursing diagnoses for a child with an AFB include the following (NANDA-I © 2012):

- Airway Clearance, Ineffective related to obstruction by a foreign body
- Ventilation: Spontaneous, Impaired related to respiratory muscle fatigue

Accuracy of pulse oximetry readings (SpO₂) can be improved by doing the following (Krauss & Mason, 2009; Mininni, Herzer, Marino, et al., 2009):

- Place sensor over clean dry skin (e.g., finger, foot, or earlobe). Do not place on the same extremity used for blood pressure measurements.
- Avoid placing the sensor probe over sites covered with dark nail polish.
- Cover sensors with a light barrier when the patient is under a bright light or in sunshine to reduce interference.
- Confirm that the heart rate by direct measurement matches that detected by the sensor.
- Assess when the child is not moving or shivering.
- Recognize that anemia, vasoconstriction, arrhythmia, or shock may lead to an inaccurate reading.
when oxygen need exceeds oxygen intake, the airway is partially occluded, or the transfer of oxygen and carbon dioxide in the alveoli is disrupted. This disruption may occur when a malfunction of respiratory center stimulation occurs (the alveoli do not receive the message to diffuse, e.g., a narcotic overdose), muscles of ventilation are fatigued and do not work effectively (e.g., status asthmaticus), or the relationship between ventilation and blood flow to the alveoli (perfusion) is impaired. **Hypoxemia** (lower than normal blood oxygen level) and **hypercapnia** (an excess of carbon dioxide in the blood) result from hypoventilation. When the blood levels of oxygen and carbon dioxide reach abnormal levels, hypoxia (lower than normal oxygen in the tissues) occurs and respiratory failure begins.

Signs of impending respiratory failure include worsened respiratory distress with increased respiratory effort (dyspnea, tachypnea, nasal flaring, and intercostal retractions), irritability, lethargy, and cyanosis. Grunting in infants is a sign of severe disease and the potential need for mechanical ventilation (Prodhan, Sharoor-Karni, Lin, et al., 2011). **Hypoxemia that persists when supplemental oxygen is given is a sign of respiratory failure.** See Table 20–2.

### Clinical Therapy

Arterial blood gas values help to identify hypoxemia and hypercapnia. Pulse oximetry helps determine when an arterial blood gas measurement is needed. See Appendix D for expected arterial blood gas values and the Clinical Skills Manual (SKILLS). Refer to Chapter 18 for interpretation of acidosis and alkalosis that must be considered simultaneously.

Medical management is focused on treating the cause of respiratory failure and reversing the severe hypoxemia with oxygen, mechanical ventilation, and positive end-expiratory pressure (PEEP) to increase functional residual capacity. These children are admitted to the pediatric intensive care unit (PICU).

The child’s ability to maintain an open airway decreases as the level of responsiveness deteriorates. Endotracheal (ET) intubation is a short-term, emergency measure to stabilize the airway by placing a tube in the trachea. The ET tube must be protected and stabilized to prevent its displacement. End-tidal CO₂ monitoring is used to ensure that the tube is correctly positioned in the trachea (see the Clinical Skills Manual (SKILLS)).

A **tracheostomy**, the creation of a surgical opening into the trachea through the anterior neck at the cricoid cartilage, is performed when longer term airway management is needed.

Assisted ventilation may be needed until mechanical ventilation is initiated or the child breathes spontaneously. Children are often sedated to improve mechanical ventilation. Continuous positive airway pressure is one therapy used to improve oxygenation and lung compliance. Respiratory arrest results if respiratory failure cannot be managed.

### Nursing Management

Early recognition of impending respiratory failure is the most important aspect of care for a child with any signs of respiratory compromise. Assess the child using guidelines found in the Assessment Guide on page 524. Monitor the child for changes in vital signs, respiratory status, SpO₂, and level of responsiveness. When the child has a chronic respiratory condition, development of respiratory failure may be gradual and signs will be subtle. Be particularly alert to behavior changes in addition to respiratory signs. Serial blood gases may be needed to monitor the child.

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**SAFETY ALERT!**

As the child tires from the prolonged work effort of breathing, the respiratory rate may begin to decrease. This is an ominous sign and may progress to respiratory arrest without intervention.

Place a child who has respiratory compromise in an upright position (elevate the head of the bed). Respiratory distress, anxiety, excessive crying, and even fever can deplete metabolic reserves and increase the child’s need for oxygen. Administer oxygen as ordered and keep emergency equipment at the child’s bedside. Be prepared to provide assisted ventilation if the respiratory status deteriorates. (See the Clinical Skills Manual (SKILLS)).

Because ET and tracheostomy tubes prevent vocal cord vibration, intubated children cannot cry or talk. Infants and young children often express initial frustration when they realize they cannot communicate verbally. When the child is alert, provide a bell or noisemaker as a way to gain attention. A communication

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### Table 20–2 Clinical Manifestations of Respiratory Failure and Imminent Respiratory Arrest

<table>
<thead>
<tr>
<th>Physiologic Cause</th>
<th>Clinical Manifestations</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Initial Signs of Respiratory Failure</strong></td>
<td>Restlessness, Tachypnea, Tachycardia, Diaphoresis</td>
</tr>
<tr>
<td>The child is trying to compensate for oxygen deficit and airway blockage. Oxygen supply is inadequate; behavior and vital signs reflect compensation and beginning hypoxia.</td>
<td></td>
</tr>
<tr>
<td><strong>Early Decompensation</strong></td>
<td>Nasal flaring, Retractions, Grunting, Wheezing, Anxiety, irritability, Mood changes, Headache, Hypertension, Confusion</td>
</tr>
<tr>
<td>The child tries to use accessory muscles to assist oxygen intake; hypoxia persists and efforts now waste more oxygen than is obtained.</td>
<td></td>
</tr>
<tr>
<td><strong>Severe Hypoxia and Imminent Respiratory Arrest</strong></td>
<td>Dyspnea, Bradycardia, Cyanosis, Stupor and coma</td>
</tr>
<tr>
<td>The oxygen deficit is overwhelming and beyond spontaneous recovery. Cerebral oxygenation is dramatically affected; central nervous system changes are ominous.</td>
<td></td>
</tr>
</tbody>
</table>
board can be used with older children. Suction airway secretions as needed and provide tracheostomy care if present. See the Clinical Skills Manual. Many children are discharged from the hospital and cared for at home for an extended period with a tracheostomy tube in place. Parents must demonstrate competence in all aspects of tracheostomy care (how to maintain and suction the airway, clean the tracheostomy site, and change the tube), as well as emergency resuscitation skills adapted to the tracheostomy. A home healthcare nurse can provide follow-up care and support for the child and family. (See the Clinical Skills Manual.)

APNEA

Infants commonly have periodic breathing, an irregular rhythm, and may have pauses of up to 20 seconds between breaths. This breathing pattern is not apnea. Apnea is the cessation of respiration lasting longer than 20 seconds, or any pause in respiration associated with cyanosis, marked pallor, hypotonia, or bradycardia. Apnea may be the first major sign of respiratory dysfunction in the newborn.

Apparent Life-Threatening Event (ALTE)

Apparent life-threatening event (ALTE) is defined as a frightening episode of apnea accompanied by a color change (e.g., cyanosis or pallor), limp muscle tone, choking, or gagging. Most affected infants are about 2 months of age; ALTE does not occur after 12 months of age (Berg, Nadkarni, Gausche-Hill, et al., 2010).

Potential causes of ALTE include gastroesophageal reflux, seizures, and lower respiratory disorders. Other causes may include trauma, metabolic disorder, cardiac arrhythmias, sepsis, pertussis, medication dosage error, and child abuse. ALTE and sudden infant death syndrome (SIDS) have different clinical and epidemiologic factors; however, these infants are at increased risk for SIDS (Hunt & Hauck, 2011).

A detailed history helps identify the potential condition associated with ALTE. Diagnostic tests may include an electrocardiogram, complete blood count with differential, serum electrolytes, cultures, serum ammonia levels, and a chest radiograph. No cause is found for about 50% of ALTE cases (Bonkowski & Tieder, 2009). Physical stimulation or emergency resuscitation may be required to revive the infant. Treatment is targeted at the underlying condition.

Nursing Management

After ALTE, infants are usually admitted to the hospital for evaluation and cardiorespiratory monitoring. Assess the infant’s responsiveness and behavior (e.g., irritability or unexplained sleepiness). Monitor vital signs, and assess the child’s growth. The focus of the physical examination is to detect signs of injury, infection, neurologic abnormalities, or features suggestive of a genetic or metabolic syndrome.

Attach a cardiorespiratory monitor and pulse oximeter to continuously assess the heart rate, respiratory rate, and oxygenation status while the infant is awake and asleep. Because the infant who has had ALTE continues to be at risk for cardiopulmonary arrest, keep emergency resuscitation equipment and drugs readily accessible at all times.

Provide emotional support. Establishing rapport and open communication with the parents is essential for creating a sense of trust. To obtain further information about the episode, use open-ended questions and active listening skills. Parents are fearful and anxious about the infant’s prognosis. Explanations of tests and treatment help to decrease their anxiety and increase their understanding of the situation.

During hospitalization the infant should be held to provide a sense of security and well-being. Encouraging parents’ participation in the infant’s care helps to meet these needs and promotes family bonding. Often parents are afraid to touch the infant, because they might disconnect the monitoring cable. Wrapping the cable inside the infant’s blanket helps secure the wires, increasing parents’ feelings of confidence in handling the infant.

Support the mother to continue breastfeeding and maintaining a supply of breast milk by pumping, if necessary. Ensure that the mother gets adequate fluids and nutrition. Provide privacy for breast pumping and store breast milk for future feedings.

Discharge Planning and Home Care Teaching. Address home care needs in advance of the infant’s discharge. Review guidelines for safe sleep positions. Some infants may be discharged with a cardiorespiratory monitor. Teach parents how to operate the monitor, what to do when the infant has an apneic episode, and how to perform cardiopulmonary resuscitation (CPR) and choking intervention techniques (see the Clinical Skills Manual.) See Families Want to Know: Home Care Instructions for the Infant Requiring a Cardiorespiratory Monitor.

Obstructive Sleep Apnea

Obstructive sleep apnea syndrome (OSAS) is a disorder of breathing during sleep that involves increased respiratory resistance leading to recurrent episodes of partial and complete upper airway obstruction that disrupt normal ventilation and sleep patterns (Katz & D’Ambrosio, 2010). This results in labored breathing and snoring when the child tries to move air past the obstruction. OSAS is believed to affect 1% to 3% of school-age children (Loghmanee & Sheldon, 2010).

The upper airway contains about 30 muscles that permit the pharynx to collapse, enabling the child to talk and swallow, but also maintain airway patency. When the child is awake, muscle tone is maintained and the airway remains patent even when potential obstructions are present. During sleep, the airway muscles relax, the pharynx becomes obstructed, and airway resistance increases, leading to snoring. Reduced upper airway tone and obstruction cause apnea episodes that lead to hypoxemia, hypercapnia, and an elevated blood pressure. Hypertrophy of the adenoids and tonsils is the most common cause of OSAS, followed by craniofacial abnormalities, obesity, and neuromuscular disorders (e.g., cerebral palsy, muscular dystrophy). Children with OSAS snore and have labored breathing during sleep such as retractions and paradoxical breathing. After snoring or breathing pauses, the child may snort, gasp, choke, move, or arouse to take a breath. Sleep is restless, and the child may sleep in unusual positions to hyperextend the neck and airway. Symptoms of sleep deprivation (daytime sleepiness, poor attention, aggression, acting-out behavior, and poor school
performance) may be noted. The child may also have daytime mouth breathing, enuresis, and a morning headache.

Initial diagnosis occurs with a detailed history about snoring. **Polysomnography**, a sleep study that simultaneously records the sleep state, gas exchange, breathing efforts, cardiac rhythm, and muscle activity and movement, is performed. Adenotonsillectomy (adenoidectomy and tonsillectomy) is the most common treatment for OSAS, and the condition resolves in the majority of children. Continuous positive airway pressure (CPAP) is used for children with surgical contraindications or those with persistent OSAS (craniofacial anomalies, Down syndrome, or neuromuscular disorders) after adenotonsillectomy. Weight loss strategies may be implemented for children with obesity. OSAS may recur in children with obesity after adenotonsillectomy (Loghmanee & Sheldon, 2010). Without treatment, complications can include failure to thrive, pulmonary hypertension, **cor pulmonale** (obstruction of pulmonary blood flow that leads to right ventricular hypertrophy and heart failure), systemic hypertension, and cognitive impairment.

**Nursing Management**

In the community setting, all children should be screened for snoring as part of their routine health care. Assess the child for signs of nasal obstruction, mouth breathing, and enlarged tonsils. Determine if the child has symptoms of sleep deprivation or if a condition is present that places the child at high risk for OSAS. When snoring is present, encourage the family to keep a sleep diary.

When a polysomnogram is ordered, talk with the parents about how to prepare the child for the strange setting and wires that will be attached during the sleep study. Most pediatric centers will allow the parent to stay with the child during the study.

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**Families Want to Know**

**Home Care Instructions for the Infant Requiring a Cardiorespiratory Monitor**

**Apnea Equipment**

- Review how the monitor operates, the lead wires, placement of skin electrodes and pulse oximetry sensor, and how to set the event recorder. Keep the battery fully charged and keep the manual for troubleshooting handy.

**Emergency Preparation**

- Have an emergency plan and complete an emergency information form about the infant’s health problem. Notify the telephone company, electric company, local ambulance service, and the local emergency department (to get priority service status).
- Post the emergency response phone numbers by all phones and save in cell phones, along with the phone numbers for the physician, medical equipment company, power company, neighbor, and key family members.
- Take a cardiopulmonary resuscitation (CPR) course.

**Safety Precautions**

- Place monitor on firm surface; keep away from other appliances (television, microwave oven) and water.
- Ensure that alarms are audible from all locations.
- Double-check that the monitor and event recorder are on before putting the infant down for a nap or at bedtime.

- Thread cable and wires through lower end of infant’s clothes.
- Ensure integrity of leads, monitor cable, and power cord (replace if frayed).

**Routine Care**

- Explain the reasons for the apnea monitor and frequency of use. Use it whenever the infant sleeps. Review the manual for troubleshooting.
- Show how to attach and detach infant chest leads and belt. Evaluate the skin for irritation or sores under the electrodes and move the electrode if skin is irritated. Use no oils or lotions on the chest.

**Responding to an Alarm**

- Observe the infant for breathing first to determine if this is a real event or a loose lead.
- Stimulate the infant if respirations are absent or infant is lethargic. Start by calling the infant’s name and gently touching, proceeding to vigorous touch if needed.
- If no response, proceed with CPR.
- If a loose lead is suspected, determine if electrode patches are loose. Check the wires from the electrode or monitor cable. Check the power supply. Is the monitor malfunctioning?

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Following adenotonsillectomy, the hospital nurse monitors the child for bleeding and respiratory distress, such as obstructive sleep apnea and pulmonary edema. Continuous pulse oximetry is used to detect oxygen desaturation. See Chapter 19 for care of the child having adenoectomy and tonsillectomy.

Sleep center nurses provide education and support to families of children who need to use CPAP to treat OSAS. The nurse helps identify the best fitting mask or nasal prong system for CPAP delivery. Parents may need guidance about helping children go to sleep wearing the mask until they are accustomed to it.

**Sudden Infant Death Syndrome**

Sudden infant death syndrome (SIDS) is defined as the sudden death during sleep of an infant under 1 year of age that remains unexplained after a thorough investigation, including an autopsy, a review of the circumstances of death, and the clinical history. SIDS is the third leading cause of infant mortality in the United States (MacDorman, Hoyert, & Mathews, 2013). Most SIDS deaths occur in infants between 2 and 4 months of age. It is currently unpredictable and in some cases unpreventable.

SIDS is called a “syndrome” because infants are believed to have a vulnerability that increases the risk for sudden death such as a genetic cardiac dysrhythmia (e.g., long-QT syndrome) or a defect in neural networks that control respirations, sleep, and arousal (Hunt & Hauck, 2011). Abnormalities associated with the neurotransmitter serotonin in the medulla oblongata may interfere with arousal responses during sleep in a critical development period (Duncan, Patterson, Hoffman, et al., 2010). Cerebral oxygenation is depressed in healthy term infants when

Table 20–3 Risk Factors for Sudden Infant Death Syndrome (SIDS)

<table>
<thead>
<tr>
<th>Infant Risk Factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Preterm or low birth weight</td>
</tr>
<tr>
<td>- Native American and African American infants are at higher risk; Caucasians, Asians, and Hispanics are at lower risk</td>
</tr>
<tr>
<td>- Males are at higher risk</td>
</tr>
<tr>
<td>- Maternal smoking, alcohol intake, or substance abuse</td>
</tr>
<tr>
<td>- Socioeconomic disadvantages</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Environmental Risk Factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Sleeping prone or side-lying position; bed sharing</td>
</tr>
<tr>
<td>- Soft bedding, use of pillows, blankets, and stuffed animals with bedding</td>
</tr>
<tr>
<td>- Overheating</td>
</tr>
<tr>
<td>- Secondhand tobacco smoke exposure</td>
</tr>
</tbody>
</table>


Clinical Tip

A review of several studies evaluated the relationship between breastfeeding and SIDS. Findings revealed that breastfeeding for any period of time is protective, and greater protection occurs if breastfeeding is exclusive (Hauck, Thompson, Tenabe, et al., 2011).

Croup Syndromes

Croup is a term applied to a broad classification of upper airway illnesses that result from inflammation and swelling of the epiglottis and larynx. The swelling usually extends into the trachea and bronchi. Viral croup syndromes include spasmodic laryngitis (spasmodic croup) and laryngotracheobronchitis (LTB). Bacterial croup syndromes include bacterial tracheitis and epiglottitis (see Pathophysiology Illustrated: Airway Changes with Croup).

