A child’s healthcare needs are determined by the developmental level and specific health condition. The child may experience a health alteration related to any one body system, or may experience health alterations to several body systems simultaneously. The nurse applies knowledge of growth and development, anatomy, and pathophysiology in assessing the child with an altered health status. The nurse partners with the family in establishing a plan of care that will promote optimal achievement of growth and development, which may be affected by specific health conditions. The nurse also collaborates with other health professionals to provide individualized healthcare to the child and family.
Emily, a 6-month-old infant with bronchopulmonary dysplasia, lives at home with her mother and two siblings who are 4 and 8 years old. Emily has a tracheostomy and receives humidified oxygen. When Emily developed a fever, labored breathing, and more secretions than usual in the tracheostomy, her mother called for an urgent care visit with Emily’s healthcare provider.

When Emily is initially seen by the office nurse, her temperature is 38.8°C (102°F), her respiratory rate is 50, and her heart rate is 130. Intercostal and substernal retractions are visible, and crackles can be heard over the lower right lobe. The nurse assists Emily’s mother in suctioning her tracheostomy as the secretions seem to be excessive. Because of her respiratory signs, the nurse moves Emily ahead of other children waiting to be seen by the physician. After assessing Emily, the physician believes that her respiratory distress may worsen. She may need oxygen supplementation as well as IV fluids and medication that cannot be provided in the office setting. A chest radiograph is also needed for diagnosis. While the physician coordinates Emily’s transfer to the hospital’s short-stay unit for observation and treatment, the office nurse talks with Emily’s mother, who has become increasingly anxious. The nurse listens to her concerns, provides support, and makes sure she understands the reason for the planned transfer. The nurse also obtains consent to provide all documentation from this visit and important historical information to the pediatric transport team that transfers Emily to the hospital.
“Mom spends a lot of time taking care of Emily. I try to help as much as I can. I help to listen and make sure she does not have trouble breathing when she takes a nap. Then I try to play with her when she is awake.”

—Isabel, age 8

### Learning Outcomes

After completing this chapter, you will be able to:

- Describe unique characteristics of the pediatric respiratory system anatomy and physiology and apply that information to the care of children with respiratory conditions.
- Define the different respiratory conditions and injuries that can cause respiratory distress in infants and children.
- Assess the child’s respiratory signs and symptoms to distinguish between mild, moderate, and severe respiratory distress and describe the appropriate nursing care for each level of severity.
- Describe different methods to evaluate the infant and child with a respiratory condition.
- Synthesize information and develop a nursing care plan in partnership with the family for a child with common acute respiratory conditions.
- Synthesize information and develop a nursing care plan in partnership with the family for a child with a chronic respiratory condition.

### Key Terms

- adventitious sounds/97
- airway remodeling/131
- airway resistance/93
- alveolar hypoventilation/98
- apnea/101
- atelectasis/114
- bronchiolitis obliterans/148
- cor pulmonale/105
- dysphagia/112
- dysphonia/112
- dyspnea/95
- grunting/101
- hypoxemia/99
- hypoxia/99
- laryngospasm/109
- paradoxical breathing/97
- periodic breathing/101
- polysomnography/106
- pulpux paradoxus/133
- retractions/94
- stridor/108
- tachypnea/95
- tidal volume/104
- tracheostomy/100
- trigger/131

### Resources

- **CD-ROM**
  - Animations
    - Carbon Dioxide Transport
    - Gas Exchange in the Lung
    - Oxygen Transport
    - Asthma
    - Salmeterol
  - Audio Glossary
  - NCLEX Review
- **COMPANION WEBSITE**
  - Web Links
  - NCLEX Review
  - MediaLink Applications
    - Determine the Respiratory Risks in a Childcare Setting
    - Develop an Emergency Care Plan: The Child with Bronchopulmonary Dysplasia
    - Develop a Health Promotion and Maintenance Plan: The Child with Cystic Fibrosis
    - Teaching Plan: Dust Mites
    - Teaching Plan: Educating Asthmatics Based on Severity
    - Teaching Plan: Metered-Dose Inhaler
This chapter explores several special factors in the child’s respiratory system that create ongoing threats to respiratory function and overall health. Most respiratory problems in children produce mild symptoms, last a short time, and can be managed at home. Other respiratory conditions are chronic and have a significant impact on the child’s growth and development. Pediatric respiratory conditions may occur as a primary problem or as a complication of nonrespiratory conditions. They may be life threatening or have long-term implications. Acute respiratory problems are the most common cause of illness requiring hospitalization in infants and children under 10 years of age and a leading cause of hospitalization in children between 10 and 15 years of age (Health Resources and Services Administration, 2002).

Respiratory conditions may be a result of 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 this normal process from irritants (such as large particles and chemicals) or invaders (such as viruses or bacteria). Alterations in other organ systems, especially the immune and neurologic systems, may also threaten respiratory function. Nurses must learn to assess the child’s current respiratory status quickly, monitor progress, and anticipate potential complications. When reading this chapter, keep in mind the distinction between structural and functional problems to help you understand what is normal and what is abnormal about the child’s maturing respiratory system. Refer to Chapter 24 for information on upper respiratory conditions such as colds, otitis media, sinusitis, and pharyngitis.

**ANATOMY AND PHYSIOLOGY OF 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.

### AS THEY GROW

**Comparison of Airway Structures**

- Smaller nasopharynx, easily occluded during infection.
- Lymph tissue (tonsils, adenoids) grows rapidly in early childhood; atrophies after age 12.
- Smaller nares, easily occluded.
- Small oral cavity and large tongue increase risk of obstruction.
- Long, floppy epiglottis vulnerable to swelling with resulting obstruction.
- Larynx and glottis are higher in neck, increasing risk of aspiration.
- Because thyroid, cricoid, and tracheal cartilages are immature, they may easily collapse when neck is flexed.
- Because fewer muscles are functional in airway, it is less able to compensate for edema, spasm, and trauma.
- The large amounts of soft tissue and loosely anchored mucous membranes lining the airway increase risk of edema and obstruction.

*FIGURE 25–1 It is easy to see that a child’s airway is smaller and less developed than an adult’s airway, but why is this important? The infant and child are more vulnerable to the consequences of an upper respiratory tract infection, enlarged tonsils and adenoids, an allergic reaction, positioning of the head and neck during sleep, and small objects that can be aspirated. All can cause an airway obstruction that results in respiratory distress.*
CHAPTER 25  Alterations in Respiratory Function

Upper Airway Differences

The child's tracheal airway is shorter and narrower than an adult's airway. These differences create a greater potential for obstruction (Figure 25–1 and Table 25–1). The infant's airway is approximately 4 mm in diameter, about the width of a drinking straw or the diameter of the infant's little finger, in contrast to the adult's airway diameter of 20 mm. The upper airway increases in length rather than diameter during the first 5 years of life. The trachea in a child is higher and at a different angle than the adult's (Figure 25–2). The airway resistance, the effort or force needed to move oxygen through the trachea to the lungs, is greater in the child's narrower airway than in an adult (Figure 25–3). As air moves from the child's nares down the trachea to the distal airways (alveoli), it must flow through a relatively small area. Friction and increasing resistance are generated as air passes through the airway. When edema and swelling of the trachea occur in response to a virus, bacterium, or other irritant, the airway is further narrowed, and air is inspired more quickly to maintain oxygenation status. The resulting negative pressure in the airway draws tissues closer together, further narrowing the airway and increasing airway resistance.

Physiologically the upper airway is the port for inspiration of oxygen and expiration of carbon dioxide. Infants, children, and adults can breathe through either the nose or the mouth. Until at least 4 weeks of age, newborns are obligatory nose breathers. The coordination of mouth breathing is controlled by maturing neurologic pathways; thus, young infants do not automatically open the mouth to breathe when the nose is obstructed. The only time newborns breathe through the mouth is when they cry.

Nasal patency in newborns is therefore essential for activities such as breathing and eating.

Lower Airway Differences

While the tracheobronchial tree is complete at birth, the child’s lower airway is also constantly growing. At birth, the lung tissue contains only 25 million alveoli, which are not fully developed. The number of alveoli increases to 300 million by

### TABLE 25–1 Summary of Upper Airway Differences Between Children and Adults

<table>
<thead>
<tr>
<th>DIFFERENCE IN CHILDREN</th>
<th>SIGNIFICANCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small oral cavity and large tongue</td>
<td>Increases risk of obstruction; nasal patency is critical in infants</td>
</tr>
<tr>
<td>Newborns and young infants are nose breathers</td>
<td>Will not automatically open mouth to breathe if nose is obstructed. Nasal passages must be kept patent.</td>
</tr>
<tr>
<td>Rapid growth of lymph tissue (tonsils and adenoids) during early childhood, atrophy after age 12</td>
<td>Larger tissues in smaller pharyngeal structures; infection can easily cause obstruction of upper airway as lymph tissues swell in response</td>
</tr>
<tr>
<td>Larynx and glottis high in neck</td>
<td>Increases chance of aspiration</td>
</tr>
<tr>
<td>Thyroid, cricoid, and tracheal cartilages immature and incomplete</td>
<td>Easily collapse when neck is flexed, further narrowing airway; less protective of glottis</td>
</tr>
<tr>
<td>Large amount of soft tissue and loosely anchored mucous membranes lining length of airway</td>
<td>Increases likelihood of airway edema and obstruction</td>
</tr>
<tr>
<td>Long, floppy epiglottis</td>
<td>Vulnerable to swelling with resultant obstruction</td>
</tr>
<tr>
<td>Fewer functional muscles in the airways</td>
<td>Less able to compensate for edema, spasm, and trauma; may swallow more mucus than able to sneeze or cough out</td>
</tr>
</tbody>
</table>

Nasal patency in newborns is therefore essential for activities such as breathing and eating.

### AS THEY GROW

**Trachea Position**

- 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.

**FIGURE 25–2** In children, the trachea is shorter and the angle of the right bronchus at bifurcation is more acute than in the adult. Where is an aspirated foreign body likely to land? When you are resuscitating or suctioning, you must allow for the differences in the length of the trachea as it is easier to slip into the right bronchus with an endotracheal tube or suction catheter.
8 years of age, and then the alveoli continue developing in size, shape, and complexity until puberty (Froh, 2002). Alveolar growth increases the area available for gas exchange. At birth the distal (peripheral) bronchioles that extend to the alveoli are narrow and fewer in number than in an adult. The child’s overall growth can be correlated to the increased branching of the peripheral bronchioles as the alveoli continue to multiply. The taller the child, the greater the lung surface area.

The bronchi and bronchioles are lined with smooth muscle. The newborn does not have enough smooth muscle bundles to help trap airway invaders. By 5 months of age, however, sufficient muscles exist to react to irritants by bronchospasm and muscle contraction. Smooth muscle development is complete and comparable to that of an adult by 1 year of age (Webster & Huether, 1998).

Ventilation is the movement of air in and out of the lungs and alveoli. The circulatory system transports oxygen to the tissues and carbon dioxide back to the lungs for the gas exchange at the alveolar-pulmonary capillary membranes. Chemoreceptors respond to the levels of arterial oxygen and carbon dioxide levels and to the hydrogen ion concentration in the blood and spinal fluid. When excessive levels of carbon dioxide are detected, the chemoreceptors signal the respiratory center that regulates the respiratory muscles.

The lungs, which have no muscles of their own, rely on the diaphragm and intercostal muscles to power respiration. Children up to 6 years are primarily dependent upon the diaphragm to breathe. The negative pressure caused by the downward movement of the diaphragm draws in air, and the abdomen rises as the abdominal contents are slightly compressed. The intercostal muscles increase the chest diameter. As the ribs are primarily cartilage and very flexible, and the intercostal muscles are less strong, their efficiency in assisting ventilation is reduced. In cases of respiratory distress the increased effort to move air through a narrower airway with increased airway resistance causes retractions, seen as indentations between the ribs during inspiration. See Figure 25–4 for sites of retractions associated with respiratory distress.

From the moment a child is born, airway integrity is vulnerable because of the immaturity of the respiratory muscles and neurologic system. For example, preterm and full-term infants respond differently to hypoxia and elevated Pco2 levels than adults. Preterm infants’ response to hypoxia is blunted, further depressing the respiratory center’s sensitivity to an elevated carbon dioxide level. As a consequence, these infants have a diminished rather than an increased inspiratory effort (Head & Bhatia, 2000).

**RESPIRATORY DISTRESS AND RESPIRATORY FAILURE**

Many conditions associated with the respiratory system progress from difficulty breathing to respiratory distress, and if the condition is not managed, it progresses to respiratory failure. Recognition of the child’s respiratory signs and symptoms is critical in ensuring that appropriate care is provided to prevent the progression to respiratory failure. Foreign-body aspiration is a common cause of respiratory distress.

**Foreign-Body Aspiration**

Airway obstruction exists when air passage in the respiratory tract and lungs is slowed or blocked. Foreign-body aspiration is the inhalation of any object (solid or liquid, food or nonfood) into the respiratory tract. It is a major health problem for infants and young toddlers due to their increasing mobility and tendency to place small objects in the mouth. In young children aspiration occurs most often during feeding and reaching activities, while crawling, or during playtime. However, aspiration may occur in children of any age.

In 2001, 17,537 children 14 years of age and younger were treated in an emergency department for a choking-related episode. Rates were highest for infants less than 1 year of age and rates decreased with advancing age (Centers for Disease Control and Prevention [CDC], 2002). Foreign-body aspirations result in approximately 300 childhood deaths annually in the United States, and they are a common cause of unintentional injury death in the home among children under 6 years of age (Muniz & Joffe, 1999).

**Etiology and Pathophysiology**

In infants over 6 months of age and in children, aspiration may be caused by small objects that...
 CHAPTER 25  Alterations in Respiratory Function  ■  95

PATHOPHYSIOLOGY ILLUSTRATED

Retraction Sites

Supraclavicular

Suprasternal

Intercostal

Substernal

Subcostal

FIGURE 25–4  The chest wall is flexible in infants and young children because the chest muscles are immature and the ribs are cartilaginous. With respiratory distress, the negative pressure created by the downward movement of the diaphragm to draw in air is increased, and the chest wall is pulled inward causing retractions. Intercostal retractions are seen in mild respiratory distress. As the severity of respiratory distress increases, retractions can be seen in the substernal and subcostal areas. In cases of severe distress, accessory muscles (sternocleidomastoid and trapezius muscles) are used, and retractions are seen in the supraclavicular and suprasternal areas.

enter the child’s mouth. Common aspirated items include the following:

- Foods such as nuts, popcorn, hard candy, or small pieces of raw vegetables or hot dog
- Small, loose toy parts such as wheels and bells
- Household objects and substances such as beads, safety pins, coins, buttons, balloon pieces, colorful liquids (mouthwash, perfume), and enticing packages (small screw bottle tops)

Many aspirations occur when the young child who has something in the mouth takes a deep and rapid inspiration after bumping the head or falling. Partial and sometimes complete airway obstruction may occur.

The severity of the obstruction depends on the size and composition of the object or substance and its location within the respiratory tract. The majority of aspirated foreign bodies (AFBs) usually cause bronchial, not tracheal, obstruction. An object lodged high in the airway above the vocal cords is frequently coughed out easily or with some assistance (such as use of chest thrusts and back blows or the abdominal thrust). The right lung is the more common site of lower airway aspiration because of the sloped angle of its bronchus (see Figure 25–2). Objects may migrate from higher to lower airway locations. An object may also move back up to the trachea, creating extreme respiratory difficulty. An object lodged in the trachea is a life-threatening situation. If oxygen is depleted for an extended time, brain damage may occur.

Clinical Manifestations

The child may initially have spasmodic coughing, or gagging without fever or other symptoms of illness. The child may have signs of increased respiratory effort such as dyspnea (difficulty breathing), tachypnea (increased respiratory rate), nasal flaring, and retractions (a visible drawing in of the skin of the neck and between the ribs of the chest, which occurs on inspiration in infants and young children in respiratory distress). As respiratory distress progresses, the child may have a concentrated focus on breathing, have an anxious expression, and sit in a forward position with the neck extended, as if to straighten out the airway. Retractions may not be present if air movement is diminished. As the child becomes increasingly hypoxic, behavioral changes such as irritability and decreased responsiveness will be seen.

The older child who aspirates and has an airway obstruction may clutch the neck—the universal sign for choking (Figure 25–5). In some cases, the child becomes asymptomatic after coughing for 15 to 30 minutes as the airway adapts to the foreign body. Coughing, choking, gagging, dysphonia, and wheezing may be brief or may persist for several hours if the object drops below the trachea into one of the mainstem bronchi. See the clinical manifestations table on page 96 for signs associated with obstructions in various locations of the airway. If the foreign body drops into the lower airway and is not removed, the child may present weeks later with complications of the aspiration such as a chronic cough, persistent or recurrent pneumonia, or a lung abscess.
Clinical Therapy

When total airway obstruction occurs, efforts to clear the obstruction include back blows and chest thrusts in an infant. Abdominal thrusts are used on older children. In the emergency department, oxygen is administered. Efforts are made to visualize the foreign body if the object aspirated is radiopaque or if a chest radiograph shows abnormalities. A forced expiratory film may also be ordered to observe for local hyperinflation or air trapping and mediastinal shift away from the affected side.

COLLABORATIVE CARE

Initial management is focused on maintaining a patent airway and relieving the airway obstruction.

Diagnostic Tests

Children are usually brought to the hospital after a sudden episode of coughing. Discovery of an open container with small objects may prompt parents to seek medical assistance for the child. Clinical therapy focuses on taking a careful history to determine whether aspiration has actually occurred. Choking associated with feeding or crawling on the floor is usually a confirming event. The physical examination often reveals decreased breath sounds, stridor, and respiratory distress in the child without a witnessed aspiration.

A chest radiograph is performed. When the object aspirated is radiopaque, it can be seen on the radiograph (Figure 25–6). A special chest radiograph, called a forced expiratory film, may also be ordered. This shows abnormalities caused by the foreign body, such as local hyperinflation (air trapping) and a mediastinal shift away from the affected side (Hazinski, 1999).

Clinical Manifestations of Airway Obstructions in Different Locations

<table>
<thead>
<tr>
<th>LOCATION OF AIRWAY OBSTRUCTION</th>
<th>CLINICAL MANIFESTATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nasopharyngeal obstruction, enlarged tonsils or adenoids</td>
<td>Sonorous snoring</td>
</tr>
<tr>
<td>Partially obstructed upper airway (in the larynx, subglottic space, and upper trachea)</td>
<td>Inspiratory stridor</td>
</tr>
<tr>
<td>Obstruction of the mid to lower trachea and central bronchus</td>
<td>Expiratory stridor or wheeze</td>
</tr>
<tr>
<td>Supralaryngeal obstruction, epiglottitis or retropharyngeal abscess</td>
<td>Muffled voice</td>
</tr>
<tr>
<td>Croup or tracheal foreign body</td>
<td>Harsh, barking cough</td>
</tr>
</tbody>
</table>

body with a laryngoscope and remove it with Magill forceps. When possible, the child is taken to the operating room so that optimal conditions exist to protect and maintain the child’s airway during removal of the foreign body. When a partial airway obstruction exists, fluoroscopy and fiber-optic bronchoscopy may be used to identify, locate, and extract the foreign body.

Following removal of the foreign body, the child is stabilized and observed for a few hours in a short-stay unit. Depending on the type of object, location of the object, and degree of obstruction, surgical removal and hospitalization may be required. See the section on pneumonia, page 121, for clinical therapy for the child with complications due to aspiration.

Nursing management is focused on assessment and monitoring the child until the obstruction can be removed, supporting the child and family during the crisis, and preventing future airway obstructions.

Nursing Assessment and Diagnosis

Physiologic Assessment
The child will be in respiratory distress. Perform the respiratory assessment following guidelines in Box 25–1 and Table 25–2. If the object remains lodged in the airway, observe the child for increasing signs of respiratory distress, especially vital signs and audible wheezing on auscultation. Identify the types of retractions present to help determine the severity of respiratory distress. If the obstruction occurs above the trachea, inspiration is more affected. If the obstruction occurs below the trachea, expiration is more affected.

Changes in breath sounds, from noisy to decreasing to absent, on the affected side are noted. This can indicate that the object is moving and blocking a mainstem bronchus.

Attach the child to a cardiorespiratory monitor and pulse oximeter to assess the child for subtle signs of increasing hypoxia associated with the obstruction. See Box 25–2 for guidelines to increase the accuracy of pulse oximeter readings. Constant assessment is performed as the child may develop a complete obstruction.

Psychosocial Assessment
The unexpected and acute nature of the event creates anxiety for parents and child. The child will be anxious and fearful because

*NURSING MANAGEMENT*

*Nursing Assessment and Diagnosis*

Physiologic Assessment
The child will be in respiratory distress. Perform the respiratory assessment following guidelines in Box 25–1 and Table 25–2. If the object remains lodged in the airway, observe the child for increasing signs of respiratory distress, especially vital signs and audible wheezing on auscultation. Identify the types of retractions present to help determine the severity of respiratory distress. If the obstruction occurs above the trachea, inspiration is more affected. If the obstruction occurs below the trachea, expiration is more affected.

*CLINICAL TIP*
If the child cannot say “P” in words like Pluto or Peter Pan, the expiratory effort is noticeably diminished as a result of the foreign body.

Changes in breath sounds, from noisy to decreasing to absent, on the affected side are noted. This can indicate that the object is moving and blocking a mainstem bronchus.

*PRACTICE ALERT*
The depth and location of retractions is associated with the severity of respiratory distress. Isolated intercostal retractions indicate mild distress. Subcostal, suprasterial, and supraclavicular retractions indicate moderate distress. These retractions accompanied by use of accessory muscles in the neck indicate severe distress.

Attach the child to a cardiorespiratory monitor and pulse oximeter to assess the child for subtle signs of increasing hypoxia associated with the obstruction. See Box 25–2 for guidelines to increase the accuracy of pulse oximeter readings. Constant assessment is performed as the child may develop a complete obstruction.

*PRACTICE ALERT*
The following signs and symptoms signal the body’s response to increased metabolic demands for oxygenation as a result of stress or impending illness.

- Increasing restlessness, irritability, unexplained sudden confusion
- Rapid heart rate accompanied by a rapid respiratory rate

Psychosocial Assessment
The unexpected and acute nature of the event creates anxiety for parents and child. The child will be anxious and fearful because

*BOX 25–1*  
Assessment Guidelines for a Child in Respiratory Distress*

<table>
<thead>
<tr>
<th>QUALITY OF RESPIRATIONS</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>➤ Inspect the rate, depth, and respiratory effort. (See Table 25–2 for expected respiratory rate ranges by age.)</td>
<td></td>
</tr>
<tr>
<td>➤ Identify the signs of respiratory distress: tachypnea (abnormally rapid rate of respirations), retractions, nasal flaring, inspiratory stridor, expiratory grunting.</td>
<td></td>
</tr>
<tr>
<td>➤ Note lack of simultaneous chest and abdominal rise with inspiration (paradoxical breathing).</td>
<td></td>
</tr>
<tr>
<td>➤ Auscultate breath sounds. Note if they are bilateral, diminished or absent, if adventitious sounds are present (wheezes, crackles, rhonchi).</td>
<td></td>
</tr>
<tr>
<td>➤ Assess nasal patency in newborn.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>QUALITY OF PULSE</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>➤ Assess the rate and rhythm. Tachycardia may indicate hypoxia.</td>
<td></td>
</tr>
<tr>
<td>➤ Compare pulse sites (apical to brachial) for strength and rate.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>COLOR</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>➤ Observe overall color. With respiratory distress, color progresses from pallor to mottled to cyanosis. Central cyanosis is a late sign of respiratory distress.</td>
<td></td>
</tr>
<tr>
<td>➤ Compare peripheral and central color. Assess capillary refill and nailbed color and inspect mucous membranes. Central cyanosis in mucous membranes is more ominous.</td>
<td></td>
</tr>
<tr>
<td>➤ Note whether crying improves or worsens color.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>COUGH</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>➤ Quality: note whether dry (nonproductive), wet (productive, mucousy), brassy (noisy, musical), coughy (barking, seal-like).</td>
<td></td>
</tr>
<tr>
<td>➤ Effort: note whether forceful or weak. Weak cough may indicate an airway obstruction or fatigue from prolonged respiratory effort (not valid in newborns).</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>BEHAVIOR CHANGE</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>➤ Note level of consciousness. Lethargy may indicate hypoxia.</td>
<td></td>
</tr>
<tr>
<td>➤ Restlessness and irritability are associated with hypoxia.</td>
<td></td>
</tr>
<tr>
<td>➤ Watch for abrupt behavior changes. Restlessness, irritability, and lowered level of consciousness may indicate increasing hypoxia.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SIGNS OF DEHYDRATION</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>➤ Inspect for dry mucous membranes, lack of tears, poor skin turgor, sunken fontanel in an infant, and decreased urine output, which indicate that fluid needs are not being met.</td>
<td></td>
</tr>
</tbody>
</table>

*Refer to Chapter 8 for the actual assessment techniques mentioned in this table.*
of the difficulty breathing. Parents may be experiencing a variety of other emotions such as fear, anger, or guilt. Assess the family’s level of distress and coping ability.

**Developmental Assessment**

As the child’s condition stabilizes, observe how well the child’s developmental abilities match the parents’ understanding of age-appropriate behaviors. See Chapters 12 and 13.

Common nursing diagnoses for a child with an aspirated foreign body include the following:

- Ineffective Airway Clearance related to foreign-body aspiration
- Impaired Spontaneous Ventilation related to foreign-body aspiration and respiratory muscle fatigue
- Fear (parent or child) related to uncertainty of prognosis, unfamiliar surroundings, and procedures

**Planning and Implementation**

The period immediately after aspiration until the foreign body can be removed is critical, and subtle changes in the child’s respiratory status during this period must be documented and reported promptly. A nurse must remain with the child who has significant airway obstruction, and emergency resuscitation equipment must be immediately accessible.

Allow the child to select the position of comfort. In many cases this will be sitting upright or a semi-Fowler’s position. Avoid performing any procedures that will increase the child’s anxiety or stress. Sudden movements or increased respiratory efforts may cause the obstruction to move and potentially completely obstruct the airway.

Keep the child and family informed about planned procedures and provide them with emotional support. Provide a quiet environment and encourage the presence of the parents to help reduce the child’s fear and anxiety.

**Discharge Planning and Home Care Teaching**

Prevention of future foreign-body aspirations is a major focus for nursing care. Provide education or reinforcing information about developmental characteristics of the child and potential safety hazards in the environment. Encourage the parents to learn CPR, choking-prevention techniques, and back blows, chest thrusts, or abdominal thrusts.

**Evaluation**

Expected outcomes of nursing care include the following:

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

**Respiratory Failure and Acute Respiratory Distress Syndrome**

Respiratory failure occurs when the body can no longer maintain effective gas exchange. The physiologic process that ends in respiratory failure begins with hypoventilation of the alveoli.

**Etiology and Pathophysiology**

Alveolar hypoventilation occurs when any of the following factors exist.

- The body’s need for oxygen exceeds actual oxygen intake.
- The airway is partially occluded.
- The transfer of oxygen and carbon dioxide in the alveoli is disrupted. This disruption may occur either because of a malfunction of respiratory center stimulation (the alveoli do not receive the message to diffuse) or because the alveolar membrane is defective (a structural problem).

Gas exchange is optimal in children when there is an equal match between ventilation and pulmonary blood flow. The usual ratio between ventilation and perfusion is 0.8 to 0.9 because perfusion (circulation) is somewhat greater than ventilation in the lung bases (less inspired air reaches the lowest levels of the lungs). A mismatch between ventilation and perfusion can occur because airflow is inadequate to well-perfused areas of the lungs, such as occurs with constriction of the bronchi or when alveoli are obstructed or collapsed. In this case the blood flowing through pulmonary capillaries receives less oxygen than normal and thus causes hypoxemia. Supplemental oxygen does not effectively treat the condition because the blood flowing through the affected capillary beds never gets exposed to the oxygen. Poor perfusion with well-ventilated lungs may also result in a ventilation-perfusion mismatch, such as occurs with hypovolemia (Froh, 2002). See Figure 25–7.