LTB and bacterial tracheitis affect a large number of children across all age groups in both sexes. Epiglottitis, previously a common serious respiratory illness, is rare in the United States due to the Haemophilus influenzae type B vaccine. The initial symptoms of all three conditions include inspiratory stridor (a high-pitched, musical sound that is created by narrowing of the airway), a “seal-like” barking cough, and hoarseness. LTB is the most common disorder, but epiglottitis and bacterial tracheitis are more serious.

Laryngotracheobronchitis

Although the term croup is applied to several viral and bacterial syndromes, it most often refers to LTB, a viral invasion of the upper airway that extends throughout the larynx, trachea, and bronchi.

Etiology and Pathophysiology

Acute viral LTB is most common in children 6 months to 6 years of age, with a peak incidence from 7 to 36 months of age (Wald, 2010). Boys are affected more often than girls. LTB is of greatest concern in infants and children under the age of 6 years because of potential airway obstruction. The causative organism is usually parainfluenza virus type I, II, or III, which appears during fall and winter months. Other viruses causing LTB include influenza, adenoviruses, respiratory syncytial virus (RSV), Mycoplasma pneumonia, human metapneumovirus, and human coronavirus (Wald, 2010).
Clinical Question
In 2008, 15% of all infants were estimated to sleep in the prone position; however, the rate of prone or side-lying sleep is much higher among African American infants (38%) (Carrier, 2009). What will help encourage African American parents to place their infant to sleep in the supine position with safer bedding?

The Evidence
A qualitative study investigated the beliefs and perceptions of 73 African American mothers from all socioeconomic levels with infants under 6 months of age regarding SIDS. Three major themes emerged. Mothers did not see a plausible connection between SIDS and sleep position, because the cause of SIDS cannot be explained. Mothers also believed SIDS occurs randomly and could be “God’s will.” The best protection for their baby was stated to be their own vigilance. Some mothers reported placing the infant in bed with them to closely monitor the infant (Moon, Oden, Joyner, et al., 2010).

The impact of nurse modeling of safe sleep practice in seven hospitals in an urban area with a large population of African American parents was evaluated. Policy changes requiring the supine sleep position for newborns and other infants were implemented, nurses were educated about sleep position recommendations, and crib audits were used to assess changes in practice. The policy change and education resulted in nurses positioning infants on their back to sleep and increasing the effort to educate parents about safe sleep positioning (Shaefer, Herman, Frank, et al., 2010).

A study used focus groups and interviews with 83 African American mothers from diverse socioeconomic groups to learn about surfaces and soft bedding used for their infants. Findings revealed that parents had different interpretations of firm bedding, and they believed that soft bedding (pillows, blankets, and crib bumper pads) increased the infant’s comfort and in some cases safety. For example, parents believed that the surface was firm if a pillow or blanket was placed between the mattress and the sheet and the sheet was tucked tautly around the pillow or blanket. Misconceptions about firm and soft bedding increase the risk for suffocation and SIDS as the infant sleeps (Ajao, Oden, Joyner, et al., 2011).

Best Practice
While the Back to Sleep Campaign has successfully promoted supine sleep positions for infants, African American mothers less commonly use this sleep position. They report awareness of the recommendation but do not necessarily believe it (Oden, Joyner, Ajao, et al., 2010). Nurses need to understand the mother’s perspective so education can appropriately address beliefs and concerns. Appropriate sleep position and firm bedding should always be modeled in the hospital.

Clinical Reasoning
Identify if policies exist for infant sleep position in the maternity and pediatric sections of your hospital. Conduct an audit of cribs and bassinets to determine what proportions of infants are sleeping in the supine position.

Pathophysiology Illustrated
Airway Changes with Croup

Two important changes occur in the upper airway with croup: The epiglottis swells, occluding the airway, and the trachea swells against the cricoid cartilage, causing restriction.
Airway tissues respond to the invading virus with inflammation and edema. Copious secretions further increase the child’s respiratory distress. The laryngeal inflammation causes the airway diameter to narrow in the subglottic area, site of the smallest upper airway diameter. Even small amounts of mucus or edema can quickly obstruct the airway. During inspiration, the walls of the inner airway are pulled together, causing further respiratory distress.

Clinical Manifestations
Most children brought to the emergency department with LTB have been ill for a couple of days with upper respiratory symptoms. These symptoms progress to a cough and hoarseness. Fever may be present. Children commonly have a runny nose, tachypnea, inspiratory stridor, and a seal-like barking cough. Symptoms may be worse at night. Expiratory stridor, severe tachypnea, retractions, and a low SpO2 indicate a more severe airway inflammation and swelling. Mental status changes may indicate hypoxemia and potential respiratory failure. See Table 20–4 for clinical manifestations distinguishing these croup syndromes.

Clinical Therapy
Diagnosis is often made by history and clinical signs. Pulse oximetry is used to detect hypoxemia. Anteroposterior (AP) and lateral radiographs of the upper airway may reveal the classic symmetric subglottic narrowing called a “steeple sign.”

**SAFETY ALERT!**
Throat cultures and visual inspection of the inner mouth and throat are contraindicated in children with LTB and epiglottitis. These procedures can cause laryngospasms (spasmodic vibrations that close the larynx) as a result of the child’s anxiety or of probing this reactive and already compromised area. A complete airway obstruction may result.

Management consists of maintaining and improving respiratory effort with medications, and in some cases supplemental oxygen. (See Medications Used to Treat Laryngotracheobronchitis.) Children who respond well to medications are often sent home from the emergency department after an observation period. Children with moderate to severe symptoms after nebulizer medications are admitted for further observation and treatment. Airway obstruction is a potential complication of LTB requiring intubation and transfer to the PICU. Most children who are admitted respond to the medications and oxygen therapy and are discharged within 48 to 72 hours.

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**Table 20–4  Summary of Croup Syndromes**

<table>
<thead>
<tr>
<th>Viral Syndromes</th>
<th>Bacterial Syndromes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Acute Spasmodic Laryngitis</strong> (Spasmodic Croup)</td>
<td><strong>Laryngotracheitis/ Laryngotracheobronchitis</strong></td>
</tr>
<tr>
<td>Severity</td>
<td>Least serious</td>
</tr>
<tr>
<td>Age affected</td>
<td>3 months to 3 years</td>
</tr>
<tr>
<td>Onset</td>
<td>Abrupt nighttime onset; resolves over 24 to 48 hours; recurs*</td>
</tr>
<tr>
<td>Clinical manifestations</td>
<td>Afebrile; mild respiratory distress; barking-seal cough</td>
</tr>
<tr>
<td>Etiology</td>
<td>Unknown; suspect viral with allergic/emotional influences</td>
</tr>
</tbody>
</table>

*Classic parameter or key point (distinguishes condition).

NURSING MANAGEMENT for the Child with Laryngotracheobronchitis

Nursing Assessment and Diagnosis

The initial and ongoing physical assessment of the child with LTB focuses on adequacy of respiratory functioning. Attach a cardiorespiratory monitor and pulse oximeter. Have the child in an area in which continuous visual monitoring is possible to identify changes in severity of respiratory distress (see Table 20–5 for levels of croup severity).

Medications Used to Treat Laryngotracheobronchitis

<table>
<thead>
<tr>
<th>Medication and Action</th>
<th>Nursing Management</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beta-agonists and beta-adrenergics (e.g., albuterol, racemic epinephrine): aerosolized through face mask Rapid-acting bronchodilator, decreases bronchial and tracheal secretions and mucosal edema. Reduces need for intubation.</td>
<td>■ Signs improve in about 30 minutes, but relief lasts about 2 hours, providing time for the corticosteroid to work. ■ Monitor for tachycardia (160–200 beats/min), hypertension, dizziness, headache, and nausea; may necessitate stopping medication.</td>
</tr>
<tr>
<td>Corticosteroids (e.g., dexamethasone): IM, PO, nebulized budesonide Anti-inflammatory, used to decrease edema; has a long half-life of 36–54 hours. Reduces need for an endotracheal tube.</td>
<td>■ Monitor for cardiovascular symptoms (hypertension), observing closely for individual response.</td>
</tr>
</tbody>
</table>

Rapid-acting bronchodilator, decreases bronchial and tracheal secretions and mucosal edema. Reduces need for intubation.

Pay particular attention to the child’s respiratory effort, breath sounds, preferred position, and responsiveness. Exhaustion can diminish the intensity of retractions and stridor. As the child uses remaining energy reserves to maintain ventilation, breath sounds may actually diminish. Noisy breathing (audible airway congestion, coarse breath sounds) in this situation verifies adequate energy stores. Responsiveness decreases as hypoxemia increases.

The following nursing diagnoses might be appropriate for the child with acute LTB (NANDA-I © 2012):

- **Breathing Pattern, Ineffective** related to airway narrowing, decreased energy, and fatigue
- **Fluid Volume: Deficient, Risk for** related to inadequate fluid intake prior to admission
- **Fear (Child)** related to dyspnea, unfamiliar surroundings, procedures, and separation from support system

Planning and Implementation

**Maintain Airway Patency**

Supplemental oxygen with humidity may be needed for hypoxemia, but cool mist and humidified air have no proven benefit (Wald, 2010). Allow the child to assume a comfortable position. Be immediately available to attend to the child’s respiratory needs and keep resuscitation equipment and an intubation tray at the bedside. Administer medications. Ensure that a means of communication (sign language or simple word cues) is established so the older child can alert nursing staff to respiratory difficulty.

**Meet Fluid and Nutritional Needs**

The illness preceding the emergency department visit may have compromised the child’s fluid status. Recognize the potential fluid deficit and monitor the child’s hydration and nutritional status. Fluids help thin secretions and provide calories for energy and metabolism.

Children with LTB usually prefer cool, noncarbonated, nonacidic drinks such as oral rehydration fluids or fruit-flavored drinks, gelatin, and popsicles. Encourage the parents to gain the child’s cooperation in taking oral fluids. An intravenous infusion may be necessary to rehydrate the child, maintain fluid balance, or provide emergency access. Observe the child closely for difficulty in swallowing or drooling, which may be an early sign of epiglottitis or bacterial tracheitis.

**Discharge Planning and Home Care Teaching**

During the child’s observation period, take every opportunity to assess the parents’ knowledge of symptoms of LTB and discuss actions to take if symptoms recur. For example, instruct parents to call the child’s healthcare provider if:

- Mild symptoms do not improve after 1 hour of exposure to cool outdoor air or air conditioning.
- The child’s breathing is rapid and labored with nasal flaring and retractions.
- The child does not drink adequate fluids and the urine output is reduced.

Table 20–5  Assessment of Croup Severity

<table>
<thead>
<tr>
<th>Level of Severity</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mild</td>
<td>Occasional barking cough, no audible stridor at rest, no retractions</td>
</tr>
<tr>
<td>Moderate</td>
<td>Frequent barking cough, audible stridor at rest, mild retractions at rest, no agitation</td>
</tr>
<tr>
<td>Severe</td>
<td>Frequent barking cough, prominent stridor, tachypnea, marked retractions, agitation, and/or distress</td>
</tr>
<tr>
<td>Impending respiratory failure</td>
<td>Frequent barking cough, stridor at rest, retractions, lethargy or decreased level of consciousness, cyanosis. Cough, stridor, and retractions may not be present due to respiratory fatigue and airway compromise</td>
</tr>
</tbody>
</table>

Evaluation
Expected outcomes of nursing care include the following:

- The child responds to medications with decreased respiratory distress.
- The child’s fear and anxiety is managed with family support and explanations about care.

Epiglottitis (Supraglottitis)
Epiglottitis is an inflammation of the epiglottis, the long narrow structure that closes off the glottis during swallowing. Because edema in this area can rapidly (within minutes or hours) obstruct the airway by occluding the trachea, epiglottitis is considered a potentially life-threatening condition. (Table 20–4 compares epiglottitis and other croup syndromes.)

Epiglottitis is caused by bacterial invasion of the soft tissue of the larynx by streptococcus, staphylococcus, or by *Haemophilus influenzae* type B (Hib) in unimmunized children. The resulting inflammation and tissue edema surrounding the epiglottis lead to airway obstruction. Since the widespread use of the Hib vaccination, a 10-fold decrease in the incidence of epiglottitis has occurred (D’Agustino, 2010).

A previously healthy child suddenly becomes very ill with a high fever (greater than 39°C [102.2°F]) and sore throat. Four classic “D” signs include dysphonia (muffled, hoarse voice and pain with talking), dysphagia (difficulty in swallowing), drooling, and distressed respiratory effort with inspiratory stridor. The child often refuses to lie down and assumes a “sniffing” or tripod position (Figure 20–2). The child’s anxiety increases as it becomes more difficult to breathe.

Diagnosis is often based on physical signs and a lateral neck radiograph, which reveals a narrowed airway and an enlarged, rounded epiglottis, seen as a mass at the base of the tongue. Recall that visual inspection of the mouth and throat is contraindicated.

Because of the risk for total airway obstruction, immediate clinical therapy usually involves insertion of an endotracheal tube to maintain the airway. At the same time, a blood culture and epiglottitis culture are taken. Antibiotics effective for gram-positive organisms and *H. influenzae* (ceftriaxone, cefotaxime, or ampicillin plus sulbactam) are given until culture sensitivities are available, after which the antibiotic may be changed. Racemic epinephrine and corticosteroids are not effective. If *H. influenzae* is the causative organism, rifampin prophylaxis should be prescribed for all family members if the family includes a child under 48 months who is not completely immunized against *H. influenzae* or when any child member is immunocompromised (American Academy of Pediatrics [AAP], 2012, p. 347).

Nursing Management
Nursing management consists of airway management, drug therapy, hydration, and emotional and psychosocial support of the child and parents.

Until the child is intubated, do not leave the child unattended. Allow the child to stay in the position of comfort, often sitting. Observe the child’s respiratory and airway status continuously. Note any change in the child’s level of consciousness.
Bacterial Tracheitis

Bacterial tracheitis is a secondary infection of the upper trachea following a viral LTB, often caused by *Staphylococcus aureus*, Group A *streptococcus*, *Moraxella catarrhalis*, or *H. influenzae* (usually in unimmunized children). The child has signs of viral croup for several days before the onset of a productive cough, high fever, and a toxic appearance. Dysphagia and drooling are rarely present, and the child can lie flat. Table 20–4 compares bacterial tracheitis and other croup syndromes.

Bacterial tracheitis may be misdiagnosed initially as LTB because of similar signs. However, the child’s condition worsens rather than improves with LTB therapy. Diagnosis is then made by blood cultures. The subglottis is edematous with ulceration, and thick mucopurulent exudate may obstruct the airway. Most children need intubation until swelling diminishes. Antibiotics are prescribed for a full 10- to 14-day course.

Nursing Management

The child with bacterial tracheitis is frequently cared for in the PICU until the endotracheal tube is removed. The tube is suctioned frequently, because thick tracheal secretions pool high in the upper airway. Provide humidified air or oxygen. Antibiotics are administered as ordered. The previous section on epiglottitis discusses other nursing care interventions that may also be appropriate for the child with bacterial tracheitis.

LOWER AIRWAY DISORDERS

Lower airway disorders occur because a structural or functional problem interferes with the lungs’ ability to complete the respiratory cycle. Disorders of the lower airway include bronchitis, bronchiolitis, pneumonia, and tuberculosis.

Bronchitis

Acute bronchitis, inflammation of the trachea and bronchi, rarely occurs in childhood as an isolated problem. The bronchi can be affected simultaneously with adjacent respiratory structures during a respiratory illness. Bronchitis occurs most commonly in the winter months.

The classic symptom of bronchitis is a dry, hacking cough that increases in severity at night. The cough may or may not be productive. The child may swallow sputum and vomit as a result. The chest and ribs may be sore because of the deep and frequent coughing. Over several days breath sounds may become coarse with fine crackles, and some scattered high-pitched wheezing may be heard. Treatment is palliative unless a secondary bacterial infection occurs that needs antibiotic therapy.

Nursing Management

Nursing management includes supporting respiratory function through rest, humidification, hydration, and symptomatic treatment. Refer to the sections on asthma and pneumonia for detailed information on treatment measures.

Home care should emphasize the self-limiting nature of the disorder. Advise parents who smoke that quitting or not smoking in the child’s presence may benefit the child.

Bronchiolitis and Respiratory Syncytial Virus

Bronchiolitis is a lower respiratory tract illness that occurs when a viral or bacterial organism causes inflammation and obstruction of the bronchioles. Bronchiolitis affects 1 in 7 infants in the first year of life, and causes about 100 deaths each year in the United States (Alverson & Ralston, 2011). Children with bronchiolitis have an increased risk for wheezing and asthma later in childhood (Sorce, 2009).

Etiology and Pathophysiology

*Respiratory syncytial virus* (RSV) is the most common cause of bronchiolitis, but adenovirus, parainfluenza virus, and human metapneumovirus may also be responsible. RSV occurs in annual epidemics from October to March. It is transmitted through direct contact with respiratory secretions or indirectly through contaminated surfaces. The infected child sheds the virus for 3 to 8 days, and the incubation period is 2 to 8 days. Nearly all children have been infected with RSV by 2 years of age, and reinfection throughout life is common (AAP, 2012, p. 609). Risk factors for severe RSV infection include immunosuppression, very low birth weight, lung disease, severe neuromuscular disease, or complicated congenital heart defects (Miller, 2010).

Viruses, acting as parasites, are able to invade the mucosal cells that line the small bronchi and bronchioles. The invaded cells die when the virus bursts from inside the cell to invade adjacent cells. The membranes of the infected cells fuse with adjacent cells, creating large masses of cells or “syncytia.” The resulting cell debris clogs and obstructs the bronchioles and irritates the airway. In response, the airway lining swells and produces excessive mucus. Despite this protective effort by the bronchioles, the actual effect is partial airway obstruction and bronchospasms.

The cycle is repeated throughout both lungs as the airway cells are invaded by the virus. The partially obstructed airways allow air in, but the mucus and airway swelling block expulsion of the air. This creates the wheezing and crackles in the airways. Air trapped below the obstruction also interferes with normal gas exchange, leading to hypoxemia. The child with RSV is therefore at risk for apnea and respiratory failure as hypoxemia and hypercarbia develop.

Clinical Manifestations

Some children have mild symptoms such as rhinitis, cough, low-grade fever, wheezing, tachypnea, poor feeding, vomiting, and diarrhea. Dehydration may be present if the child has been sick for several days. Parents report that the infant or child is acting more ill—appearing sicker, less playful, and less interested in eating. Infants, especially, may refuse to feed or may spit up what they eat along with thick, clear mucus.

The infant or child with a more severe infection has tachypnea greater than 70 breaths per minute, grunting, increased wheezing, retractions, nasal flaring, irritability, lethargy, poor fluid intake, and a distended abdomen from overexpanded...
lungs. As hypoxia develops the infant becomes cyanotic and has decreasing mental status. As the airflow continues to decrease, breath sounds diminish. Thus, the noisier the lungs, the better—this indicates that the child is still able to move air in and out of the lungs. While RSV bronchiolitis resolves in 5 to 7 days, increased airway resistance and airway hypersensitivity may persist for weeks or even months. Bronchiolitis in infancy may increase a child’s risk of developing asthma (Stewart, 2008).

**Clinical Therapy**

The history and physical examination provide the data needed to diagnose bronchiolitis. Chest radiographs show hyperinflation, patchy atelectasis, and other signs of inflammation. Enzyme-linked immunosorbent assay (ELISA) or immunofluorescent assay performed on a posterior nasopharyngeal specimen are laboratory tests used to identify the virus causing bronchiolitis (see the Clinical Skills Manual). Treatment is supportive. The child is isolated to minimize the spread of the virus to other hospitalized children. Humidified oxygen is provided to infants with severe hypoxemia, when the SpO2 readings fall to less than 90% (Selden & Scarfone, 2009). Other supportive care includes hydration with oral or IV fluids and nasal suctioning before feeding. Continuous positive airway pressure (CPAP) may be used in the child with moderate to severe bronchiolitis. Chest physiotherapy does not affect severity or length of hospital stay and is not recommended (Zentz, 2011).

Common medications used to treat acute episodes of RSV and bronchiolitis include nebulized epinephrine, albuterol, or nebulized saline (Tudor & Haffner, 2013). Oral dexamethasone administered with nebulized albuterol shortened hospital length of stay in one study (Alansari, Sakran, Davidson, et al., 2013). Antipyretics may be used. Antibiotics are used only when a bacterial infection is present.

Prevention of RSV is a focus for children at high risk for severe bronchiolitis, including the following groups of children (AAP, 2012, pp. 614–616):

- Children under age 24 months with bronchopulmonary dysplasia who have needed medical therapy within 6 months of the start of RSV season
- Children under age 24 months with significant congenital heart disease, requiring medical therapy
- Infants born before 32 weeks’ gestation, during their first 12 months of life
- Infants born at 32 to 35 weeks’ gestation with either of these two risk factors: childcare attendance or a sibling less than 5 years of age
- Infants born before 32 weeks’ gestation with either of these two risk factors: childcare attendance or a sibling less than 5 years of age
- Infants born at 32 to 35 weeks’ gestation with either of these two risk factors: childcare attendance or a sibling less than 5 years of age
- Cardiopulmonary treatment (e.g., CPAP) within the first 6 months of life
- Infants born at 32 to 35 weeks’ gestation with either of these two risk factors: childcare attendance or a sibling less than 5 years of age
- Intramuscular palivizumab (Synagis) is used for prophylaxis for a child in one of the high-risk categories. A dose of 15 mg/kg is given every 30 days for 5 months beginning in October or November at the onset of the RSV season. Palivizumab is expensive but less costly than hospitalization for an infant with RSV. Palivizumab does not interfere with administration of normal recommended childhood vaccines (AAP, 2012, p. 38).

**NURSING MANAGEMENT for the Child with Bronchiolitis and RSV**

**Nursing Assessment and Diagnosis**

**Physiologic Assessment**

Assess airway and respiratory function carefully. Good observation skills are important to ensure timely interventions for worsening respiratory symptoms and prevention of respiratory failure (see the Table 20–1 and Assessment Guide on pages 523 and 524). Assess the child’s hydration status, weigh the child daily, and monitor the intake and output. Attach a cardiorespiratory monitor and pulse oximeter. An oxygen saturation level below 90% is the best indicator of the condition’s severity.

**SAFETY ALERT!**

RSV bronchiolitis often increases in severity before beginning to resolve. Stay alert for signs of increasing respiratory distress and a greater need for oxygen. Signs of life-threatening illness include central cyanosis, respiratory rate greater than 70 breaths a minute, listlessness, diminished breath sounds, and apnea episodes. Inform the physician immediately of any significant changes in respiratory status.

**Psychosocial Assessment**

Observe children and their parents for signs of fear and anxiety. The unfamiliar hospital environment and procedures can increase stress. Parents’ questions, as well as their nonverbal cues, help direct nursing interventions during admission and throughout hospitalization.

The accompanying Nursing Care Plan: The Child with Bronchiolitis lists common nursing diagnoses for the child with bronchiolitis. Others that might also be appropriate include (NANDA-I © 2012):

- **Airway Clearance, Ineffective** related to increased airway secretions in bronchioles
- **Activity Intolerance** related to imbalance between oxygen supply and demand
- **Family Processes, Interrupted** related to sudden acute illness of the infant

**Planning and Implementation**

Nursing management of the hospitalized child with bronchiolitis focuses on maintaining respiratory function, supporting overall physiologic function and hydration, reducing the child’s and family’s anxiety, and preparing the family for home care.
### Nursing Care Plan  The Child with Bronchiolitis

<table>
<thead>
<tr>
<th>Intervention</th>
<th>Rationale</th>
<th>Expected Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Goal:</strong> The child will return to respiratory baseline and will not experience respiratory failure.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Assess respiratory status (see Assessment Guide) when child is calm and not crying at least every 2–4 hours, or more often as indicated for an increasing or decreasing respiratory rate and episodes of apnea.</td>
<td>- Changes in breathing pattern may occur quickly as the child’s energy reserves are depleted. Baseline and subsequent assessments help detect changes in the respiratory rate and respiratory effort.</td>
<td>- Child will return to respiratory baseline within 48–72 hours.</td>
</tr>
<tr>
<td>- Attach a cardiorespiratory monitor and pulse oximeter with alarms set. Record and report changes promptly to physician.</td>
<td>- The alarm can alert the nurse to any sudden respiratory changes and lead to more rapid interventions.</td>
<td></td>
</tr>
<tr>
<td><strong>Goal:</strong> The child’s oxygenation status will return to baseline.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Administer humidified oxygen via mask, nasal cannula, hood, or tent.</td>
<td>- Humidified oxygen loosens secretions, helps maintain oxygenation status, and eases respiratory distress.</td>
<td>- Child’s respiratory effort will ease. The SpO2 level will remain at 95% or higher during treatment.</td>
</tr>
<tr>
<td>- Assess and compare the child’s SpO2 level on room air and when on supplemental oxygen.</td>
<td>- Comparison of SpO2 levels provides information about improvement status.</td>
<td>- Child will tolerate therapeutic measures with no adverse effects.</td>
</tr>
<tr>
<td>- Note child’s response to ordered medications.</td>
<td>- Medications act systemically to improve oxygenation and decrease inflammation.</td>
<td>- Child will rest quietly in position of comfort.</td>
</tr>
<tr>
<td>- Position head of bed up or place child in position of comfort on parent’s lap, if crying or struggling in crib or bed.</td>
<td>- Position facilitates improved aeration and promotes decrease in anxiety (especially in toddlers) and energy expenditure.</td>
<td></td>
</tr>
<tr>
<td>- Assess tolerance to feeding and activities.</td>
<td>- Provides an assessment of condition improvement.</td>
<td></td>
</tr>
<tr>
<td><strong>Goal:</strong> The child’s immediate fluid deficit will be corrected.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Evaluate need for intravenous fluids. Maintain IV, if ordered.</td>
<td>- Previous fluid loss may require immediate replacement.</td>
<td>- Child’s hydration status will be maintained during acute phase of illness as demonstrated by appropriate urine output and moist mucous membranes.</td>
</tr>
<tr>
<td><strong>Goal:</strong> The child will be adequately hydrated, be able to tolerate oral fluids, and progress to normal diet.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Calculate maintenance fluid requirements and give oral fluids, IV fluids, or both.</td>
<td>- Assessment of fluid requirements enables the child to maintain hydration while transitioning to oral fluids.</td>
<td>- Child will take adequate oral fluids after 24–48 hours to maintain hydration.</td>
</tr>
<tr>
<td>- Offer clear fluids and incorporate parent in care. Offer fluid choice when tolerated.</td>
<td>- Choice of fluid offered by parent gains the child’s cooperation.</td>
<td>- Child will accept beverage of choice from parent or nursing staff.</td>
</tr>
<tr>
<td>- Maintain strict intake and output monitoring and evaluate specific gravity at least every 8 hours.</td>
<td>- Monitoring provides objective evidence of fluid loss and ongoing hydration status.</td>
<td>- Child’s weight will stabilize after 24–48 hours; skin turgor will be supple.</td>
</tr>
<tr>
<td>- Perform daily weight measurement on the same scale at the same time of day. Evaluate skin turgor.</td>
<td>- Further evidence of improvement of hydration status.</td>
<td>- Child will show evidence of improved hydration.</td>
</tr>
<tr>
<td>- Assess mucous membranes and presence of tears.</td>
<td>- Moist mucous membranes and tears are signs of adequate hydration.</td>
<td></td>
</tr>
</tbody>
</table>
Nursing Care Plan  The Child with Bronchiolitis (continued)

<table>
<thead>
<tr>
<th>Intervention</th>
<th>Rationale</th>
<th>Expected Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>3. Nursing Diagnosis: Anxiety (Child and Parent) related to acute illness, hospitalization, uncertain course of illness and treatment, and home care needs (NANDA-I © 2012)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NIC Priority Intervention: Anxiety reduction: Minimizing apprehension, dread, foreboding, or uneasiness related to an unidentified source of anticipated danger</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Goal:</strong> The child and parents will demonstrate behaviors that indicate less anxiety.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Encourage parents to express fears and ask questions; provide direct answers and discuss care, procedures, and condition changes.</td>
<td>- Parents have the opportunity to vent feelings and receive timely, relevant information. This helps reduce parents’ anxiety and increase trust in nursing staff.</td>
<td>- Parents and child will show less anxiety as symptoms improve and as child and parents feel more secure in hospital environment. Parent will freely ask questions and participate in the child’s care. Child will cry less and allow staff to hold or touch him or her.</td>
</tr>
<tr>
<td>- Incorporate parents in the child’s care. Encourage parents to bring familiar objects from home. Ask about and incorporate in care plan the home routines for feeding and sleeping.</td>
<td>- Familiar people, routines, and objects decrease the child’s anxiety and increase parents’ sense of control over an unexpected, uncertain situation.</td>
<td></td>
</tr>
<tr>
<td><strong>Goal:</strong> Parents will verbalize knowledge of bronchiolitis symptoms and use of home care methods before the child’s discharge from the hospital.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Explain symptoms, treatment, and home care of bronchiolitis.</td>
<td>- Anticipating the potential for recurrence assists the family to be prepared should respiratory symptoms recur after discharge.</td>
<td>- Parent will accurately describe respiratory symptoms and initial home care actions.</td>
</tr>
<tr>
<td>- Provide written instructions for follow-up care arrangements, as needed.</td>
<td>- Written and verbal instructions reinforce knowledge. Parents may not “hear” and remember details if only given verbally.</td>
<td></td>
</tr>
<tr>
<td>- Make sure parents can read the instructions provided in family’s primary language.</td>
<td>- Many families have reading difficulties or may read a language other than English.</td>
<td></td>
</tr>
</tbody>
</table>

**Maintain Respiratory Function**

Close monitoring is essential to evaluate the child’s improvement or to spot early signs of deterioration. Patent nares are important to promote oxygen intake. A bulb syringe and saline nose drops can be used to quickly clear the nasal passages. Elevate the head of the bed to ease the work of breathing and drain mucus from the upper airways. Supplemental oxygen with humidity may be provided via nasal cannula, mask, hood, or tent. When the child resists or is frightened by the oxygen apparatus, engage the parent to soothe the child and promote acceptance of the therapy.

**Support Physiologic Function**

Group nursing tasks to decrease stress and promote rest. Medications may be administered to control temperature and promote comfort as needed. Infants may have feeding difficulty and are at risk for aspiration. Suction the nasal passages before giving oral feedings. Feed smaller volumes more frequently to help conserve energy in infants who are formula- or breastfed. When the risk of aspiration is high, nasogastric tube feedings may be used to provide nutrition. An IV infusion may be ordered to rehydrate the child and maintain fluid balance until oral fluid intake is adequate.

**Reduce Anxiety**

The need for hospitalization and assistive therapies creates anxiety and fear in the child and parents. The parents may be frightened by the child’s continued respiratory difficulty. Infants may respond to their parents’ anxiety and be more irritable. Provide parents with thorough explanations and daily updates, and encourage their participation in the child’s care. Reassure them that holding or touching the child will not dislodge wires or tubing and that their presence will calm and support the child.

If the child has been ill for a few days before admission, the parents are likely to be tired. Acknowledging parents’ physical and emotional needs creates a spirit of caring and enhances communication between staff and family. Encourage the parents to take turns at the child’s bedside and to take breaks for meals and rest.

**Discharge Planning and Home Care Teaching**

Children are discharged once they maintain stable oxygenation on room air along with eased respiratory effort and decreased mucus production. In most children, symptoms decrease within 24 to 72 hours, but all symptoms like coughing may take weeks to resolve. See Families Want to Know: Discharge Teaching for Bronchiolitis.

Teach the parents proper administration of medications. Acetaminophen or ibuprofen may be prescribed for persistent low-grade fevers and general discomfort. Advise parents that RSV infection can recur. Educate them to recognize symptoms and when to call the physician.
Evaluation

Expected outcomes of nursing care for the child with bronchiolitis are provided in the Nursing Care Plan.

Pneumonia

Pneumonia, an inflammation or infection of the bronchioles and alveolar spaces of the lungs, occurs most often in infants and young children. In the United States, 201.1 per 100,000 children and youth under 19 years of age are hospitalized annually for pneumonia (Bradley, Byington, Shah, et al., 2011). Pneumonia can be community-acquired (CAP) or hospital acquired (e.g., associated with mechanical ventilation). The focus of this discussion is CAP.

Pneumonia may be viral, mycoplasmal, or bacterial in origin. Children under 5 years of age most often have pneumonia caused by RSV, human metapneumovirus, influenza, parainfluenza virus, or adenovirus. Bacterial pneumonia occurs in all age groups but is more common in children over 5 years old. Common bacterial organisms include Streptococcus pneumoniae, Chlamydophila pneumoniae, and Staphylococcus aureus. Group B streptococcus, enteric gram-negative bacilli, and Chlamydia trachomatis are found in infants younger than 3 months of age. Children with cystic fibrosis or immunosuppression are susceptible to other bacterial, parasitic, or fungal infections.

Bacterial and viral invaders act differently within the lungs:

- Bacterial invaders circulate through the bloodstream to the lungs, where they damage cells and cause inflammation and edema. Cellular debris and mucus cause airway obstruction. Bacteria tend to be distributed evenly throughout one or more lobes of a single lung, a pattern termed unilateral lobar pneumonia.
- Viruses enter through the upper respiratory tract, infiltrating the alveoli nearest the bronchi of one or both lungs. Viruses invade the cells, replicating and bursting out forcefully, killing the cells and sending out cell debris. Adjacent areas are invaded, distributed in a scattered, patchy pattern referred to as bronchopneumonia.
- Aspiration of food, emesis, gastric reflux, or hydrocarbons causes a chemical injury and inflammatory response, which sets the stage for bacterial invasion.

CAP is often preceded by an upper respiratory tract infection including rhinitis and a cough. Other symptoms include fever, rhonchi, crackles, wheezes, cough, dyspnea, tachypnea, restlessness, and decreased breath sounds if consolidation exists. Newborns and infants may have grunting, nasal flaring, retractions, irritability, lethargy, and a reduced appetite. Diminished breath sounds may be noted. Children with bacterial pneumonia may have chest pain and try to splint the chest when coughing.

Diagnosis is based on history and physical findings. Strong predictors of pneumonia include SpO2 of 92% or less, crackles, chest pain, and fever (Neuman, Monuteaux, Scully, et al., 2011). Rapid influenza and other respiratory virus testing is recommended to help distinguish between viral and bacterial causes of CAP. A chest radiograph and blood cultures are performed when the child has respiratory signs requiring hospitalization (Bradley et al., 2011).

Clinical management for all types of pneumonia includes pain and fever control, and supportive care through airway management, fluids, and rest. Because most CAP is viral, antibiotics are not routinely prescribed. Amoxicillin is prescribed for bacterial pneumonias. Antiviral therapy is prescribed for some children. Supplemental oxygen and IV fluids are needed for hospitalized children with severe CAP.

Nursing Management

If the child with community-acquired pneumonia is hospitalized, assess the child, paying particular attention to respiratory rate, heart rate, and temperature, and observe color for pallor or cyanosis. Attach a pulse oximeter to monitor the SpO2 level. Assess hydration status. Assess for the presence of pain with coughing.

Nursing measures used for the child with bronchiolitis are generally applicable (see page 535). Provide supportive therapies (chest physiotherapy, antibiotics, and hydration). Teach the child and parent how to splint the chest by hugging a small pillow or teddy bear to make coughing less painful. Acetaminophen or ibuprofen may be prescribed for pain management and temperature control. Promote hydration and nutrition by encouraging the intake of preferred clear liquids and small servings of soft foods.

For home management, teach parents about administering prescribed antibiotics, any potential side effects, and the need to give the full course. Educate parents about signs that the child’s condition may be worsening (increased breathing difficulty or refusal to take fluids). Most children recover uneventfully, but some continue to have worsening reactive airway problems or abnormal results on pulmonary function tests.