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**TABLE 25–2 Normal Respiratory Rate Ranges by Age**

<table>
<thead>
<tr>
<th>AGE</th>
<th>RESPIRATORY RATE PER MINUTE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Newborn</td>
<td>30–60</td>
</tr>
<tr>
<td>1 year</td>
<td>20–40</td>
</tr>
<tr>
<td>3 years</td>
<td>20–30</td>
</tr>
<tr>
<td>6 years</td>
<td>16–22</td>
</tr>
<tr>
<td>10 years</td>
<td>16–20</td>
</tr>
<tr>
<td>17 years</td>
<td>12–20</td>
</tr>
</tbody>
</table>

**BOX 25–2 Guidelines for Increasing the Accuracy of Pulse Oximetry Readings**

- Place the sensor probe over clean and dry skin that is exposed to minimal movement. Avoid sites with nail polish as this can interfere with the sensor.
- Avoid exposing the sensor probe to bright light or sunshine as this may falsely increase the reading.
- Make sure the heart rate detected by the pulse oximeter matches the child’s heart rate by direct assessment for accuracy. The oximeter may be unable to accurately detect pulsatile blood flow if the extremity used is cool with vasoconstriction present, or if peripheral blood flow is decreased due to dysrhythmias or shock.

Alveolar hypoventilation results in hypoxemia (lower than normal blood oxygen level) and hypercapnia (greater than normal amount of carbon dioxide in the blood). When the blood levels of oxygen and carbon dioxide reach abnormal levels, hypoxia (lower than normal oxygen level in the tissues) occurs and respiratory failure begins.

Children may develop respiratory failure and acute respiratory distress syndrome (ARDS). An acute lung injury causes an inflammatory-immune response and alveolar capillary membrane damage. Examples of conditions that injure the lungs include sepsis, pneumonia, meconium aspiration, aspiration of stomach contents, smoke inhalation, and near drowning. Information on most of these conditions occurs later in the chapter. (See Chapter 33∞ for information on near drowning.)

The increased permeability of the damaged alveolar-capillary membrane allows fluid and protein to accumulate in the alveoli. This in turn results in decreased lung compliance and functional residual capacity, reducing airflow and causing a ventilation-perfusion mismatch and hypoxemia (Moloney-Harmon, 1999). Other body systems may also contribute directly or indirectly to an increased workload, causing the respiratory system to fail.

**Clinical Manifestations**

Signs of respiratory distress worsen with impending respiratory failure and include irritability, lethargy, cyanosis, diaphoresis, and increased respiratory effort such as dyspnea (difficulty breathing), tachypnea (increased respiratory rate), nasal flaring, and retractions.

**PATHOPHYSIOLOGY ILLUSTRATED**

Ventilation-Perfusion Ratio

![Diagram of ventilation-perfusion ratio](image)

**FIGURE 25–7** A ventilation-perfusion mismatch can occur when an infant or child has an abnormal distribution of ventilation or perfusion. A, Children with normal lung function and circulation have a ventilation-perfusion ratio of 0.8 to 0.9 because perfusion is greater than ventilation (air exchange) in the lung bases. B, When ventilation is inadequate to well-perfused areas of the lungs, the ventilation-perfusion ratio is low or mismatched, resulting in shunting. Blood passing through the pulmonary capillaries gets less oxygen exchange than normal and hypoxemia occurs. This is the case in asthma due to bronchoconstriction and in pneumonia because alveoli are filled with fluid. C, In the case of neonatal hyaline membrane disease the alveoli are collapsed, so blood passes through the alveolar capillaries and no oxygenation occurs. The ventilation-perfusion ratio is very low with significant shunting that does not respond to oxygen therapy because the capillary bed never gets exposed to the supplemental oxygen.

**CLINICAL TIP**

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

See the table on page 100 for clinical manifestations of respiratory failure and imminent respiratory arrest. Hypoxemia is unresponsive to increased oxygen administration due to a ventilation-perfusion mismatch.

**PRACTICE ALERT**

When the child has a chronic respiratory condition, development of respiratory failure may be gradual. Signs will be subtle. Be particularly alert to behavior changes in addition to respiratory signs. Pulse oximetry and serial blood gases may be needed to monitor the child.

**COLLABORATIVE CARE**

Physicians, nurses, and respiratory therapists collaborate on treating the respiratory failure and its cause in an effort to prevent its progression to death.

**Diagnostic Tests**

The child’s history, vital signs, and respiratory signs provide important clues about the progression from respiratory distress to respiratory failure. Pulse oximetry and arterial blood gases are
used to assess respiratory failure. Pulse oximetry provides an estimate of the hemoglobin saturated by oxygen (SpO₂) and it is expressed as the percentage of hemoglobin capable of transporting oxygen. See Figure 25–8 for guidelines to interpret pulse oximetry readings. See Table 25–3 for normal ranges of arterial blood gases. Refer to Chapter 23 for interpretation of acidosis and alkalosis that must be considered simultaneously with assessment of oxygenation status. Hypercapnia in the presence of acidosis is a sign of respiratory failure. Hypoxemia even when supplemental oxygen is given is also a sign of respiratory failure.

Clinical Therapy
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. As the child becomes more hypoxic, the level of responsiveness deteriorates and the child’s ability to keep the airway patent decreases. Respiratory problems that do not respond to oxygen therapy or medications require the insertion of an endotracheal tube to stabilize the airway. Assisted ventilation must be provided until the child breathes spontaneously or until a ventilator is hooked up. Oxygen saturation and end-tidal CO₂ monitoring are helpful to assure appropriate positioning of the endotracheal tube. A tracheostomy, the creation of a surgical opening into the trachea through the anterior neck at the cricoid cartilage, is often performed if long-term airway management is needed. Children are often sedated to optimize ventilation. Continuous positive airway pressure (CPAP) is one form of PEEP used to improve oxygenation and lung compliance. Nitric oxide administered by inhalation is used in some cases to promote vasodilation and increase blood flow in the alveoli that are well ventilated. When respiratory failure becomes life threatening, extracorporeal membrane oxygenation (ECMO) may be initiated. ECMO is a highly invasive cardiopulmonary bypass system with external oxygenation and a pump mecha-

### TABLE 25–3 Normal Ranges of Arterial Blood Gases

<table>
<thead>
<tr>
<th>Partial Pressure of Oxygen (PaO₂)</th>
<th>All children: 83–108 mm Hg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infant:</td>
<td>27–41 mm Hg</td>
</tr>
<tr>
<td>Children:</td>
<td>32–48 mm Hg</td>
</tr>
</tbody>
</table>

nism that can be used to provide respiratory and hemodynamic support while the lungs heal. It also reduces mechanical ventilation time and associated complications; however, several significant complications may occur in the child placed on ECMO. This complex and expensive treatment is available in special neonatal and pediatric intensive care centers, so the child may have to be transferred to another hospital to receive this therapy. Survival rates are influenced by the severity of the condition causing the respiratory failure (Morris, Gonzalez, Stewart, et al., 2000).

**NURSING MANAGEMENT**

Nursing care is focused on the recognition of progression from respiratory distress to respiratory failure and supportive care to the child and family.

### Nursing Assessment and Diagnosis

Early recognition of impending respiratory failure is the most important aspect of care for a child with any signs of respiratory compromise. Perform the respiratory assessment using guidelines in Box 25–1. **Grunting**, a physiologic mechanism that slows the expiratory flow to increase the lung volume and alveolar pressure, is a sign associated with the onset of respiratory failure in newborns and infants. Attach a cardiorespiratory monitor and pulse oximeter. Monitor the child for changes in vital signs, respiratory status, and level of responsiveness.

If the child has an endotracheal or a tracheostomy tube, assess for secretions that may further obstruct the airway.

Examples of nursing diagnoses associated with respiratory failure include:

- Ineffective Breathing Pattern associated with prolonged tachypnea and muscle fatigue
- Ineffective Airway Clearance related to sedation and loss of protective cough reflex
- Impaired Gas Exchange related to structural injury to the alveolar membrane
- Compromised Family Coping related to child’s life-threatening illness

### Planning and Implementation

Place the child in an upright position (by elevating the head of the bed) and the head in midline to help maintain the airway. Administer oxygen as ordered. See the Skills Manual for a review of oxygen delivery systems and amount of oxygen delivered by each. Keep a bag-valve mask and emergency equipment readily available at the bedside to assist ventilations if respiratory status deteriorates.

Because endotracheal and tracheostomy tubes prevent vocal cord vibration, intubated children cannot cry or talk. Once infants and young children who are intubated recover from the sedation or anesthesia, they often express initial frustration and fear when they cannot communicate verbally. Explain the reasons for the inability to cry and talk to the child and parents. When the child is alert, give suggestions for ways to make noise and gain attention when needed, such as striking the mattress. For older children obtain and demonstrate the use of a communication board.

Suction airway secretions as needed, and provide tracheostomy care if present. See Skills Manual for tracheostomy care procedures. Provide good skin care around the endotracheal tube or tracheostomy to prevent breakdown over pressure points.

Provide support to parents and children. The parents will be stressed because of the life-threatening nature of the disorder. Help the family identify resources and support to care for other children so parents may spend more time with the child who is critically ill. Provide age-appropriate information to the child once sedation wears off to reduce fear, and permit the parents to be with the child as much as possible.

Once the child begins responding to clinical therapy, the child is weaned from the ventilator and the endotracheal tube is removed. The child will be moved to the pediatric nursing unit for the remainder of treatment for the condition causing respiratory failure.

**Discharge Planning and Home Care Teaching**

Many children are discharged from the hospital and cared for at home for an extended period with a tracheostomy tube in place. It is essential to teach parents how to maintain and suction the airway, clean the tracheostomy site, and change the tube. They must demonstrate competence in all aspects of tracheostomy care, as well as emergency resuscitation skills adapted to the tracheostomy. Make a referral to a home health agency and supply company. A home health care nurse can provide follow-up care and support for the child and family. See Skills Manual for management of the tracheostomy tube.

### Evaluation

Expected outcomes of nursing care include the following:

- The child’s airway and ventilation are supported until the respiratory failure is reversed.
- The child is provided with a method of communication when alert but unable to talk.
- Skin integrity is maintained around the artificial airway and pressure surfaces of the body.
- The family is educated to provide tracheostomy care at home and referrals are made to provide family support.

**APNEA**

Newborns normally have periodic breathing, an irregular rhythm with occasional 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 can be characterized in the following ways.

- Central apnea—complete cessation of breathing effort
- Obstructive apnea—absence of nasal airflow when respiratory efforts are present (remember that newborns are nasal breathers and thus do not open the mouth to breathe.)
- Mixed apnea—central respiratory pause that either precedes or follows airway obstruction

Apnea may be the first major sign of respiratory dysfunction in the neonate. Two types of apnea occur during infancy, but they are different conditions. Apnea of prematurity (AOP) occurs in preterm infants, usually as a result of immaturity. An apparent life-threatening event (ALTE), sometimes referred to as apnea of infancy, occurs in near-term or term infants. In the past, both AOP and ALTE were often called “near-miss sudden infant death” or “aborted crib death.” These terms erroneously implied a close association between such episodes and sudden infant death syndrome (SIDS). SIDS should not be confused with apnea and is discussed later in this chapter. Obstructive sleep apnea occurs in children.

**Apnea of Prematurity**

AOP is a pathologic apnea with no definable cause in infants less than 37 weeks gestational age. It usually presents between 2 and 7 days of life, and its incidence increases with lower gestational age. It resolves in most infants by 40 weeks postconceptional age (Theobald, Botwinski, Albanna, et al., 2000).

AOP may be caused by neurologic and immunologic immaturity, or immature muscle development and coordination. The primary sign of AOP is one or more episodes of cessation of breathing for 20 seconds or longer associated with bradycardia and color change. The clinical manifestations of AOP are associated with the potential cause of the condition. See clinical manifestation below for signs and symptoms associated with AOP.

**Collaborative Care**

Diagnostic procedures performed include a pneumogram and other tests to identify potential underlying conditions contributing to the AOP. These include gastroesophageal reflux, sepsis, metabolic errors or electrolyte abnormalities, poor thermoregulation, seizures, and anatomic abnormalities. See the clinical manifestations table below for specific tests performed.

Therapy is initiated to prevent irreversible neurologic damage that could result from repeated or prolonged episodes. Any infant considered to be at high risk for apnea will have cardiorespiratory monitors set to detect prolonged pauses in breathing. Medications are given orally or intravenously to stimulate breathing. See the medication table on page 103. CPAP may also be used when obstructive apnea is suspected.

**Nursing Management**

Nurses play an important role in evaluating signs and symptoms associated with potential contributing factors. Monitor the infant for apnea episodes.

| CAUSES AND CLINICAL MANIFESTATIONS of Apnea of Prematurity and Apparent Life-Threatening Event |
|---------------------------------|---------------------------------|---------------------------------|
| **ETIOLOGY** | **CLINICAL MANIFESTATIONS** | **DIAGNOSTIC PROCEDURES** |
| Functional or structural airway problem or immaturity | Apnea of 20 sec or longer; accompanied by bradycardia or cyanosis | Cardiorespiratory monitoring, sleep study, pneumogram, sepsis workup |
| Aspiration as a result of dysfunctional swallowing or gastroesophageal reflux | Choking, coughing, cyanosis, vomiting | Barium swallow, esophageal pH probe |
| Cardiac problems | Tachycardia, tachypnea, dyspnea | Cardiorespiratory monitoring, electrocardiogram, echocardiogram, arterial blood gases |
| Drug toxicity or poisoning; maternal history of ingestion | Central nervous system depression, hypotonia | Serum magnesium level, toxicity screen |
| Environmental, thermoregulation problem | Lethargy, tachypnea, hypothermia or hyperthermia | Cardiorespiratory and temperature monitoring, environmental temperature level (ambient air temperature) |
| Impaired oxygenation, respiratory disease (pulmonary edema, atelectasis, pneumonia) | Cyanosis, tachypnea, respiratory distress, anemia, choking, coughing | Oximetry, chest radiograph, arterial blood gases, complete blood count, upper airway evaluation, sleep study, serum electrolytes |
| Acute infection (sepsis, meningitis, necrotizing enterocolitis) | Feeding intolerance, lethargy, temperature instability | Complete blood count, cultures when appropriate, C-reactive protein, chest and abdominal radiographs |
| Intracranial pathology (intraventricular hemorrhage, ventricular dilation, CNS anomalies, meningitis) | Abnormal neurologic examination, seizures | Cranial ultrasound, computed tomography scan, electroencephalogram, magnetic resonance imaging, cerebrospinal fluid evaluation |
| Metabolic disorders | Jitteriness, poor feeding, lethargy, central nervous system depression or irritability, hypotonia | Serum electrolytes (potassium, sodium, chloride), glucose, calcium, arterial blood gases |

Supportive care for AOP includes placing the neonate with the head at midline and the neck in the neutral position or slightly extended to minimize upper airway obstruction. Tactile stimulation, such as rubbing the infant’s back or feet, often is enough to halt an apneic episode.

The medication dosage administered is small and must be carefully titrated. Observe the neonate for the drug’s side effects. Monitor the neonate for apneic episodes until the drug is completely eliminated from the body. Prolonged follow-up provides assurance that the respiratory system has matured adequately, and further apneic spells should not occur.

**Apparent Life-threatening Event (ALTE)**

ALTE is defined as an episode of central or obstructive apnea occurring in a near-term or term infant who is greater than 37 weeks’ gestation. The majority of these events occur in infants under 4 months of age, with a peak incidence between 1 week and 2 months (Davies & Gupta, 2002).

**Etiology and Pathophysiology**

Potential causes of ALTE include infection, gastrointestinal reflux, seizures or breath-holding spells, cardiac arrhythmias, respiratory center dysfunction, obstructive sleep apnea, and metabolic and endocrine problems. In the case of repeated episodes without identifiable cause, ALTE may be the result of intentional suffocation or Munchausen syndrome by proxy, both a form of child abuse (see Chapter 7∞).

**Clinical Manifestations**

Clinical manifestations include apnea (central or obstructive) accompanied by a color change (cyanosis, pallor, or occasionally ruddiness), limp muscle tone, choking, or gagging. These episodes may occur during sleep, wakefulness, or feeding.

**COLLABORATIVE CARE**

After an ALTE, the infant is usually admitted to the hospital for evaluation and cardiorespiratory monitoring. See the clinical manifestations table on page 102 for potential causes and tests used for diagnosis. In 50% of cases, however, no cause is identified (Loughlin & Carroll, 1999). Physical stimulation or emergency resuscitation is usually required to revive the infant.

**NURSING MANAGEMENT**

Nursing care includes collecting a detailed history of the event, observing and monitoring cardiorespiratory status, providing supportive care to the infant and family, facilitating the diagnostic process, and anticipating the need for emergency resuscitation and for the diagnostic process.

**Nursing Assessment and Diagnosis**

Establish rapport with the parents to create a sense of trust. Do not give parents the impression that their parenting skills are being judged or questioned. Collect historical information that includes the infant’s color, tone, apnea, rescue breaths or CPR, state of arousal, and duration of the episode. Seek information about the potential relationship between the event and feeding. Additional information about any past episodes, recent infections, medications, seizure activity, birth history or perinatal insults, family history of infant deaths, apnea, or cardiac problems should also be collected. Ask family members about how they responded to the event (CPR, bulb suctioning, and repositioning) and the infant’s response.

Attach a cardiorespiratory monitor to continuously assess the heart rate and respiratory rate while the infant is awake and asleep (Figure 25–9 ■). Pulse oximetry provides continuous evaluation of the infant’s oxygenation status.

Examples of nursing diagnoses associated with ALTE include:

- Ineffective Breathing Pattern related to airway obstruction or metabolic disorder
- Caregiver Role Strain associated with need for continuous respiratory monitoring and fear of future apneic episodes
- Interrupted Breastfeeding related to infant’s hospitalization and change in established routines
- Interrupted Family Processes related to increased monitoring of infant and change in family routines

**Planning and Implementation**

ALTE can frighten the parent or observer, who often fears the infant has died. Parents experience fear and anxiety about the infant’s prognosis. Explanations of tests and treatment help to

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**Medications Used to Treat Apnea of Prematurity**

<table>
<thead>
<tr>
<th>Medication</th>
<th>Action</th>
<th>Nursing Considerations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Methylxanthines</td>
<td>Stimulates the respiratory center in the brain, stimulates diaphragm</td>
<td>Monitor vital signs and clinical response.</td>
</tr>
<tr>
<td>(aminophylline,</td>
<td>ic contractility and prevents diaphragmatic fatigue. Caffeine is preferred</td>
<td>Monitor the serum drug level because the metabolism and elimination rates of the drug</td>
</tr>
<tr>
<td>caffeine)</td>
<td>because it enhances diaphragmatic contraction, has a longer action</td>
<td>can be unpredictable.</td>
</tr>
<tr>
<td></td>
<td>time, fewer side effects, and a more stable plasma concentration.</td>
<td>Because of the delayed elimination of the medications, the infant should be caref</td>
</tr>
<tr>
<td></td>
<td>The drug is discontinued once the infant is past 37 weeks</td>
<td>fully monitored for apneic episodes for 7 to 10 days after discontinuation.</td>
</tr>
<tr>
<td></td>
<td>postconceptional age.</td>
<td></td>
</tr>
<tr>
<td>Doxapram</td>
<td>Respiratory and CNS stimulant used only when apnea of prematurity</td>
<td>IV formulation has benzyl alcohol and must be used with caution. Oral formulation is</td>
</tr>
<tr>
<td></td>
<td>is not responsive to methylxanthines.</td>
<td>poorly absorbed by preterm infants.</td>
</tr>
</tbody>
</table>

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Infants who experience an episode of apnea or apparent life-threatening event are usually admitted to the hospital for cardiorespiratory monitoring. Decrease parental anxiety and increase their understanding of the situation.

During hospitalization the infant should be held and cuddled 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 they might disconnect the monitoring cable if they handle the infant. Wrapping the cable inside the infant’s blanket helps secure the wires, thus increasing parents’ feelings of confidence when handling the infant.

Assist the mother to continue breastfeeding and maintaining the supply of breast milk by pumping if necessary. Support the mother’s desire to continue breastfeeding by ensuring that she gets adequate fluids and nutrition. Provide privacy for breast pumping, and store breast milk for future feedings.

Because the infant who has had an ALTE continues to be at risk for cardiopulmonary arrest, emergency resuscitation equipment and drugs should be readily accessible at all times.

**Discharge Planning and Home Care Teaching**

Home care needs should be identified and addressed early during the hospitalization. Some infants will be sent home with an apnea monitor, and parents need to be taught how to operate it. See Partnering with Families: Home Care Instructions for the Infant Requiring Apnea Monitoring. Teach parents what to do when the infant has an apneic episode and techniques for choking intervention. Encourage parents to attend a cardiopulmonary resuscitation (CPR) class. Talk with parents about how to manage this new family stressor and still meet needs of other family members.

**Evaluation**

Expected outcomes of nursing care include the following:

- The child’s apneic episode is managed promptly and respirations are restored.
- Parents learn to identify and manage future apneic episodes.
- The mother continues to breastfeed the infant.
- The infant’s sense of security and development is promoted.

**Obstructive Sleep Apnea**

Obstructive sleep apnea (OSA) syndrome is a disorder of breathing during sleep that is characterized by prolonged partial upper airway obstruction and/or intermittent complete obstruction (obstructive apnea) that disrupts normal ventilation during sleep and normal sleep patterns (American Academy of Pediatrics, 2002). When the child tries to move air past the obstruction, the breathing becomes labored, and snoring or noisy breathing is heard. Snoring is noticed in 7% to 12% of children; however, not all children who snore have OSA syndrome (Perkin, Downey, & MacQuarrie, 1999). The severe obstruction and resulting impact on the child’s health occurs in about 2% of children of all ages, including newborns. Its incidence peaks between 2 and 6 years of age when tonsils and adenoids are at their largest in relation to the size of the airway; however, it is also a relatively common condition in children up to 11 years of age. Black children are at higher risk than White children, and former preterm infants are at higher risk than full-term infants (Rosen, Larkin, Kirchner, et al., 2003).

**Etiology and Pathophysiology**

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 obstructions such as enlarged adenoids and tonsils, craniofacial anomalies, or obesity are present. During sleep, the airway muscles relax and the pharynx becomes obstructed. Breathing during sleep is also less deep as the ventilatory drive decreases. During nonrapid eye movement sleep, the tidal volume (the amount of air inhaled and exhaled during a normal breath) and respiratory rate are lower, resulting in a lower volume breathed each minute (minute ventilation). When the airway muscles are relaxed, airway resistance is increased. During rapid eye movement sleep, the skeletal muscles relax and the respiratory rate is irregular. The combination of decreased intercostal muscle activity, a variable respiratory rate, and tidal volume predisposes the child to hypoxemia. Reduced upper airway tone and obstruction then result in apnea episodes.
Severity of this condition may range from a continuous partial airway obstruction to episodes of no air movement despite breathing effort. Many children arouse frequently and repeatedly from sleep to increase airway muscle tone so that they can breathe. Other children do not arouse from sleep easily and sleep with obstructive hypoventilation, a partial airway obstruction that lasts for several hours without interruption (Marcus, 1998). In both cases, the child experiences hypoxemia, hypercapnia, acidemia, and hemodynamic alterations, such as elevated blood pressure and increased pulmonary arterial pressure in association with apnea episodes. Cerebral blood flow is also decreased during sleep.

Hypertrophy of the adenoids and tonsils is the most common cause of OSA. Other children at risk for OSA include those with craniofacial anomalies (e.g., Apert syndrome, Pierre Robin syndrome, Treacher Collins syndrome, Crouzon syndrome), Down syndrome, obesity, neuromuscular disorders (e.g., cerebral palsy, muscular dystrophy), macroglossia, Prader Willi syndrome, and mucopolysaccharidoses.

**Clinical Manifestations**

Children with OSA snore and have signs of labored breathing during sleep such as retractions and paradoxical breathing. After pauses in snoring or lack of airflow, the child may be noted to 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. Daytime sleepiness and other symptoms of sleep deprivation (poor attention, increased activity, aggression, acting out behavior, poor school performance) may be noted. The child may also have enuresis and report a morning headache resulting from carbon dioxide retention.

On physical examination, findings may be normal but mouth breathing and enlarged tonsils and adenoids may be seen. Failure to thrive may be present, potentially because the airway obstruction makes eating difficult or because of increased energy expenditure due to the work of breathing. Without treatment, complications develop that 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.

**COLLABORATIVE CARE**

Clinical management is focused on diagnosing children with OSA and selecting the appropriate therapy for the child.

Diagnostic Tests
Health professionals must be proactive in inquiring about snoring and its characteristics during examinations. See Box 25–3 for screening questions to use for OSA and associated problems. Diagnosis is made by polysomnography, a sleep study that simultaneously records brain activity, eye movement, and respiration. The number of hypopnea and apnea episodes and associated oxygen desaturation and sleep disturbances are measured.

Clinical Therapy
Adenotonsillectomy is the most common treatment for OSA and resolution of the condition occurs in the majority of children. (See Box 25–4 for children at higher risk for respiratory complications in the immediate postoperative period.) Weight-loss strategies may be implemented for children with obesity. Continuous positive airway pressure (CPAP) is used for children with surgical contraindications or those with persistent OSA (craniofacial anomalies, Down syndrome, or neuromuscular disorders) after adenotonsillectomy. CPAP levels are set at the pressure that eliminates apneic episodes, sleep arousals, and hypoxemia. Pressure levels may need to be changed as the child grows. Craniofacial surgery or even tracheostomy may be treatment options in some cases. Oxygen is not usually prescribed as it decreases the ventilatory drive. Polysomnography is usually repeated about 6 to 8 weeks after surgery to determine if any residual OSA remains.

NURSING MANAGEMENT

The goal of nursing care is to identify children at risk for OSA and to support the family during surgery or other therapies.

Nursing Assessment and Diagnoses
In the community setting, all children should be screened for snoring as part of their routine healthcare. Assess the child for signs of nasal obstruction, mouth breathing, and enlarged tonsils. Determine if the child has symptoms of sleep deprivation or a condition is present that places the child at high risk for OSA. Coordinate referral to a sleep center for polysomnogram evaluation.

Following adenotonsillectomy, the child is usually hospitalized overnight to monitor for development of complications. Carefully assess the child for bleeding and respiratory complications.

The following nursing diagnoses might be appropriate for the child with OSA:
- Impaired Gas Exchange related to airway obstruction associated with enlarged tonsils and adenoids
- Ineffective Tissue Perfusion (cerebral) related to hypventilation
- Ineffective Management of Therapeutic Regimen (child and family) related to nonadherence in use of continuous positive airway pressure

Planning and Implementation
Nursing care in the community is initially focused on educating the parents about the potential serious complications associated with OSA and the interventions that can resolve or control the condition. Explain the purpose of polysomnography evaluation and 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. Encourage the family to return for a follow-up sleep study after adenotonsillectomy to determine if the condition is resolved or if additional intervention is needed. Ongoing growth and development is monitored to observe for improved growth patterns and behavior after intervention begins.

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 24∞ for additional nursing care, family education, and home care following adenotonsillectomy.

Sleep center nurses provide education and support to families of children who need to use CPAP to treat the OSA. The nurse helps identify the best fitting mask or nasal prong system for CPAP

BOX 25–3 History Questions for Assessment for Obstructive Sleep Apnea

➤ Does your child snore? If so how often, and how loudly?
➤ Do you ever see your child stop breathing during sleep?
➤ Is your child restless during sleep or assume unusual sleep positions?
➤ Does your child wet the bed?
➤ Does your child exhibit signs of being excessively sleepy during the day?
➤ Does your child complain of headaches in the morning?
➤ Does your child often breathe with the mouth open?
➤ Is your child having difficulty with schoolwork or relationships?
➤ Does your child have any signs of hyperactivity or aggressiveness?


BOX 25–4 Children with Severe OSA at Risk for Respiratory Complications after Adenotonsillectomy

➤ Younger than 3 years of age
➤ Severe OSA on polysomnography
➤ Cardiac complications of OSA (e.g., right ventricular hypertrophy)
➤ Failure to thrive
➤ Obesity
➤ Prematurity
➤ Recent respiratory infection
➤ Craniofacial anomalies
➤ Neuromuscular disorders

delivery. Parents may need guidance about helping children to go to sleep wearing the mask until they are accustomed to it.

Evaluation

Expected outcomes of nursing care include the following:
- The child has minimal snoring and sleep is no longer disturbed by apnea episodes.
- Catch-up growth for children with failure to thrive is noted.
- Behavior and school performance improve.

Sudden Infant Death Syndrome

Sudden infant death syndrome (SIDS) has been defined as the sudden death of an infant under 1 year of age that remains unexplained after a complete autopsy, a death scene investigation, and review of the history. It remains a leading cause of death in infants between 1 month and 1 year of age, with 90% of cases occurring before 6 months of age (American Academy of Pediatrics Committee on Fetus and Newborn, 2003). SIDS occurs rarely in infants less than 2 weeks. It is unpredictable and in some cases unpreventable.

Etiology and Pathophysiology

The current evidence suggests a genetic susceptibility to SIDS, and no relationship exists between apnea and SIDS (American Academy of Pediatrics Committee on Fetus and Newborn, 2003). One theory regarding the etiology of SIDS is that an abnormality in the arcuate nucleus of the brainstem causes a delayed development of arousal, cardiorespiratory control, or cardiovascular control (Parnighrathy, Filiano, Sleeper, et al., 1997). Sleep studies conducted on infants who later died due to SIDS revealed less frequent cortical arousal during sleep (Kato, Franco, Groswasser, et al., 2003). Other proposed causes include H. pylori gastrointestinal infection and a cardiac dysrhythmia called long QT syndrome. See Box 25–5 for the infant, maternal, and familial factors that appear to place infants at risk for SIDS. SIDS has not been found to be associated with newborn apnea or immunizations for diphtheria, tetanus, and pertussis (DTP). Child abuse or homicide may be associated with 1% to 5% of suspected SIDS cases (American Academy of Pediatrics Committee on Child Abuse and Neglect, 2001). SIDS is referred to as a “syndrome” because of the many and varied autopsy and clinical findings that characterize most infants who die from the disorder. The autopsy typically does not identify a disease process that caused the death.

Clinical Manifestations

The first symptom is cardiopulmonary arrest. Clinical findings include evidence of a struggle or change in position and the presence of frothy, blood-tinged secretions from the mouth and nares. SIDS occurs more often in the fall and winter and during periods of sleep. Most deaths are unobserved. Typically parents find the infant dead in the crib in the morning and report having heard no cries or disturbances during the night.

<table>
<thead>
<tr>
<th>BOX 25–5</th>
<th>Risk Factors for Sudden Infant Death Syndrome</th>
</tr>
</thead>
<tbody>
<tr>
<td>INFANT</td>
<td>➤ Prematurity, gestational age &lt; 28 weeks</td>
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<tr>
<td></td>
<td>➤ Low birth weight</td>
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<tr>
<td></td>
<td>➤ Multiple birth</td>
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<tr>
<td></td>
<td>➤ Race (in decreasing order of frequency): most common in Native American infants, followed by African American, Hispanic, White, and Asian infants</td>
</tr>
<tr>
<td></td>
<td>➤ Gender: more common in males than females</td>
</tr>
<tr>
<td></td>
<td>➤ Age: most common in infants between 2 and 4 months of age</td>
</tr>
<tr>
<td></td>
<td>➤ Time of year: more prevalent in winter months</td>
</tr>
<tr>
<td></td>
<td>➤ Exposure to passive smoke</td>
</tr>
<tr>
<td></td>
<td>➤ History of cyanosis, respiratory distress, irritability, and poor feeding in the nursery</td>
</tr>
<tr>
<td></td>
<td>➤ Sleeping in bed with others, particularly siblings</td>
</tr>
<tr>
<td></td>
<td>➤ Use of pillows and quilts with bedding</td>
</tr>
<tr>
<td></td>
<td>➤ Sleeping prone or sleeping on side and turning to prone position</td>
</tr>
</tbody>
</table>

MATERNAL AND FAMILIAL

➤ Maternal age less than 20 years
➤ Prenatal smoking, binge alcohol use, and illicit drug use (increases incidence 10 times)
➤ Anemia
➤ Multiple pregnancies, with short intervals between births
➤ History of sibling with SIDS (increases incidence 4 to 5 times)
➤ Low socioeconomic status; crowding
➤ No or late prenatal care, low weight gain

Collaborative Care

The Back to Sleep Campaign, which encourages the placement of infants in supine position for sleeping, was initiated in 1992. The SIDS postneonatal mortality rate declined 38.9% between 1991 and 1997 presumably as a result of this changed sleeping position. Fears of aspiration in infants associated with supine sleep position have not been noted, as the mortality rate for aspiration-related deaths also declined in the same time period (Malloy, 2002).

Practice Alert

The American Academy of Pediatrics recommends that infants be placed on their back to sleep (American Academy of Pediatrics Committee on Fetus and Newborn, 2003). The dramatic decrease in SIDS deaths, from 67% of postneonatal deaths in 1993 to 28% in 1998, is believed to be related to the success of educational campaigns about infant sleep position. Recent findings indicate that infants who are placed to sleep on the stomach have a 13.1 times greater risk for SIDS while those placed to sleep on the side who then turn to the stomach have a 45.4 times greater risk for SIDS. This is believed to be a factor in the rising incidence of SIDS found in childcare settings (Cote, Gerez, Brouillette, et al., 2000; Moon, Patel, & Schaefer, 2000).
The sudden, unexpected nature of the infant’s death is confirmed in the emergency department. The nurse’s role is to be empathetic and provide support during one of the greatest crises a family must face. The focus is on supporting the family during the acute grieving period (Table 25–4). Guidelines for the support of families experiencing SIDS should include baptism services, religious support, grief counseling, assistance with funeral arrangements, and counseling on cessation of breastfeeding when appropriate. Giving parents information about the potential reactions of siblings can help them address their needs. See Chapter 22.

Reassure the parents that they are not responsible for the infant’s death and assist them in contacting other family members and mobilizing support. Older children may need reassurance that SIDS will not happen to them. They may also believe that bad thoughts or wishes about their baby brother or sister caused the death. Support groups can help parents, siblings, and other family members express these fears and work through their feelings about the infant’s death. The SIDS Alliance and SHARE organizations can help families locate a support group in their geographic area. Parents may need extra support with the birth of a subsequent newborn.

Nurses can play an important role in educating the public about the link between SIDS and infant positioning during sleep. Educate all parents of neonates and infants about the recommended sleep position for their infants at home and ask them to make sure this sleep position is used when the infant is cared for by another family member, babysitter, or childcare center (Moon et al., 2000). In addition to sleep position, parents and care providers should place the infant on a firm mattress and avoid the use of loose bedding, toys, and pillows. Avoid overheating the infant with too many clothes and blankets. Parents should stop smoking. Hospitalized infants should be placed to sleep in supine position rather than side-lying or prone.

### CROUP SYNDROMES

Croup is a term applied to a broad classification of upper airway illnesses that result from swelling of the epiglottis and larynx. The swelling usually extends into the trachea and bronchi. Included under the classification of croup syndromes are virus-caused syndromes such as spasmodic laryngitis (spasmodic croup), laryngotracheitis, and laryngotracheobronchitis (LTB) as well as bacterial-caused syndromes such as bacterial tracheitis and epiglottitis (Figure 25–10 and Table 25–5).

LTB, epiglottitis, and bacterial tracheitis are referred to as the “big three” of pediatric respiratory illness because they affect the greatest number of children across all age groups in both sexes. LTB is the most common disorder, but epiglottitis and bacterial tracheitis are more serious. 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. See the following sections for differences between these conditions. Laryngitis and laryngotracheitis are mild illnesses that can be managed at home. LTB is the most serious type of viral croup, frequently necessitating an emergency department visit for infants and children under 6 years of age. Epiglottitis is a life-threatening illness.

### 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. Table 25–5 compares LTB and other croup syndromes.

**Etiology and Pathophysiology**
Acute viral LTB is most common in children 3 months to 4 years of age but can occur up to 8 years of age. Males are affected more often than females. LTB is of greatest concern in infants and children under the age of 6 years, due to potential airway obstruction. The causative organism is usually parainfluenza virus type I, II, or III, which appears during winter months in clustered outbreaks. Other viruses causing this disorder include influenza A and B, adenovirus, respiratory syncytial virus, and measles (Perkin & Swift, 2002).

The tracheal and laryngeal airway tissues respond to the invading virus with inflammation and edema. Copious, tenacious secretions further increase the child’s respiratory distress. The laryngeal inflammation causes the airway diameter to narrow in the subglottic area, the narrowest part of the airway. Even small amounts of mucus or edema can quickly obstruct the airway (see Figure 25–10). Both the large and small airways can be affected.

**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. Low-grade fever and an inflamed pharynx may or may not be present. Common presenting signs are runny nose, tachypnea, inspiratory stridor, and a seal-like barking cough. The presence of expiratory stridor, severe tachypnea, retractions, and oxygen desaturation are associated with a more serious illness. Table 25–6 can be used to assess the severity of stridor.

**COLLABORATIVE CARE**
**Diagnostic Procedures**
Diagnosis is often made by history and clinical signs. Pulse oximetry is used to detect hypoxemia. If the diagnosis of LTB is in question, anteroposterior (AP) and lateral radiographs of the upper airway are taken; these may show a tapered symmetric subglottic narrowing called a “steeple sign” in about 50% of children. Another rationale for the radiograph is to rule out the presence of a foreign body that could be causing symptoms.

**Practice 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) to occur as a result of the child’s anxiety or of probing this reactive and already compromised area.

**Clinical Therapy**
Management consists of maintaining and improving respiratory effort with humidification, medications, and supplemental oxygen when the saturated oxygen level is less than 92%. Nebulized epinephrine constricts the capillary arterioles and reduces laryngeal mucosal edema with improvement in symptoms occurring in less than 30 minutes. Dexamethosone is given orally or intramuscularly to reduce inflammation until the child recovers from the virus. See medications used to treat laryngotracheobronchitis on page 111.

Children with a positive response to medications are often sent home from the emergency department after a 3- to 4-hour observation period. Children with persistence of moderate to severe symptoms after medication administration are admitted for further observation and treatment. Heliox, a mixture of 60% to 80% helium and 20% to 40% oxygen, may be used to manage severe LTB. It decreases the density of the gas and work of breathing by reducing the airway resistance. Heliox treatment is used to support the child until other therapeutic agents work effectively. Airway obstruction is a potential complication of severe LTB. The child may require intubation and transfer to the PICU to maintain airway patency.
The following nursing diagnoses might be appropriate for the child with acute LTB:

- Ineffective Breathing Pattern related to tracheobronchial obstruction, decreased energy, and fatigue
- Ineffective Airway Clearance (copious secretions)
- Risk for Fluid Volume Deficit related to inadequate fluid intake
- Fear (child) related to dyspnea, unfamiliar surroundings, procedures, and separation from support system

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- Fear (child) related to dyspnea, unfamiliar surroundings, procedures, and separation from support system

The initial and ongoing physical assessment of the child with LTB focuses on adequacy of respiratory functioning. Table 25–7 provides guidelines for assessment and rationale for actions. Close monitoring is required to identify changes in airway patency. The child should be continuously monitored in the emergency department, short-stay observation area, or the PICU. Infants and preverbal toddlers require constant supervision to monitor respiratory status. A means of communication (sign language or simple word cues) must be established to enable the older child to alert nursing staff about respiratory difficulty.

Particular attention should be paid to the child’s respiratory effort, breath sounds, and responsiveness. Physical exhaustion can diminish the intensity of retractions and stridor. As the child uses the remaining energy reserve to maintain ventilation, breath sounds may actually diminish. Noisy breathing (audible airway congestion, coarse breath sounds) in this situation verifies adequate energy stores. Responsiveness will decrease as hypoxemia increases.

### NURSING MANAGEMENT

#### Nursing Assessment and Diagnosis

The initial and ongoing physical assessment of the child with LTB focuses on adequacy of respiratory functioning. Table 25–7 provides guidelines for assessment and rationale for actions. Close monitoring is required to identify changes in airway patency. The child should be continuously monitored in the emergency department, short-stay observation area, or the PICU. Infants and preverbal toddlers require constant supervision to monitor respiratory status. A means of communication (sign language or simple word cues) must be established to enable the older child to alert nursing staff about respiratory difficulty.

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Planning and Implementation

Skillful nursing care can greatly assist children with LTB and their families to cope with the symptoms of the illness. Nursing care focuses on maintaining airway patency, promoting fluid balance, reducing stress, and teaching the family how to care for the child at home.

Maintain Airway Patency

Supplemental oxygen with humidity may be needed for hypoxemia. Allow the child to assume a position of comfort, which will most likely be sitting or lying with the head elevated. Administer medications. Cool mist is presumed to moisten airway secretions and soothe the inflamed mucosa; however, research has not revealed a significant benefit to this treatment (Perkin & Swift, 2002).

An important developmental consideration is the child’s ability to communicate reliably. The nurse must be immediately available to attend to the child’s respiratory needs during emergency department or outpatient care. If hospitalization is needed, place the child in a room near the nurses’ station and maintain emergency resuscitation equipment at the bedside. Parents are helpful in providing support to the child and alerting the nurse when the respiratory symptoms worsen.

Meet Fluid and Nutritional Needs

The illness preceding the emergency department visit may have compromised the child’s fluid status. Recognizing fluid deficit and monitoring the child’s hydration and nutritional status are essential. Respiratory distress can compromise the child’s ability and desire to drink fluids. Fluids promote liquification of secretions and provide calories for energy and metabolism. Children with LTB usually prefer cool, noncarbonated, nonacidic drinks such as apple juice or fruit-flavored drinks. Remember that gelatin, ice, and fruit-flavored ice pops are also fluids. Oral rehydration fluids may also be used. Parents can be encouraged to participate in gaining the child’s cooperation in taking oral fluids. An intravenous infusion may be necessary to rehydrate the child, maintain fluid balance, or provide emergency medication access. The child should be observed 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, the nurse should 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 the following occurs.

- Mild symptoms do not improve after 1 hour of humidity and cool air treatment.
- The child’s breathing is rapid and labored.
- The child does not drink adequate liquids, and urine output is reduced.

<table>
<thead>
<tr>
<th>MEDICATION</th>
<th>ACTION/INDICATION</th>
<th>NURSING CONSIDERATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beta-agonists and beta-adrenergics (e.g., albuterol, racemic epinephrine): aerosolized through face mask</td>
<td>Rapid-acting bronchodilator, decreases bronchial and tracheal secretions and mucosal edema, used to decrease symptoms of moderate to severe respiratory distress; and constriction of subglottic mucosa and submucosal capillaries. Used until dexamethasone begins working.</td>
<td>Provides only temporary relief; improvement in 30 minutes which lasts about 2 hours, it gives time for the steroid to work; the child may experience tachycardia (160–200 beats/min) and hypertension; dizziness, headache, and nausea may necessitate stopping medication; reduces the need for artificial airway.</td>
</tr>
<tr>
<td>Corticosteroids (e.g., dexamethasone): IM, PO Nebulized budesonide</td>
<td>Anti-inflammatory, used to decrease edema; has a long half-life of 36–54 hours.</td>
<td>The child may experience cardiovascular symptoms (hypertension); requires close observation for individual response; children less frequently need emergency airways; stridor resolves faster.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>TABLE 25–7</th>
<th>Nursing Assessment of Child with Respiratory Difficulty</th>
</tr>
</thead>
<tbody>
<tr>
<td>NURSING ACTION</td>
<td>RATIONALE</td>
</tr>
<tr>
<td>Assess heart rate and respiratory rate.</td>
<td>Tachypnea and tachycardia indicate increasing respiratory effort.</td>
</tr>
<tr>
<td>What is the child’s position (sitting, prone, or supine)?</td>
<td>Upright or semi-Fowler’s promotes airway patency; the child’s change to a more upright position may signal increased distress.</td>
</tr>
<tr>
<td>Assess overall quality of respiratory effort. Determine inspiratory and expiratory breath sounds, ability to speak, and presence of stridor, cough, retractions, nasal flaring, cyanosis.</td>
<td>Reflects overall adequacy of airway and respiratory function.</td>
</tr>
<tr>
<td>Initiate stridor severity assessment (Table 25–6), continue scoring every 30 minutes or more frequently if distress increases; initiate nursing actions appropriate for croup score.</td>
<td>Provides consistent and objective assessment data with score for future comparison.</td>
</tr>
<tr>
<td>Attach cardiorespiratory monitor and pulse oximeter.</td>
<td>Provides continuous assessment data as part of ongoing physiologic monitoring.</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 are managed with family support and explanations about care.

Epiglottitis (Supraglottitis)

Epiglottitis (also known as supraglottitis) is an inflammation of the tissues surrounding 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 25–5 compares epiglottitis and other croup syndromes.)

Etiology and Pathophysiology

Epiglottitis is caused by bacterial invasion of the soft tissue of the supraglottic area by streptococcus, staphylococcus, or by Haemophilus influenzae type B (Hib) in unimmunized children. The resulting cellulitis causes swelling in the tissues surrounding the epiglottis leading to airway obstruction. Since use of the Hib vaccine has become widespread, there has been a 10-fold decrease in the incidence of epiglottitis (Isaacson & Isaacson, 2003).

Clinical Manifestations

Characteristically, a previously healthy child suddenly becomes very ill. The child initially develops a high fever (greater than 39°C [102.2°F]), with a severe sore throat. The four classic signs of epiglottitis, in order of their appearance, are as follows:

- Dysphonia, muffled, hoarse, or absent voice sounds
- Dysphagia, difficulty in swallowing
- Drooling, the child refuses fluids or resists swallowing due to intense throat pain
- Distressed respiratory effort with inspiratory stridor

To fully open the airway and improve air intake, the child sits up and leans forward with the jaw thrust forward in the classic “sniffing” or tripod posture and refuses to lie down. The child’s anxiety increases as respiratory distress progresses.

NURSING MANAGEMENT

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

Nursing Assessment and Diagnosis

The child’s respiratory and airway status should be observed closely and often. The child often breathes slowly and with great concentration as the airway obstruction increases. Note any change in the child’s level of consciousness—from anxiety to lethargy to stupor as hypoxia increases.

Examples of nursing diagnoses include the following:

- Ineffective Airway Clearance related to increased swelling of the epiglottis and drooling
- Anxiety (child) related to increasing difficulty breathing
- Anxiety (parents) related to sudden onset of life-threatening illness

Planning and Implementation

Until intubated, the child is never left unattended or transported away from equipment or from personnel who can perform emergency airway interventions. Allow the child to sit upright or assume a position of comfort to maintain the airway patency.
and breathe more easily. Supplemental humidified oxygen may be used initially to reverse hypoxemia. Provide a quiet environment with as little stress as possible to decrease anxiety and crying. Anxiety-provoking procedures, such as venipuncture, are postponed until the airway is secure. Crying stimulates the airway, increases oxygen consumption, and can precipitate laryngospasm; the calmer the child, the better the respiratory function (Eichelberger, Ball, Pratsch, et al., 1998).

**PRACTICE ALERT**

Observe the child continuously for absence of voice sounds, increasing degree of respiratory distress, inability to swallow, and acute onset of drooling (an ominous sign of supraglottic obstruction). If any of these signs occur, get medical assistance immediately. The quieter the child, the greater the cause for concern.

Provide support to parents as they cope with the sudden onset of a life-threatening illness. Identify ways to help parents notify family members and ensure that other children are cared for during the crisis. Keep parents informed about the child’s status and permit them to stay with the child to help keep the child calm.

The child is often cared for in an intensive care unit after the airway has been stabilized. Administer prescribed antibiotics to treat the infection and IV fluids to provide hydration. Because the child was febrile with a sore throat before admission, fluid intake may have been compromised. Most children show rapid improvement once cool mist and oxygen, antibiotics, and fluid therapy are started. The endotracheal tube can usually be removed within 24 to 36 hours once the child is afebrile and swallowing comfortably (Hazinski, 1999).

The dyspnea and loss of voice, or even the inability to create sounds, can be frightening to a child. The unfamiliar hospital environment and strange equipment can create stress for child and parent alike. It is important to reassure the parents that the child’s voice loss is temporary and to explain the need for the various pieces of equipment. Home care may involve completing the course of antibiotics. Parents need instructions on proper administration and potential side effects of drug therapy.

**Evaluation**

Expected outcomes of nursing care include the following:

- The child’s acute infection resolves, the endotracheal tube is removed, and the voice returns.
- The parents cope effectively during the child’s illness and provide support to the child.

**Bacterial Tracheitis**

Bacterial tracheitis occurs as a secondary infection of the upper trachea following an initial viral laryngotracheitis. The secondary infection may be caused by *Staphylococcus aureus, alpha-hemolytic Streptococcus, group A Streptococcus, Moraxella catarrhalis, or Haemophilus influenzae*. The disorder starts with a viral upper respiratory infection, croupy cough, and stridor but progresses to include a high fever greater than 39°C (102.2°F), respiratory distress, and a toxic appearance (Stroud & Friedman, 2001). No drooling is present. Table 25–5 compares bacterial tracheitis and other croup syndromes.

Diagnosis is often made by blood cultures after the child is found unresponsive to usual LTB management. Endoscopic examination may be performed on children with minimal airway symptoms. The subglottis is edematous with ulceration, and thick mucopurulent exudate may obstruct the trachea and main bronchi. Culture and sensitivities are obtained.

Due to the similarity of symptoms, bacterial tracheitis is often misdiagnosed initially as LTB. Instead of improving with nebulized epinephrine, the child’s condition worsens. Antibiotics are given for 10 to 14 days. Most children are intubated for 3 to 11 days. Frequent suctioning, humidification, and monitoring for patency of the endotracheal tube are required.

**Nursing Management**

The child with bacterial tracheitis is frequently cared for in the intensive care unit after intubation. The child must have airway patency assessed frequently. Airway maintenance is often required because of the thick tracheal secretions that pool high in the upper airway. Since most children need to be intubated for 3 to 11 days, monitor the patency of the endotracheal tube, suction as needed, and provide humidified air or oxygen. Mechanical suctioning helps remove the thick secretions to help maintain the airway. Children generally prefer lying flat to sitting up. This seems to be a position of comfort that allows the child to conserve energy. Antibiotics are administered as ordered.

The earlier section on epiglottitis discusses other nursing care interventions that may also be appropriate for the child with bacterial tracheitis.

**LOWER AIRWAY DISORDERS**

The lower airway, or bronchial tree, lies below the trachea and includes the bronchi, bronchioles, and alveoli. Lower airway disorders occur because a structural or functional problem interferes with the lungs’ ability to complete the respiratory cycle. Lower airway disorders include neonatal respiratory distress syndrome, meconium aspiration, transient tachypnea of the newborn, bronchitis, bronchiolitis, pneumonia, and tuberculosis.

**Neonatal Respiratory Distress Syndrome**

Neonatal respiratory distress syndrome (RDS), also known as hyaline membrane disease, manifests during the first hours of life in preterm newborns with surfactant deficiency. RDS is the most common cause of respiratory failure and death in the newborn, accounting for 20% to 30% of preterm newborn deaths (Froh, 2002). RDS is more common in Whites and males.

**Etiology and Pathophysiology**

In utero, the fetal lungs are filled with fluid. When the infant takes the first breath after birth, this fluid is expelled from the alveoli. Most of the fetal lung fluid is moved to the interstitial spaces and absorbed. A small amount is expelled in a term birth,
but less is expelled by preterm newborns because of the lack of mechanical forces during passage through the birth canal. With the onset of breathing, inspiration and negative thoracic pressures fill the alveoli with air. When the surface tension of the lung tissue is high, the alveoli are difficult to inflate.

Surfactant is a substance that lowers the surface tension of the alveoli and prevents the interior walls of the alveoli from adhering. Pulmonary surfactant consists of 90% lipid and 10% protein. It plays a major role in development of the normal surface lining layer of the lung (Krauss, 2003). Without sufficient surfactant, fluid droplets remaining in the alveoli cause the surface tension to increase and the sides of the alveoli collapse or stick together on expiration. Significant negative pressure is needed for the newborn to breathe and reopen the alveoli. This is difficult due to the compliant chest wall and stiff lungs, leading to atelectasis (collapse of a portion of the lung). Atelectasis actually results because of surfactant depletion. As a consequence the newborn uses more energy to exert this negative pressure and becomes exhausted and is unable to sustain the work of breathing. Fatigue associated with respiratory effort results in decreased air movement and hypoxia. The hypoxia and atelectasis lead to vasoconstriction of the pulmonary vascular beds, increased pulmonary vascular resistance, respiratory acidosis, and partial return to fetal circulation. (See information on fetal circulation in Chapter 26.) Metabolic acidosis develops following a prolonged lack of oxygen at the cellular level. Several factors are associated with the development of chronic lung disease following RDS such as long-term ventilatory support, oxygen administration, and infections.

**Clinical Manifestations**

Signs and symptoms appear apparently shortly after birth. They include tachypnea (at rates greater than 60 breaths/min), nasal flaring, intercostal and subcostal retractions, expiratory grunting, crackles, cyanosis, slow capillary refill, paradoxical breathing (in which the chest falls and the abdomen rises on inspiration), decreased breath sounds, and labored breathing. Apnea and irregular breathing are seen as the newborn tires.

**NURSING MANAGEMENT**

The newborn is cared for in a neonatal intensive care nursery. The respiratory status of the infant with RDS is closely monitored. Nursing assessment focuses on identifying changes in respiratory status such as quality of respirations and pulse, grunting respirations, nasal flaring, retractions, apnea, overall color, signs of dehydration, and changes in the infant’s behavior. Pulse oximetry and blood gases are monitored to aid in assessment. Care of the infant is organized to eliminate unnecessary physical stimulation, as this additional stress contributes to respiratory compromise. The infant is usually placed in a warmer to stabilize the temperature and to reduce metabolic demands. Fluid management is critical as excess fluids can lead to pulmonary edema. Provide fluids and nutrition to help meet energy needs. Position the infant to facilitate breathing. Parents need clear explanations about the infant’s health status and planned interventions. By remaining available to parents and answering their questions, the nurse establishes a positive relationship and facilitates essential communication.

Due to the potential for respiratory distress and chronic lung disease after discharge, parents should be taught CPR and oxygen administration if ordered. The infant also has apnea or if supplemental oxygen is ordered, a home apnea monitor may be used. Some monitors permit data to be downloaded enabling the healthcare provider to evaluate the frequency and length of apnea spells that occur at home. Home care nursing may be needed to provide follow-up support. Parents may benefit from a referral to a support group.