Preventive measures are limited. The Haemophilus influenzae type B (Hib) and pneumococcal conjugate (PCV13) vaccines...
Tuberculosis

Tuberculosis (TB) is an infection caused by Mycobacterium tuberculosis, which is transmitted through the air in infectious particles called droplet nuclei. In 2007, 820 children under 15 years of age in the United States acquired TB (Cruz & Starke, 2010). Rates are higher among foreign-born persons and among Hispanics, non-Hispanic blacks, and Asians (Centers for Disease Control and Prevention [CDC], 2011a). In U.S. children less than 5 years of age, those who are foreign-born or born in the United States of foreign-born parents are at significantly higher risk of TB than children with U.S.-born parents (Pang, Teeter, Katz, et al., 2014).

Etiology and Pathophysiology

Children usually acquire a TB infection from infected adults who cough, sneeze, speak, or sing, and send out tiny droplets containing the bacillus. When inhaled, the bacillus is small enough to travel directly to the alveoli and cause infection. When the organism reaches the alveolus, an immune response is initiated, and macrophages surround and wall off the bacillus in a small hard capsule, called a tubercle. The tubercle bacilli grow slowly, dividing every 25 to 32 hours. The bacilli grow for 2 to 12 weeks until they number 1,000 to 10,000, at which point the cellular immune response to a TB skin test (TST) would occur.

In persons with intact cell-mediated immunity, activated T cells and macrophages form granulomas around the tubercles that limit multiplication. The proliferation of TB is arrested, but small numbers of viable bacilli remain in the tubercle. These individuals have latent tuberculosis infection (LTBI), a positive TST, and no clinical or radiographic signs of disease. They are not infectious and cannot transmit the disease.

Active TB can develop as the bacilli grow, divide within the tubercle, and break free. Infants and adolescents have the greatest risk of transitioning from LTBI to active TB. Factors that increase that risk include immunosuppressive therapy, HIV co-infection, malnutrition, and chronic medical conditions (AAP, 2012, p. 738). The greatest risk for LTBI transition to active TB (including meningitis and disseminated TB) occurs within 2 to 12 months after initial infection (Ranganathan & Sonnappa, 2009). Children under age 10 years with active TB are rarely infectious and cannot transmit the disease.

Active and latent TB are treated with isoniazid, rifampicin, pyrazinamide, and ethambutol. Therapy for active TB usually involves a 6-month regimen consisting of isoniazid, rifampin, pyrazinamide, and ethambutol for the first 2 months and isoniazid and rifampicin for the remaining 4 months. LTBI in children less than 12 years of age is treated with a single daily dose of isoniazid for 9 months (or rifampicin for 6 months if TB is drug resistant to isoniazid). Direct-observed drug therapy administered by a healthcare provider 2 to 3 times a week for the duration of treatment is recommended for children with active TB and when daily therapy adherence is not assured for children with LTBI (AAP, 2012, p. 751). Healthy youth with LTBI, ages 12 years and
older, may receive once-weekly, direct-observed drug therapy with isoniazid and rifampicin for 12 weeks (Jereb, Goldberg, Powell, et al., 2011).

The local public health department is notified to search for disease contacts of the child with newly diagnosed LTBI or active TB. The child is considered a sentinel case, and the adult contact with active TB must be identified.

**Nursing Management**

Assessment focuses on identifying children at high risk of TB exposure and performing a PPD as appropriate. Infant and young children with a positive PPD are at greater risk to develop active TB, so assess them carefully for weight loss, fever, fatigue, coughing, and respiratory status. Consider the child’s immunosuppression status. If TB is suspected, implement airborne isolation precautions until the infection status is known.

Nursing care of the child with LTBI focuses on administering medications and providing supportive care. Teach parents about the disease process, medications, possible side effects, and the importance of completing long-term therapy. Emphasize the importance of taking medications as prescribed on an empty stomach. Initiate direct-observed drug therapy twice a week if poor adherence is suspected.

Encourage proper nutrition and rest to promote normal growth and development. The child can return to school or childcare when effective therapy has been instituted, adherence to therapy has been documented, and clinical symptoms have diminished substantially (AAP, 2012, p. 758). Children should receive all usual immunizations. Most children treated for TB can lead essentially normal lives. See the discussion of pneumonia on page 538 and of meningitis in Chapter 27 for other nursing care measures.

**CHRONIC LUNG DISEASES**

**Asthma**

Asthma is a common chronic disorder in children characterized by bronchial constriction, hyperresponsive airways, and airway inflammation. In 2009 in the United States, 7.1 million (9.6%) children ages 0 to 17 years had an asthma diagnosis. An acute asthma episode was reported by 57.2% of these children in the prior 12 months, often resulting in a missed day of school. Of these children, 32.5% made an emergency department visit, and 8% were hospitalized. Approximately 174 deaths due to asthma occur annually in children and youth in the United States (Akinbami, Moorman, & Liu, 2011; CDC, 2011b). See Developing Cultural Competence: Asthma Prevalence.

**Etiology and Pathophysiology**

Asthma is a chronic inflammatory disease caused by multiple factors (e.g., environmental exposures, viral illnesses, allergens, and a genetic predisposition) that occur at a crucial time in the immune system’s development. More than 100 genes are associated with the susceptibility and pathology of asthma (Brashers, 2010a). Risk factors for asthma include passive smoke exposure, indoor air contaminants (for example, pet dander, cockroach feces), outdoor air pollutants, recurrent respiratory viral infections, and allergic disease (atopic eczema, food allergies). Protective factors include a large family size, later birth order, childcare attendance, dog in the family, and living on a farm. These factors increase exposure to infections early in life, enabling the child’s immune system to develop along a nonallergic pathway (National Asthma Education and Prevention Program [NAEPP], 2007, p. 23).

Inflammation causes the normal protective mechanisms of the lungs (mucous formation, mucosal swelling, and airway muscle contraction) to overreact in response to a trigger (an inflammatory or noninflammatory stimulus that initiates an asthma episode). Triggers include exercise, infectious agents, allergens, fragrances, food additives, pollutants, weather changes, emotions, and stress. Inflammatory mechanisms enhance airway responsiveness, and triggers stimulate bronchospasms (smooth muscle contractions).

The trigger may activate IgE and sensitized mast cells, leading to the release of inflammatory mediators (e.g., histamines, prostaglandins, and leukotrienes). The inflammatory mediators release pro-inflammatory cytokines, causing chronic airway inflammation, which may be associated with permanent airway damage. The resulting decreased airway elasticity and lung function are not prevented or fully reversed by treatment (Brashers, 2010a). The reactive airway responses exist before the trigger initiates the physiologic sequence that results in an acute asthma episode.

Airway narrowing results from bronchial constriction, airway swelling, and mucus production. Mucus clogs small airways, trapping air below the plugs (see Pathophysiology Illustrated: Asthma). Decreased perfusion of the alveolar capillaries results from hypoxic vasoconstriction and increased pressure due to hyperinflation of the alveoli. Hypoxemia leads to an increased respiratory rate, but because of airway resistance, less air is inspired per minute, worsening hypoxemia.

**Clinical Manifestations**

The sudden onset of breathing difficulty (cough, wheeze, or shortness of breath) is an acute asthma episode or asthma attack. The infant or child who has had frequent episodes of coughing or respiratory infections should be evaluated for asthma. Frequent coughing, especially at night, is a signal that the child’s airway is very sensitive to stimuli, and this could be a sign of “silent” asthma.

<table>
<thead>
<tr>
<th>Asthma Prevalence</th>
<th>The pediatric asthma prevalence rate in the United States varies by racial and ethnic groups (Akinbami et al., 2011):</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Non-Hispanic black: 11.1%</td>
<td></td>
</tr>
<tr>
<td>- Non-Hispanic white: 8.2%</td>
<td></td>
</tr>
<tr>
<td>- Hispanic: 6.3% (ranging from 16.6% for Puerto Ricans to 4.9% for Mexicans)</td>
<td></td>
</tr>
<tr>
<td>- Asian: 5.3%</td>
<td></td>
</tr>
<tr>
<td>- American Indian and Alaska Native: 8.8%</td>
<td></td>
</tr>
</tbody>
</table>
Some asthma triggers are exercise, infection, and allergies. Asthma obstructs airflow through constriction and narrowing of the airway, along with increased production of mucus.

During an acute episode, respirations are rapid and labored, and the child often appears tired because of the ongoing effort to breathe. Nasal flaring and intercostal retractions may be visible. The child exhibits a productive cough and expiratory wheezing, a prolonged expiratory phase, decreased air movement, accessory muscle use, and respiratory fatigue. The child may complain of chest tightness. Anxiety increases as the acute episode worsens, and the increasing anxiety intensifies the child’s physical responses.

In a severe acute episode, wheezing may not be heard because of low airflow. Head bobbing may be seen in young children using the accessory muscles to breathe. Hypoxia and the cumulative effect of administered medications may cause behaviors ranging from wide-eyed agitation to lethargic irritability. In children who have repeated acute episodes, a barrel chest and accessory muscle use are common findings.

**Clinical Therapy**

Diagnosis is made by history, physical examination, and pulmonary function testing (spirometry) that shows evidence of episodic airflow obstruction (that is at least partially reversible) and airway hyperresponsiveness. Spirometry readings are most commonly measured as forced expiratory volume in 1 second (FEV₁) and expressed as a percentage of predicted FEV₁ for the child’s height, age, gender, and race. A chest radiograph may help determine if a foreign body could account for symptoms. Skin testing may be used to identify allergens (asthma triggers).

Asthma may go into remission or increase in severity over time. Asthma severity is categorized by the child’s amount of impairment and risk (or the number of acute episodes needing oral systemic corticosteroid therapy). See Tables 20–6 and 20–7 for the classification of asthma severity in children of different age groups. Recommended therapy is tied to this asthma severity classification. While current asthma treatment is effective in controlling symptoms, reducing airflow limitations, and preventing exacerbations, the underlying severity of asthma is not prevented (NAEPP, 2007, p. 28).

Clinical therapy includes medications, hydration, education, and support of parents and child. Pharmacologic treatment is matched to the severity of asthma for daily control and for management of acute episodes. See Medications Used to Treat Asthma. The goal is to maintain asthma control long term, using the least amount of medication and reducing the risk for adverse effects.

A stepwise approach to medication therapy is recommended that matches the child’s asthma severity, adding and changing specific medications if the severity progresses during an acute episode, usually by 5 to 6 years of age. Coach the child to give the best effort each time. Encourage the child to seal the lips tightly around the mouthpiece. The child is then instructed to breathe out as hard as possible and then to breathe in deeply.
Components of Severity

<table>
<thead>
<tr>
<th>Impairment</th>
<th>Intermittent</th>
<th>Persistent Mild</th>
<th>Moderate</th>
<th>Severe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Symptoms</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nighttime awakenings</td>
<td>2 or fewer days a week</td>
<td>Greater than 2 days a week, but not daily</td>
<td>Daily</td>
<td>Throughout the day</td>
</tr>
<tr>
<td>SABA use for symptom control (not prevention of exercise-induced bronchospasm)</td>
<td>2 or fewer days a week</td>
<td>Greater than 2 times a week, but not daily</td>
<td>Daily</td>
<td>Several times a day</td>
</tr>
<tr>
<td>Interference with normal activity</td>
<td>None</td>
<td>Minor limitation</td>
<td>Some limitation</td>
<td>Extremely limited</td>
</tr>
</tbody>
</table>

Risk

<table>
<thead>
<tr>
<th>Exacerbations requiring oral systemic corticosteroids</th>
<th>0 to 1 time a year</th>
<th>2 or more times a year</th>
</tr>
</thead>
</table>

Frequency and severity may fluctuate over time for patients in any severity category.

Recommended step for initiating therapy (see Figure 20–3)

<table>
<thead>
<tr>
<th>Step</th>
<th>In 2 to 6 weeks, depending on severity, evaluate level of asthma control that is achieved. If no clear benefit is observed in 4 to 6 weeks, consider adjusting therapy or alternative diagnoses</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Risk</th>
<th>Exacerbations requiring oral systemic corticosteroids</th>
<th>0 to 1 time a year</th>
<th>2 or more times a year</th>
</tr>
</thead>
</table>

Frequency and severity may fluctuate over time for patients in any severity category.

Note: SABA = short-acting beta₂ agonist.


or diminishes while maintaining control (NAEPP, 2007, p. 284). The child’s response to therapy after 2 to 6 weeks guides the need to further step up the medications to better control symptoms. See Figures 20–3 ●, 20–4 ●, and 20–5 ● for the nationally recommended stepwise approach by age group (see pages 546–548). Reducing or stepping down medications may be considered if the child’s asthma has been well controlled for at least 3 months (Williams, 2009).

Recommendations for children with persistent asthma include the use of daily inhaled corticosteroids and additional long-term control medications as severity increases. Children with intermittent asthma may only need short-acting beta₂ agonists. If asthma control is difficult to achieve, refer the child to an asthma specialist.

Acute Asthma Episodes. Most children with acute exacerbations respond to aggressive management in the emergency department with continuous albuterol by nebulizer, oral systemic corticosteroids, and inhaled ipratropium. Children who do not respond or who are already being managed at home on corticosteroids have a greater chance of hospital admission.

Exercise-Induced Asthma. More than 75% of children and youth report shortness of breath, wheezing, coughing, difficulty taking a deep breath, noisy breathing, or chest tightness to occur during and after exercise (Ostrom, Eid, Craig, et al., 2011). Pretreatment with a short-acting beta₂-agonist immediately before exercise often prevents exercise-induced asthma and provides relief for up to 3 hours (Robinson & Van Asperen, 2009).

Severe Asthma Episodes. Children with potentially life-threatening asthma episodes need aggressive intervention in the intensive care unit, such as those treated for an acute asthma episode in the past 24 hours. Laboratory findings indicating a need for ICU admission include hypoxemia (may be masked by supplemental oxygen), a PaCO₂ of 42 mmHg or greater, respiratory acidosis, and sometimes metabolic acidosis (Gott & Froh, 2010). Intravenous magnesium sulfate may be added to other medications used for the acute episode. Heliox (70% helium, 30% oxygen) may be used to drive the nebulizer (Robinson & Van Asperen, 2009). Some children need mechanical ventilation or CPAP. A few children progress to respiratory failure and die.

**NURSING MANAGEMENT for the Child with Asthma**

**Nursing Assessment and Diagnosis**

The nurse usually encounters the child and family in the emergency department, health center, or nursing unit. In these settings, acute care has become necessary, because the child’s level of respiratory compromise cannot be managed at home.
### Table 20–7 Classification of Asthma Severity in Children 5 Years to Adulthood

<table>
<thead>
<tr>
<th>Components of Severity</th>
<th>Classification of Asthma Severity (5 to 11 Years of Age and 12 Years to Adulthood)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Impairment Symptoms</td>
<td>intermittent</td>
</tr>
<tr>
<td>Nighttime awakenings</td>
<td>Persistent Mild</td>
</tr>
<tr>
<td>SABA for symptom control (not prevention of exercise-induced bronchospasm)</td>
<td>Moderate</td>
</tr>
<tr>
<td>Interference with normal activity</td>
<td>Severe</td>
</tr>
<tr>
<td>Lung function (5 to 11 years)</td>
<td>Normal FEV₁ between exacerbations FEV₁ greater than 80% predicted FEV₁/FVC greater than 85%</td>
</tr>
<tr>
<td>Lung function (12 years to adulthood)</td>
<td>Normal FEV₁ between exacerbations FEV₁ greater than 80% predicted FEV₁/FVC normal</td>
</tr>
<tr>
<td>Risk</td>
<td>Exacerbations requiring oral systemic corticosteroids 0 to 1 time a year ← 2 or more times a year →</td>
</tr>
</tbody>
</table>

#### Physiologic Assessment

Identify the child’s current respiratory status first by assessing the ABCs—airway, breathing, and circulation—to make sure the child’s condition is not life threatening. If the child is moving air or talking, assess the quality of breathing. Observe the child’s color, and assess the respiratory and heart rates. Auscultate the lungs for the quality of breath sounds and for the presence or absence of wheezing. Note whether a cough or stridor is present. Inspect the chest for retractions to assess the severity of respiratory distress. Move on to other aspects of assessment only after finding no life-threatening respiratory distress.