**Meconium Aspiration Syndrome**

Meconium is the greenish-black, sticky material present in the bowels of the fetus. It consists of amniotic fluid, mucus, lanugo, bile, exfoliated cells, glycoproteins, various enzymes, minerals, and lipids. In cases of fetal distress, the meconium may be released into the amniotic fluid and then aspirated in utero, during labor, or during delivery. Amniotic fluid is stained by meconium in 8% to 19% of term deliveries, and the risk increases with advancing gestational age. Thicker meconium-stained amniotic fluid and a longer duration of exposure to it increase the risk for developing meconium aspiration syndrome. As many as 33% of infants born with meconium-stained amniotic fluid may develop meconium aspiration syndrome (Fuloria & Wiswell, 2000).
**Etiology and Pathophysiology**

Meconium aspiration can lead to partial or complete airway obstruction, atelectasis, air trapping with increased functional residual capacity, and air leaks. Meconium causes a chemical inflammation of the airway leading to pulmonary edema, and cellular necrosis. Meconium interferes with the production of surfactant and its ability to reduce the surface tension of pulmonary fluids. Air can be inhaled but not exhaled, leading to distention and rupture of the alveoli. This can cause air leaks, pneumomediastinum, or a pneumothorax. Nearly one third of infants with meconium aspiration syndrome develop persistent pulmonary hypertension with persistent fetal circulation. See Chapter 26 for more information. All of these pathophysiologic changes lead to hypoxia, hypercapnia, and respiratory and metabolic acidosis.

**Clinical Manifestations**

Newborns have respiratory distress with tachypnea, grunting, flaring, retractions, and cyanosis. Yellowish staining of the skin, nails, and umbilical cord is usually present because of meconium in the amniotic fluid. Typical findings on chest radiograph are patchy infiltrates, areas of consolidation, and hyperinflation. Signs of neurologic depression are also apparent. Grunting slows the expiratory flow and increases the lung volume and alveolar pressures. This sign of severe disease suggests the onset of respiratory failure (Margolis & Gadomski, 1998).

### COLLABORATIVE CARE

A chest radiograph will be obtained to identify if a pneumothorax or air leak is present. An umbilical arterial line is inserted to monitor the arterial blood pressures, blood pH, and blood gases as needed.

Newborns with meconium-stained amniotic fluid must have the nasal and oral pharyngeal airways suctioned as soon as the baby’s head is delivered in an effort to reduce aspiration. Newborns with depressed respiratory or neurologic function are aggressively resuscitated after thorough suctioning is completed. Immediate tracheal suctioning and intubation of infants born through meconium-stained amniotic fluid is performed when the newborn has depressed respirations or requires positive pressure ventilation soon after birth. IV fluids, blood, and medications are infused through an umbilical arterial line. Surfactant replacement therapy may be used. Other therapies are under investigation, such as bronchoalveolar lavage, glucocorticoids, and nitrous oxide. If the newborn progresses to respiratory failure and is not responding to other therapies, transfer to a neonatal intensive care unit for nitric oxide or extracorporeal membranous oxygenation (ECMO) therapy may be necessary.

### NURSING MANAGEMENT

The newborn with meconium aspiration syndrome is cared for in a neonatal intensive care nursery. Nursing management follows guidelines previously described for RDS. Actions involve carefully assessing and monitoring the newborn for hypoglycemia, signs of complications, and response to treatment. Regulation of the environmental temperature and maintenance of adequate oxygenation and ventilation are essential. Caloric requirements, IV fluids, and medication administration are priorities of nursing care.

Provide support to families who must cope with suddenly changed expectations about having a healthy baby. Help them understand the infant’s health problems and rationale for the treatment provided.

### Transient Tachypnea of the Newborn

Transient tachypnea of the newborn is a progressive respiratory distress disorder that commonly develops in near-term infants that is sometimes difficult to distinguish from RDS. The disorder often follows a preterm or term newborn delivery that was uneventful.

**Etiology and Pathophysiology**

The primary cause of this disorder is failure to clear the airway of fetal lung fluid, mucus, or other debris. Alternatively excess fluid may be in the lungs because amniotic fluid or tracheal fluid is aspirated. The lung fluid is believed to decrease pulmonary compliance (increased lung stiffness) and tidal volume while increasing dead space. Vaginal-birth newborns less commonly develop the disorder because their thorax is compressed during delivery, forcing out some of the lung fluids. Other newborns at risk include those with intrauterine asphyxia due to maternal oversedation, maternal bleeding, prolapsed cord, breech birth, or maternal diabetes (Ladewig, London, Moberly, et al., 2002).

**Clinical Manifestations**

The newborn has no initial breathing difficulties at birth. Shortly after birth respiratory distress develops with signs including expiratory grunting, nasal flaring, retractions, and mild cyanosis when on room air. Tachypnea with rates up to 100 to 140 breaths per minute develops within 6 hours of birth. No crackles or rhonchi are heard on auscultation. These infants often do not appear to be severely ill. Condition improvement begins by 8 to 24 hours of age. Recovery is usually sudden within 72 hours of age.

### COLLABORATIVE CARE

Diagnosis is based on absence of adventitious breath sounds and chest radiograph. Blood gas and electrolyte levels may be obtained. Radiograph findings reveal prominent vascular markings, hyperaeration of the alveoli, and a flattened diaphragm contour. The chest radiograph findings clear within 48 to 72 hours. Clinical therapy sometimes involves supplemental oxygen (usually less than 40% concentration), fluids, and electrolytes.

### NURSING MANAGEMENT

Nursing assessment and management for transient tachypnea of the newborn is the same as for RDS during the acute care phase. Monitor and identify changes in newborn’s respiratory status, as well as fluid and electrolyte levels. Attach a cardiorespiratory monitor and pulse oximeter. Monitor oxygen delivery and infant’s response to supplemental oxygen.
RSV by 2 years of age, and reinfection (via siblings or close family contacts) throughout life is common (National Respiratory and Enteric Virus Surveillance System, 2000). RSV is the most common cause of lower respiratory tract infections in infants and children. RSV causes severe or fatal illness in infants with conditions such as congenital heart disease, bronchopulmonary dysplasia (BPD), prematurity, and immunosuppression.

Viruses 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 response by the bronchioles, the actual effect is partial airway obstruction during expiration 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. Atelectasis occurs in some areas and air trapping and hyperinflation in others. Hypoxemia results because of the ventilation-perfusion mismatch. See page 99. The child with RSV is therefore at risk for respiratory failure as the oxygen level decreases and the carbon dioxide level increases. Apnea and pulmonary edema may occur.

**Clinical Manifestations**

The infant or child with bronchiolitis may have been ill with upper respiratory symptoms such as nasal stuffiness, cough (not usually noted in infants), and fever (less than 39°C [102.2°F]) for a few days. As the illness progresses and the lower respiratory tract becomes involved, symptoms increase and include rhinitis, low-grade fever, inspiratory and expiratory wheezing; a deeper, more frequent cough; tachypnea; retractions; and more labored breathing. In severe cases, signs and symptoms include rapid, shallow respirations, nasal flaring and marked retractions, crackles, cyanosis, and decreased breath sounds. As the airflow continues to decrease, breath sounds diminish. Thus the noisier the lungs, the better, as this indicates that the child is still able to move air in and out of the lungs.

Dehydration may be present if the child has been sick for several days. Abdominal distention may occur due to air swallowing. 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. Airway hyperresponsiveness may persist for weeks after the virus has resolved.

**Collaborative Care**

Care is focused on providing oxygen, fluids, and medications to support the infant and young child until the infection resolves.
Diagnostic Procedures
The history and physical examination provide the data needed to diagnose bronchiolitis. Laboratory tests that are used to identify the virus causing bronchiolitis include enzyme-linked immunosorbent assay (ELISA) or direct fluorescent assay that can provide information in a few hours. The assays are performed on nasal wash specimens placed in viral transport medium. Chest radiographs show hyperinflation, patchy atelectasis, and other signs of inflammation.

Clinical Therapy
Children who test positive for RSV are isolated, roomed together, or placed on the same unit to minimize the spread of the virus to other hospitalized children. Oxygen administration and supportive care are provided, especially when the causative agent is unknown and the condition is mild to moderate in severity. See Table 25–8 for additional clinical therapies.

Various medications may be prescribed for RSV and bronchiolitis in an effort to treat symptoms and shorten the course of the infection. Bronchodilators, nebulized epinephrine, and corticosteroids are occasionally used, but effectiveness has not been documented by studies. Research continues to be conducted to identify medications that might be effective in treating bronchiolitis, such as oral dexamethasone and montelukast. Antibiotics are not used routinely unless the child also has a bacterial infection.

The child with apnea or respiratory failure will be cared for in the critical care unit and may be intubated and ventilated. Ribavirin is an antiviral drug specifically available for RSV treatment, and acts to slow viral replication. Because studies have not confirmed its effectiveness, it is reserved for life-threatening cases, such as infants with complicated congenital heart disease, BPD, cystic fibrosis, or other chronic lung disease (Wright, Pomerantz, & Luria, 2002).

While RSV bronchiolitis resolves in 5 to 7 days, increased airway resistance and airway hypersensitivity may persist for weeks or even months. Some evidence suggests that bronchiolitis in infancy may increase the risk for childhood wheezing and asthma. It also may be a major risk factor for chronic obstructive pulmonary disease later in life (Webster & Huether, 1998).

Prevention of RSV is a focus for children under 2 years of age at high risk for severe bronchiolitis caused by RSV. The characteristics of children who fall into this high-risk category are the following (American Academy of Pediatrics Committee on Infectious Diseases and Committee on Fetus and Newborn, 2003a):

- Prematurity—born at 32 week’s gestation or earlier, particularly if less than 6 months of age at the start of the RSV season
- Chronic lung disease such as BPD who have required supplemental oxygen, bronchodilator, diuretic or corticosteroid therapy within 6 months of the start of RSV season
- Complicated congenital heart disease, particularly those on medication to control congestive heart failure, with cyanosis, and with moderate to severe pulmonary hypertension
- Immunocompromised infants and children

Intravenous RSV immune globulin (Respigel) or intramuscular palivizumab (Synagis) may be used for prophylaxis for the above group of children under 2 years of age. Prophylactic treatment is expensive, so it is limited to high-risk children. Monthly treatment for 5 months beginning in October or November is initiated at the onset of the RSV season and terminated at the end of the RSV season. Monthly treatment has been associated with reduced hospitalization of high-risk infants. Palivizumab is preferred treatment because it is easier to administer and has fewer side effects.

### TABLE 25–8  Clinical Therapy for Bronchiolitis

<table>
<thead>
<tr>
<th>COLLABORATIVE CARE</th>
<th>RATIONALE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cardiorespiratory monitor and pulse oximeter</td>
<td>Enable provider to follow course and assess need for specific therapies.</td>
</tr>
<tr>
<td>Humidified oxygen therapy by hood or face tent, mask or nasal cannula</td>
<td>Delivery method chosen based on desired concentration of oxygen, degree of humidity, and child’s response.</td>
</tr>
<tr>
<td>Intubation and assisted ventilation (PEEP/CPAP)</td>
<td>Used when the child becomes too fatigued to breathe effectively.</td>
</tr>
<tr>
<td>Hydration with intravenous or oral fluids</td>
<td>Provider must consider insensible fluid loss, decreased intake, the child’s current electrolyte and hydration status, and risk for pulmonary edema.</td>
</tr>
<tr>
<td>Postural drainage and chest physiotherapy</td>
<td>Helps to further loosen and mobilize trapped mucus.</td>
</tr>
<tr>
<td>Systemic medications</td>
<td>Symptomatic treatment may include antipyretics (acetaminophen or ibuprofen preferred; no antibiotics are given unless evidence of secondary bacterial infection [e.g., otitis media] is present). Bronchodilators, nebulized epinephrine, and corticosteroids are occasionally used.</td>
</tr>
</tbody>
</table>

**High-Risk Infant or Child**

- RSV immune globulin (Respigam) IV
- Palivizumab (Synagis) IM

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*Defined as a child with congenital heart disease, bronchopulmonary dysplasia, chronic lung problems, or cystic fibrosis or who is premature or severely ill and less than 6 weeks old.
side effects. Palivizumab does not interfere with vaccine administration, but children receiving RSV immune globulin should wait 9 months before receiving the live virus vaccines (MMR and varicella). Children under 2 years of age with complicated cyanotic or congenital heart disease should only receive palivizumab. Children with severe immunodeficiencies receiving immune globulin monthly could have RSV immune globulin substituted during RSV season (American Academy of Pediatrics Committee on Infectious Diseases and Committee on Fetus and Newborn, 2003a).

**NURSING MANAGEMENT**

An important nursing role is prevention of RSV by educating parents and caregivers about methods to reduce exposure and transmission of the disease by frequent handwashing, eliminating exposure to crowds and other children, as well as cigarette smoke.

**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 distress (see Box 25–1 and the clinical manifestations table on page 100). A decreased oxygen saturation level below 90% is the best indicator of the severity of the disease.

**PRACTICE ALERT**

Signs of life-threatening illness in the infant with bronchiolitis include central cyanosis, respiratory rate greater than 70 breaths per minute, listlessness, and apneic spells. The chest is hyperinflated and air exchange is so poor that breath sounds are very diminished on auscultation.

The nurse may be asked to obtain the nasal wash specimen. Use standard precautions. Instill 1 to 2 drops of sterile saline without preservative into each naris. Then gently suction nasal contents using an 8 French catheter attached to a suction trap. Follow hospital guidelines for adding viral transport medium and transport to the laboratory. The child may have increased coughing and nasal secretions after the procedure.

**Psychosocial Assessment**

Children and their parents should be observed for signs of fear and anxiety (Box 25–6). 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 lists common nursing diagnoses for the child with bronchiolitis. The following diagnoses might also be appropriate.

- Ineffective Airway Clearance related to increased airway secretions, fatigue from coughing and dyspnea, and air trapping

**BOX 25–6  Psychosocial Assessment of the Child with an Acute Respiratory Illness**

<table>
<thead>
<tr>
<th>CHILD</th>
<th>PARENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>➤ Assess for indications of anxiety or fear that may have an impact on respiratory status.</td>
<td>➤ Assess parents’ reactions: Are they anxious? Fearful? Verbal or quiet? Asking appropriate questions?</td>
</tr>
<tr>
<td>➤ For young children, inquire about security objects (such as a blanket or doll), the child’s reaction to strangers, and reaction to absence of parents.</td>
<td>➤ Observe for nonverbal cues. Often parents have financial worries (cost of hospital stay, lost work and wages) and personal worries (siblings at home who are ill) that they may not readily share with staff.</td>
</tr>
</tbody>
</table>

**Planning and Implementation**

Nursing management 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. Refer to the accompanying nursing care plan, which summarizes nursing care for the child with bronchiolitis.

**Maintain Respiratory Function**

Close monitoring is essential to evaluate the child’s improvement or to spot early signs of deterioration. Oxygen and pulmonary care therapies are administered. High humidity and supplemental oxygen may be provided with a mist tent if the child requires only moisture and minimal oxygen. If more concentrated oxygen is required, it can be given via nasal cannula, hood, or tent. Pulse oximetry is used to evaluate oxygenation.

Patent nares are important to promote oxygen intake. A bulb syringe and saline nose drops can be used to quickly and easily clear the nasal passages. The head of the bed should be elevated to ease the work of breathing and drain mucus from the upper airways. Chest physiotherapy is often administered by a respiratory therapist.

**Support Nutrition**

Infants may have feeding difficulties and are at risk for aspiration. Smaller volumes and more frequent feedings will help conserve energy for infants with bronchiolitis who are formula and breastfed. Thickened formula may improve swallowing and prevent aspiration in infants with RSV bronchiolitis (Gadomski, 2002).
### 1. Ineffective Breathing Pattern related to increased work of breathing and decreased energy (fatigue)

<table>
<thead>
<tr>
<th>GOAL</th>
<th>INTERVENTION</th>
<th>RATIONALE</th>
<th>EXPECTED OUTCOME</th>
</tr>
</thead>
<tbody>
<tr>
<td>NIC Priority Intervention—Respiratory monitoring: Collection and analysis of patient data to ensure airway patency and adequate gas exchange.</td>
<td>The child will return to respiratory baseline. The child will not experience respiratory failure.</td>
<td>Changes in breathing pattern may occur quickly as the child’s energy reserves are depleted. Assessment and monitoring baseline reveal rate and quality of air exchange. Frequent assessment and monitoring provides objective evidence of changes in the quality of respiratory effort, enabling prompt and effective intervention.</td>
<td>The child returns to respiratory baseline within 48–72 hours.</td>
</tr>
<tr>
<td>The child’s oxygenation status will _return_to_baseline.</td>
<td>• Assess respiratory status (Box 25–1) when child is calm and not crying a minimum of every 2–4 hours, or more often as indicated for an increasing or decreasing respiratory rate and episodes of apnea. Cardiorespiratory monitor and pulse oximeter attached with alarms set. Record and report changes promptly to physician.</td>
<td>Humidified oxygen loosens secretions and helps maintain oxygenation status and ease respiratory distress.</td>
<td>The child’s respiratory effort eases. Pulse oximetry reading remains ≥ 95% oxygen saturation during treatment.</td>
</tr>
<tr>
<td></td>
<td>• Administer humidified oxygen via mask, nasal cannula, hood, or tent.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Assess pulse oximetry on room air and compare to reading when child is on oxygen.</td>
<td>Comparison of pulse oximetry readings provides information about improvement status.</td>
<td>The child tolerates therapeutic measures with no adverse effects.</td>
</tr>
<tr>
<td></td>
<td>• Note child’s response to ordered medications.</td>
<td>Medications act systemically to improve oxygenation and decrease inflammation.</td>
<td></td>
</tr>
<tr>
<td></td>
<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 (especially in toddlers) and energy expenditure.</td>
<td>The child rests quietly in position of comfort.</td>
</tr>
<tr>
<td></td>
<td>• Assess tolerance to feeding and activities.</td>
<td>Provides an assessment of condition improvement.</td>
<td></td>
</tr>
</tbody>
</table>

### 2. Risk for Imbalanced Fluid Volume related to inability to meet body requirements and increased metabolic demand

<table>
<thead>
<tr>
<th>GOAL</th>
<th>INTERVENTION</th>
<th>RATIONALE</th>
<th>EXPECTED OUTCOME</th>
</tr>
</thead>
<tbody>
<tr>
<td>NIC Priority Intervention—Fluid management: Promotion of fluid balance and prevention of complications resulting from abnormal or undesired fluid levels.</td>
<td>Child’s immediate fluid deficit is corrected.</td>
<td>Previous fluid loss may require immediate replacement.</td>
<td>Child’s hydration status is maintained during acute phase of illness.</td>
</tr>
<tr>
<td></td>
<td>Evaluate need for intravenous fluids. Maintain IV, if ordered.</td>
<td>Assessment ensures child receives appropriate fluids to maintain hydration while transitioning to oral fluids.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Calculate maintenance fluid requirements and give oral and/or IV fluids.</td>
<td>Monitoring provides objective evidence of fluid loss and ongoing hydration status.</td>
<td>Child takes adequate oral fluids after 24–48 hours to maintain hydration.</td>
</tr>
<tr>
<td>Child will be adequately hydrated, be able to tolerate oral fluids, and progress to normal diet.</td>
<td>Maintain strict intake and output monitoring and evaluate specific gravity at least every 8 hours.</td>
<td>Further evidence of improvement of hydration status.</td>
<td>Child’s weight stabilizes after 24–48 hours; skin turgor is supple.</td>
</tr>
<tr>
<td></td>
<td>Perform daily weight measurement on the same scale at the same time of day. Evaluate skin turgor.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<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>The child accepts beverage of choice from parent or nursing staff.</td>
</tr>
</tbody>
</table>
Support Physiologic Function

The grouping of nursing tasks promotes the child’s physiologic function by decreasing stress and promoting rest. Rest is a key component in improving the child’s breathing and overall health. Medications may be administered to control fever and promote comfort as needed. An intravenous infusion may be ordered to rehydrate and maintain fluid balance until the child is capable of taking sufficient oral fluids.

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 and the presence of assistive equipment at bedside. An important part of nursing care is anticipating, recognizing, and acting to decrease the child’s and parents’ anxiety. Provide parents with regular updates and explanations, and answer questions they may have about planned care.

Partner with parents to care for the child in the hospital. Their presence and ability to calm the infant or child can be helpful in the child’s recovery. They should be reassured that holding or touching the child will not dislodge wires or tubing. 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 facilitates 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 show sufficient stability in maintaining adequate oxygenation (as evidenced by easing of respiratory effort and decreased mucous production). In most children, symptoms decrease within 24 to 72 hours; however, resolution of all symptoms may take weeks. Coughing may continue for a few weeks postdischarge. The same supportive therapies implemented in the hospital may be needed at home.

- Use of the bulb syringe to suction the nares of an infant under 1 year of age
- Fluid intake to thin respiratory secretions (making them easier to clear) and provide sucrose in water for energy (since the child’s appetite may not return to normal for several days)
- Rest

Children are usually capable of recognizing their own activity limits. However, parents should encourage active toddlers to nap and take rest periods. Teach the parents proper administration of medications. Acetaminophen may be prescribed for persistent low-grade fevers and general discomfort.
Advise parents that RSV infection can recur; therefore, they need to know how to recognize symptoms and when to call the physician. See Partnering with Families: Recognizing Worsening Condition in the Child with Bronchiolitis.

### Evaluation

Expected outcomes of nursing care are provided on the accompanying nursing care plan.

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### Pneumonia

Pneumonia is an inflammation or infection of the bronchioles and alveolar spaces of the lungs. It occurs most often in infants and young children. The incidence of pneumonia in the United States is 35 to 40 cases for every 1,000 children younger than 5 years of age, and 16 to 22 years for every 1,000 children older than 5 years of age (Patel & Turcios, 2003). Pneumonia in children often resolves much sooner than in adults. The key is early recognition, enabling most children to be managed at home rather than in the hospital. Risk factors for developing pneumonia include chronic lung disease, anatomic problems, gastroesophageal reflux with aspiration, neurologic disorders that compromise the airway, and altered immune status (Sectish & Prober, 2004).

### Etiology and Pathophysiology

Infectious organisms that can cause pneumonia are viral, bacterial, mycoplasmal, and fungal. In children under 5 years, pneumonia is most often caused by viruses such as RSV, influenza, parainfluenza virus, adenovirus, rhinovirus, and enterovirus. Bacteria more commonly cause pneumonia in children over 5 years of age. Common bacterial organisms include the following:

- *Staphylococcus aureus* is a common complication of viral pneumonia.
- *Streptococcus pneumoniae* is a common bacterial cause of pneumonia in all age groups, but it is anticipated that a decline in incidence should occur as more children are immunized.
- *Group B streptococci* and *Chlamydia trachomatis* are common causes of pneumonia in newborns.
- *Hemophilus influenza type b* is now an uncommon cause in immunized children.

*Mycoplasma pneumoniae* is a common cause of pneumonia in school-age children. Children with an underlying illness such as cystic fibrosis or immunosuppression are susceptible to many other bacterial, parasitic, or fungal infections.

### Bacterial Pathophysiology

Bacterial invaders circulate through the bloodstream to the lungs, where they damage cells. An inflammatory response and edema usually result. Cellular debris and mucus cause airway obstruction. This leads to the proliferation of organisms that spread to nearby areas. Bacteria tend to be distributed evenly throughout one or more lobes of a single lung, a pattern termed unilateral lobar pneumonia.

### Viral Pathophysiology

Viruses frequently enter from the upper respiratory tract, infiltrating the alveoli nearest the bronchi of one or both lungs. They invade the cells, replicate, and burst out forcefully, killing the cells and sending out cell debris. Airway obstruction occurs due to swelling and cellular debris. The viral cells rapidly invade adjacent areas, distributing themselves in a scattered, patchy pattern, often referred to as bronchopneumonia. The small airway in infants increases the risk for progression to atelectasis, edema, and a ventilation-perfusion mismatch. The resulting lung injury makes the child susceptible to secondary bacterial pneumonia.

### Aspiration Physiology

Aspiration of materials, such as foods, emesis, gastric reflux, or hydrocarbons, causes a chemical lung injury and resulting inflammatory response. Often the pH of the material is related to the severity of the chemical injury and pneumonitis, with a lower pH (acidic) causing greater irritation. Newborns may aspirate amniotic fluid and debris during birth, and develop pneumonia as a secondary infection. Hypoxemia, atelectasis, hemorrhagic pneumonitis, necrosis of damaged airway tissues, intravascular fluid shifts, and pulmonary edema may result. The stage is then set for a secondary bacterial invasion.

### Clinical Manifestations

Pneumonia is often preceded by an upper respiratory tract infection including rhinitis and a cough. Regardless of the causative agent, symptoms include fever (usually a lower temperature is associated with viral pneumonia), crackles, wheezes, cough, dyspnea, tachypnea, restlessness, and decreased breath sounds if consolidation exists. Newborns and infants may have grunting, nasal flaring, irritability, lethargy, and a diminished appetite. Diminished breath sounds may be noted. Children with bacterial pneumonia may have chest pain and try to splint the chest when coughing. As the condition increases in severity, the infant or child will have increased work of breathing, cyanosis, retractions, and use of accessory muscles. See the clinical manifestations table on page 122.
**CLINICAL MANIFESTATIONS of Pneumonia by Causative Organism**

<table>
<thead>
<tr>
<th>ETIOLOGY</th>
<th>CLINICAL MANIFESTATIONS</th>
<th>CHEST RADIOGRAPH FINDINGS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mycoplasma pneumoniae</td>
<td>Insidious onset, malaise, muscle aches, headache, fever, sore throat, rhinorrhea, dry hacking cough that becomes productive, fine crackles, anorexia.</td>
<td>Patchy infiltrates and mild pleural effusions</td>
</tr>
<tr>
<td>Viral pneumonia</td>
<td>Sudden or insidious onset, rhinitis, slight cough that may become productive, fever and chills, crackles, and wheezes.</td>
<td>Hyperinflation and diffuse, patchy infiltrates</td>
</tr>
<tr>
<td>Streptococcus pneumoniae</td>
<td>Sudden onset, high fever, cough, shaking, chills, chest pain, nasal flaring, retraction, fine crackles, dullness on percussion, fremitus.</td>
<td>Lobar consolidation</td>
</tr>
<tr>
<td>Staphylococcus aureus</td>
<td>Upper respiratory infection and abrupt change in condition, high fever, cough, shaking, chills, lethargy, chest pain, nasal flaring, retraction, fine crackles, dullness on percussion, fremitus.</td>
<td>Limited patchy infiltrate, usually only right lung involved.</td>
</tr>
<tr>
<td>Chlamydia pneumoniae</td>
<td>Insidious onset, minimal or absent fever, tachypnea, malaise, persistent cough, pharyngitis.</td>
<td>Pleural effusions and lobar infiltrates</td>
</tr>
</tbody>
</table>

**Diagnostic Procedures**
Diagnosis is made based on history, physical signs and symptoms. Chest radiography helps distinguish the type of pneumonia present. See the clinical manifestations above for characteristic findings. The child's age, severity of symptoms, and presence of an underlying lung, cardiac, or immunodeficiency disease may result in some children having variations from classical clinical findings. Children with recurrent pneumonia (two or more episodes in a year or a lifetime total of three or more episodes) need to be evaluated for immunodeficiency syndromes, foreign-body aspiration, obstruction or compression of the airway, structural abnormality, cystic fibrosis, and asthma.

**Clinical Therapy**
Clinical management for all types of pneumonia includes symptomatic therapy (pain and fever control) and supportive care through airway management, fluids, fever management, and rest. Mycoplasma and bacterial pneumonias are treated with organism-sensitive antibiotics; viral pneumonias usually improve without antibiotics, but antibiotics may be ordered if secondary bacterial invasion is suspected. Infants and children with severe infections will be hospitalized to monitor the condition and observe for increased respiratory distress. Some children need oxygen and IV fluids to maintain hydration.

**NURSING MANAGEMENT**
Most children with pneumonia are cared for at home. For those infants and children who are hospitalized, the goal of nursing care is to monitor the child’s condition for increasing respiratory distress and to restore optimal respiratory function.

**Nursing Assessment and Diagnosis**
Assess the infant’s or child’s condition, 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.

Examples of nursing diagnoses include the following:
- Fatigue related to respiratory distress and coughing
- Ineffective Breathing Pattern related to constant coughing and inability to clear airways
- Risk for Deficient Fluid Volume related to increased metabolic rate, fever, and anorexia

**Planning and Implementation**
Assist the child to take deep breaths to fully aerate the lungs and to promote coughing to clear secretions and cellular debris. Teach the child and parent how to splint the chest, by hugging a small pillow, teddy bear, or doll, to make coughing less painful. Pain medication (acetaminophen or ibuprofen) can provide the added benefits of temperature control and may aid in sleep.

Maintain hydration by offering preferred clear fluids. Administer IV fluids when the infant or child is unable to maintain an adequate fluid intake. Encourage small amounts of soft foods when tolerated. Give medications as prescribed.

**Discharge Planning and Home Care Teaching**
Discharge planning should be addressed early in the hospital stay. Medications, especially antibiotics, must be taken at prescribed intervals and for the full course. Make sure parents learn the proper administration of drugs and any side effects. Inform parents of signs indicating the infant’s or child’s condition may be worsening that need immediate care, such as increased difficulty breathing and refusal to take fluids. A chest radiograph may be obtained during a follow-up visit to see if the lungs are clear. Symptoms of pneumonia usually disappear long before the lungs are completely healed. Some children continue to have worsening reactive airway problems or abnormal results on pulmonary function tests. Most children, however, recover uneventfully.

Preventive measures against pneumonia are limited; however, the Hemophilus influenza b vaccine has dramatically re-
TB sends out tiny droplets of moisture that remain in the air. If these droplets are inhaled, the bacillus is small enough to travel through the airways and reach the alveoli. Four factors are associated with the transmission of TB. Pulmonary infection occurs only when the bacillus reaches the alveoli. Length of time the exposed person breathes the contaminated air

Immune status of the exposed person (a person with a compromised immune status or HIV infection is more likely to develop active TB if infected)

Once the bacillus reaches the alveoli, an immune response is initiated and macrophages are sent to kill it. If the bacillus survives, it begins to multiply within the macrophage that has surrounded it and walled it off in small hard capsules, called tubercles. The tubercle bacillus grows slowly, dividing every 25 to 32 hours within the macrophage. The organisms grow for 2 to 12 weeks until they number 1,000 to 10,000. At this point, the cellular immune response to TB can be elicited by a response to the TB skin test. However, before the development of cellular immunity, the tubercle bacilli may spread by the lymphatic system to the hilar lymph nodes and then to the bloodstream and to other sites. Children have a greater risk for developing extrapulmonary TB, such as TB meningitis and miliary (disseminated) TB (Maltezou, Spyridis, & Kafetzis, 2000).

In persons with intact cell-mediated immunity, activated T cells and macrophages form granulomas that limit multiplication and spread of the organism. Proliferation of TB is arrested once cell-mediated immunity develops, but small numbers of viable bacilli may remain in the granuloma. These individuals have latent tuberculosis infection rather than active disease, and thus are not infectious and cannot transmit the disease.

In young children, the disease develops as an immediate complication of the primary infection. Children with HIV infection or immunosuppression may have more rapidly progressive disease. If the tubercle extends into a blood vessel, the bacillus may spread through the bloodstream to affect the liver, spleen, kidney, bone marrow, or meninges (tubercular meningitis). This systemic form of TB (meningeval or miliary tuberculosis) may lead to serious illness or death.

**Clinical Manifestations**

Infants, children, and adolescents with latent TB (exposed and infected) are asymptomatic. If the disease develops, signs and symptoms may appear between 1 and 6 months after becoming infected. Infants with TB may have a persistent cough, weight loss or failure to gain weight, and fever. Wheezing, crackles, and decreased breath sounds may be present. Children with active TB may have fatigue, cough, anorexia, weight loss or growth delay, night sweats, chills, and a low-grade fever.

**Diagostic Procedures**

TB is diagnosed by a positive tuberculin skin test (5 tuberculin units of purified protein derivative [PPD]) that is injected intradermally. See Box 25–7 for interpretation of PPD tests. A positive test indicates that the child has been exposed to and infected with TB, and antibodies have been produced against the bacillus. See Table 25–9 for current recommendations for PPD skin testing in children. Only those children at
high risk of exposure or at high risk for acquiring the infection because of immune status are routinely tested.

See Table 25–10 for other diagnostic procedures that may be required to confirm the diagnosis. Acid-fast stains of blood, gastric aspirate, and sputum cultures reveal the bacillus. Chest radiographic findings vary depending on the child’s condition, and may include a granuloma, calcification, adenopathy, atelectasis, or infiltrate of a segment or lobe; pleural effusion; cavitary lesions; or miliary (disseminated) disease. For infants, children, and adolescents with active TB, a chest radiograph should be obtained after 2 to 3 months of therapy to evaluate response.

**Clinical Therapy**
Management focuses on diagnosis and treatment of active and latent TB with antitubercular drug therapy. See the medications used to treat TB on page 126. Drug resistance to these medications has occurred because infected individuals did not complete courses of medications, permitting the TB bacillus to develop resistance. Therapy for active, drug-susceptible TB usually involves a 6-month regimen consisting of isoniazid, rifampin, and pyrazinamide for the first 2 months and isoniazid and rifampin for the remaining 4 months. Direct observed drug therapy is recommended for treatment of children and adolescents with active TB in the United States to reduce treatment failure and development of drug-resistant organisms.

For infants, children, and adolescents with latent TB, a single daily dose of isoniazid is given for 9 months, as only one drug is used. When adherence with daily therapy with isoniazid cannot be ensured, twice-a-week direct observed drug therapy can be considered.

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**NURSING MANAGEMENT**

**Nursing Assessment and Diagnosis**
Assessment focuses on retaining a heightened awareness that certain children are at higher risk for exposure to TB and for developing the infection, such as recent contact with a case of tuberculosis, family history of tuberculosis, positive tuberculin skin test reactions in other current household members, and foreign birth or prolonged travel to a country with high tuberculosis rates (American

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**TABLE 25–9 Recommendations for Tuberculin Skin Testing in Children**

<table>
<thead>
<tr>
<th>CLASSIFICATION OF CHILDREN</th>
<th>FREQUENCY OF TESTING</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contact with persons confirmed or suspected infectious TB</td>
<td>Immediate and 10–12 weeks later</td>
</tr>
<tr>
<td>Children with radiologic or clinical findings suggesting TB</td>
<td>Immediate</td>
</tr>
<tr>
<td>Children emigrating from countries with high rates of TB (Asia, Middle East, Africa, Latin America)</td>
<td>Immediate and 10–12 weeks later</td>
</tr>
<tr>
<td>Children with travel history to countries with high rates of TB or contact with indigenous persons in those countries</td>
<td>Immediate and 10–12 weeks later</td>
</tr>
<tr>
<td>Infected with HIV</td>
<td>Annual</td>
</tr>
<tr>
<td>Incarcerated adolescent</td>
<td>Annual</td>
</tr>
<tr>
<td>Exposed to the following individuals: HIV infected, homeless, nursing home residents, institutionalized adolescents or adults, users of illicit drugs, incarcerated adolescents or adults, migrant farm workers; foster children with exposure to persons in these high-risk groups</td>
<td>Every 2–3 years</td>
</tr>
<tr>
<td>Parents immigrated from region of the world with high prevalence of TB; continued potential exposure by travel to the endemic areas and/or household contact with people from the endemic areas (with unknown TST status)</td>
<td>Once at 4–6 years</td>
</tr>
<tr>
<td>Once at 11–16 years</td>
<td></td>
</tr>
<tr>
<td>Children beginning immunosuppressive therapy, including prolonged steroid administration, for any child with an underlying condition that necessitates immunosuppressive therapy</td>
<td>Once prior to beginning therapy</td>
</tr>
<tr>
<td>Children without a specific risk factor who reside in a high-risk neighborhood or community within a large city</td>
<td>Once at 4–6 years</td>
</tr>
<tr>
<td>Once at 11–16 years</td>
<td></td>
</tr>
</tbody>
</table>

Academy of Pediatrics, 2003b). Additionally consider the child’s immigration status, immunosuppression status, and exposure to individuals with HIV infection. Follow guidelines for tuberculin skin testing in these children presented in Table 25–9.

Carefully evaluate infants and young children who have a tuberculin skin test conversion as they are at greater risk to develop active TB over the next few months. When the ill child presents for healthcare, perform a complete physical assessment, but carefully assess for weight loss, fever, fatigue, coughing, and respiratory status. If TB is suspected, implement standard precautions until the infection status is known. The nurse assists with the collection of blood, sputum, and gastric aspirate cultures so that drug sensitivity can be identified.

Examples of nursing diagnoses that might be appropriate include the following:

- **Imbalanced Nutrition: Less than Body Requirements related to anorexia and active infection**
- **Activity Intolerance related to active infectious process**
- **Ineffective Therapeutic Regimen Management related to nonadherence to daily medication regimen**

### Planning and Implementation

Nursing care centers on administering medications, education, and providing supportive care. Parents and children need to be taught about the disease process, medications, strategies for medication administration to infants and toddlers, possible side effects, the importance of long-term therapy (e.g., that drug therapy may last for 6 to 9 months), and the need for frequent follow-up.

Children with active TB should receive “directly observed drug therapy” by a nurse or other healthcare provider to ensure that the drug is being taken. Direct observation should be done daily for at least 2 weeks and then decreased to twice a week if the patient is responding to treatment and is compliant with the treatment regimen (Stowe & Jacobs, 1999). Children with latent TB should receive “directly observed drug therapy” twice a week (American Academy of Pediatrics, 2003b).

The nurse works with the families of children and adolescents with latent TB infections to encourage completion of therapy. Help the family to develop a strategy that enables them to remember to give the medication. In the case of an adolescent, the nurse encourages increased responsibility for healthcare. Although parents need to be involved, the adolescent can make choices about the time of day to take the medication and to set up a reminder system to take it. Parents can support the adolescent by establishing a contract with incentives when the adolescent takes all medications in the established time period.

Unless the child is seriously ill, hospitalization is not needed. In most cases when the child is hospitalized, standard precautions are maintained as the child is not infectious. If the child or adolescent has extensive pulmonary infection, positive sputum cultures, or suspected congenital tuberculosis airborne precautions are used, including room isolation and a “fitted” and “sealed” particulate respirator for all patient contacts. Airborne precautions are used until culture smears indicate a diminishing number of organisms and the child’s cough is improving (American Academy of Pediatrics, 2003b). Family members should use masks (reverse airborne precautions) when visiting the child in the hospital until it is determined that they are not infectious, to reduce the risk of infection to other children and hospital staff. Facilitate tuberculin skin testing of family members and close contacts followed by chest radiographs as necessary.

The family needs information and education to care for the child at home. Emphasize the importance of taking medications as prescribed on an empty stomach, and ensuring 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 (American Academy of Pediatrics, 2003b). Most children who have been successfully treated for TB are able to lead essentially normal lives.

By law, cases of active TB must be reported immediately to the public health department so that disease contacts can be traced to help prevent the further spread of TB. Public health nurses have a significant role in tracking close contacts, arranging tuberculin skin testing, and encouraging treatment or supervising “directly observed drug therapy.”

### Table 25–10: Diagnostic Procedures for Tuberculosis

<table>
<thead>
<tr>
<th>Diagnostic Test</th>
<th>Indication and Rationale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intradermal injection of purified protein derivative (PPD)</td>
<td>Confirms infection (latent or active) with the TB organism (3–12 weeks after exposure)</td>
</tr>
<tr>
<td>Chest radiograph (anteroposterior and lateral views)</td>
<td>Confirms presence of pulmonary TB (small, seedlike opacities may be visible); however, radiologic changes may look like other chronic lung conditions</td>
</tr>
<tr>
<td>Blood cultures for Mycobacterium tuberculosis</td>
<td>Proves diagnosis; defines specific drug sensitivity</td>
</tr>
<tr>
<td>Gastric washings (aspirates), performed in early morning after overnight fast on 3 consecutive days</td>
<td>Confirms active pulmonary TB. Used in children under 12 years as they do not produce sputum</td>
</tr>
<tr>
<td>Sputum cultures (expectorated or from bronchoscopic examination)</td>
<td>Confirms active pulmonary TB</td>
</tr>
<tr>
<td>Pleural biopsy for culture and tissue examination</td>
<td>Taken when pleural effusion is present</td>
</tr>
<tr>
<td>Lumbar puncture</td>
<td>Confirms meningeal TB</td>
</tr>
</tbody>
</table>
### MEDICATIONS Used to Treat Latent and Active TB in Infants, Children, and Adolescents

<table>
<thead>
<tr>
<th>MEDICATION</th>
<th>NURSING CONSIDERATIONS</th>
</tr>
</thead>
</table>
| Isoniazid                   | • Obtain baseline bilirubin and liver function studies as hepatotoxicity can occur.  
• Obtain a baseline weight.  
• Assess ophthalmologic and hematopoietic status studies.  
• Give 1 hour before or 2 hours after meals unless GI irritation occurs, then give with food. Tablets can be crushed.  
• Interferes with hepatic metabolism of phenytoin, may cause toxicity.  
• Monitor for symptoms of hypersensitivity, signs of hepatotoxicity (anorexia, fever, malaise, nausea, vomiting, diarrhea, weight loss), dark urine, jaundice.  
• Adolescent should avoid alcohol.  
• Pyridoxine supplementation (vitamin B<sub>6</sub>) is recommended for children and adolescents with meat- and milk-deficient diets, with nutritional deficiencies, and those who are pregnant or HIV infected to prevent peripheral neuritis and seizures. |
| Rifampin                    | • Obtain baseline bilirubin and liver function studies as this drug can alter the pharmacokinetics and serum concentrations of other drugs.  
• Assess renal and hematopoietic status studies.  
• Give 1 hour before or 2 hours after meals unless GI irritation occurs, then give with food. Capsule contents can be sprinkled on applesauce or suspended in flavored syrup.  
• Monitor for symptoms of jaundice and other side effects.  
• Assess medications taken for interaction with rifampin (i.e., diazepam, beta-adrenergics, barbiturates, analgesics, corticosteroids, oral contraceptives, digitals, and others).  
• Inform parents and child about orange body fluids.  
• Sexually active adolescent females should not use oral contraceptives as rifampin makes them ineffective. |
| Pyrazinamide                | • Obtain baseline liver function studies, and renal and hematopoietic status studies. Monitor for symptoms of hepatotoxicity.  
• Monitor blood glucose level in children with diabetes as glycemic control may be affected.  
• When used in combination with isoniazid and rifampin, a 6-month course of therapy is possible. |
| Ethambutol                  | • Obtain baseline liver function studies, and renal and hematopoietic status studies. Perform a baseline and monthly ophthalmologic test of visual acuity, visual fields, and color discrimination as the drug may cause reversible or irreversible optic neuritis, particularly in children with impaired renal function.  
• Give with meals if gastrointestinal irritation occurs.  
• Inform parents and child to report any vision changes. |
| Streptomycin                | • IM injections are painful so provide guidance for pain management.  
• Monitor for ototoxicity, assess hearing acuity regularly.  
• Monitor intake and output, looking for signs of reduced kidney function.  
• Educate parents to immediately report these symptoms: nausea, vomiting, incoordination, dizziness, impaired hearing, fullness in ears. |

### Evaluation
Expected outcomes of nursing care include the following:

- The child completes the full course of preventive TB medications.
- The child recovering from active TB regains energy and appetite, and catch-up growth is documented.
- Family members and close contacts are tested for TB and have treatment initiated as appropriate.

### CHRONIC LUNG DISEASES

#### Bronchopulmonary Dysplasia (Chronic Lung Disease)

Bronchopulmonary dysplasia (BPD), also called chronic lung disease (CLD), results from an acute respiratory disease during the neonatal period. It is the most prevalent and serious chronic respiratory disorder that begins during infancy. Premature infants are affected more often than full-term infants, and morbidity is greater in males than in females. Risk factors for developing BPD include prematurity, lung immaturity, RDS in the neonatal period, high inspired oxygen concentrations, positive pressure ventilation, patent ductus arteriosus, and vitamin A deficiency (Froh, 2002). The incidence is increasing due to advances in medical technology that permit very-low-birth-weight infants to survive (Daigle & Cloutier, 1997). It is estimated that 10% to 35% of very-low-birth-weight infants develop BPD (Froh, 2002).

#### Etiology and Pathophysiology

BPD results from positive pressure ventilation and oxygen treatment for RDS and inflammatory changes in the airways. The sequence of events is as follows: an interruption in alveolar development that occurs when preterm infants need mechanical ventilation and supplemental oxygen. Inflammation and persistent hypoxia also contribute to the development of the chronic lung disease. Other disorders that contribute to the development of BPD include neonatal pneumonia, meconium aspiration syndrome, patent ductus arteriosus, fluid overload, and lung hypoplasia (Capper-Michel, 2004).
Clinical Manifestations
The infant with BPD has persistent signs of respiratory distress: tachypnea, wheezing, crackles, irritability, nasal flaring, grunting, retractions, pulmonary edema, and failure to thrive. The severity of the condition varies in infants. The infant has intermittent bronchospasms and mucous plugging. Air trapping persists and in time the chest assumes a barrel shape (Figure 25–12). The infant may seem stable and improving, and then has a BPD episode that consists of sudden respiratory deterioration associated with an expiratory airflow limitation due to tracheobronchial narrowing. The child becomes dusky or cyanotic and agitated. The episodes may be caused by a sudden increase in pulmonary vascular resistance. Normal activities, such as feeding, can create increased oxygen demands that are difficult for the compromised infant to meet.

Collaborative Care
Care is focused on supporting the infant’s lung function and providing care for episodes of respiratory compromise until lung healing and development occur.

Diagnostic Procedures
The chest radiograph is the best indicator of lung changes and is the key to medical diagnosis. The radiograph often shows hyperexpansion, atelectasis, and interstitial thickening (Capper-Michel, 2004).

Clinical Therapy
Management focuses initially on prevention of BPD with gentle ventilation techniques, shortened intubation time, early treatment of a patent ductus arteriosis, infections, and nutritional support. Once BPD has occurred, clinical therapy focuses on symptomatic treatment that supports respiratory function and good nutrition, which helps to accelerate lung maturity. Infants with severe BPD must be cautiously weaned off assisted ventilation. Supplemental oxygen with humidity is used to keep the \( \text{SaO}_2 \) more than 90% to 92% even during sleep and feeding. A tracheostomy may be performed for long-term airway management.

Increased calories are provided to support growth, but fluids are restricted to prevent pulmonary edema. Some children require gastrostomy or nasogastric feeding to get adequate calories. Chest physiotherapy and medications (diuretics, bronchodilators, anti-inflammatories, and inhaled corticosteroids) are also used (Figure 25–13). See the medications table on page 128 for specific medications and their action.

With improvement and adequate weight gain, the child is weaned off of oxygen, diuretics, and bronchodilators. Long-term sequelae include asthma and respiratory infections with frequent rehospitalization. Potential long-term outcomes for the child with BPD include developmental delays, growth retardation, continuing airway obstruction, and persistent airway hypersensitivity.

Nursing Management
The goal of nursing management is to assess and manage the infant’s acute episodes, assuring adequate nutritional support and thus promoting the infant’s growth and development.

Nursing Assessment and Diagnosis
The infant with chronic BPD may become acutely ill at any time, as occurred with Emily in the opening scenario. Observe for signs of infection that can be a threat because of a compromised immune system. During hospitalizations for acute infections, a cardiorespiratory monitor and pulse oximeter will be 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 Skills Manual for tracheostomy care.

Monitor growth as the infant often experiences poor weight gain. Evaluate development regularly as the infant may develop motor, language, and cognitive delays. Coordinate a periodic assessment of hearing and vision.

Nursing diagnoses that may be appropriate include:

- Dysfunctional Ventilatory Weaning Response related to inappropriate pacing of diminished ventilator support and BPD
Risk for Caregiver Role Strain related to 24-hour responsibility for infant with BPD
- Delayed Growth and Development related to inadequate calories to support physical growth and energy needed for respiratory functions
- Ineffective Infant Feeding Pattern related to oral hypersensitivity resulting from long-term orogastric feeding

Planning and Implementation

Care of the hospitalized infant is organized to eliminate unnecessary physical stimulation, as this additional stress contributes to respiratory compromise. Position the infant to facilitate breathing and provide tracheostomy care when present. Provide humidified oxygen if ordered.

Provide fluids and nutrition to help meet energy needs. Fluid management is critical as excess fluids can lead to pulmonary edema. Support the mother who desires to breastfeed. Caloric supplementation may be needed for either the breastfed or formula-fed infant. Administer medications as ordered. Management of fever will help minimize energy needs.

Provide toys and mobiles that are age appropriate but do not encourage excessive activity so that growth and development is promoted. Support the parents with clear explanations about the infant’s health status and planned interventions to reduce anxiety.

Discharge Planning and Home Care

Plans for care at home must be carefully planned and coordinated early in the child’s hospitalization. Including parents in the infant’s care early on promotes bonding and prepares them for home care responsibilities. Make referrals for needed oxygen, respiratory supplies, medications, an early intervention program, and follow-up care. Some families require home health nursing assistance, especially during the initial transition period. Help families identify additional family members who might be willing to learn how to care for the infant so that the parent can have a few hours of respite during the week. Families may need assistance in planning a schedule that the infant receives needed care and leaves some time free for other children and family activities. Inform families of the need for RSV prophylaxis and provide the first injection prior to discharge if during RSV season.

Once home, many infants need assisted ventilation therapy, supplemental oxygen, and medications (Figure 25–14). Electrolytes may be monitored monthly. It is important to provide for the infant’s normal development through rest, nutrition, stimulation, and family support. Frequent rehospitalization may occur. While the lungs may function adequately, they remain vulnerable throughout childhood to common respiratory illnesses. Infants with BPD do not have the same respiratory reserve as healthy infants, and can become very ill rapidly.

Teach parents to identify signs of respiratory compromise indicating a need for rapid intervention. Such planning was done with Emily’s parents, and the healthcare providers were called before a crisis developed. However, an emergency care plan should also be developed for the parents in those cases when the infant becomes suddenly ill and emergency care is needed. A model emergency information form for emergency care providers is available from the American Academy of Pediatrics.

Nutritional requirements to support growth must be balanced with fluid restrictions to prevent the development of pulmonary edema. A formula supplemented with carbohydrates and medium chain triglycerides may be given to promote weight gain.

<table>
<thead>
<tr>
<th>MEDICATION</th>
<th>ACTION/INDICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bronchodilators (β₂-adrenergics, anticholinergics, theophylline, albuterol nebulizer)</td>
<td>Decreases airway resistance, increases expiratory flow in small airways, stimulates mucus clearance; different drugs work together for best response</td>
</tr>
<tr>
<td>Anti-inflammatory agents (corticosteroids, inhaled cromolyn, beclomethasone)</td>
<td>Reduces pulmonary edema and inflammation in small airways, enhances effect of bronchodilators; helps decrease the need for other drugs and oxygen; for moderate disease only</td>
</tr>
<tr>
<td>Diuretics (furosemide, chlorothiazide, spironolactone)</td>
<td>Helps remove excess fluid from lungs, decreases pulmonary resistance and increases pulmonary compliance; may cause electrolyte imbalances</td>
</tr>
<tr>
<td>Potassium chloride</td>
<td>Prevents electrolyte imbalances associated with diuretics</td>
</tr>
<tr>
<td>Antibiotics</td>
<td>Specific treatment for identified organisms</td>
</tr>
<tr>
<td>Vitamin A</td>
<td>Plays a role in normal lung development</td>
</tr>
<tr>
<td>Palivizumab (Synagis)</td>
<td>Protects infant from respiratory syncytial virus</td>
</tr>
</tbody>
</table>
Many children with BPD are cared for at home, with the support of a home care program to monitor the family’s ability to provide airway management, oxygen, and support. This premature infant girl, who is now 4 months old but weighs only about 5 pounds, requires respiratory support, which is provided by a portable oxygen tank.

Gain. Some children need nasogastric or gastrostomy tube feedings to get adequate nutrition when cyanosis is noted with feeding. Oral tactile hypersensitivity that interferes with feeding may be a problem in these children because of the long term use of nasogastric, orogastric, and endotracheal tubes. See Chapter 9. All infants with BPD need more frequent health promotion visits and immunizations.

**Evaluation**

Expected outcomes of nursing care may include:

- The infant receives adequate calories to sustain growth in length and weight. Introduction of oral foods is tolerated.
- Acute illness episodes are rapidly identified by the family and emergency care is provided to prevent and/or manage the infant’s respiratory decompensation.
- The infant receives attention and exposure to developmentally appropriate toys and activities to promote development.

**Health Supervision**

- Assess blood pressure to detect abnormal findings associated with pulmonary hypertension.
- Perform hematocrit frequently during the first year of life to assess for anemia.
- Perform a chest radiograph and pulmonary function tests annually or as needed for clinical condition.
- Perform routine hearing assessment at each visit.
- Coordinate vision screening by an ophthalmologist every 2–3 months during the first year of life. Myopia and strabismus are common.
- Coordinate pulmonary function tests annually or as needed for clinical condition.
- Perform 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 the Denver II and record the developmental assessment corrected for gestational age.

**Nutrition**

- Review caloric intake and ensure that intake is optimal for growth. Assess difficulties with feeding related to oral motor function. Refer to a nutritionist as necessary.

**Physical Activity**

- Organize care so that child has periods of time to rest during the day.

**Relationships**

- Identify ways to coordinate care during the night to reduce number of times child and family have sleep disturbed.
- Provide discipline appropriate for developmental age.
- Encourage development. Provide developmentally appropriate toys and activities.

**Disease Prevention Strategies**

- Reduce exposure to infections. If out-of-home childcare is used, select a provider caring for a small number of children. If possible, avoid the use of childcare centers during RSV season.
- Immunize the child with the routine schedule based on chronological age.
- Give the influenza vaccine annually and 23-valent pneumococcal vaccine at 2 years of age.
- Provide monthly injections of palivizumab throughout the RSV season to protect the child from respiratory syncytial virus.

**Condition-Specific Guidance**

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

Asthma (also called bronchial asthma) is a chronic inflammatory disorder of the airway with airway obstruction that can be partially or completely reversed and increased airway responsiveness to stimuli (Kieckhefer & Ratcliffe, 2004). It affects about 5 million children in the United States. Nearly 3.8 million children (a rate of 54 per 1,000 children) between 0 and 17 years had an asthma attack in the previous year (Centers for Disease Control and Prevention, 2001). See Figure 25–15 for the change in age-specific asthma prevalence in children. Canada estimates that 12.2% of its children and youth under 20 years of age have asthma, and it is one of the country’s most prevalent chronic conditions (Health Canada, 1999).

In the United States, the greatest increase in asthma prevalence has been noted in children 0 to 4 years of age, at a rate of 160% between 1980 and 1994 (Foley, 2002). Affected children have about 10 days of school absenteeism and 20 days of restricted activity per year (Sydnor-Greenberg & Dokken, 2000). Most children with asthma experience their first symptoms before the age of 5 years.

Asthma is a chronic condition with acute exacerbations or persistent symptoms. Children require continuous coordinated care to control sudden symptoms and minimize long-term airway changes. Although unusual in the past, severe persistent asthma is more common now. Hospitalizations for asthma have increased from 21.6 per 10,000 children in 1980–1981 to 26.9 per 10,000 children in 1998–1999, with the highest hospitalization rates found in children between 0 to 4 years of age. In the same time period, asthma mortality increased from 1.8 to 3.3 per 1 million children, with the highest mortality found in non-Hispanic Black children (10.1 per million) and in children between 11 and 17 years (4.4 per million) (Akinbami & Schoendorf, 2002). Risk factors for death from asthma include (American Academy of Allergy, Asthma, and Immunology, 1999):

- Past history of sudden exacerbation of asthma
- Prior intubation for asthma
- Prior admission to an intensive care unit for asthma

Table 25–11 Public Health Policy Recommendations for Improving Childhood Asthma Outcomes

<table>
<thead>
<tr>
<th>For Promoting Quality of Care for Key Childhood Asthma Services</th>
</tr>
</thead>
<tbody>
<tr>
<td>Develop and implement primary care performance measures for childhood asthma care.</td>
</tr>
<tr>
<td>Teach all children with persistent asthma and their families a specific set of self-management skills.</td>
</tr>
<tr>
<td>Provide case management to high-risk children.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>For Expanding Coverage and Improving Benefits Design</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extend continuous health insurance coverage to all uninsured children.</td>
</tr>
<tr>
<td>Develop model benefit packages for essential childhood asthma services.</td>
</tr>
<tr>
<td>Educate healthcare purchasers about asthma benefits.</td>
</tr>
</tbody>
</table>

Public Health Funding of Asthma-Related Community and Health Services Not Currently Funded by Insurance System

- Establish public health grants to foster asthma-friendly communities and home environments.
- Promote asthma-friendly schools and school-based asthma programs.