Attach a pulse oximeter; a SpO₂ reading of less than 92% indicates hypoxemia. Assess skin turgor, intake and output, and urine specific gravity. The child may be unable to use the spirometer due to respiratory distress. Because asthma can be a symptom of another illness, perform a head-to-toe assessment to identify other associated problems. See the Assessment Guide on page 524.
### Medications Used to Treat Asthma

<table>
<thead>
<tr>
<th>Quick Relief Medications, Route, and Action</th>
<th>Nursing Management</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Short-acting β₂-agonists (SABA)</strong></td>
<td></td>
</tr>
<tr>
<td>Albuterol, levalbuterol, pirbuterol</td>
<td>Use before inhaled steroid, wait 1–2 minutes between puffs, wait 15 minutes to give inhaled steroid. Child should hold breath 10 seconds after inspiring. Then rinse mouth and avoid swallowing medication. Use a spacer. Differences in potency exist, but all products are comparable on a per puff basis. Dose-related side effects include tachycardia, nervousness, nausea and vomiting, headaches. Regular use more than 2 days a week for symptom control indicates a loss of control and need for additional therapy.</td>
</tr>
<tr>
<td>Metered-dose inhaler or nebulizer</td>
<td></td>
</tr>
<tr>
<td>Relaxes smooth muscle in airway leading to rapid bronchodilation (within 5 to 10 minutes) and mucus clearing Drug of choice for acute therapy and prevention of exercise-induced bronchospasm</td>
<td></td>
</tr>
</tbody>
</table>

| **Corticosteroids**                         | |
| Methylprednisolone, prednisone, prednisolone | Short-term therapy should continue until child achieves 80% peak expiratory flow personal best, or until symptoms resolve. |
| Oral                                        | Give with food to reduce gastric irritation. |
| Diminishes airway inflammation, secretions, and obstruction, enhances bronchodilating effect of β₂-agonists. Used for acute episodes not fully responsive to β₂-agonists; reduces hospitalization rates | Give oral dose in early morning to mimic normal peak corticosteroid blood level. |

| **Anticholinergic**                         | |
| Ipratropium                                 | Rinse mouth afterward to get rid of bitter taste. |
| Metered-dose inhaler or nebulizer           | Side effects include increased wheezing, cough, nervousness, dry mouth, tachycardia, dizziness, headache, palpitations. |
| Inhibits bronchoconstriction and decreases mucus production Not for primary emergency treatment because of 30- to 90-minute time of onset. | Prevent medication contact with eyes. |

<table>
<thead>
<tr>
<th>Daily Control Medications, Route, and Action</th>
<th>Nursing Management</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Long-acting β₂-agonists (LABA)</strong></td>
<td></td>
</tr>
<tr>
<td>Salmeterol, formoterol</td>
<td>Do not use for acute asthma episode.</td>
</tr>
<tr>
<td>Dry powder inhaler</td>
<td>Take pre-exercise dose 30 to 60 minutes before activity. Do not use additional dose before exercise if already using twice daily doses, which should be 12 hours apart.</td>
</tr>
<tr>
<td>Relaxes smooth muscle in airway. Used for nocturnal symptoms and prevention of exercise-induced bronchospasm. For children, used in combination with corticosteroids (U.S. Food and Drug Administration, 2010).</td>
<td>Caution against overdosage because side effects such as tachycardia, tremor, irritability, insomnia will last 8 to 12 hours.</td>
</tr>
<tr>
<td><strong>Inhaled corticosteroids (ICS)</strong></td>
<td>Report failure to respond to usual dose because this may indicate need for stepped-up therapy.</td>
</tr>
<tr>
<td>Beclomethasone, budesonide, flunisolide, fluticasone, mometasone, triamcinolone</td>
<td></td>
</tr>
<tr>
<td>Metered-dose inhaler or nebulizer</td>
<td>Administer with spacer or holding chamber.</td>
</tr>
<tr>
<td>Anti-inflammatory, controls seasonal, allergic, and exercise-induced asthma; effectively reduces mucosal edema in airways.</td>
<td>Separate parts and clean inhaler daily.</td>
</tr>
</tbody>
</table>

| **Methylxanthines**                          | |
| Theophylline                                 | Do not crush or chew tablet. Give at same time each day. |
| Oral                                         | Maintain therapeutic serum level of 10–20 mcg/L; requires serum level checks and dose adjustment. |
| Relaxes muscle bundles that constrict airways; dilates airway; provides continuous airway relaxation. Used for long-term control and prevention of nocturnal symptoms. | Limit caffeine intake. |

Side effects include tachycardia, dysrhythmias, restlessness, tremors, seizures, insomnia, hypotension, severe headaches, vomiting, and diarrhea. |
### Medications Used To Treat Asthma (continued)

<table>
<thead>
<tr>
<th>Daily Control Medications, Route, and Action</th>
<th>Nursing Management</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mast cell inhibitors</strong>&lt;br&gt;Cromolyn sodium, nedocromil&lt;br&gt;Metered-dose inhaler or nebulizer&lt;br&gt;Anti-inflammatory, inhibits early and late phase asthma response to allergens and exercise-induced bronchospasm. May be used for unavoidable allergen exposure.</td>
<td>■ Do not use at time of symptom development or acute episode.&lt;br&gt;■ Must be used up to 4 times a day to be effective.&lt;br&gt;■ Therapeutic response seen in 2 weeks, maximum benefit may not be seen for 4 to 6 weeks.&lt;br&gt;■ Adverse reactions include wheezing, bronchospasm, throat irritation, nasal congestion, and anaphylaxis. Immediately report these symptoms to physician.</td>
</tr>
<tr>
<td><strong>Leukotriene receptor antagonist (LTRA)</strong>&lt;br&gt;Montelukast, zafirlukast&lt;br&gt;Oral&lt;br&gt;Reduces inflammation cascade responsible for airway inflammation; improves lung function and diminishes symptoms and need for quick-relief medications.</td>
<td>■ Available in granules for infants and chewable tablets for young children.&lt;br&gt;■ Administer montelukast in the evening; may be given with food or without.&lt;br&gt;■ Make sure child chews montelukast chewable tablet rather than swallowing whole. Granules may be mixed in applesauce or ice cream; do not mix in liquid.&lt;br&gt;■ Administer zafirlukast 1 hour before or 2 hours after meal.&lt;br&gt;■ Report fever, acute asthma episodes, flu-like symptoms, severe headaches, or lethargy.&lt;br&gt;■ Take as prescribed; do not withdraw abruptly.</td>
</tr>
<tr>
<td><strong>Immunotherapy</strong>&lt;br&gt;Omalizumab&lt;br&gt;Subcutaneous&lt;br&gt;A therapeutic antibody that blocks IgE from causing reactions leading to asthma symptoms.</td>
<td>■ Approved for children 12 years and older with moderate or severe persistent asthma.&lt;br&gt;■ Injections required every 2 to 4 weeks based on serum IgE levels.&lt;br&gt;■ Be alert for anaphylaxis; it should be administered in a health center prepared to treat anaphylaxis.</td>
</tr>
<tr>
<td><strong>Other</strong>&lt;br&gt;Hyposensitization (allergy shots)&lt;br&gt;Subcutaneous&lt;br&gt;Series of injections with gradual dose increase that can increase the child’s tolerance of unavoidable allergens (e.g., mold, pollen)</td>
<td>■ May be of value for child with persistent asthma having allergies that can be addressed by immune therapy.</td>
</tr>
</tbody>
</table>


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### Assess Asthma Management

Key questions to consider asking parents and older children or adolescents include the following (Lynch, 2011):

■ Which medicines is the child currently taking? How often?
■ How and when is the medication administered?
■ Have you missed taking any of your medications? How many times a week?
■ What issues have you had related to giving the medicine (cost, time, lack of perceived need)? Do you have any concerns about the prescribed asthma medication?
■ What other treatments for asthma have you tried or are you using (e.g., complementary therapies)?
■ Show me how you use your inhaler.

### Psychosocial Assessment

Assess the child’s anxiety or fear related to the asthma episode or hospitalization. How are parents responding to the current acute episode? Are they anxious, concerned, or frustrated? Do they potentially have concerns about finances, missing work, or other family members at home? Assess whether the child thinks this episode could have been avoided if medications had been used.

Examples of nursing diagnoses for the child experiencing an acute asthma episode include the following (NANDA-I © 2012):

■ **Airway Clearance, Ineffective** related to airway compromise, copious mucous secretions, and coughing
■ **Gas Exchange, Impaired** related to airway obstruction
■ **Fluid Volume: Deficient, Risk for** related to inability to drink adequate fluids when in respiratory distress
■ **Anxiety/Fear (Child and Parents)** related to difficulty breathing
■ **Therapeutic Regimen Management: Family, Ineffective** related to lack of understanding about the need for daily management of a chronic disease
**Figure 20–3** Stepwise approach to managing asthma in children 0 to 4 years of age.


### Planning and Implementation

Pharmacologic and supportive therapies are used to reverse the airway obstruction and promote respiratory function. Nursing interventions focus on maintaining airway patency, meeting fluid needs, promoting rest and stress reduction for the child and parents, supporting the family's participation in care, and providing the family with information to enable them to manage the child's disease.

#### Maintain Airway Patency

If the child is exhibiting breathing difficulty, give supplemental humidified oxygen by nasal cannula or face mask. Humidity prevents drying and thickening of mucous secretions. Place the child in a sitting (semi-Fowler's) or upright position to promote and ease respiratory effort. Evaluate the effectiveness of positioning and oxygen administration by pulse oximeter and by observing for improved respiratory status (see the Clinical Skills Manual SKILLS).

The respiratory distress and need for supplemental oxygen can be stressful for parents and child alike (Figure 20–6 ●). Encouraging the parents’ presence can be reassuring for the child. Keep the parents informed of procedures and results and get their input when developing the treatment plan.

Most medications are given by inhalation (Figure 20–7 ●). (See the Clinical Skills Manual SKILLS.) The aerosol droplets provide the added benefit of moisture. Continuous nebulizer treatments may be used for some children with severe acute episodes. See Growth and Development for considerations in administering medications with inhalation devices. Monitor the child for medication side effects. The frequency of vital sign assessment is determined by the severity of symptoms.

#### Meet Fluid Needs

Fluid therapy is often necessary to restore and maintain adequate fluid balance. Adequate hydration is essential to thin and break up trapped mucous plugs in the narrowed airways. An intravenous infusion may be needed if the child cannot meet fluid needs by mouth, and for administering certain medications and glucose. Monitor the child’s intake, output, and specific gravity to avoid overhydration that could lead to pulmonary edema in severe asthma episodes.

As respiratory difficulty diminishes, offer oral fluids slowly. The child’s fluid preferences should be determined and choices given when possible. Involve parents to help gain the child's cooperation in taking oral fluids.
### Chronic Lung Diseases

#### Intermittent Asthma
- **Step 1**
  - **Preferred:** SABA PRN
  - **Alternative:** Cromolyn, LTRA, Nedocromil, or Theophylline

#### Persistent Asthma: Daily Medication
- **Step 2**
  - **Preferred:** Either: Low-dose ICS + either LABA, LTRA, or Theophylline OR Medium-dose ICS
  - **Alternative:** Medium-dose ICS + either LTRA or Theophylline

- **Step 3**
  - **Preferred:** High-dose ICS + LABA
  - **Alternative:** High-dose ICS + either LTRA or Theophylline

- **Step 4**
  - **Preferred:** High-dose ICS + LABA + oral systemic corticosteroid
  - **Alternative:** High-dose ICS + either LTRA or Theophylline + oral systemic corticosteroid

- **Step 5**
  - **Preferred:** High-dose ICS + LABA + oral systemic corticosteroid
  - **Alternative:** High-dose ICS + either LTRA or Theophylline + oral systemic corticosteroid

- **Step 6**
  - **Preferred:** High-dose ICS + LABA + oral systemic corticosteroid
  - **Alternative:** High-dose ICS + either LTRA or Theophylline + oral systemic corticosteroid

#### Discharge Planning and Home Care Teaching
- **Assess control**
  - Step down if possible (and asthma is well controlled at least 3 months)
  - Step up if needed (first, check adherence, inhaler technique, environmental control, and comorbid conditions)

#### Patient Education and Environmental Control at Each Step
- **Quick-Relief Medication for All Patients**
  - SABA as needed for symptoms. Intensity of treatment depends on severity of symptoms: up to 3 treatments at 20-minute intervals as needed. Short course of oral systemic corticosteroids may be needed.
  - Caution: Increasing use of SABA or use greater than 2 days a week for a symptom relief (not prevention of EIB) generally indicates inadequate control and the need to step up treatment.

#### Key:
- Alphabetical order is used when more than one treatment option is listed within either preferred or alternative therapy. EIB, exercise-induced bronchospasm; ICS, inhaled corticosteroid; LABA, inhaled long-acting beta2-agonist; LTRA, leukotriene receptor antagonist; SABA, inhaled short-acting beta2-agonist

#### Figure 20–4
- Stepwise approach to managing asthma in children 5 to 11 years of age.


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#### Clinical Tip
- Iced beverages precipitate bronchospasms in some children with asthma. Offer room-temperature or slightly cooled fluids instead.

#### Promote Rest and Stress Reduction
- The child having an acute asthma episode is usually very tired when admitted to the nursing unit because of labored breathing and hypoxemia. Put the child in a quiet room that is accessible for frequent monitoring to promote relaxation and rest. Group tasks to avoid repeatedly disturbing the child.

#### Support Family Participation
- Recognize that parents may be exhausted after spending hours with their child in respiratory distress. Give parents the option of assisting with the child’s treatments, rather than expecting them to help, in addition to comforting the child. Provide frequent updates about the child’s condition and encourage the parents to take breaks as needed.

- Length of hospitalization depends on the child’s response to therapy. Any underlying or accompanying health problem, such as preexisting lung disease or pneumonia, can complicate and extend the child’s hospital stay. Communicate with the family of the hospitalized child frequently about the child’s condition.

#### Discharge Planning and Home Care Teaching
- Parents need a thorough understanding of asthma—how to prevent asthma episodes and how to follow the asthma action plan to manage the child’s acute episodes earlier to prevent unnecessary hospitalization. When possible, educate parents when they are rested but refer the child to a healthcare provider for more comprehensive education. Make sure the child receives an appointment with an allergist or asthma specialist if moderate to severe persistent asthma exists. Support of parents and the child should focus on helping them to understand and cope with the diagnosis and the need for daily management to promote near-normal respiratory function while the child continues to grow and develop normally. See Developing Cultural Competence: Asthma Disparity Factors.

- Discharge planning for the child with asthma focuses on increasing the family’s knowledge about the disease, medication therapy, and the need for follow-up care. The required lifestyle changes may be difficult for the child and parents. The need to modify the home to remove allergens, to remove a loved pet, or to have family members stop smoking in the home may create...
Figure 20-5  Stepwise approach to managing asthma in children 12 years of age and older.


Figure 20-6  An acute asthma episode requires management in the emergency department. The child is placed in a semi-Fowler position to facilitate respiratory effort. Support both the child and parent during these acute episodes. This mother looks exhausted after a sleepless night of caring for her son.

Figure 20-7  Medications given by inhalation therapy reach the bloodstream rapidly while minimizing the systemic effects. A nebulizer works well for young children because it does not require coordination of breathing with medication inhalation.
Chronic Lung Diseases

Developing Cultural Competence

Asthma Disparity Factors

African American and Hispanic children have a higher prevalence rate for asthma. A major factor may be lower access to high-quality ambulatory care than Caucasian children. Other factors associated with the high prevalence rate may include (Hill, Graham, & Divgi, 2011):

- Environmental exposures (e.g., air pollution in urban areas, public housing with more exposure to molds and cockroaches)
- Medication beliefs associated with concerns over safety of inhaled corticosteroids and development of tolerance with daily use
- Emotional stress within the home

Identify potential factors contributing to child’s asthma to provide effective education and support to the child and family.

Growth and Development

Asthma Inhaler Use

Metered-dose inhalers (MDIs), nebulizers, and dry powder inhalers (DPIs) are devices used for inhalation therapy. These devices cause special challenges for infants and young children because many devices require cooperation and coordination. The appropriate technique must be taught and reinforced frequently.

- Children over 5 years usually have the ability to use an MDI, coordinating medication release and inspiration; however, they may prefer to use a holding chamber or spacer with a valve. Spacers enhance the amount of drug delivered to the lungs while reducing the amount of drug deposited in the mouth and throat, which can cause local and systemic effects (Zagaria, 2010).
- Spacers have a mouthpiece or mask attachment. Select a spacer with a mask for infants and young children that fits the face and has a flexible seal to prevent an air leak. Crying leads to prolonged exhalation and short inspiration, reducing lung deposition. Use play and distraction to improve cooperation for medication delivery. Wash the plastic spacer with household detergent and air dry it to reduce the static charge that can attract medication particles.
- When a spacer is used, release a puff of medication and immediately put the mask on the face or the mouthpiece in the mouth. Have the child take 4 to 6 breaths. Move the spacer away from the face or mouth and have the child hold his or her breath for 10 seconds (Asthma Initiative of Michigan for Healthy Lungs, 2011). Wash the child’s face after using a spacer with a mask.
- Some MDIs or DPIs have a whistle. It may warn that the inhaled breath is too fast or too shallow, but in other devices it indicates the breath was adequate. Be sure to inform the child and family about what the whistle on the child’s inhaler indicates. Teach the child to use an MDI without a spacer by breathing slowly through a straw.
- A nebulizer changes liquid medication into aerosol particles. No coordination of breathing is required, making them easier for young children to use. Nebulizers are not more efficient than MDIs with a spacer, but the outcome may be better because the child only needs to breathe normally. The nebulizer mouthpiece should be sealed by the lips, and mouth breathing is important for drug delivery. If the child cannot coordinate mouth breathing, use a face mask. Nebulizers take 8 to 10 minutes per treatment, and it may be difficult for infants and young children to cooperate for that duration.
- DPIs are activated when the patient takes a breath, so puffs do not need to be coordinated with inhalation. No spacer or propellant is used. Children starting at age 5 years may be able to take the rapid, deep, and sustained breath needed to effectively use the device. Children less than 6 years of age who are wheezing may not be able to inspire at a rate fast enough to obtain the optimal amount of medication.
- Steps for using DPI include the following: Remove the lid, load the dose (puncturing the blister or capsule), fully breathe out away from the device, put the mouthpiece between the lips and teeth, and breathe in deeply and forcefully. Hold the breath for 10 seconds and remove the mouthpiece from the mouth (Asthma Initiative of Michigan for Healthy Lungs, 2011). To teach the child to use a DPI, have the child place a paper tissue over the open mouth and inhale deeply for a count of 5 seconds. The tissue should stay against the mouth without being held for that time to be able to use a DPI correctly (Amirav, 2010).


Community-Based Nursing Care

Nurses provide care to children with asthma in pediatricians’ offices, specialty asthma clinics, schools, and summer camps. The child’s asthma control and management should be assessed at each visit. The Test for Respiratory and Asthma Control in Kids (TRACK) is a validated tool that can be used to help the healthcare provider obtain basic information about the child’s asthma control (Chippes, Zeiger, Murphy, et al., 2011).