Increasing Public Awareness and Knowledge of Asthma

- Develop a national asthma surveillance system.
- Develop and implement a national agenda for asthma prevention research.

Asthma is a chronic inflammatory disease of the lungs that is caused by multiple factors, including environmental exposures, viral illnesses, allergens, and a genetic predisposition. It is thought that several chromosomal regions may be the site of genes leading to asthma susceptibility, including chromosomes 5q, 6p, 11q, 12q, and 13q (Foley, 2002). Exposure to environmental factors early in life or in utero is thought to stimulate the onset of asthma. For the development of asthma, a recent report found strong evidence that house dust mites and environmental tobacco smoke, and suggestive evidence that cockroaches, infections with respiratory syncytial virus, and mold resulting from indoor home dampness contributed to the development of asthma (Institute of Medicine, 2000).

The respiratory difficulties of an asthmatic episode result from inflammation that contributes to airway obstruction. The inflammation causes the normal protective mechanisms of the lungs (mucous formation, mucosal swelling, and airway muscle contraction) to react excessively in response to a stimulus. Asthma is a progressive disease. Chronic inflammatory changes result in airway remodeling that includes thickening of the basement membrane, airway smooth muscle hypertrophy, and mucus gland hypertrophy (Froh, 2002).

The stimulus, more correctly termed a trigger, that initiates an asthmatic episode can be inflammatory or noninflammatory. Triggers increase the frequency and severity of smooth muscle contraction, and airway responsiveness is enhanced through inflammatory mechanisms. Asthmatic triggers include exercise, viral or bacterial agents, allergens (mold, dust, pollen, furry pets, birds), fragrances, food additives, pollutants, weather changes (humidity and temperature), and emotions. See Box 25–8 for more information on the link between passive smoke exposure and asthma. Exercise is also a trigger in some children and adolescents. The lungs lose heat and water during exercise. A bronchospasm is triggered by rapidly breathing air that is cooler and dryer than the air in the respiratory tract, occurring during or shortly after vigorous physical activity (Baker, Friedman, & Schmitt, 2002a).

During the acute allergic reaction, an antigen binds to the specific immunoglobulin E surface on the mucosal mast cells, and histamine is released along with intercellular chemical mediators (leukotrienes, prostaglandin platelet-activating factor, and certain cytokines) resulting in bronchospasm, mucus edema, and mucous secretion. The late allergic response starts 6 to 9 hours later when inflammatory cells respond and another wave of mediator release occurs. This stimulates more airway inflammation and bronchospasm (Kieckhefer & Ratcliffe, 2004). The reactive airway responses to stimuli are present before the trigger initiates the physiologic sequence that results in an asthmatic episode.

Airway narrowing results from bronchial constriction, airway swelling, and production of copious amounts of mucus. Mucus clogs small airways, trapping air below the plugs (Figure 25–16). The airways swell, creating muscle spasms that often become uncontrolled in the large airways. 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 with a reduced minute volume (air breathed per minute) because of airway resistance. With time, repeated episodes of bronchospasm, mucus edema, and mucous plugging can damage the respiratory cells that line the airway. This is referred to as airway remodeling, an irreversible thickening of the subepithelial basement membrane and proliferation of smooth muscle cells in size and number. This results in decreased airway elasticity and decreased lung function.

The psychologic sequence of events during an asthmatic episode starts with moderate anxiety as the episode begins. The anxiety becomes severe as the episode intensifies. Severe anxiety, in turn, intensifies physical responses and symptoms. Recognizing and addressing the child’s fear and panic are essential for reestablishing normal respirations.

**Clinical Manifestations**
Asthma is characterized by airway inflammation, airway obstruction or narrowing, and airway hyperreactivity. The sudden appearance of breathing difficulty (cough, wheeze, or shortness of breath) is often referred to as an asthmatic episode, or “asthma attack.”
Asthmatic Episode

Restricted airflow prevents proper filling of alveoli and gas exchange.

What can cause an asthmatic episode? Some asthma triggers are exercise, infection, and allergies. This illustration shows how asthma obstructs airflow through bronchoconstriction and inflammatory changes, narrowing the airway and thus increasing production of mucus.

Normal bronchiole and alveoli

Normal alveoli

Mucous membranes become inflamed and edematous.

Mucous glands hypersecrete and proliferate.

Airway narrows, restricting airflow.

Thickened basement membrane

Mucous glands hypersecrete and proliferate.

Smooth muscles constrict.

Hyperinflated alveoli

Collapsed alveoli

Mucus production increases.

Inflammatory reaction such as increased capillary permeability and histamine release

Capillaries

Mucous gland

Normal bronchiole

Normal alveoli

FIGURE 25–16
During an acute episode, respirations are rapid and labored and the child often appears tired because of the ongoing effort required to breathe. Nasal flaring and intercostal retractions may be visible. The child exhibits a productive cough and expiratory wheezing, prolonged expiratory phase, decreased air movement, and respiratory fatigue. The child may complain of chest tightness. In cases of severe obstruction, wheezing may not be heard because of the lack of airflow. Head bobbing may be seen in young children with the use of accessory muscles (sternocleidomastoids) to breathe. **Pulsus paradoxus**, when the arterial blood pressure during expiration exceeds the arterial pressure during inspiration by 10 mm Hg, may be present. The resulting hypoxia, as well as the cumulative effect of previously administered medications, contributes to behaviors ranging from wide-eyed agitation to lethargic irritability. See clinical manifestations by exacerbation severity below. In children who have repeated acute episodes, a barrel chest (hyperinflation of the thorax) and the use of accessory muscles of respiration are common findings (see Figure 25–12).

### COLLABORATIVE CARE

#### Diagnostic Procedures

Preliminary diagnosis is initially based on physical signs and symptoms of airway constriction. A spirometer tests how effectively the lungs work by measuring the volume of air the child can expel from the lungs after a maximal inspiration. Both a forced vital capacity (FVC) and a forced expiratory volume in 1 second (FEV1) readings are taken. Three readings are taken to compare with predicted normal values. Because the test requires children to cooperate and follow instructions, it is usually administered to children over 4 or 5 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.**

The spirometer helps to assess the severity of airway obstruction. A chest radiograph may be taken if other causes of the respiratory difficulty are suspected, such as a foreign body. Skin testing may be used to identify allergens (asthma triggers). The final diagnosis of asthma has four key elements: symptoms of episodic airflow obstruction; partial reversibility of bronchospasm with bronchodilator treatment; exclusion of alternate diagnosis; and confirmation by spirometry of measurement of forced expiratory flow variability.

#### Clinical Therapy

Management includes medications, hydration, education, and support of parents and child. See Box 25–9 on page 137 for an explanation of good asthma control. Pharmacologic therapies are matched to the severity of asthma for long-term control and for management of acute episodes. See Table 25–12 and Table 25–13.

<table>
<thead>
<tr>
<th>ASSESSMENT CRITERIA</th>
<th>MILD</th>
<th>MODERATE</th>
<th>SEVERE</th>
</tr>
</thead>
<tbody>
<tr>
<td>PEFR&lt;sup&gt;a&lt;/sup&gt;</td>
<td>70–90% predicted or personal best</td>
<td>50–70% predicted or personal best</td>
<td>&lt; 50% predicted or personal best</td>
</tr>
<tr>
<td>Respiratory rate, resting or sleeping</td>
<td>Normal to 30% increase above the mean</td>
<td>30–50% increase above mean</td>
<td>Increase over 50% above mean</td>
</tr>
<tr>
<td>Alertness</td>
<td>Normal</td>
<td>Normal</td>
<td>May be decreased</td>
</tr>
<tr>
<td>Dyspnea&lt;sup&gt;b&lt;/sup&gt;</td>
<td>Absent or mild; speaks in complete sentences</td>
<td>Moderate; speaks in phrases or partial sentences; infant’s cry softer and shorter, has difficulty sucking and feeding</td>
<td>Severe; speaks only in single words or short phrases; infant’s cry softer and shorter; stops sucking and feeding</td>
</tr>
<tr>
<td>Pulsus paradoxus&lt;sup&gt;c&lt;/sup&gt;</td>
<td>&lt; 10 mm Hg</td>
<td>10–20 mm Hg</td>
<td>20–40 mm Hg</td>
</tr>
<tr>
<td>Accessory muscle use</td>
<td>No intercostal to mild retractions</td>
<td>Moderate intercostal retractions with tracheostomal retractions; use of sternocleidomastoid muscles; chest hyperinflation</td>
<td>Severe intercostal retractions, tracheostomal retractions with nasal flaring during inspiration; chest hyperinflation</td>
</tr>
<tr>
<td>Color</td>
<td>Good</td>
<td>Pale</td>
<td>Possibly cyanotic</td>
</tr>
<tr>
<td>Auscultation</td>
<td>End-expiratory wheeze only</td>
<td>Wheeze during entire expiration and inspiration</td>
<td>Breath sounds becoming inaudible</td>
</tr>
<tr>
<td>Oxygen saturation</td>
<td>&gt; 95%</td>
<td>90–95%</td>
<td>&lt; 90%</td>
</tr>
<tr>
<td>PCO₂</td>
<td>&lt; 35</td>
<td>&lt; 40</td>
<td>&gt; 40</td>
</tr>
</tbody>
</table>

Note: Within each category, the presence of several parameters, but not necessarily all, indicate the general classification of the exacerbation.

<sup>a</sup>or for children 5 years of age or older.

<sup>b</sup>Parents or physicians’ impressions of degree of children’s breathlessness.

<sup>c</sup>Pulsus paradoxus does not correlate with phase of respiration in small children.

### TABLE 25–12  Asthma Severity Classification and Preferred Clinical Therapy for Children Younger than 5 Years of Age

<table>
<thead>
<tr>
<th>CLASSIFICATION (STEPS)</th>
<th>DESCRIPTION</th>
<th>MEDICATIONS FOR LONG-TERM CONTROL</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1: Mild intermittent</strong></td>
<td>Brief exacerbations with symptoms no more often than twice a week. Nighttime symptoms no more than twice a week.</td>
<td>No daily medications needed.</td>
</tr>
</tbody>
</table>
| **Step 2: Mild persistent** | Exacerbations more than twice a week, but less than once a day. Nighttime symptoms more than twice a month. | Preferred treatment  
➤ Low-dose inhaled corticosteroid (with nebulizer or MDI with holding chamber with or without face mask or DPI).  
Alternate treatment  
➤ Cromolyn (nebulizer is preferred or MDI with holding chamber).  
OR  
➤ Leukotriene receptor antagonist. |
| **Step 3: Moderate persistent** | Daily symptoms of coughing and wheezing. Nighttime symptoms more than once per week. | Preferred treatment  
➤ Low-dose inhaled corticosteroids and long-acting β₂-agonists.  
OR  
➤ Medium-dose inhaled corticosteroids.  
Alternate treatment  
➤ Low-dose inhaled corticosteroids and either leukotriene receptor antagonist or theophylline.  
If needed (particularly in children and adolescents with recurring severe exacerbations)  
Preferred treatment  
➤ Medium-dose inhaled corticosteroids and long-acting inhaled β₂-agonists.  
Alternative treatment  
➤ Medium-dose inhaled corticosteroids and either leukotriene receptor antagonist or theophylline. |
| **Step 4: Severe persistent** | Continuous daytime symptoms, limited physical activity. Frequent nighttime symptoms. | Preferred treatment  
➤ High-dose inhaled corticosteroids.  
Plus  
➤ Long-acting inhaled β₂-agonists.  
And if needed,  
➤ Oral corticosteroids at 2 mg/kg/day (not to exceed 60 mg per day). Repeated efforts should be made to reduce systemic corticosteroids and maintain control with high-dose inhaled corticosteroids. |
| **Quick relief** | Bronchodilator as needed for symptoms. Intensity of treatment will depend on severity of exacerbation.  
➤ Preferred treatment: Short-acting inhaled β₂-agonists by nebulizer, face mask, and space/holding chamber.  
➤ Alternative treatment: oral β₂-agonist.  
With viral respiratory infection  
➤ Bronchodilator every 4 to 6 hours up to 24 hours (longer with physician counsel); in general, repeat no more than once every 6 weeks.  
➤ Consider systemic corticosteroids if exacerbation is severe or patient has a history of previous severe exacerbations. Use of short-acting β₂-agonists > 2 times a week in intermittent asthma (daily, or increasing use in persistent asthma) may indicate the need to initiate (increase) long-term control therapy. |

*Note: Adapted from National Asthma Education and Prevention Program. (2002). Expert Panel Report II: Guidelines for the diagnosis and management of asthma—Update on selected topics 2002 (NIH Publication No. 02-5075). Bethesda, MD: NHLBI, NIH.*
### TABLE 25–13  
Asthma Severity Classification and Preferred Clinical Therapy for Children Older than 5 Years of Age

<table>
<thead>
<tr>
<th>CLASSIFICATION (STEPS)</th>
<th>DESCRIPTION</th>
<th>MEDICATIONS FOR LONG-TERM CONTROL</th>
</tr>
</thead>
</table>
| Step 1: Mild intermittent | Brief exacerbations with symptoms no more often than twice a week.  
Nighttime symptoms no more than twice a week.  
Asymptomatic and normal PEFR between exacerbations.  
No emergent visits and no asthma-related absences from school.  
PEFR > 80% of predicted with variability < 20%. | No daily medications needed.  
Severe exacerbation may occur, separated by long periods of normal lung function and no symptoms. A course of systemic corticosteroids is recommended. |
| Step 2: Mild persistent | Exacerbations more than twice a week, but less than once a day.  
Nighttime symptoms more than twice a month.  
Exacerbations may affect activity and cause absences from school.  
PEFR ≥ 80% of predicted with variability of 20% to 30%. | Preferred treatment  
➤ Low-dose inhaled steroid.  
Alternate treatment  
➤ Cromolyn, leukotriene modifier, or nedocromil.  
OR  
➤ Sustained-release theophylline to serum concentration of 5–15 mcg/mL. |
| Step 3: Moderate persistent | Daily symptoms of coughing and wheezing.  
Exacerbations at least twice a week that may last for days.  
Nighttime symptoms more than once per week.  
Exacerbations affect activity and several school absences occur.  
PEF or FEV₁ > 60% but < 80% of predicted with variability > 30% | Preferred treatment  
➤ Low-to medium-dose inhaled corticosteroid.  
Plus  
Long-acting β₂-agonists  
Alternate treatment  
➤ Increase inhaled corticosteroids to within medium-dose range  
OR  
➤ Low-dose inhaled steroid and either leukotriene modifier or theophylline.  
If needed (particularly in children and adolescents with recurring severe exacerbations)  
Preferred treatment  
➤ Increase inhaled corticosteroids within medium-dose range and add long-acting inhaled β₂-agonists.  
Alternative treatment  
➤ Increase inhaled corticosteroids within medium-dose range and add either leukotriene modifier or theophylline. |
| Step 4: Severe persistent | Continuous daytime symptoms, limited physical activity.  
Frequent exacerbations.  
Frequent nighttime symptoms.  
Limited physical activity.  
Hospitalizations are frequent with PICU admissions for severe exacerbations.  
PEF or FEV₁ ≤ 60% of predicted, with variability > 30% | Preferred treatment  
➤ High-dose inhaled corticosteroids.  
Plus  
➤ Long-acting inhaled β₂-agonists.  
And if needed,  
➤ Oral corticosteroids at 2 mg/kg/day (not to exceed 60 mg per day).  
Repeated efforts should be made to reduce systemic corticosteroids and maintain control with high-dose inhaled corticosteroids. |
| Quick relief | Bronchodilator as needed for symptoms. Intensity of treatment will depend on severity of exacerbation.  
➤ Preferred treatment: Short-acting inhaled β₂-agonists by nebulizer, face mask, and space/holding chamber.  
➤ Alternative treatment: oral β₂-agonist.  
With viral respiratory infection  
➤ Bronchodilator every 4–6 hours up to 24 hours (longer with physician counsel); in general, repeat no more than once every 6 weeks.  
➤ Consider systemic corticosteroids if exacerbation is severe or patient has a history of previous severe exacerbations.  
➤ Use of short-acting β₂-agonists > 2 times a week in intermittent asthma (daily or increasing use in persistent asthma) may indicate the need to initiate (increase) long-term control therapy. |
### RESCUE MEDICATION

**Beta₂-agonists (short-acting)**
- Albuterol, metaproterenol, terbutaline, levalbuterol: inhalation, PO

Relax smooth muscle in airway, increase water content in bronchial mucus to promote muciliary clearance resulting in rapid bronchodilation within 5–10 minutes. Drug of choice for acute therapy (MDI or nebulizer).

- Use this rescue medication 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 spacer.
- Some side effects (tachycardia, nervousness, nausea and vomiting, headaches), but these are usually dose related.
- Repetitive or excessive use can mask increasing airway inflammation and hyperresponsiveness and increase need for higher dosage to get same effect.
- Use of more than 1 canister a month indicates inadequate control.
- Not used as primary treatment.
- Onset of action is 4–6 hours.
- Short-term therapy for 3–10 days until symptoms resolve or child achieves 80% peak expiratory flow personal best.
- Give with food.
- Give daily oral dose in early morning to mimic normal peak corticosteroid blood level.
- Assess for potential adverse effects of long-term therapy: decreased growth, unstable blood sugar, immunosuppression.
- Side effects include increased wheezing, cough, nervousness, dry mouth, tachycardia, dizziness, headache, palpitations.
- Avoid eye contact.
- Should not be used for acute asthma attack.
- Should not be used in place of inhaled corticosteroids.
- Caution against overdosage as side effects such as tachycardia, tremor, irritability, insomnia will last 8–12 hours.
- Report use of more than 4 puffs a day as this may indicate need for stepped-up therapy.
- Tablet should not be crushed or chewed.
- Used for long-term control, so continuous administration is needed; works best when a specific amount is maintained in the bloodstream (therapeutic serum level, 10–20 mcg/L).
- Requires serum level checks and dose adjustment.
- Side effects include tachycardia, dysrhythmias, restlessness, tremors, seizures, insomnia, hypotension, severe headaches, vomiting, and diarrhea.
- Not used at time of symptom development or acute exacerbation.
- Must be used up to 4 times a day to be effective.
- Therapeutic response seen in 2 weeks, maximum benefit may not be seen for 4–6 weeks.
- Adverse reactions include wheezing, bronchospasm, throat irritation, nasal congestion, anaphylaxis.

### Corticosteroids
- Methylprednisolone: IV
- Prednisone
- Prednisolone: PO

Diminish airway inflammation and obstruction, enhance bronchodilating effect of β₂-agonists.

- Not used as primary treatment.
- Onset of action is 4–6 hours.
- Short-term therapy for 3–10 days until symptoms resolve or child achieves 80% peak expiratory flow personal best.
- Give with food.
- Give daily oral dose in early morning to mimic normal peak corticosteroid blood level.
- Assess for potential adverse effects of long-term therapy: decreased growth, unstable blood sugar, immunosuppression.

### Anticholinergic
- Ipratropium: inhalation

Inhibits bronchoconstriction and decreases mucus production.

- Not for primary treatment.
- Side effects include increased wheezing, cough, nervousness, dry mouth, tachycardia, dizziness, headache, palpitations.
- Avoid eye contact.

### CONTROLLER MEDICATION

**Beta₂-agonists (long acting)**
- Salmeterol
- Formoterol: inhalation

Relax smooth muscle in airway, used for nocturnal symptoms and prevention of exercise-induced bronchospasm.

- Should not be used for acute asthma attack.
- Should not be used in place of inhaled corticosteroids.
- Caution against overdosage as side effects such as tachycardia, tremor, irritability, insomnia will last 8–12 hours.
- Report use of more than 4 puffs a day as this may indicate need for stepped-up therapy.

**Methylxanthines**
- Theophylline: PO
- Aminophylline: IV

Relax muscle bundles that constrict airways; dilate airway; provide continuous airway relaxation; sustained release for prevention of nocturnal symptoms.

- Tablet should not be crushed or chewed.
- Used for long-term control, so continuous administration is needed; works best when a specific amount is maintained in the bloodstream (therapeutic serum level, 10–20 mcg/L).
- Requires serum level checks and dose adjustment.
- Side effects include tachycardia, dysrhythmias, restlessness, tremors, seizures, insomnia, hypotension, severe headaches, vomiting, and diarrhea.

**Mast Cell Inhibitors**
- Cromolyn sodium
- Nedocromil: aerosol

Anti-inflammatory, inhibit early- and late-phase asthma response to allergens and exercise-induced bronchospasm; may be used for unavoidable allergen exposure.

on pages 134–135 for nationally recommended guidelines for the treatment of children under 5 years of age and children 5 years of age and older with acute and chronic asthma. See the medications used to treat asthma above. Control of asthma symptoms is the goal, and if control is not achieved with the regimen prescribed, then the regimen should be changed to correspond to the next step of asthma severity. Once control of asthma symptoms is achieved, the treatment plan can be reviewed in 1 to 6 months to determine if a reduction in asthma severity is appropriate (Hogan & Wilson, 2003). See Box 25–10.

The use of a peak expiratory flow (PEF) meter can assist in the management of asthma by helping to identify when obstruction occurs. This device measures the maximum flow of air that the child can push forcefully out of the lungs when cooperating. See Table 25–14 on page 138 for interpretation of peak expiratory flow meter readings. Medication administration can be based on peak expiratory flow rate (PEFR) readings and the effectiveness of treatment confirmed by improved PEFR numbers.

Most children with acute exacerbations respond to aggressive management in the emergency department. Children who do not respond or who are already being managed at home on corticosteroids have a greater chance of being admitted. Some children will need mechanical ventilation.
The goal of nursing management is to perform assessments and interventions to support the child during acute asthmatic episodes and to assist the child and family to control asthma symptoms.

**Nursing Assessment and Diagnosis**

**Hospital-Based Care**

The nurse usually encounters the child and family in the emergency department, nursing unit, or health center. Acute care has become necessary because the child’s level of respiratory compromise cannot be managed at home.

**Physiologic Assessment**

Identify the child’s current respiratory status first by assessing the ABCs—airway, breathing, and circulation—to make sure that the child’s condition is not life threatening. If the child is moving air or talking, assess the quality of breathing. Assess the respiratory rate. Inspect the chest for retractions to assess the severity of respiratory distress. 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. Observe the child’s color and assess the heart rate. Determine the severity of symptoms from the clinical manifestations table on page 133. Only after no life-threatening respiratory distress is found should the assessment move on to other systems.

Attach a pulse oximeter to monitor oxygen saturation. Assess peak expiratory flow rate, skin turgor, intake and output, and urine specific gravity. Because asthma can be a symptom of another illness, a head-to-toe assessment should be performed to identify other associated problems. See Box 25–1 and Table 25–7 for assessment guidelines.

The infant or child who has had episodes of frequent coughing or frequent respiratory infections (especially pneumonia or bronchitis) should also be evaluated for asthma. The cough is the warning signal that the child’s airway is very sensitive to stimuli; it may be the only sign in “silent” asthma.

**Psychosocial Assessment**

Assess the child’s anxiety. (Refer to Box 25–6 for guidelines.) The child and parents may be frustrated because another asthma episode has occurred. Assess whether the child thinks this episode could have been avoided if medications had been taken. The nurse should look for clues to hidden stress and self-blaming.

Common nursing diagnoses for the child experiencing an acute asthmatic episode include the following:

- Ineffective Airway Clearance related to airway compromise, copious mucous secretions, and coughing
- Impaired Gas Exchange related to airway obstruction, possible additional respiratory illness, and poor response to medication
- Risk for Deficient Fluid Volume related to difficulty in taking adequate fluids with respiratory distress
- Anxiety/Fear (child and parents) related to difficulty breathing and change in health status
- Ineffective Therapeutic Regimen Management (family) related to inadequate education on daily management of a chronic disease

**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 child and family with information to enable them to manage the child’s disease and ongoing developmental needs.

**Maintain Airway Patency**

If the child is exhibiting breathing difficulty, supplemental oxygen is required. Oxygen is best administered by nasal cannula or face mask. Humidified oxygen should be used to prevent drying and thickening of mucous secretions. The child should be placed in a sitting (semi-Fowler’s) or upright position to promote and ease respiratory effort. The effectiveness of positioning, response to medications, and oxygen administration is evaluated by pulse oximeter and by observing for improved respiratory status.
The respiratory distress and need for supplemental oxygen can be stressful for parents and child alike (Figure 25–17). Encouraging the parents’ presence can be reassuring for the child. The parents should be kept informed of procedures and results, and their input should be obtained in developing the treatment plan.

Many medications are given by inhalation route (Figure 25–18). The advantages of inhalation are that the medication acts quickly, enabling the pulmonary blood vessels to absorb the medication; systemic effects are minimized; and the inhaled droplets provide the added benefit of moisture. Continuous aerosol treatments may be implemented in some children with severe exacerbations. Monitor the child for medication side effects. The frequency of vital sign assessment is determined by the severity of symptoms. See Box 25–11 on page 140.

**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 adequate oral intake may not be possible with the child’s compromised respiratory status. An intravenous infusion may be needed, and this route also may be used for administering medications and providing glucose. Overhydration must be avoided to prevent pulmonary edema in severe asthma attacks.

As respiratory difficulty diminishes, oral fluids can be offered slowly. Continue to monitor the child’s hydration status. Involving parents in feeding can help gain the child’s cooperation in taking oral fluids. The child’s fluid preferences should be determined and choices provided when possible.

**Promote Rest and Stress Reduction**

The child who has had an acute asthmatic episode is usually very tired when admitted to the nursing unit. Labored breathing and low oxygenation may leave the child exhausted. Place the child in a quiet, private room if possible, to promote relaxation and rest. By grouping tasks, nurses can avoid repeatedly disturbing the child.

**Support Family Participation**

The parents may stay with the child, but may be exhausted after hours of their child’s respiratory distress. Give parents the option of assisting with the child’s treatments, rather than expecting them to do the care 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 acute episodes and how to use treatment to maintain the child’s health and avoid unnecessary hospitalization. When possible, educate parents when they are rested, but refer the parents...
and child to a healthcare provider who can provide more comprehensive education. Support of the parents and 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.

Discharge planning for the asthmatic child focuses on increasing the family’s knowledge about the disease, medication therapy, and the need for follow-up care according to guidelines of the National Asthma Education and Prevention Program. The required lifestyle changes may be difficult for the child and parents. The need to modify the home by removing a loved pet or by having family members stop smoking in the home may create stress and resistance.

The nurse can play a role in keeping lines of communication open and can facilitate discussion and clarification of ways to prevent asthmatic episodes. Teach the family how to measure and interpret peak expiratory flow rate readings. Discuss the rescue medications used to manage asthma episodes, as well as controller medications for daily management. Begin encouraging 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 medications. The family should be reassured that most children with asthma can lead a normal life with some modifications. See Partnering with Families: Home Care for the Child with Asthma on page 142.

**Care in the Community**

Nurses provide care to children with asthma in pediatricians’ offices, specialty asthma clinics, schools, and summer camps. Once the stress of the acute episode has passed, take advantage of opportunities to provide more extensive education at each health visit.

Teach children how the lung works and what happens when an asthmatic episode occurs. Special summer camps are available that help children with asthma learn to manage their disease.

Make sure the parents and the child understand that asthma is a chronic and progressive condition rather than an episodic illness. Teach the child and family about the importance of the controller medication program and develop a written plan to help the family manage asthma. The plan should include not only the daily controller medications, but also the rescue medications to take once symptoms of an asthma episode are identified and when to call the health professional. Determine if the family uses any complementary and alternative therapies for asthma management. See Complementary Therapy: Alternative Asthma Treatments.

Provide printed educational materials and referral to a local support group to help parents gain additional knowledge and confidence that will enable them to help their child lead a normal life (Figure 25–19). *Pediatric Asthma: Promoting Best Practice* is a good resource for families and is available from the American Academy of Asthma, Allergy, and Immunology.

Regularly review the child’s technique for using an inhaler to ensure that proper technique is used. Assess how often the child uses the rescue inhaler by how frequently a new inhaler is purchased. There are 200 puffs per inhaler, and if one inhaler per month (or 6 to 7 puffs per day) is used, further investigation is needed. This could reflect poor asthma control or poor technique in using the inhaler so that full benefit of the medication is not gained.

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**BOX 25–11 Medication Administration: Growth and Development Considerations**

Inhalation is the preferred method of asthma medication administration. Metered-dose inhalers, nebulizers, and dry powder inhalers are devices used for this route of medication administration. Inhalation rapidly delivers the medication to the lungs for prompt onset of action. Other benefits are reduced risk of adverse effects and lower dosing compared to the oral route. However, inhalers are relatively inefficient and have special challenges for infants and young children. Effective medication delivery to the lung is affected by respiratory rate, degree of airflow obstruction, the medication, and the device used. Many devices require cooperation, coordination, and appropriate technique (Pongracic, 2003).

- **Children over 6 years usually have the ability to use a metered-dose inhaler, coordinating medication release and inspiration; however, they may prefer to use a holding chamber or spacer with a valve.**

- **Spacers help increase the proportion of particles in the range that can reach the lungs. They also trap larger particles preventing them from reaching the mouth and being swallowed, which can cause local and systemic side effects. Valves prevent the escape of medication during use. With proper technique 12% to 15% of the dose may reach the lower airways.**

- **Spacers have a mouthpiece or mask attachment. When selecting a spacer for infants and young children, choose one with a mask because these children tend to be nasal breathers. Choose a mask size that fits the child’s face and that has a flexible seal to prevent an air leak around the facial features. When the young child is uncooperative, it may still be difficult to maintain a seal. Work with young children to improve cooperation for medication delivery with play and distraction. Crying leads to prolonged exhalation and short inspiratory efforts which reduces lung deposition.**

- **Some inhaler and spacer brands have a whistle on inhalation that indicates that a breath is too fast or too shallow, but in others it indicates an adequate breath has been taken. When teaching the child and family about inhaler use, make sure you know what the whistle indicates.**

- **Nebulizers do not require coordination, making them easier for young children to use. A mask or mouthpiece must be used. They provide increased humidification during treatment. When the nebulizer mouthpiece is held 1 cm from the mouth, lung deposition of the medication is reduced by 50%. When it is held 2 cm from the mouth, up to 80% of the medication does not reach the lungs (Marshik, 2004). Nebulizers are inefficient, expensive, and take 8 to 10 minutes for the treatment. Infants and young children may have difficulty cooperating for the duration of the nebulizer treatment. Crying and a face mask that is too large for the child’s face can further decrease the delivery of the medication to the lower airways.**

- **Dry powder inhalers are activated when the patient takes a breath, so puffs do not need to be coordinated with inhalation. No spacer is required, so it is more convenient to carry. No propellant is used. Delivery to the lower airway varies between 15% and 30% depending upon the type of inhaler. Children under 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.**
Review the family’s daily plan for monitoring the child’s respiratory status. Evaluate the child’s technique for PEFR and the parent’s ability to identify the timing and type of stepped-up care needed to manage worsening symptoms. The goal is to bring asthma episodes under control with stepped-up care before a significant episode occurs. This can be achieved only with daily monitoring.

Environmental control is an important part of asthma management. When possible, pets and plants should not be kept in the home (and never in the child’s bedroom). Active dust mite control should be attempted, but is challenging as mites live in the carpets, mattresses, upholstered furniture, bedcovers, soft toys, and clothes. Particular attention should be directed at controlling dust mites in the child’s bed and bedroom. The child’s mattress and pillow should be encased in plastic covers. Cockroach eradication should be initiated. Smoke from cigarettes, wood stoves, and fireplaces should be eliminated.

Help the child learn the signs of early respiratory distress so that treatment can be obtained before signs become more serious. Help parents to communicate with school personnel regarding the child’s condition, and to have an individual school health plan developed so that medications are given as needed, even in preparation for exercise. For young school-age children, make sure their teachers can help recognize respiratory distress and can reduce their fear of going to the nurse for rescue medications. Make sure the child has a supply of medications at school or childcare as well as at home.

Encourage the school-age child or parent of younger children to use a symptom diary to note the daytime and nighttime symptoms, including peak flow measurements for 2 weeks prior to the next health visit.

Assess family support systems and family response to the chronic illness. Work to establish a partnership with the child and family that supports their ability to perform and maintain controller medication regimens. Reasons for nonadherence include the following:

- Improper use of delivery devices
- Inconvenient or frequent dosing regimens
- Lag time for medications to suppress inflammation
- Length of time for reappearance of symptoms following discontinuation of medications
- Fear of side effects
- Lack of support from family

See Evidence-Based Practice: Effective Asthma Management.

Ensure that the child gets regular health promotion and maintenance care, including routine and supplemental immunizations (influenza). If the child has severe asthma and uses high doses of aerosol or oral glucocorticoids to control asthma episodes, monitor the child’s growth every 6 months as the disease and these medications may affect overall growth. Recent studies have revealed that inhaled corticosteroids may reduce the growth of prepubescent children, but the effect diminishes with chronic treatments, and final adult height is not affected. However, untreated asthma may reduce growth velocity in a child by nearly 0.9 cm per year (Stempel, Pedersen, & Blaiss, 2002).

Exercise is important for all children for physical fitness and to maintain appropriate body weight. Assess the amount of exercise children

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**FIGURE 25–19** This educational piece from the American Lung Association explains what triggers an asthmatic episode. The required lifestyle changes for the child and family will be significant, so be sensitive to the family’s situation and needs. Culture sometimes plays a significant part in exposure to lifestyle triggers.

Reprinted with permission ©2004 American Lung Association. For more information on how you can support to fight lung disease, the third leading cause of death in the United States, please contact the American Lung Association at 1-800-LUNG-USA (1-800-586-4872) or log on to the website at www.lungusa.org.
PARTNERING WITH FAMILIES

Home Care for the Child with Asthma

Identify parents’ knowledge about the condition
➤ Review why asthma occurs and assess parents’ understanding of the physiologic process. Ask:
➤ What happens in your child’s lungs during an asthma attack?
➤ What are the early warning signs of an asthma episode in your child?
➤ What are your child’s symptoms and how does he or she respond to them? Does your child use the peak expiratory flow meter to evaluate symptoms?
➤ To help toddlers learn how to use a peak flow meter, have them practice by blowing into party favors (i.e., noisemakers).
➤ Determine if the parents or child understands that asthma is a chronic condition that needs daily medication and environmental management to be controlled.
➤ Help parents explore and understand how asthma affects their child.
➤ Does the child wake up at night?
➤ Does the child cough a lot? When?
➤ Does the child avoid sports practice? What physical activities does the child like to do? If none, why?
➤ Does asthma interfere with social activities or activities with friends?
➤ Identify asthma triggers and assess parents’ understanding of how to prevent, avoid, or minimize their effect in a timely manner. Ask:
➤ Do you know your child’s personal asthma triggers? (Suggest that the parents and child keep a notebook to track episodes so they can learn more about these triggers.) Where do most episodes begin—home, school, outdoors, with exercise?
➤ What steps can you take to minimize or eliminate your child’s exposure to indoor pollutants (cigarette smoke, molds, dust mites, allergens, furry animals, etc.)?

Set up a schedule for parents to learn asthma management
➤ Make sure the parents understand the need for daily management and how that enables the family and child to have control over asthma.
➤ Ensure that the family knows when and where to seek emergency medical help. Describe actions the family can take before seeking medical assistance.

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 the parent knows the difference between controller medications to be used every day and rescue medications to be used during an episode.
➤ Color labels to match the peak flow meter zones can be used to help children and parents tell the difference between their medications. A green label can be used on controller medications, to be used every day. Yellow and red labels can be used on the rescue medications with the number of puffs to use when the child’s peak flow meter reading is in either color zone.
➤ Evaluate the child’s technique for the use of an inhaler. To help children use a metered-dose inhaler, let them practice breathing in slowly through a straw. To help children use a dry powder inhaler, obtain a practice inhaler from the pharmaceutical representative so the child learns to listen for the whistle corresponding to correct use for that inhaler. (Some inhalers have a whistle when the inspiration is too fast or when the inspiration is the correct rate.)
➤ To help parents provide a nebulizer treatment to the infant or young child, suggest different types of diversion that might be used to help the child cooperate during the 8- to 10-minute treatment.
➤ Make sure the parent and child have a written action plan that includes daily management and steps to take when an episode begins.

Address associated issues
➤ Do parents know how to store and properly transport medications?
➤ What are the financial considerations of medication cost and lifestyle changes?
➤ Has the child’s school or teacher been notified? What arrangements have been made for the child’s use of medications at school?
➤ Has a medical identification bracelet or medallion been obtained for the child to facilitate assistance when away from home?

Identify need for follow-up care
➤ Do parents know when to see a physician? When drug levels need to be checked?
➤ Does child need to see an allergist?
➤ Do the child and parents have special emotional needs?
➤ Would a self-help group or camp experience be helpful for the child?

with asthma are getting and any symptoms they experience such as chest tightening, wheezing, or shortness of breath. Exercise-induced asthma typically occurs 5 to 10 minutes after stopping the activity and resolves in another 20 to 30 minutes. In the infant and toddler, excitement, giggling, and crying are exercise equivalents (Strunk, 2002). Avoid asking questions such as, “Do you have asthma symptoms when exercising?” or “Do you use your rescue inhaler for exercise?” without first determining that the child gets some exercise. Determine how frequently the child has symptoms of asthma and compare that to the classification of asthma severity in Table 25–13. For example, exercise-induced asthma symptoms that occur daily would put the child in the moderate persistent category. Ensure the appropriate controller and rescue medication treatment plan is used by the child.

Refer to the nursing care plan for the child with asthma in the community setting.

Evaluation

Expected outcomes of nursing care include the following:

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

**Status Asthmaticus**

Status asthmaticus is unrelenting, severe respiratory distress and bronchospasm in an asthmatic child, which persists despite pharmacologic and supportive interventions. These children are in acute respiratory distress and use many accessory muscles, appear restless and anxious, have altered mental status, cannot say more than a word or two without gasping for a breath, are diaphoretic, and are dusky or cyanotic. The child may have diminished or absent breath sounds and pulsus paradoxus. Laboratory findings for the child who needs admission to an intensive care unit may include:

- Peak expiratory flow rate < 25% predicted
- Significant hypoxemia (arterial oxygen saturation < 90% when on oxygen)
- Hypercarbia

**EVIDENCE-BASED PRACTICE**

**Effective Asthma Management**

Adherence to recommended controller asthma medications is important to help manage asthma symptoms so the child has as normal a life as possible. Many children with asthma have less than optimal medication management to control symptoms. As a result, many children have increased asthmatic episodes and suboptimal asthma control. What information about the knowledge and perceptions about managing the child with asthma is available to help nurses improve their communication and partnership with families for effective asthma management?

**EVIDENCE**

A study of children with persistent asthma symptoms in East Harlem revealed that anti-inflammatory medications were underused (Diaz, Sturm, Matte, et al., 2000). Parental concerns specific to long-term medication use were identified as a barrier to effective asthma management in another study (Mansour, Lamphear, & DeWitt, 2000). Recent research on parental beliefs, knowledge, experience of living with a child who has asthma, and attitudes about controller medication was conducted through interviews with 18 mothers of children and adolescents with asthma. Parents expressed that they learned to manage the child’s asthma through “trial and error.” Even though they had been taught about medications at one time, they had significant gaps in current knowledge with regard to medication actions. Parents expressed the desire to have health professionals (particularly those providing episodic and emergency care) listen to them regarding their child’s healthcare needs. These same parents reported that taking medications on a daily basis was the most difficult aspect of asthma care; however, when they did use them they saw a good response in the child (Peterson-Sweeney, McMullen, Yos, et al., 2003). A questionnaire was administered to parents of 109 children with asthma to explore their attitudes and understanding of asthma. Findings revealed that 31 children had mild intermittent asthma, and only 27 of the 78 children with persistent asthma had an appropriate medication regimen. Seventeen parents reported no anti-inflammatory medication use even when the child had moderate to severe asthma. Parents in this study had various beliefs about inhaled steroids, such as they should be a last-resort therapy and after they are taken for a while they will fail to work when needed. These parents also anticipated that their children would have activity limitations and episodic emergency department visits (Yoos, Kitzman, & McMullen, 2003).

**IMPLICATIONS**

The expressed desire for parents to be respected by health professionals for their knowledge about their children and daily management of asthma is important to acknowledge. Such respect for the parent’s knowledge of the child’s health status and response to asthma management is essential for an effective partnership with the parent. It is important to talk with parents about their beliefs about inhaled steroids to make sure appropriate information is provided. The following screening statements may be useful in identifying parents and children with a suboptimal asthma regimen (Yoos et al., 2003).

- There is little I can do to control my child’s symptoms.
- I expect that my child will have no emergency room visits or hospitalizations.
- I believe that my child can be symptom free most of the time.
- I expect that asthma will not affect my child’s school attendance.
- I expect that my child can fully participate in gym and normal physical activity.
- I expect that my child will have no emergency room visits or hospitalizations because of asthma.

**CRITICAL-THINKING APPLICATION**

Consider the possible perceptions and beliefs of parents and children with asthma in your practice setting. Use these statements to survey parents of children with moderate to severe persistent asthma to identify their beliefs about asthma and medication management. Then develop an education program that integrates these beliefs and perceptions to help improve their understanding of medication actions, the differences between inhaled and oral corticosteroids, and collaboration with health professionals to improve the control of their child’s asthma.

Cystic Fibrosis

Cystic fibrosis is a common inherited autosomal recessive disorder of the exocrine glands that results in physiologic alterations in the respiratory, gastrointestinal, and reproductive systems. The incidence of cystic fibrosis varies by race—1:3,300 in Caucasians, 1:17,000 in African Americans, 1:8,000 in Hispanics, and 1:32,000 in Asian Americans (McMullen & Bryson, 2004). Gender is not a factor in incidence (Figure 25–20 ■). Approximately 30,000 children and adults have cystic fibrosis in the United States, and approximately one third of these individuals are adults (Cystic Fibrosis Foundation, 2004). The mean age at diagnosis is 4.8 years; however, some children with a milder form of the disease may be adolescents or young adults before symp-

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### Nursing Care Plan

**THE CHILD WITH ASTHMA IN THE COMMUNITY SETTING**

<table>
<thead>
<tr>
<th>GOAL</th>
<th>INTERVENTION</th>
<th>RATIONALE</th>
<th>EXPECTED OUTCOME</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Readiness for Enhanced Family Coping related to increased control of asthma with daily therapeutic care</td>
<td>NIC Priority Intervention—Family Support: Promotion of family interests and goals.</td>
<td>The parents’ concerns may not be the same as the nurse’s. If the parents’ concerns are not addressed, the parents may not comply with recommended care.</td>
<td>The parents express greater confidence in averting and managing their child’s asthma attacks.</td>
</tr>
<tr>
<td></td>
<td>The child and parents will work in partnership with the nurse to improve the child’s asthma management.</td>
<td>Listen to the family’s concerns about asthma management and respond with information to correct any misconceptions. Proper use of equipment and appropriate medication dosage will help alleviate asthma symptoms. Support and reinforcement of learning during an asthma attack will increase the parents’ confidence in managing future attacks.</td>
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</tr>
<tr>
<td></td>
<td>■ Listen to the family’s concerns about asthma management and respond with information to correct any misconceptions.</td>
<td>■ Teach the family skills (assessment, use of equipment, and giving medications) for managing the child’s asthma. ■ Provide telephone consultation to the parents during management of the first few asthma attacks. ■ Educate the parents about when to call for future medical advice or to seek emergency treatment.</td>
<td>■ The parents express greater confidence in averting and managing their child’s asthma attacks.</td>
</tr>
<tr>
<td></td>
<td>■ The parents’ concerns may not be the same as the nurse’s. If the parents’ concerns are not addressed, the parents may not comply with recommended care.</td>
<td>■ Proper use of equipment and appropriate medication dosage will help alleviate asthma symptoms. ■ Support and reinforcement of learning during an asthma attack will increase the parents’ confidence in managing future attacks.</td>
<td></td>
</tr>
<tr>
<td>2. Ineffective Family Therapeutic Regimen Management related to knowledge deficit</td>
<td>NIC Priority Intervention—Family Involvement: Facilitating family participation in the emotional and physical care of the patient.</td>
<td>The peak flow meter helps quantify changes in respiratory status before symptoms are detected. Identifying a personal best peak flow helps establish the ranges to be used for future symptom identification. Giving medications before an asthma attack becomes established may help avert the actual attack. Monitoring the response gives the family information to determine when home care is inadequate and medical intervention is needed.</td>
<td>The number of asthma attacks requiring medical intervention is reduced.</td>
</tr>
<tr>
<td></td>
<td>The child and parents will recognize early signs of an asthma episode and begin appropriate treatment.</td>
<td>Teach the child and parents to use a peak flow meter. Help the child recognize his or her personal best peak flow and range indicating development of asthma symptoms. Teach the family and child to give medications when the peak flow falls to the yellow range. Teach the child and family to monitor the child's response to medications with the peak flow meter.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>■ Teach the child and parents to use a peak flow meter.</td>
<td>■ Help the child recognize his or her personal best peak flow and range indicating development of asthma symptoms. ■ Teach the family and child to give medications when the peak flow falls to the yellow range. ■ Teach the child and family to monitor the child’s response to medications with the peak flow meter.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>■ The peak flow meter helps quantify changes in respiratory status before symptoms are detected.</td>
<td>■ Identifying a personal best peak flow helps establish the ranges to be used for future symptom identification. ■ Giving medications before an asthma attack becomes established may help avert the actual attack. ■ Monitoring the response gives the family information to determine when home care is inadequate and medical intervention is needed.</td>
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</table>

Without aggressive and immediate intervention the child with status asthmaticus may progress to respiratory failure and die. The child is placed on a cardiorespiratory monitor and pulse oximetry. Aggressive treatment with continuous nebulized albuterol and intravenous medications such as corticosteroids and aminophylline are implemented.

Heliox may be used to improve oxygenation and reduce the work of breathing. If improvement is not noted with these interventions, the child may ultimately require endotracheal intubation and mechanical ventilation. The section on respiratory failure earlier in the chapter gives additional information on the nurse’s role in providing respiratory care for the child who is critically ill.
toms appear (Farrell, Kosorok, Rock, et al., 2001). The median life span for individuals with cystic fibrosis in the United States is 32 years, but it is even higher in Canada (Orenstein, Winnie, & Altman, 2002).

Etiology and Pathophysiology

A gene isolated on the long arm of chromosome 7 directs the function of the cystic fibrosis transmembrane conductance regulator (CFTR). There are nearly 1,000 mutations of the CFTR gene that can cause cystic fibrosis (Orenstein, et. al., 2002). Approximately 1 in 29 individuals in the United States is a carrier of a defective CFTR gene (Parad & Comeau, 2003).

With a defective CFTR, there is defective chloride-ion transport across the exocrine and epithelial cells that causes decreased chloride secretion and increased sodium absorption. Decreased water flows across cell membranes, resulting in an

<table>
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<tr>
<th>GOAL</th>
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<th>RATIONALE</th>
<th>EXPECTED OUTCOME</th>
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</thead>
<tbody>
<tr>
<td>3. Ineffective Health Maintenance related to lack of school asthma management plan</td>
<td>NIC Priority Intervention—Health System Guidance: Facilitating a patient’s location and use of appropriate health services.</td>
<td>• Provide the family with educational materials to give to the school nurse and school administrators. • Advocate for all children to have an asthma management plan developed. • Support the family to have a school health plan that includes the healthcare provider's written orders customized for the child. • Include in the IHP participation in school/class activities such as field trips and physical education, and what to do if asthma symptoms occur at school. • Help the family to obtain extra equipment and medications that can be provided to the school. • Work with the parents and school nurse to teach the specific asthma interventions to a designated person in the school nurse’s absence.</td>
<td>• School personnel need the latest information about effective asthma management in school settings. • Establishing a school policy will help all children with asthma receive appropriate care. • The child with asthma needs a personalized care plan to be most successful in controlling asthma attacks. • Participation, even with modification or premedication, prior to activities promotes self-esteem and peer relationships. • Schools will provide care, but the families must provide all supplies, equipment, and medications. • School nurses often travel between several schools. The school administrator or secretary often serves as the backup care provider. • Implementation of the school health plan reduces the number of school absences for asthma attacks that occur during school hours and increases participation in school activities.</td>
</tr>
<tr>
<td>4. Risk for Situational Low Self-Esteem (child) related to need to seek special care during school hours</td>
<td>NIC Priority Intervention—Self-Esteem Enhancement: Assisting a patient to increase his or her personal judgment of self-worth.</td>
<td>• Assess the child’s peer relationships and opportunities for age-appropriate interactions. • Motivate the child and family to gain increased control of asthma so the child can participate in normal childhood activities. • Identify types of conflict and teasing the child experiences with peers, and teach the child defense tactics to deal with them.</td>
<td>• Assessment is important to identify the best strategies to support the child and family. • Motivation may increase compliance with recommended daily asthma control interventions. • If the child is able to gain some control over these situations, his or her self-esteem will be improved. ◼ The child establishes friendships and engages in activities with peers.</td>
</tr>
</tbody>
</table>
abnormal accumulation of viscous, dehydrated mucus that affects the respiratory, gastrointestinal, and reproductive systems. Inflammation and lung changes are present as early as 4 weeks of age. Ultimately, all body organs with mucous ducts become obstructed and damaged (McMullen & Bryson, 2004). The rate of progression is variable among affected children.

Because of the blocked pancreatic ducts and resulting pancreatic damage, the natural enzymes necessary to digest fats and proteins are not secreted. Food is poorly digested and thick mucus is also found in the intestines. This results in poor digestion and malabsorption in 90% of children with cystic fibrosis by 1 year of age, resulting in failure to thrive in many children. In some children the pancreas may stop producing sufficient insulin and the body may fail to utilize insulin normally, resulting in the development of diabetes mellitus.

Children have a classic cough because the lungs are filled with thick mucus, which the respiratory cilia cannot clear. This causes air to become trapped in the small airways, resulting in hyperinflation and atelectasis. Secondary respiratory infections and chronic bacterial colonization occur because the thick secretions provide an environment conducive to bacterial growth. Pneumothorax and hemothorax may occur in older children. Respiratory failure is the major leading cause of mortality.

Nearly all males who have cystic fibrosis are sterile because of blockage or absence of the vas deferens. Females have difficulty conceiving because of chronic illness and thickened mucous secretions in the reproductive tract that interfere with the passage of sperm (McMullen & Bryson, 2004).

Metabolic function is altered as a result of the imbalances created by excessive electrolyte loss through perspiration, saliva, and mucous secretion. These children are at risk for dehydration secondary to electrolyte imbalance. The “salty taste” of the skin is the result of sodium chloride that makes its way through skin pores to the skin surface.

**Clinical Manifestations**

The primary symptom of cystic fibrosis is the production of thick, sticky mucus. Up to 10% of newborns with cystic fibrosis present in the first 48 hours with meconium ileus, a small bowel obstruction (McMullen & Bryson, 2004). Stools of the child with cystic fibrosis may have the following characteristics: steatorrhea (fatty or greasy), frothy (bulky and large quantity), foul smelling, and floating. Constipation is common and intestinal obstruction may occur in older children. Rectal prolapse, resulting from the large, bulky, difficult-to-pass stools, may occur (Figure 25–21). Respiratory signs and symptoms include a chronic moist, productive cough and frequent infections. Frontal headaches, facial tenderness, purulent nasal discharge, and postnasal discharge are associated with chronic sinus infections. Nasal polyps are found in 10% of children with cystic fibrosis (McMullen & Bryson, 2004). Most children have a voracious appetite, but have difficulty maintaining and gaining weight because of malabsorption of food and an increased metabolic rate associated with frequent infections. Clubbing, an enlargement of the distal phalanges of the fingers and toes, occurs as the disease progresses due to chronic fibrotic changes within the lungs (Figure 25–22). Children with a milder form of the disease may reach the teenage or young adult years before symptoms appear.

Various disorders develop in the older child with more advanced cystic fibrosis. Unilateral chest pain of sudden onset associated with shortness of breath is an indication of pneumothorax. Minor hemoptysis (blood streaking the expectorated mucus) is common; however, massive hemoptysis (240 mL in 24 hours) is a serious complication and much less common (McMullen & Bryson, 2004). Distal intestinal obstruction syndrome, presenting
as crampy abdominal pain and decreased stools, occurs in about 10% of adolescents and adults.

**COLLABORATIVE CARE**

**Diagnostic Procedures**

Cystic fibrosis is usually diagnosed in infancy or early childhood following one of three major presentations: newborn meconium ileus, malabsorption or failure to thrive, or chronic recurrent respiratory infections. In infants and toddlers, fecal impaction and intussusception ("telescoping" of the bowel) may be the first signs of cystic fibrosis (see Chapter 29∞).

Genetic testing is available for adults with a positive family history, partners of individuals with cystic fibrosis, and couples seeking prenatal testing to detect the majority of CF gene alterations. Rare CF gene alterations are not always detected in genetic testing (Cystic Fibrosis Foundation, 2004).

Newborns with CF have an elevated serum level of the pancreatic enzyme trypsinogen. Newborn screening can be performed on dried blood samples to detect immunoreactive trypsinogen, although this test has high false-positive and false-negative rates. Therefore genetic testing of the child’s DNA is performed on the positive immunoreactive trypsinogen tests. Approximately 10% of newborns are screened in the United States. Newborn screening for CF is mandated in Wisconsin, Colorado, Wyoming, Mississippi, New Jersey, and New York, and offered as an option in several other states (Parad & Comeau, 2003).

A sweat chloride test by pilocarpine iontophoresis is considered the gold standard for diagnosis of cystic fibrosis. The majority of children with cystic fibrosis are diagnosed by a positive sweat chloride test and the presence of classic symptoms or a positive family history (McMullen & Bryson, 2004) (Table 25–15). Sweat chloride tests can be performed on infants who are only a few days old; however, inadequate sweat samples may not be collected until the infant is more than 4 weeks (Orenstein et al., 2002; McMullen & Bryson, 2004). Two tests are performed to confirm the diagnosis (Figure 25–23■).

A spirometer is used on children older than 6 years to monitor pulmonary function. Forced vital capacity (FVC) and forced expiratory volume in 1 second (FEV1) readings are taken. Sputum specimens are obtained to test for culture and sensitivity for treatment.

**Clinical Therapy**

Clinical therapy focuses on maintaining respiratory function, managing infection, promoting optimal nutrition and exercise, and preventing intestinal obstruction. See Table 25–16. Newly diagnosed children who begin treatment before the onset of symptomatic lung disease are aggressively treated to improve their outcome and maintain near-normal lung function as long as possible. The goal of therapy is to prevent or slow the progression of airway damage. Pulmonary function declines 2% to 4% per year even with aggressive treatment (Vallotta, 1998).