Review the family’s daily plan for monitoring the child’s respiratory status. Encourage the school-age child or the parents of stress and resistance. The nurse can facilitate discussion and clarification of ways to prevent asthma episodes. Teach the family how to measure and interpret peak expiratory flow readings (see Families Want to Know: Using a Peak Expiratory Flow Meter). Discuss quick-relief medications to manage asthma episodes, as well as control medications for daily management. Reassure the family that most children with asthma can lead a normal life with some modifications.
A peak expiratory flow meter is a useful tool for asthma self-management. It measures the child's ability to push air forcefully out of the lungs. Changes in the peak expiratory flow rate (PEFR) signal worsening lung function and the beginning of an asthma episode. To use a peak expiratory flow meter:

- Set the device at zero or the base level.
- Stand up and take as deep a breath as possible.
- Put the mouthpiece of the meter in the mouth and firmly close the lips around it. Do not cough or let your tongue block the mouthpiece. Blow out as hard and fast as possible over 1 to 2 seconds.
- To help toddlers learn how to use a peak flow meter, have them practice by blowing into a noisemaker or party favor.
- Write down the reading.
- Repeat the process 2 times and record the highest of the 3 numbers on the chart.
- Measure and record the best PEFR reading twice a day for 2 weeks so the physician can determine the child's personal best reading. (Make sure the child is optimally treated with medications during the day to obtain the best reading.)
- The physician will use the child's personal best average readings to set the green, yellow, and red color zones to guide treatment in the child's asthma action plan. The child's personal best changes as the child grows taller, so the child's personal best should be measured every year.
- The physician provides guidelines for the child and family to use when monitoring the peak expiratory flow rate. If the child or parent suspects the child might have the onset of breathing difficulty, the peak flow meter can be used. Some children have problems identifying early symptoms of an acute asthma episode onset (increased cough, wheezing, or shortness of breath). The peak flow meter measures the change in how hard the child can blow out air. Using the zones established by the healthcare provider, the child and family can determine what action to take.

- **Green zone:** The PEFR reading is between 80% and 100% of the child's personal best. Air is moving well in the child's lungs. In this case the child has good asthma control and can continue daily activities. No modification of the treatment plan is needed.
- **Yellow zone:** The PEFR reading is between 50% and 80% of the child's personal best. In this case the child is developing breathing problems. The parents should follow directions in the child's asthma action plan, which usually involves quick-relief medications. The child should feel better and the PEFR should improve over the next hour. If symptoms and the PEFR do not improve, contact the child's healthcare provider for additional treatment guidance.
- **Red zone:** The PEFR is less than 50% of the child's personal best. In this case the child has a severe asthma episode and needs urgent treatment with quick-relief medication. Call the child's healthcare provider for additional care guidelines or take the child to the emergency department.


**Clinical Tip**

A 2012 study revealed that using a peak expiratory flow meter provided parents with an objective measure of the child’s asthma symptoms and empowered them to initiate treatment earlier than without the meter. Communication with the child’s healthcare provider was more effective when a peak expiratory flow meter was used (Burkhart, Rayens, & Oakley, 2012). A 2012 study revealed that using a peak expiratory flow meter provided parents with an objective measure of the child’s asthma symptoms and empowered them to initiate treatment earlier than without the meter. Communication with the child’s healthcare provider was more effective when a peak expiratory flow meter was used (Burkhart, Rayens, & Oakley, 2012).

Youth children to keep a symptom diary that includes PEFR for 2 weeks prior to a health visit as well as all daytime and nighttime symptoms. Evaluate the child’s use of the peak expiratory flow meter and MDI or DPI and correct the child’s technique as needed.

Assess the parent’s ability to identify the timing and type of stepped-up care needed to manage worsening symptoms identified on the child’s asthma action plan. The goal is to bring asthma episodes under control with stepped-up care before emergency care is needed.

**Health Maintenance** Provide routine health promotion and maintenance care, including immunizations. Live virus vaccines may need to be postponed if the child has used oral corticosteroids recently. Carefully monitor the child’s growth, especially when the child uses inhaled corticosteroids and episodic oral corticosteroids, which can slow growth (Williams, 2009).

Exercise is a frequent trigger of asthma symptoms in many patients, but routine exercise such as running and swimming has benefits such as improved fitness and decreased severity of asthma symptoms (Rance & O’Laughlen, 2011). A study with 45 children evaluated the safety of a 9-week program of vigorous swimming and moderate-intensity golf. Benefits found were reduced childhood asthma symptoms and physician office visits (Weisgerber, 2008).
**Families Want to Know** Home Care for the Child with Asthma

**Identify Current Knowledge About the Condition and Its Impact on the Child:**
- What happens in the lungs during an asthma episode?
- What are the child’s early warning signs of an asthma episode?
- What are the child’s symptoms (wake up at night, cough a lot)? How does the child respond to them?
- Is the child involved in any exercise activity? If no, why not?
- Do asthma symptoms occur when the child is exercising?
- Does asthma interfere with social activities or activities with friends?
- What are the child’s personal asthma triggers? (Suggest keeping a log of symptoms that occur during the day and night, including when and where, to help identify triggers, e.g., home, school, outdoors, with exercise.)

**Set Up a Schedule for Parents to Learn Asthma Management:**
- Make sure the parents and child know that asthma is a chronic condition that needs daily management and environmental control to reduce or prevent acute asthma episodes.
- Review the asthma action plan for daily management, quick relief, and when to call the physician or to seek emergency care.
- Assess the child’s technique with a peak expiratory flow meter, and correct technique as needed. Discuss when to use the meter and how to interpret and use the results for asthma control. Keep a record of peak flow readings for 2 weeks prior to each health visit.

**Review Parents’ Understanding of Medication Therapy:**
- Provide information about medications: name, type of drug, dose, method of administration, expected effect, possible side effects. Make sure families understand that daily control medications help prevent acute asthma episodes; the child will not feel them work like the quick-relief medications. Discuss any concerns the family has about the use of “steroid” medication and describe how they differ from the anabolic steroids abused by athletes.
- Assess the child’s MDI or DPI technique and correct as needed.
- When a nebulizer is used to treat an infant or young child, suggest diversions to promote cooperation during the 8- to 10-minute treatment.

**Address Associated Issues:**
- What are the financial considerations of medication cost and lifestyle changes?
- Have arrangements been made for the child to use medications at childcare or school?
- Does the child have a medical identification bracelet or tag?
- Would a self-help group or camp experience be helpful for the child?

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**Child and Family Education** Once the stress of an acute episode has passed, take advantage of opportunities to provide more extensive education at each health visit. See Families Want to Know: Home Care for the Child with Asthma to guide asthma education.

Engage the child in learning about how the lungs work and what happens when an acute asthma episode occurs. Teach the child how to begin steps toward self-management as appropriate. Encourage the child to ask questions. Provide an activity or coloring book for the child and printed educational materials for the parents. Refer parents to a local support group to gain additional knowledge and confidence in asthma management. Many hospitals have family resource centers that can assist the parents to find helpful information on the Internet.

Teach the child and family about the importance of the daily control medication program and collaborate with the physician to develop a written asthma action plan for the child and family. The plan should include the daily control medications, quick-relief medications to take once symptoms of an asthma episode are identified, and when to call the health professional. Identify routines that may improve adherence to daily medication use, such as keeping medications where they will be seen at mealtime.

Encourage school-age children to assume more responsibility for care, including avoidance of known triggers, early symptom recognition, relaxation breathing, and the proper use of inhaled medication. Help the child learn the early signs of an asthma episode (coughing, breathlessness, or peak expiratory flow meter reading) and to take quick-relief medication before signs become more serious. Determine if the family uses any complementary care therapies for asthma management.

**Preventing Asthma Episodes** Environmental control is an important part of asthma management. When possible, remove pets and plants from the home (especially from the child’s bedroom). Dust mites live in the carpets, mattresses, upholstered furniture, bedcovers, soft toys, and clothes. Controlling dust mites in the child’s bed and bedroom is a high priority. Encase the child’s mattress and pillow in plastic covers. Bathe pets frequently to reduce pet dander. Initiate cockroach eradication. Smoke from cigarettes, wood stoves, and fireplaces should be eliminated. See Chapter 22 for Families Want to Know: Removing Common Allergens from the Home.

**School Management** Provide a physician order so the child’s asthma symptoms can be treated at school. The parents should work with school administrators to have an individualized health plan (that includes an asthma action plan) developed so medications can be administered, including pretreatment for exercise. Provide a supply of medications to the school or child-care organization. Make sure teachers of young children can help recognize signs of an acute asthma episode and reduce a child’s anxiety about going to the nurse for quick-relief medications. Many schools are attempting to improve the environment and reduce asthma triggers.
Clinical Tip

All 50 states have legislation that entitles a child with asthma to carry and self-administer asthma medications at school (Allergy and Asthma Network, 2010). Families of children old enough to recognize worsening asthma symptoms and to self-administer rescue medications should make sure the school knows about the state law.

Evaluation

Expected outcomes of nursing care include the following:

- The child recognizes early asthma symptoms and promptly uses quick-relief medications, fluids, and relaxation breathing before severe respiratory distress occurs.
- The child learns to identify and avoid asthma triggers.
- The child and family implement the prescribed daily treatment plan and asthma action plan to reduce the number of asthma episodes the child has.
- The child with a serious asthma episode responds to oxygen, fluids, and medication therapy, avoiding hospital admission.

Bronchopulmonary Dysplasia (Chronic Lung Disease)

Bronchopulmonary dysplasia (BPD) is defined as the need for supplemental oxygen for at least 28 days after premature birth. It is one of the most serious chronic respiratory disorders in infancy. BPD more commonly develops in infants born at less than 28 weeks’ gestation with a birth weight less than 1000 g (Fakhoury, Sellers, Smith, et al., 2010). BPD is estimated to occur in one third of newborns with a birth weight less than 1500 g (Stroustrup & Trasande, 2010).

Etiology and Pathophysiology

BPD results from positive-pressure ventilation and oxygen treatment for respiratory failure and respiratory distress syndrome. Abnormal pulmonary development or arrested lung development may be a factor; the infant has fewer and larger alveoli with less functional surface area and abnormal development of capillaries in the alveolar region (Gott & Froh, 2010). Inflammation following intrauterine infection or sepsis or a patent ductus arteriosus may also contribute to BPD development. Antenatal corticosteroids, surfactant replacement therapy, and gentle ventilation techniques have reduced the incidence of BPD in more mature preterm infants (Pfister & Goldsmith, 2010).

Clinical Manifestations

The infant with BPD has persistent signs of respiratory distress: tachypnea, nasal flaring, grunting, retractions, wheezing, crackles, and irritability. Normal activities like feeding create increased oxygen demands and fatigue that may lead to failure to thrive. The infant has intermittent bronchospasms, mucous plugging, and chronic air trapping, which may lead to a barrel-shaped chest (see Pathophysiology Illustrated: Barrel Chest). Cyanosis may be seen in severe cases.

Clinical Therapy

Diagnosis is made by the neonate’s dependence on supplemental oxygen for at least 28 days after birth, and severity is increased if CPAP or mechanical ventilation is also needed. A chest radiograph is often obtained.

Medical management involves symptomatic treatment that supports respiratory function and good nutrition, which helps to accelerate lung maturity. Supplemental oxygen with humidity is used. A tracheostomy may be needed for long-term airway management to prevent narrowing of the trachea. Infants with severe BPD are carefully weaned off of assisted ventilation. Increased calories are needed to support growth, but fluids are restricted to prevent pulmonary edema. Some children need gastrostomy or nasogastric tube feeding to get adequate calories.

Chest physiotherapy and medications (diuretics, bronchodilators, anti-inflammatories, and methylxanthines) are used (see Medications Used to Treat Bronchopulmonary Dysplasia). Antibiotics are used to aggressively treat infections. Palivizumab is given monthly to prevent RSV (see page 535). With improvement and adequate weight gain, the child is weaned off oxygen, diuretics, and bronchodilators. Some infants develop recurrent infections and complications, and some die due to respiratory failure. BPD is a significant risk factor for motor and cognitive impairments (Kelly, 2010).
### Medications Used to Treat Bronchopulmonary Dysplasia

<table>
<thead>
<tr>
<th>Medication and Action</th>
<th>Nursing Management</th>
</tr>
</thead>
</table>
| **Bronchodilators** (<i>beta₂-adrenergics, anticholinergics, theophylline, albuterol nebulizer</i>) | ■ Monitor vital signs and for signs of toxicity.  
■ Administer medications at the same time each day.  
■ Encourage fluid intake. |
| Decreases airway resistance; increases expiratory flow in small airways; stimulates mucous clearance. | |
| **Anti-inflammatories** (<i>cromolyn sodium</i>) | ■ Ensure parents use proper technique for inhaler and spacer.  
■ Clean inhaler daily, rinsing and drying parts. |
| Decreases inhibition of inflammatory mediators from mast cells. | |
| **Diuretics** (<i>furosemide, chlorothiazide, spironolactone</i>) | ■ Follow guidelines for allowable fluid intake.  
■ Monitor serum potassium and sodium levels.  
■ Teach families about sodium- and potassium-rich foods to eat or avoid, depending on diuretic prescribed. |
| Removes excess fluid from lungs; decreases pulmonary resistance and increases pulmonary compliance; may cause electrolyte imbalances. | |
| **Potassium chloride** | ■ Monitor serum potassium level.  
■ Teach families about potassium-rich foods to avoid or use in moderation. |
| Prevents electrolyte imbalances associated with diuretics. | |
| **Methylxanthines** (<i>caffeine, theophylline</i>) | ■ Monitor vital signs and respiratory status.  
■ Monitor for adverse effects such as irritability, tremor, tachycardia, nausea, and vomiting. |
| Increases respiratory drive, decreases apnea, and relaxes muscle bundles that constrict airways. | |

### NURSING MANAGEMENT for the Child with Bronchopulmonary Dysplasia

Nursing management focuses on assessing and managing the infant’s acute episodes, ensuring adequate nutrition, and promoting growth and development.

### Nursing Assessment and Diagnosis

At each healthcare visit, assess the infant’s respiratory status and growth. The infant may have poor weight gain, because the work of breathing requires extra calories. Assess how well the family is managing care for the child in the home and any stressors that might exist. Evaluate development regularly because the infant may have motor, language, and cognitive delays. Coordinate a periodic assessment of hearing and vision. Infants with BPD may become acutely ill at any time, so observe for signs of infection.

During hospitalization for acute infections, a cardiorespiratory monitor and pulse oximeter are used. Assess airway and respiratory function, vital signs, color, and behavior changes to identify signs of worsening respiratory symptoms, even when oxygen is provided. Observe for airway obstruction when the infant has a tracheostomy and suction as needed. See the Clinical Skills Manual SKILLS for tracheostomy care.

Nursing diagnoses that may be appropriate include (NANDA-I © 2012):

- **Gas Exchange, Impaired** related to ventilation-perfusion imbalance
- **Nutrition, Imbalanced: Less Than Body Requirements** related to high metabolic needs and fatigue associated with feeding
- **Caregiver Role Strain** related to 24-hour responsibility for infant with BPD
- **Development: Delayed, Risk for** related to chronic condition and limited opportunities to practice motor skills

### Planning and Implementation

Organize care for the hospitalized child to reduce unnecessary physical stimulation. Position the infant to facilitate breathing.

Administer medications as prescribed. Careful fluid management is essential to reduce the risk for pulmonary edema. Provide nutrition to meet energy needs. Support the mother who desires to breastfeed. A high-calorie formula (24 to 30 calories/oz) may be given to promote weight gain. Some children need nasogastric or enteral feedings to get adequate nutrition when cyanosis is noted with feeding.

Once home, many infants need ventilation therapy, oxygen, tracheostomy care, multiple medications, fluid restrictions, and high-calorie feedings (Figure 20–8). Make referrals for needed oxygen, respiratory supplies, medications, an early intervention program, and follow-up care well in advance of the infant’s discharge. Some families need home health nursing assistance, especially during the initial transition period. Teach parents to provide the complex care needed by the infant and to identify
Cystic Fibrosis

Cystic fibrosis (CF) is a common inherited autosomal recessive disorder of the exocrine glands, leading to physiologic alterations in the respiratory, gastrointestinal, and reproductive systems. The incidence of CF varies by race—1:3200 in Caucasians, 1:7000 in Hispanics, 1:15,000 in African Americans, and 1:31,000 in Asian Americans (Gott & Froh, 2010; Hazle, 2010). Gender is not a factor in disease incidence. Approximately 30,000 children and adults have CF in the United States, and approximately 45% are older than age 18 years. The median life span for individuals with CF is mid-30s (Cystic Fibrosis Foundation [CFF], 2011a) (Figure 20–9 ●).

Etiology and Pathophysiology

A gene isolated on the long arm of chromosome 7 directs the function of the transmembrane conductance regulator (CFTR), a protein that controls the movement of chloride and sodium in and out of the cells that line respiratory, digestive, and reproductive organs. More than 1,700 mutations of the CFTR gene on chromosome 7 can cause CF (Lomas & Fowler, 2010). An estimated 1 in 31 persons in the United States is a carrier of a defective CFTR gene, and carriers are healthy (Gott & Froh, 2010).

With a defective CFTR protein, chloride-ion transport across the exocrine and epithelial cells is impaired and increased sodium absorption reduces water movement across cell membranes. Secretions become thickened in the sweat ducts, airway, pancreatic duct, intestine, biliary tree, and vas deferens. The lungs become clogged with thickened mucus that can harbor bacteria. The lubricating layer between the airway epithelium and mucus inhibits normal ciliary action and cough clearance.

Air becomes trapped in the small airways, leading to hyperinflation, atelectasis, and secondary respiratory infections. Even with antibiotics and a good response, over time the
Health Promotion  The Child with Bronchopulmonary Dysplasia

Health Supervision
- Assess blood pressure to detect abnormal findings associated with pulmonary hypertension.
- Coordinate vision screening by an ophthalmologist every 2 to 3 months during the first year of life. Myopia and strabismus are common in premature infants.
- Coordinate pulmonary function tests annually or as needed for clinical condition.
- Perform hearing and other screening tests as recommended for age.

Growth and Developmental Surveillance
- Assess growth and plot measurements on a growth chart corrected for gestational age. Even if length and weight are lower than normal, monitor for continued growth following the growth curves.
- Perform a developmental assessment and record the findings after correcting for gestational age.

Nutrition
- Review fluid and caloric intake. Ensure that increased calories are provided to support growth while limiting fluids to prevent pulmonary edema. Assess feeding difficulties related to oral motor function associated with long-term enteral feeding. Refer to a nutritionist as necessary.

Physical Activity
- Organize care to provide rest periods during the day.
- Give parents ideas for promoting the infant’s motor development, such as reaching for and moving toward toys and objects of interest.

Family Interactions
- Identify ways to coordinate nighttime care to reduce child and family sleep disturbances.
- Provide discipline appropriate for developmental age.

Disease Prevention Strategies
- Reduce exposure to infections. Encourage selection of a childcare provider who cares for a small number of children, if one is used. If possible, avoid the use of childcare centers during RSV season.
- Immunize the child with the routine schedule based on chronologic age.
- Administer the 23-valent pneumococcal vaccine at 2 years of age.
- Provide monthly injections of palivizumab throughout the RSV season.

Condition-Specific Guidance
- Develop an emergency care plan for times when the infant’s condition rapidly worsens.

Airways develop chronic bacterial and fungal colonization and bronchiectasis (a persistent abnormal dilation of the bronchi), and respiratory failure occurs. Pneumothorax and hemothorax may occur in older children. The rate of disease progression is variable.

Obstructions in the pancreatic ducts impede the natural enzyme flow that enables the body to digest fats, fat-soluble vitamins, and proteins. Nutritional deficits may cause failure to thrive. As the child ages, the pancreas may stop producing sufficient insulin, leading to glucose intolerance and the development of cystic fibrosis–related diabetes mellitus.

Failure to secrete enough chloride and fluid into intestines causes meconium ileus (a small bowel obstruction in newborns), affecting 15% of newborns with CF (O’Sullivan & Freedman, 2009). Older children may have intermittent and recurrent episodes of partial small bowel obstruction that can progress to total obstruction, abdominal distention, and vomiting. Chronic inflammation may occur in the intestines, leading to the development of Crohn’s disease. About 5% of children with CF develop liver disease (O’Sullivan & Freedman, 2009).

The imbalances created by excessive electrolyte loss through perspiration, saliva, and mucous secretion alter metabolic function. These children are at risk for hyponatremic dehydration secondary to electrolyte imbalance.

Clinical Manifestations
One of the first signs of CF noticed by the parents is a salty taste to the skin. A meconium ileus may be found in the newborn. Other primary symptoms are associated with thick, sticky mucus. See Table 20–8.

Clinical Therapy
CF is usually diagnosed in infancy or early childhood with one of four major presentations: newborn meconium ileus, malabsorption or failure to thrive, chronic recurrent respiratory infections, or fecal impaction and intussusception (see Chapter 25 88).

Newborn screening is performed (in all 50 states and the District of Columbia) on dried blood samples to detect immunoreactive trypsinogen (IRT) concentrations, which are high in newborns with CF (CFF, 2011b). If the reading is high, a
Pathophysiology

Upper Respiratory

Clogged sinuses
Nasal polyps
Chronic sinusitis, frontal headaches, purulent nasal discharge, postnasal discharge

Lower Respiratory

Reduced ciliary clearance; obstructed airways; air trapping and hyperinflation; bacterial colonization
Chronic moist, productive cough; wheezing; coarse crackles
Frequent infections
Shortness of breath, decreased exercise tolerance
Barrel chest
Clubbing of fingers and toes (Figure 20–10 ●)

Pancreas

Damaged pancreatic ducts obstruct enzymes needed for digestion
Produced enzymes damage the pancreas, leading to inadequate insulin secretion
Poorly digested food
Vitamin A, D, E, and K deficiencies
Poor weight gain or failure to thrive; delayed onset of puberty
CF-related diabetes mellitus

Gastrointestinal

Thickened intestinal secretions and decreased gut mobility
Obstructed bile ducts
Meconium ileus at birth
Abdominal distention
Greasy, bulky stools (steatorrhea) that are frothy, foul smelling, and floating
Constipation or intestinal obstruction
Rectal prolapse
Liver cirrhosis

Reproductive

Males—absence of vas deferens, low sperm count
Females—thick vaginal discharge and decreased cervical secretions
Males—infertility
Females—may have difficulty conceiving

Sweat Glands

Excess chloride and sodium electrolyte loss in the sweat
Salty sweat
Salt depletion, hyponatremia


Figure 20–10 Digital clubbing, enlargement of the distal phalanges, occurs in children with cystic fibrosis due to chronic fibrotic changes within the lungs.

Second IRT concentration test is performed in 2 to 3 weeks. Some states perform a DNA analysis to detect a CF chromosome mutation on the same blood sample if the second IRT concentration is high (Rock & Sharp, 2010). The IRT and DNA analyses are considered screening tests for CF. Genetic testing is also available for adults with a positive family history, partners of individuals with CF, and couples seeking prenatal testing to identify carriers of CF gene mutations.

A sweat chloride test by pilocarpine iontophoresis is considered the gold standard for diagnosis of CF. A sweat chloride concentration of 50 to 60 mEq/L is suspicious. A chloride concentration greater than 60 mEq/L is diagnostic with other signs (meconium ileus, high IRT level, or positive family history). The test is often repeated to confirm the diagnosis (Figure 20–11 ●).
A spirometer is used to monitor pulmonary function in children 6 years and older. Forced vital capacity (FVC) and forced expiratory volume in 1 second (FEV₁) readings are taken. Sputum cultures are obtained to identify infectious organisms and antibiotic sensitivities.

Clinical therapy focuses on maintaining respiratory function, managing infection, promoting optimal nutrition and exercise, and preventing gastrointestinal blockage (Table 20–9). Newly diagnosed children without symptomatic lung disease are aggressively treated to slow the development of chronic respiratory infections and reduction in pulmonary function, and to improve nutrition and support growth.

Treatment is focused on controlling infection and inflammation, and on reducing mucus accumulation. Various devices and airway clearance techniques are used regularly to reduce the accumulation of mucus in the lungs, such as chest physiotherapy, forced expiratory technique (huffing), and high-frequency chest wall oscillation. Research has revealed no significant differences between airway clearance techniques to increase mucus transport out of the lungs used for short-term and long-term management (Pryor, Tannenbaum, Scott, et al., 2010).

Frequent prolonged courses of antibiotics for infections may be prescribed to improve pulmonary function, exercise

![Figure 20–11](image-url) This 6-month-old girl is being evaluated for cystic fibrosis using the sweat chloride test.

<table>
<thead>
<tr>
<th>Table 20–9 Clinical Therapy for Cystic Fibrosis</th>
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<tbody>
<tr>
<td>Clinical Therapy</td>
</tr>
<tr>
<td><strong>Respiratory Therapy</strong></td>
</tr>
<tr>
<td>Exercise and physical fitness</td>
</tr>
<tr>
<td>Airway clearance techniques—chest physiotherapy twice a day for all lung segments (percussion or vibration with the child positioned to promote sputum drainage), oscillating chest vests, or other expiratory techniques (see page 560)</td>
</tr>
<tr>
<td>Immunizations</td>
</tr>
<tr>
<td>Chest tube drainage of air leaks</td>
</tr>
<tr>
<td>Thoracoscopy to sew over ruptured alveoli</td>
</tr>
<tr>
<td>Lung transplantation</td>
</tr>
<tr>
<td><strong>Gastrointestinal Tract Therapy</strong></td>
</tr>
<tr>
<td>Acid suppression therapy</td>
</tr>
<tr>
<td>Hyperosmolar enemas, isotonic fluid lavage of the intestines (oral or by nasogastric tube)</td>
</tr>
<tr>
<td><strong>Nutrition</strong></td>
</tr>
<tr>
<td>Well-balanced diet with 110% to 150% of recommended daily allowance (RDA) for calories with 35% to 40% fat intake for energy (Michel, Maqbool, Hanna, et al., 2009)</td>
</tr>
<tr>
<td>Pancreatic enzyme supplements</td>
</tr>
</tbody>
</table>
# Medications Used to Treat Cystic Fibrosis

<table>
<thead>
<tr>
<th>Medications and Actions</th>
<th>Nursing Management</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Beta&lt;sub&gt;2&lt;/sub&gt;-adrenergic receptor agonist bronchodilators</strong>&lt;br&gt;Aerosol&lt;br&gt;Opens large and small airways.</td>
<td>Use before airway clearance procedure. Have the child hold the breath 10 seconds after inhalation. Avoid swallowing the medicine, and rinse the mouth afterward.</td>
</tr>
<tr>
<td><strong>Dornase alpha</strong>&lt;br&gt;(DNAse or Pulmozyme)&lt;br&gt;Aerosol&lt;br&gt;Loosens, liquefies, and thins pulmonary secretions.</td>
<td>Keep refrigerated until placed in the nebulizer. Monitor for improvement in dyspnea and mucus clearance.</td>
</tr>
<tr>
<td><strong>Hypertonic saline (7%)</strong>&lt;br&gt;Aerosol&lt;br&gt;Hydrates the airway mucus and stimulates coughing (Montgomery &amp; Howenstine, 2009).</td>
<td>Use following a bronchodilator.</td>
</tr>
<tr>
<td><strong>Ibuprofen</strong>&lt;br&gt;Oral&lt;br&gt;Slows the rate of pulmonary function decline (Cohen-Cymberknoh, Shoseyov, &amp; Kerem, 2011).</td>
<td>Educate the child and parents to monitor for signs of gastrointestinal bleeding. Ensure that the child does not take aspirin or other NSAIDs unless approved by physician.</td>
</tr>
<tr>
<td><strong>Antibiotics</strong>&lt;br&gt;Aerosol, oral, or IV&lt;br&gt;Used to treat and suppress infections.</td>
<td>Higher doses than normal and prolonged courses may be prescribed. Teach the child and family to develop a schedule to give the correct dose at appropriate intervals.</td>
</tr>
<tr>
<td><strong>Pancreatic enzyme supplements</strong>&lt;br&gt;(Cotazym-S, Pancrease, Viokase)&lt;br&gt;Oral&lt;br&gt;Assists in digestion of nutrients decreasing fat and bulk.</td>
<td>Given prior to food ingestion. Ensure that enzymes are taken with meals and snacks.</td>
</tr>
<tr>
<td><strong>Vitamins A, D, E, and K</strong>&lt;br&gt;Oral&lt;br&gt;Supplements vitamins not produced.</td>
<td>Ensure that vitamins are prescribed in non–fat-soluble form to promote absorption. Give twice a day.</td>
</tr>
</tbody>
</table>

tolerance, and quality of life. Sputum culture results and sensitivities help guide the selection of the specific antibiotics. Children with *Pseudomonas aeruginosa* or *Burkholderia cepacia* infections have a poorer outcome. Medications are used to reduce sputum viscosity and to dilate the airways. Anti-inflammatory treatment is sometimes prescribed. Vitamins and pancreatic enzymes are also provided to improve the child’s nutritional status. See *Medications Used to Treat Cystic Fibrosis*.

Collaborative care by physicians, nurses, respiratory therapists, and nutritionists has resulted in improved medical management and nutrition that prolongs the lives of children and adults with CF. However, new complications such as CF-related diabetes (often with insulin insufficiency and insulin resistance) that develops in 20% of adolescents must be carefully managed along with the progression of the disease (see Chapter 30) (Moran, Becker, Casella, et al., 2010). CF-related diabetes is difficult to manage, because the child needs a large caloric intake that must be balanced by insulin dosage.

Approximately 120 to 150 lung transplants are performed in individuals with CF each year in the United States, and about 60% of cases survive for the first 5 years (Hazle, 2010; Wiehe & Arndt, 2010). Immunosuppressive medications cause significant problems in individuals infected with *Pseudomonas* or *Burkholderia cepacia*, making them ineligible for transplant at many centers. End-stage lung disease is the cause of death in 80% of patients with CF (O’Sullivan & Freedman, 2009).

## NURSING MANAGEMENT for the Child with Cystic Fibrosis

Care of the child with previously diagnosed CF is the focus of the following discussion.
Nursing Assessment and Diagnosis

Physiologic Assessment
Physical assessment of the child focuses on respiratory function. Inquire about the frequency and characteristics of the child's cough and sputum. Compare this information with the child's baseline. Changes in the cough may be more important than its presence or absence related to the development of a new infection. Auscultate the chest for breath sounds, crackles, and wheezes. Note any cyanosis or clubbing of the extremities. Obtain \( \text{SpO}_2 \) and spirometry readings if changes in respiratory status are suspected.

Determine if the child is maintaining an appropriate growth pattern by plotting the weight, height, and body mass index on a growth curve. Children with significantly lower percentiles for height and weight should be considered malnourished. Inquire about the child's appetite and dietary intake. Ask how nutritional supplements, pancreatic enzymes, and vitamins are used. Observe the adolescent for the appearance of secondary sex characteristics, which are often delayed due to nutritional status.

Assess the child's stooling pattern. Identify whether the child has problems with abdominal pain or bloating and whether these problems can be related to eating, stooling, or other activities. Palpate the abdomen for liver size, fecal masses, and evidence of pain.

Psychosocial Assessment
The emotional stress of this chronic disease may not be readily apparent, particularly if the child's symptoms are mild and not imminently life threatening. Ongoing observation of the child's and parents’ behavior helps direct nursing interventions. Parents may feel guilt as carriers of the disease. Siblings may also show signs of difficulty in dealing with the illness, particularly if not affected by the disease. Siblings with CF may be affected if the child is showing signs of significant deterioration, being forced to acknowledge their own future course with the disease.

Ask parents how the child’s illness has affected day-to-day functioning, potential conflicts with family activities, and how they have adapted to the child's plan of care. Investigate the need for respite care. Ask what the parents have told the child and siblings about the disease. What questions have the child and siblings asked about CF, and how have parents answered them? Has the child ever asked about his or her life expectancy? If not, what would parents say if asked?

Common nursing diagnoses for the child with cystic fibrosis include the following (NANDA-I © 2012):

- **Airway Clearance, Ineffective** related to thick mucus in lungs
- **Nutrition, Imbalanced: Less Than Body Requirements** related to need for increased calories to meet growth and metabolic needs
- **Infection, Risk for** related to the presence of mucous secretions conducive to bacterial growth
- **Role Conflict, Parental** related to interruptions in family life due to the home care regimen and child's frequent exacerbations

Planning and Implementation
Nursing management involves supporting the child and family initially, when the diagnosis is made, during subsequent hospitalizations, and during visits to specialty and primary healthcare providers. The nurse’s role begins with implementing specific medical therapies and providing nursing care to meet the child's physiologic and psychosocial needs. Airway clearance techniques, medications, and nutrition must be coordinated to promote optimal body function. Psychosocial support and reinforcement of the child's daily care needs are important in preparation for home care.

Children with CF require periodic hospitalization when a severe infection occurs or for a pulmonary and nutritional assessment. The child is often placed in a private room with standard precautions to reduce the spread of infectious organisms. Children with CF are not co-roomed to reduce the risk for transmission of *Pseudomonas aeruginosa* and *Burkholderia cepacia* between them.

Respect the parents’ experiences as the child's primary care provider and include them in the child's routine care as much as possible. However, parents may view the hospital stay as a break from the rigorous daily pulmonary routine at home and need support in taking advantage of the respite. While the family is often proficient at providing physical care to the child, the nurse should take the opportunity to review basic and new information about airway clearance techniques, medications, and nutrition. This is especially important as the child matures and begins to assume some self-care responsibilities.

Provide Respiratory Therapy
Chest physiotherapy or an alternate airway clearance technique is usually performed 1 to 3 times per day to facilitate the removal of secretions from the lungs. (See the Clinical Skills Manual.) Perform this before meals because coughing may stimulate vomiting. Aerosol treatments with a bronchodilator, as well as DNase and hypertonic saline to help thin respiratory secretions, may precede the airway clearance procedure. Respiratory therapists and nurses often collaborate in teaching parents and other family members the skills for these necessary treatments. Some children use an oscillating vest for 30 minutes twice a day rather than chest physiotherapy (Figure 20–12 ●).

Administer Medications and Meet Nutritional Needs
Antibiotics for acute exacerbation are provided by oral, inhalation, and intravenous routes. Because children with CF have an increased clearance of most antibiotics, they need higher doses and long treatment courses, often for at least 14 days until the child achieves the best possible lung function. Serum antibiotic drug levels may be ordered to ensure therapeutic dosing; however, monitor renal function tests to detect problems related to higher antibiotic dosages. In some cases, a portacath or peripherally inserted central catheter (PICC) line is placed so that IV antibiotics can be given at home.

Digestive problems can be eased with pancreatic enzymes and dietary modification. Pancreatic enzyme supplements come in powder sprinkles and capsule form and are taken orally with all meals and large snacks. The amount needed is individualized
that the child can independently manage. A high-frequency chest wall oscillation vest is another option for airway clearance and can be used depending on the location of the obstruction. If the obstruction is in the left posterior bronchi to dislodge secretions.

Chest physiotherapy with postural drainage can be achieved by clapping with a cupped hand on the chest wall over the segment to be drained to create vibrations that are transmitted to the bronchi to dislodge secretions. A. If the obstruction is in the left posterior segment, the child should be lying on the right side. Several other positions can be used depending on the location of the obstruction. B. A high-frequency chest wall oscillation vest is another option for airway clearance that the child can independently manage.

A psychosocial assessment is especially important when the child is going through major developmental stages. School-age children and adolescents are often embarrassed at being viewed as different from peers. Ask how the child or adolescent feels about the need for a special diet, medications, and the daily routine of respiratory management.

Review the child’s use of bronchodilators and airway clearance techniques. If additional short-term therapies are prescribed to help improve pulmonary status, educate the child and family about the techniques to use and help them identify the best time to fit the additional treatment into the daily schedule. Having to do the chest physiotherapy regimen 3 or 4 times a day has a significant impact on family time. Alternate airway clearance therapy techniques, such as a vest, may be more easily accepted by the family, especially because the parent does not have to physically perform the percussion and vibration. Daily aerobic exercise is recommended to promote airway clearance and overall health (Cohen-Cymberknah et al., 2011).

Managing the child’s nutrition is important and takes time and energy. Refer the parents to a nutritionist to customize a meal plan for the child’s caloric needs. Despite the child’s voracious appetite, parents may have difficulty getting the child with CF to eat enough calories for optimal nutrition. Parents need suggestions for preparing calorie-dense meals and snacks. A gastrostomy tube for nighttime feeding may be needed when the child’s weight is 85% to 90% of ideal for height. Children with adequate nutrition have a longer life expectancy.

Children with CF lose more than normal amounts of salt in their sweat, especially during hot weather, strenuous exercise, and fever. During periods of exercise and increased sweating, encourage the child to drink more fluids and increase salt intake. Allow the child to add extra salt to food and permit some

Discharge Planning and Home Care Teaching
The financial burden of medications, supplies, and medical follow-up may not be recognized immediately by a family overwhelmed by the diagnosis. Initially, parents need assistance in obtaining necessary equipment. If the parents require financial assistance, refer them to social services and the Cystic Fibrosis Foundation. Home care of the child with CF is expensive and can impact the family’s finances.

Community-Based Nursing Care
Nurses may encounter the child with CF in specialty clinics, health centers, and schools. Use the Assessment Guide on page 524 to assess the child. Observe the child’s physical appearance, noting overall body proportions and any changes characteristic of CF. Respiratory function tests are usually performed every 6 months during CF visits. Assess hearing acuity on a regular basis, especially if the antibiotic tobramycin is used.

Fat-soluble vitamins (A, D, E, and K) are not completely absorbed from food; therefore, they must be taken in water-soluble form. Multivitamins taken twice daily are usually sufficient to prevent deficiency.

Respiratory complications and a higher metabolic rate make additional calories essential. Some children and youth need supplemental nasogastric or gastrostomy feedings to gain and maintain weight. The diet should be well balanced, with an emphasis on high caloric value. Fats and salt are both necessary in the diet.

Provide Psychosocial Support
Help the parents and child learn what they must do to maintain health after discharge. Emotional support is essential, because the diagnosis of CF creates anxiety and fear in both the parents and the child. They need assistance with emotional and psychosocial issues relating to discipline, body image (stooling odor, barrel chest), frequent rehospitalization, the potentially fatal nature of the illness, the child’s feeling of being different from friends, and overall financial, social, and family concerns. Because CF is inherited, families may have more than one child with CF. Refer families to genetic counseling and support groups.

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Based on the child’s nutritional needs and digestive response to these supplements. Help families identify any foods that contribute to a child’s gastrointestinal problems. The goal is to achieve near-normal, well-formed stools and adequate weight gain.

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Help the parents and child learn what they must do to maintain health after discharge. Emotional support is essential, because the diagnosis of CF creates anxiety and fear in both the parents and the child. They need assistance with emotional and psychosocial issues relating to discipline, body image (stooling odor, barrel chest), frequent rehospitalization, the potentially fatal nature of the illness, the child’s feeling of being different from friends, and overall financial, social, and family concerns. Because CF is inherited, families may have more than one child with CF. Refer families to genetic counseling and support groups.

Provide Nutritional Support
Children with CF lose more than normal amounts of salt in their sweat, especially during hot weather, strenuous exercise, and fever. During periods of exercise and increased sweating, encourage the child to drink more fluids and increase salt intake. Allow the child to add extra salt to food and permit some

Based on the child’s nutritional needs and digestive response to these supplements. Help families identify any foods that contribute to a child’s gastrointestinal problems. The goal is to achieve near-normal, well-formed stools and adequate weight gain.

Fat-soluble vitamins (A, D, E, and K) are not completely absorbed from food; therefore, they must be taken in water-soluble form. Multivitamins taken twice daily are usually sufficient to prevent deficiency.

Respiratory complications and a higher metabolic rate make additional calories essential. Some children and youth need supplemental nasogastric or gastrostomy feedings to gain and maintain weight. The diet should be well balanced, with an emphasis on high caloric value. Fats and salt are both necessary in the diet.

Provide Psychosocial Support
Help the parents and child learn what they must do to maintain health after discharge. Emotional support is essential, because the
Injuries of the Respiratory System

Airway compromise after an injury to the respiratory system can cause death if not managed quickly and effectively. Children are vulnerable to changes in respiratory function after injury, because their airway is small and can become easily obstructed. Airway obstruction can be caused by the tongue, small amounts of blood, mucus, foreign debris, and swelling in the respiratory tract or adjacent neck tissue, leading to hypoxia. If the child’s neck is flexed or hyperextended, the soft laryngeal cartilage may also compress and obstruct the airway.

**Smoke-Inhalation Injury**

Exposure of the child’s face and airway to smoke or extreme heat leads to dramatic responses in the child’s respiratory tract. Smoke and heat increase the child’s risk for airway obstruction, carbon monoxide poisoning, acute respiratory distress syndrome, and late complications such as pneumonia and pulmonary embolism (Antoon & Donovan, 2011). The child’s higher respiratory rate also increases exposure to noxious chemicals.

The severity of the smoke-inhalation injury is influenced by the type of material burned and is more severe if the child was found in a closed space. Smoke, a product of the burning process that is composed of gases and particles, is generated in varying volumes and density. The type and concentration of toxic gases, which are usually invisible, affect the severity of pulmonary damage. The duration of exposure to the smoke and toxic gases contributes significantly to the child’s prognosis.

Exposure to extreme heat, common in house fires, leads to surface injury and upper airway damage. The upper airway normally removes heat from inhaled gases, sparing the lower airway from thermal damage. Airway edema develops rapidly over a few hours and potentially leads to acute respiratory distress syndrome.

Carbon monoxide (CO) is a clear, colorless, odorless gas that develops as a fire consumes oxygen. The CO molecule binds more firmly to hemoglobin than does oxygen. As a result, it replaces oxygen in the circulation and rapidly produces tissue hypoxia in the child. The brain receives inadequate oxygen, resulting in confusion and progressing to loss of consciousness. This is one reason fire victims have difficulty escaping. The process can be rapidly reversed by the timely administration of 100% oxygen or hyperbaric oxygen treatment, if provided before hypoxia becomes too severe (Baum, 2008).

Damage to the lower airway often results from chemical or toxic gas inhalation. Soot carried deeply into the lungs combines with water to deposit acid-producing chemicals on the lung tissue. These acids burn the tissue and destroy the cilia and surfactant. Tissue destruction, pulmonary edema, and disrupted gas exchange are the initial insult to the lungs. Days later, the damaged tissue sloughs off, obstructing the airways. The lungs become a breeding ground for microorganisms, leading to pneumonia. Healing leaves scars in the damaged alveoli that can reduce future lung function.

Clinical manifestations of inhalation injury include burns of the face and neck, singed nasal hairs, soot around the mouth or nose, and hoarseness with stridor or voice change, even when the child initially has no respiratory distress. Edema develops rapidly over a few hours and may lead to airway obstruction with signs such as tachypnea, stridor, coughing, and wheezing. Respiratory distress develops and can lead to respiratory failure. If carbon monoxide poisoning is present, the child will be confused or unconscious and have cardiac arrhythmias.

Diagnosis is based on history of smoke exposure in a closed area and physical signs of soot around the nose and mouth. Arterial blood gases and a carboxyhemoglobin level may be obtained. The child with minimal signs and symptoms when seen in the...
emergency department may be admitted to monitor for progression of respiratory distress. Initial treatment is 100% humidified oxygen. If respiratory distress develops, aggressive airway management with endotracheal tube insertion and monitoring are provided in the PICU. Mechanical ventilation and high concentration oxygen may be necessary. Chest physiotherapy and suctioning may be provided in an effort to keep the airway clear. All other injuries sustained in the fire are treated.

**Nursing Management**

Assess the child for the development of respiratory distress. Check vital signs frequently and monitor the SpO₂. Auscultate the lungs for crackles, wheezes, and decreased breath sounds. Assess for level of consciousness and behavior changes that could indicate increasing hypoxia.

Provide oxygen as ordered. Position the child to promote respiratory function. If the child's condition deteriorates, assist with procedures to secure the child's airway and prepare the child for transfer to the ICU. Assess the family's response to the life-threatening crisis and offer support with information about the child's condition (see Chapter 13).

**Blunt Chest Trauma**

Blunt chest trauma in infants and toddlers is most often due to motor vehicle crashes and abuse. Bicycles, scooters, skateboards, and skate are more commonly associated with blunt chest trauma in school-age children. Injuries from high-energy motor vehicle crashes more commonly occur in adolescents. Chest injuries may not be obvious and can be extremely difficult to evaluate.

Most children who die after sustaining severe blunt chest trauma were hypoxic because of poor airway and ventilatory control. A child's elastic, pliable chest wall and thin abdominal muscles provide minimal protection to underlying organs. This elasticity of the ribs often prevents rib fractures in children less than 12 years of age, but the energy from blunt trauma is transferred directly to the internal organs. A pulmonary contusion or pneumothorax may result.

**Pulmonary Contusion**

A pulmonary contusion is defined as bruising damage to the tissues of the lung that often occurs without rib fracture. The lung tissue bruising causes capillaries to bleed into the alveoli. Pulmonary edema develops in the lower airways as blood and fluid from damaged tissues accumulate over a couple of days. Acute respiratory distress syndrome and long-term respiratory dysfunction may result.

Initially the child may appear asymptomatic. Respiratory distress, along with fever, wheezing, hemoptysis, and crackles, often develops over several hours. Careful observation is required during the first 12 hours after the injury to detect decreased perfusion related to ventilatory impairment.

Chest radiographs or computed tomography may be diagnostic for a pulmonary contusion several hours after the injury. Therapy includes fluid restriction, supplemental oxygen, pain control, incentive spirometry, and avoiding prolonged immobilization. Children with severe injury to the lungs will require mechanical ventilation with low airway pressures. Pneumonia is a potential complication.

**Nursing Management**

Nursing care centers on providing necessary physiologic support, such as oxygen therapy, positioning, incentive spirometry, fluid management, and comfort measures. Observe for hemoptysis, dyspnea, decreased breath sounds, wheezes, crackles, and a transient temperature elevation. Agitation and lethargy can signal increasing hypoxia. Inspect the thorax for symmetric chest wall movement and auscultate for breath sounds in both lungs. The child may initially appear well but requires careful monitoring to detect signs of deterioration. Children with significant injuries are cared for in the ICU. Some children require ventilator support as the pulmonary tissues heal.

**Pneumothorax**

A pneumothorax occurs when air enters the pleural space because of tears in the tracheobronchial tree, the esophagus, or the chest wall. If blood collects in the pleural space, it is called a hemothorax, and if blood and air collect, it is called a pneumothorax. A pneumothorax is one of the more common thoracic injuries in pediatric trauma patients.

The three types of pneumothorax are open, closed, and tension. An open pneumothorax results from any penetrating injury that exposes the pleural space to atmospheric pressure, thereby collapsing the lung. A sucking sound may be heard as the air moves through the opening on the chest wall. The child may show signs of restlessness, cyanosis, and subcutaneous emphysema (air leakage in the tissue).

A closed pneumothorax is sometimes caused by blunt chest trauma with no evidence of rib fracture (see Pathophysiology Illustrated: Pneumothorax). The chest may be compressed against a closed glottis (such as with breath holding), causing a sudden increase in pressure within the thoracic cavity. The pressure increase is transferred to the alveoli, causing them to burst. A single burst alveolus may be able to seal itself off, but the lung collapses when many alveoli are damaged. Breath sounds are decreased or absent on the injured side, and the child is in respiratory distress. A thoracostomy is performed and a chest tube inserted (see the Clinical Skills Manual). A closed drainage system is attached to remove the air and reinflate the lung by reestablishing negative pressure.

A tension pneumothorax is a life-threatening emergency that results when the air leaks into the chest during inspiration but cannot escape during expiration. Internal pressure continues to build, compressing the chest contents and collapsing the lung. Venous return to the heart is impaired as the mediastinum shifts and the trachea, heart, vena cava, and esophagus are compressed toward the unaffected lung, leading to decreased cardiac output. Signs of tension pneumothorax include increasing respiratory distress, decreased breath sounds, and paradoxical breathing. Immediate care for a tension pneumothorax is a needle thoracentesis to allow air to escape and relieve the tension. A chest tube is then inserted and attached to a closed drainage system.
Nursing Management

Nursing management focuses on airway management and maintaining lung inflation. The child arrives on the nursing unit with a chest tube and drainage system in place. Continued close observation for respiratory distress is essential. Carefully monitor vital signs. When the chest tube is removed, the site is covered with an occlusive dressing and the child’s respiratory status is monitored for signs of respiratory distress. Complications include hemothorax (if the thoracostomy and chest tube are improperly placed), lung tissue injury, and scarring from poor tube placement (especially if the tube is placed too near the breast in girls).

Critical Concept Review

**Learning Outcome 20.1:** Describe unique characteristics of the pediatric respiratory system anatomy and physiology and apply that information to the care of children with respiratory conditions.

1. A child’s airway is shorter and narrower than an adult’s:
   - Increased potential for obstruction.
2. Trachea is higher and bronchial branching occurs at a different angle:
   - Increased risk for right mainstem aspiration and obstruction.
3. Newborns are obligatory nose breathers:
   - They do not open mouth if nose is obstructed.
4. Newborn has inadequate smooth muscle bundles to help trap airway invaders:
   - Increased possibility of upper respiratory infection.
5. Until age 6 the child uses the diaphragm for breathing:
   - So observe the abdomen to count respirations.

**Learning Outcome 20.2:** Contrast the different respiratory conditions and injuries that can cause respiratory distress in infants and children.

1. Respiratory conditions and injuries that can cause respiratory distress include:
   - Acute upper airway obstructions—foreign-body aspiration, croup syndrome, epiglottitis, bacterial tracheitis.
   - Obstructive sleep apnea—disorder of breathing during sleep related to enlarged tonsils and adenoids and neuromuscular disorders.
   - Acute lower airway conditions—bronchiolitis, pneumonia.
   - Chronic lung disorders—bronchopulmonary dysplasia, asthma, cystic fibrosis.
   - Acute lung injury—smoke inhalation, blunt chest trauma, pulmonary contusion, pneumothorax.
Learning Outcome 20.3: Explain the visual and auditory observations made to assess a child's respiratory effort or work of breathing.

1. The child is observed for the following signs:
   - Nasal flaring.
   - Retractions or use of accessory muscles.
   - Tachypnea.

2. Monitor the child's responsiveness and behavior to detect hypoxia and cyanosis, or the chest for signs of bruising that could indicate a blunt injury that damaged underlying tissues.

3. Cough.

Learning Outcome 20.4: Assess the child's respiratory status and analyze the need for oxygen supplementation.

1. Assess the following to identify respiratory distress:
   - Vital signs and color.
   - Respiratory effort (retractions, accessory muscle use).
   - Breath sounds and stridor, wheezes, crackles.

2. Any child in respiratory distress needs oxygen.

3. Pneumonia: initial rhinitis and cough, followed by fever, crackles, wheezes, dyspnea, tachypnea, restlessness, diminished breath sounds.

Learning Outcome 20.5: Distinguish between conditions of the lower respiratory tract that cause illness in children.

1. Bronchitis: dry hacking cough, increases in severity at night, painful chest and ribs.

2. Bronchiolitis: mild respiratory symptoms that progress to tachypnea, wheezing, retractions, nasal flaring, irritability, poor fluid intake, hypoxia, cyanosis, and decreased mental status.

3. Active pulmonary tuberculosis: persistent cough, decreased appetite, weight loss or failure to gain weight, low-grade fever, night sweats, chills, enlarged lymph nodes.

Learning Outcome 20.6: Create a nursing care plan for a child with a common acute respiratory condition.

1. Maintain airway patency.

2. Frequently assess vital signs, SpO₂, respiratory effort, color, breath sounds, and observe for behavior changes.

3. Allow child to assume position of comfort.

4. Meet fluid needs.

Learning Outcome 20.7: Develop a school-based nursing care plan for the child with asthma.

1. Develop an individual health plan. Include quick-relief medications, exercise, and avoidance of known asthma triggers.

2. Maintain a log of PEFRs and quick-relief medication administration. Give the family a copy for the child’s healthcare provider.

3. Monitor child after giving quick-relief medications for response. Call parents if little or no response.


5. Provide oxygen if ordered.

6. Promote rest and stress reduction for the child and parents.

7. Support the family’s participation in care.

8. Give the family members information that lets them learn to manage the child’s disease.

Learning Outcome 20.8: Perform a nursing assessment of the child with an acute lung injury.

1. Collect historical information and mechanism of injury that has damaged the lungs.

2. Monitor the child’s responsiveness and behavior to detect hypoxia and the potential for airway obstruction.

3. Monitor vital signs and SpO₂ frequently to identify changes indicating deterioration in condition.

4. Inspect the face for signs of burns or soot in case of smoke inhalation, or the chest for signs of bruising that could indicate a blunt injury that damaged underlying tissues.

5. Auscultate the lungs for crackles, wheezes, decreased breath sounds.

6. Note changes in voice quality or coughing.

7. Monitor the child’s perfusion.

Clinical Reasoning in Action

Adam and his mother have come to the health center to follow up on his hospitalization to get an asthma action plan and to discuss how to reduce his asthma episodes. Adam, who is 7 years old, has a history of episodic wheezing and nebulizer treatments, but he had never been hospitalized for asthma until last week. During his 2-day hospitalization, his parents were given initial education about how to manage his moderate persistent asthma.

His mother has brought along Adam’s medications (inhaled corticosteroid and salmeterol MDI for daily control, and an albuterol MDI for quick relief), his peak flow meter, spacer, and his asthma action plan. She tells you that he is also completing a dose of oral corticosteroids. You discuss the peak flow meter, the guidelines, and what type of action to take as needed. Based on his height of 48 inches, his peak flow meter green zone is 160–128, his yellow zone is 128–80, and his red zone is 80 or below. Adam is to use his daily control medications twice a day. If he has symptoms, he is to take his albuterol MDI with spacer, two puffs every 4 to 6 hours as needed.

1. What are some of the side effects associated with Adam’s albuterol MDI?

2. What is the benefit to using a spacer on Adam’s albuterol and inhaled corticosteroid MDI?

3. Address the concerns of Adam’s mother about the daily use of inhaled corticosteroids.

4. What are the signs of respiratory distress to observe for with Adam?

5. Construct a concept map for Adam that addresses nursing management in the school setting and developmentally appropriate education for Adam about asthma, recognizing early signs of an acute episode, and initial steps of self-management.