Treatment is focused on controlling infection and inflammation, and on reducing mucus accumulation. Various forms of bronchial hygiene therapy, such as manual chest physiotherapy, are used regularly to reduce the accumulation of mucus in the lungs. See Box 25–12 for the various types of chest physiotherapy used by children with cystic fibrosis.

Frequent prolonged courses of antibiotics for infections may be prescribed to improve pulmonary function, exercise tolerance, and quality of life. Infection management directed at *Haemophilus influenzae*, *Staphylococcus*, and *Pseudomonas aeruginosa* are important for children with mild disease; however, sputum culture results and sensitivities are also important in selection of the specific antibiotics used. Children who have evidence of *Pseudomonas aeruginosa* or *Burkholderia cepacia* infections have a poorer outcome. The Cystic Fibrosis Foundation has a policy stating that individuals infected with *Burkholderia*

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**TABLE 25–15 Diagnostic Test for Cystic Fibrosis (Sweat Test)**

<table>
<thead>
<tr>
<th>TEST (pilocarpine iontophoresis)</th>
<th>PURPOSE</th>
<th>NORMAL VALUES</th>
<th>DIAGNOSTIC VALUES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sweat test</td>
<td>Analysis of sodium and chloride content in sweat</td>
<td>Sodium: 10–30 mEq/L</td>
<td>Chloride: 50–60 mEq/L—suspicious; &gt; 60 mEq/L—diagnostic with other clinical signs</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Chloride: 10–35 mEq/L</td>
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</tr>
</tbody>
</table>

To collect the sweat, pilocarpine is applied to a small area on the arm or leg. An electrode with weak electrical current is placed on the area to stimulate the child to sweat. The area is cleaned and a piece of filter paper is placed over the area and covered in plastic. The filter paper is removed after 30 minutes and the sweat content is analyzed.
cepacia may not attend foundation-sponsored events in an effort to reduce the cross infection to uninfected children (Cystic Fibrosis Foundation, 2000).

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 the table of medications used to treat cystic fibrosis on page 150.

Improvements in medical management and optimal nutrition now enable many children with cystic fibrosis to survive into adulthood. As more adolescents survive into adulthood, new complications are becoming apparent and need carefully coordinated management along with cystic fibrosis. Cystic fibrosis–related diabetes is challenging to manage, because the large caloric intake needed for these adolescents needs to be balanced by insulin dosage.

Cystic fibrosis is ultimately terminal, however, because of the progressive multisystem changes and the difficulty of long-term infection management. Double-lung transplantation is occasionally performed when the patient is in the disease’s end stages to temporarily halt the disease progression, and approximately 50% of cases survive for the first 5 years (McMullen & Bryson, 2004). The posttransplant course can be complicated by infection and rejection of the grafted lungs. Acute rejection can be managed by immunologic medications. Chronic rejection, also known as bronchiolitis obliterans, involves irreversible changes to the lung tissue that are unresponsive to immunologic medication manage-

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**TABLE 25–16** Clinical Therapy for Cystic Fibrosis

<table>
<thead>
<tr>
<th>CLINICAL THERAPY</th>
<th>RATIONALE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Respiratory Therapy</strong></td>
<td></td>
</tr>
<tr>
<td>Exercise and physical fitness</td>
<td>Promotes maintenance of lung function</td>
</tr>
<tr>
<td>Chest physiotherapy for all lung segments (bilateral percussion or vibration while the patient is in a position to promote sputum drainage)</td>
<td>In association with coughing and breathing techniques secretions move to bronchi from lung areas, performed twice a day</td>
</tr>
<tr>
<td>Antibiotics (oral, IV, inhalation)</td>
<td>Treats infection</td>
</tr>
<tr>
<td>Immunizations</td>
<td>Prevention of viral and some bacterial infections</td>
</tr>
<tr>
<td>Chest tube drainage of air leaks</td>
<td>Resolves pneumothorax</td>
</tr>
<tr>
<td>Thoracoscopy to sew over ruptured alveoli</td>
<td>Repairs area of recurrent pneumothorax and prevents future episode in same location</td>
</tr>
<tr>
<td>Hospitalization for intense airway clearance</td>
<td>Promotes resolution of pulmonary exacerbations</td>
</tr>
<tr>
<td>Lung transplantation</td>
<td>Reversal of respiratory failure</td>
</tr>
<tr>
<td><strong>Gastrointestinal Tract Therapy</strong></td>
<td></td>
</tr>
<tr>
<td>Acid suppression preparation</td>
<td>Gastric acid hypersecretion may cause gastroesophageal reflux that worsens lung function; enteric coating of enzyme supplements is reduced with high acid levels in duodenum</td>
</tr>
<tr>
<td>Hyperosmolar enemas</td>
<td>Relieves meconium ileus in most infants</td>
</tr>
<tr>
<td>Isotonic fluid lavage of the intestines orally or by nasogastric tube</td>
<td>Reduces partial obstruction caused by distal intestinal obstruction syndrome (DIOS)</td>
</tr>
<tr>
<td><strong>Nutrition</strong></td>
<td></td>
</tr>
<tr>
<td>Well-balanced diet with 120–150% of RDA calories and 200% of RDA protein and moderate fat</td>
<td>Promotes essential nutrient balance for health, growth, and weight maintenance; nutritional counseling to support high-caloric intake; cultural-socioeconomic issues important</td>
</tr>
<tr>
<td>Pancreatic enzyme supplements</td>
<td>Assists in digestion of nutrients and decreasing fat and bulk</td>
</tr>
</tbody>
</table>
Nursing Assessment and Diagnosis

Physiologic Assessment
Assess the child’s respiratory status. Respiratory function tests are usually performed every 6 months during cystic fibrosis center visits. Inquire about the frequency and character of the child’s cough and characteristics of the 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 oxygen saturation and spirometry readings if changes in respiratory status are suspected.

Evaluate the child’s growth, plotting the weight and height on a growth curve. Determine whether the child is maintaining an appropriate growth pattern. Children with significantly lower percentiles for height and weight on the growth curve should be considered malnourished. Inquire about the child’s appetite and dietary intake. How are nutritional supplements, pancreatic enzymes, and vitamins used?

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.

Assess hearing acuity on a regular basis, especially if the antibiotic tobramycin is used as this medication has been associated with hearing loss.

Psychosocial Assessment
Inquire about the family’s and child’s emotional and psychosocial responses to managing the illness. The emotional stress of this chronic disease may not be readily apparent on admission, or in clinic settings particularly if the child’s symptoms are mild and not imminently life threatening. These issues are important when the child is going through major developmental stages.

Ongoing observation of the child’s and parents’ behavior helps direct nursing interventions. See Box 25–6 on page 118 for guidelines. 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 may also be affected if the child is showing signs of significant deterioration, being forced to acknowledge their own future course with the disease.

The nurse should 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. Identify what parents of young children have told the child and siblings about the disease. What kind of questions have the child and siblings asked about cystic fibrosis, 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?

Developmental Assessment
Growth and development may be altered by the chronic nature of the disease. Children with cystic fibrosis may be growth delayed. Compare the child’s height and weight to age norms and observe the adolescent for the appearance of secondary sex ment. The presence of bronchiolitis obliterans is a sign of impending patient death unless another lung transplant is performed.

NURSING MANAGEMENT

The goal of nursing management is to partner with families to manage the disease by promoting optimal nutrition and in reducing the incidence of infection.

BOX 25–12 Bronchial Hygiene Therapy

Various methods of bronchial hygiene therapy have evolved over time to treat patients needing extra support to clear mucus and secretions from the lungs. Limited research comparing the various methods has revealed that their effectiveness is fairly comparable in clearing secretions from the airway. A more definitive long-term study to compare the efficacy of chest physiotherapy, the high-frequency chest wall oscillation vest, and the flutter device is currently being conducted by the Cystic Fibrosis Foundation.

For the child with cystic fibrosis, chest physiotherapy is time consuming and unpleasant, so compliance is often less than optimal. Finding a method that the family and child will use is important in disease management. Use the following information to assist families to select the method of bronchial hygiene therapy that has a better chance of fitting into their lives.

- **Chest physiotherapy.** Considered the gold standard in bronchial hygiene therapy. A parent or therapist percusses or applies vibration over each lung segment for 3 to 5 minutes while the child is maintained in the different positions that promote drainage of the secretions loosened by percussion or vibration. This method is preferred for infants and toddlers. See the skills manual for correct techniques.

- **Positive expiratory pressure (PEP).** The patient breathes in and out about 15 times through a mouthpiece attached to a breathing device with a special expiratory valve that creates a positive pressure in the airways during exhalation. The child then removes the mouthpiece and performs two to three forced exhalations followed by a cough (huff cough technique). This method creates a back pressure in the lungs and stabilizes the smaller airways. It improves aeration to the alveoli by prolonging exhalation against positive pressure. The technique has been mastered by children as young as 3 years, but is more commonly used by school-age and older children. Studies have reported that it is comparable to manual chest physiotherapy for mucus clearance in children with cystic fibrosis (McIlvaine, Wong, Peacock, et al., 1997).

- **Flutter valve.** This form of PEP uses deep breathing and forced exhalation to promote airway clearance. The patient breathes through a mouthpiece attached to a handheld device that has a steel ball inside. The patient controls exhalations through the device and the weight of the steel ball (flutter) provides intermittent positive expiratory pressure that vibrates the airway walls to loosen secretions. Deep breathing and breath holding allow the air to get behind the mucus and the positive expiratory pressure created helps move the mucus to the larger airways. School-age and older children can use this method. A study comparing the flutter valve to conventional chest physiotherapy revealed that each therapy was effective (Homnick, Anderson, & Marks, 1998).

- **High-frequency chest wall oscillation.** The patient puts on an inflatable vest that creates an oscillating motion against the chest wall by an air pulse generator that rapidly inflates and deflates the vest. Deep breathing and coughing help mobilize secretions loosened. Children older than 4 years can use this method. One study found no statistical difference between this device and others when studying patient satisfaction and efficacy (Oermann, Accurso, Castile, et al., 1997).
 Medications Used to Treat Cystic Fibrosis

<table>
<thead>
<tr>
<th>Medications</th>
<th>Actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aerosol bronchodilators</td>
<td>Opens large and small airways; use before chest physiotherapy and with symptoms; few studies exist to demonstrate their effectiveness.</td>
</tr>
<tr>
<td>Aerosol DNAse</td>
<td>Loosens, liquefies, and thins pulmonary secretions; decreases risk of developing pulmonary infections requiring parenteral treatment in some patients (McMullen &amp; Bryson 2004).</td>
</tr>
<tr>
<td>Corticosteroids and high-dose ibuprofen on alternate days</td>
<td>Anti-inflammatory agents: reduces inflammatory response to infection; alternate day use to decrease side effects of steroids; decreases progression of lung damage in preadolescents with mild disease.</td>
</tr>
<tr>
<td>Antibiotics (oral, IV, and inhalation)</td>
<td>Treats infections. Higher doses than normal and prolonged courses may be needed. Antibiotic selection should be based on culture sensitivities. Intermittent administration of tobramycin by inhalation improves pulmonary function.</td>
</tr>
<tr>
<td>Pancreatic enzyme supplements (Cotazym-S, Pancrease, Viokase)</td>
<td>Assists in digestion of nutrients decreasing fat and bulk; given prior to food ingestion, taken with meals and snacks.</td>
</tr>
<tr>
<td>Multivitamins and vitamin E in water-soluble form; vitamins A, D, and K given when deficient; iron supplementation</td>
<td>Cystic fibrosis interferes with vitamin production; supplements are required in water-soluble form for better absorption (vitamins A, D, E, and K are naturally fat soluble); iron deficiency results from malabsorption syndrome.</td>
</tr>
<tr>
<td>Ursodeoxycholate</td>
<td>May slow progression of hepatic lesion in CF. Given when patient has elevated liver enzymes or evidence of portal hypertension.</td>
</tr>
<tr>
<td>Lactulose</td>
<td>May abort early distal intestinal obstruction syndrome and prevent recurrences.</td>
</tr>
</tbody>
</table>

characteristics, which are often delayed due to nutrition status. School-age children and adolescents often are embarrassed at being viewed as different from playmates and peers. Ask how the child or adolescent feels about the need for a special diet, medications, and the daily routine of respiratory management.

Common nursing diagnoses for the child with cystic fibrosis include the following:

- Ineffective Airway Clearance related to thick mucus in lungs
- Ineffective Breathing Pattern related to thick tracheobronchial secretions and airway obstruction
- Risk for Infection related to the presence of mucous secretions conducive to bacterial growth
- Imbalanced Nutrition: Less than Body Requirements related to inability to digest nutrients
- Parental Role Conflict 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. Respiratory therapy, medications, and diet 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 cystic fibrosis require periodic hospitalization when a severe infection occurs or for a pulmonary and nutritional “tune-up.” 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 to take advantage of the respite. The family often becomes proficient at providing physical care to the child, but the nurse should take the opportunity provided during rehospitalization to review basic and new information about respiratory care, medications, and nutrition. Keeping lines of communication open and validating parents’ understanding of their child’s disease and care needs are important steps in preparing the family to cope with this chronic health challenge.

The hospitalized child is usually placed in a single room to reduce spread of infectious organisms with standard precautions. Children with cystic fibrosis are not co-roomed to reduce risk for transfer of Pseudomonas aeruginosa and Burkholderia cepacia.

Provide Respiratory Therapy

Chest physiotherapy is usually performed one to three times per day before meals to facilitate the removal of secretions from the lungs (Figure 25–24). DNase is given by nebulizer to help thin respiratory secretions. Respiratory therapists and nurses often collaborate in teaching parents and other family members the skills for these necessary treatments. Pulmonary care may involve aerosol treatments and antibiotics when indicated. Some children use an oscillating vest for 30 minutes twice a day rather than chest physiotherapy. Exercise therapy is often utilized to increase endurance.

Administer Medications and Meet Nutritional Needs

Antibiotics for an acute exacerbation are provided by oral, inhalation, and intravenous routes. They are continued until the child achieves the best possible lung function, often for at least 14
Children with cystic fibrosis have an increased clearance of nearly all antibiotics, and therefore they need higher dosages and longer treatment courses than other children. Due to the higher antibiotic dosages, renal function needs to be monitored. Serum drug levels of antibiotics may be ordered to ensure therapeutic dosing. In some cases, IV antibiotics may be given at home to enable an earlier discharge. A portacath or peripherally inserted central catheters (PICC lines) are often placed for home IV therapy.

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 based on the child’s nutritional needs and digestive response to these supplements. Parents need to learn what foods if any should be avoided or eliminated because of the child’s gastrointestinal problems. Referral should be made to a nutritionist before the time of discharge. 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 usually are sufficient to prevent vitamin deficiency.

Respiratory complications necessitate additional energy expenditure, and some children require nutritional supplements or, supplemental nasogastric or gastrostomy feedings, to gain and maintain weight. The diet should be well balanced, with an emphasis on high caloric value. Children with CF may require 1.5 times the daily caloric requirements. Fats and salt are both necessary in the diet. Balanced with pancreatic enzyme supplements, moderate fat intake adds an important source of calories.

**Psychosocial Support**

The nurse should assist the parents and child to learn ways to promote health after discharge. Emotional support is essential because the diagnosis of this disorder creates anxiety and fear in both the parents and the child. The child and parents need assistance with emotional and psychosocial issues relating to discipline, body image (stooling and odor, clubbing, barrel chest), frequent rehospitalization, the potential fatal nature of the illness, the child’s feeling of being different from friends, and overall financial, social, and family concerns. Because the disorder is inherited, families may have more than one child with cystic fibrosis. Parents may have unspoken feelings of anger and guilt, blaming themselves for their children’s condition. Refer families to genetic counseling.

**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 family requires financial assistance, they should be referred to the appropriate social services. Home care of the child with cystic fibrosis is expensive and can be draining on the family’s finances. The cost of care varies by the severity of the child’s condition, so annual costs increase as the child ages, and may range from $5,600 to $60,700 (Balinsky & Zhu, 2004).

The chest physiotherapy regimen of three or four times a day has a significant impact on family time. See Photo Story: Managing Cystic Fibrosis on page 152. Alternate bronchial hygiene therapy techniques, such as a vest, may be more easily accepted by the family, especially if the parent does not have to physically perform the percussion and vibration. A regular vigorous exercise regimen is also beneficial in improving lung function, respiratory muscle strength, endurance, and airway clearance. Aerobic fitness is a significant factor in longer survival and quality of life for patients with cystic fibrosis.

Managing the child’s nutritional needs is important and takes time and energy. Parents often have a difficult time encouraging the child with cystic fibrosis to eat the extra calories needed for optimal nutrition, setting the stage for a potential mealtime

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**FIGURE 25–24** Postural drainage can be achieved by clapping with a cupped hand on the chest wall over the segment to be drained. This action creates vibrations that are transmitted to the bronchi so that secretions are loosened and drain by gravity to the bronchi. If the obstruction is in the posterior apical segment of the lung, the nurse can do this with the child sitting up. 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. See the Skills Manual.
S
haun, a 13-year-old with cystic fibrosis, has a challenging time managing all the aspects of his disease management. Shaun has an older sister who does not have cystic fibrosis. He lives with his mother and sister in a town about 50 miles from the cystic fibrosis center at the university medical center. He is in the 7th grade at a local middle school. He plays on a little league baseball team and enjoys riding his bicycle. He manages to keep his grades at a “C” level despite occasional school absences because of infection flare ups. He usually spends a few days in the hospital each year for intensive therapy sessions to clear his lungs.

Management of cystic fibrosis takes a lot of time each day, whether at home or in the hospital. All of his care must be scheduled around school and recreation. In most cases, the treatments cut in to his recreational time. Shaun has learned to manage many aspects of his care, relieving his mother of some responsibilities. For example, Shaun can set up his nebulizer treatment and

Children with cystic fibrosis lose more than normal amounts of salt in their sweat. This loss can become intensified during hot weather, strenuous exercise, and fever. During periods of exercise and increased sweating, the child should be encouraged to drink more fluids and increase salt intake. Parents should allow the child to add extra salt to food and should permit some salty snacks (pretzels with salt, pickles, carbonated soda). Teach parents to recognize early symptoms of salt depletion, including fatigue, weakness, abdominal pain, and vomiting, and to contact the child’s health-care provider if these symptoms occur.

At follow-up visits review the child’s use of bronchodilators and airway clearance techniques. To prevent a change in pulmonary status from progressing, short-term changes in care may be recommended. These may include intravenous and aerosol medications and antibiotics, an increase in the number of times chest physiotherapy is performed daily, and changes in dietary management. Help the family select the best time to fit the additional treatment into the schedule.

Adolescents have special developmental issues and needs that must be addressed since the median survival rate has increased
even measure the amount of DNase to use. After the nebulizer treatment, he uses an oscillating vest for chest physiotherapy for about 20 minutes per treatment. Coughing up sputum during and after the treatment is very tiring.

Shaun needs many extra calories to grow as well as to meet metabolic demands. His mother works hard to prepare and provide the extra calories he needs throughout the day. He must take pancreatic enzymes to help him digest the foods. Because Shaun sometimes has difficulty getting enough calories, he has a gastrostomy tube for nighttime feedings. This has made it possible to get enough calories to help support his adolescent growth spurt.

Adolescents with cystic fibrosis know they are different from their peers, and must learn how to cope with that difference. They also need to develop normal relationships and establish intimacy with a partner. Information about potential infertility must be provided along with the guidelines for safe sexual practices to reduce the risk for sexually transmitted diseases. Females may potentially be able to conceive and should be given contraception.

Adolescents must deal with the fact that they have a terminal condition, and they often need help to establish appropriate educational and occupational goals for their future. Transitioning to adult health-care services and planning for independent life with a chronic disease requires support and planning. Palliative care planning should be initiated in adolescents and young adults as the disease progresses to respiratory failure. Discussions about options, such as a double lung transplant, may be initiated with those considered to be candidates for the surgery. The patients who receive a transplant are not cured, but trade the problems of end-stage cystic fibrosis with lifelong immunosuppression and the resulting complications.

Cystic fibrosis affects all family members and disrupts activities of daily living for everyone. It is important to refer families to counseling and group therapy with families of other children with cystic fibrosis if indicated. The Cystic Fibrosis Foundation is a source for information on current advances in the disorder. Local chapter activities also provide emotional support for parents and children.

■ Evaluation

Expected outcomes of nursing care include the following:

- The child and family develop proficiency in providing the daily pulmonary care and reducing the incidence of respiratory infections.
• The child and family cope effectively with the child’s disease and develop a schedule and routine for daily pulmonary care that fits into family and school activities.
• The child consumes adequate calories and pancreatic enzymes to support growth and to stay within desirable weight ranges.

INJURIES OF THE RESPIRATORY SYSTEM

Airway compromise after an unintentional injury can cause death if not managed quickly and effectively. Children are vulnerable to changes in respiratory function after accidental injury because the small size of the child’s airway makes it vulnerable to obstruction. The tongue, small amounts of blood, mucus, or foreign debris or swelling in the respiratory tract or adjacent neck tissue may block the airway and lead to hypoxia and respiratory failure. If the child’s neck is flexed or hyperextended, the soft laryngeal cartilage may compress and obstruct the airway.

Smoke Inhalation Injury

Exposure of the child’s face and airway to fire or thermal conditions leads to dramatic responses in the child’s respiratory tract. In every age group, inhalation injury from smoke and heat significantly increases the child’s chance of death by 20%, and it also increases the likelihood that the burned child will develop pneumonia (Kim, 2001). Children are more vulnerable to smoke inhalation injury because their smaller airway diameter can be obstructed by edema and a higher respiratory rate increases their exposure to noxious chemicals.

Etiology and Pathophysiology

The severity of a smoke inhalation injury is influenced by the type of material burned and whether the child was exposed in an open or closed space. The composition of materials determines how easily it ignites, how fast it burns, and how much heat is released. These factors influence the production of smoke and toxic gases. Smoke, a product of the burning process that is composed of gases and particles, is generated in varying volumes and density. Chemicals and irritants from the gases result in mucosal airway damage, bronchospasm, depletion of alveolar surfactant, and mucous plugging from soot and sloughed airway mucosa. The type and concentration of invisible toxic gases affect the severity of pulmonary damage. The duration of exposure to the smoke produced and any toxic gases contribute 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 when the patient is conscious. This thermal injury results in marked edema of the upper airway, placing the small child at risk for airway obstruction.

Carbon monoxide (CO) is a clear, colorless, odorless gas that is present in all fire conditions as the fire consumes oxygen. This is a significant concern when the child is trapped in a closed-space fire, when the concentration of oxygen is decreased by up to 50%. The CO molecule binds more firmly to hemoglobin than does oxygen. As a result, it replaces oxygen in circulation and rapidly produces hypoxia in the child. The longer the exposure to CO, the greater the hypoxia. The brain and heart receive inadequate oxygen, resulting in confusion, myocardial depression, and ventricular arrhythmias.

Damage to the lower airway most often results from chemicals or toxic gas inhalation. Soot is carried deep into the lungs, where it combines with water in the lungs to deposit acid-producing chemicals on the lung tissue. These acids burn the tissue, causing loss of cilia, loss of surfactant, and edema. Tissue destruction, edema, and disruption of gas exchange produce the initial insult to the lungs and potential airway obstruction. Days later, the damaged tissue sloughs off, obstructing the airways. Because the cilia that normally help in removing debris have been destroyed, the lungs become a breeding ground for microorganisms. Pneumonia becomes a major health concern. The damaged alveoli heal by scar tissue formation. This can greatly reduce the future functioning of the lungs.

Clinical Manifestations

Burns of the face and neck, singed nasal hairs, soot around the mouth or nose, and hoarseness with stridor or voice change all indicate inhalation injury, 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 the child being exposed to smoke in a closed area, as well as signs of soot around the nose and mouth. If the child has minimal signs and symptoms when seen in the emergency department, admission for close observation and monitoring for progression of respiratory distress is often indicated. Initial treatment is 100% humidified oxygen administered through a nonrebreather mask. With the development of respiratory distress, aggressive airway management with endotracheal tube insertion, mechanical ventilation, and monitoring are provided in the intensive care unit. Bronchodilators by inhalation may be prescribed. Pulmonary physiotherapy may be provided. All other injuries sustained in the fire are treated.

NURSING MANAGEMENT

Nursing assessment for respiratory distress is a key initial role. Check vital signs frequently. Attach a pulse oximeter to monitor the oxygen saturation. Auscultate the lungs for crackles, wheezes,
and decreased breath sounds. Assess for level of consciousness and behavior changes that could indicate increasing hypoxia. Assess the family’s response to the life-threatening crisis and offer support with information about the child’s condition.

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 intensive care unit.

Blunt Chest Trauma

Blunt trauma is a common injury in children, especially associated with motor vehicle crashes (Pieper, 2000). Chest injuries may not be obvious and can be extremely difficult to evaluate.

Most children who die after sustaining severe blunt trauma were hypoxic due to poor airway and ventilatory control. A child’s elastic, pliable chest wall and thin abdominal muscles provide minimal protection to underlying organs. This elasticity often spares bone but not the underlying organs. The presence of a rib fracture in children under 12 years indicates trauma of significant force. The energy from blunt trauma is transferred directly from an external force to the internal organs, often causing a pulmonary contusion or pneumothorax.

Pulmonary Contusion

A pulmonary contusion is defined as bruising damage to the tissues of the lung that often occurs without bony injury to the thorax. This causes bleeding from the capillaries into the alveoli, which may lead to capillary rupture in the air sacs. Pulmonary edema develops in the lower airways as blood and fluid from damaged tissues accumulate. Lower airway obstruction and atelectasis may result in impaired gas exchange, acute respiratory distress, and respiratory failure (Hazinski, 1999).

Pulmonary contusion occurs in up to 76% of children with blunt or nonpenetrating chest trauma. Initially the child may appear asymptomatic. Signs of respiratory distress often develop over several hours, and include wheezing, hemoptysis, fever, crakles, and evidence of hypoxemia. Careful observation is required during the first 12 hours after the injury to detect decreased perfusion related to ventilatory impairment.

Nursing Management

The child’s level of consciousness is an excellent indicator of respiratory function. Agitation and lethargy can signal increasing hypoxia. When monitoring the status of a child who has a pulmonary contusion, do not rely on the child’s color as an indicator of adequate oxygenation. Cyanosis in children is often a late indicator of respiratory distress. Observe for hemoptysis (fresh blood in the sputum), dyspnea, decreased breath sounds, wheezes, crackles, and a transient temperature elevation. The thorax should be inspected for symmetric chest wall movement and equal presence of breath sounds in both lungs. The child may initially appear stable but requires careful and thorough monitoring to detect signs of deterioration.

Nursing care focuses on providing necessary physiologic support, such as oxygen therapy, pulmonary management, positioning, ventilatory support to provide positive end-expiratory pressure, and comfort measures.

Children with significant injuries are cared for in the intensive care unit. Some children require ventilator support as the pulmonary tissues heal. Fluids are carefully managed to prevent large increases in pulmonary edema. With severe pulmonary contusion intubation and mechanical ventilation are needed. Diuretics may be given to decrease edema in the interstitial pulmonary tissue. The child is at risk for development of acute respiratory distress syndrome. See page 98.

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 pneumohemothorax.

Etiology and Pathophysiology

Pneumothorax may develop as a complication of mechanical ventilation or high peak inspiratory or end-expiratory pressure used to achieve adequate oxygenation and ventilation. It may also occur in chronic lung conditions such as neonatal respiratory distress syndrome, status asthmaticus, and cystic fibrosis in which there is gas trapping and alveolar hyperinflation. 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, sometimes referred to as a sucking chest wound, results from any penetrating injury that exposes the pleural space to atmospheric pressure. Air is able to move freely in and out of the chest wall, collapsing the lung.

A closed pneumothorax is sometimes caused by blunt chest trauma with no evidence of rib fracture (Figure 25–25). The chest may be compressed against a closed glottis, causing a sudden increase in pressure within the thoracic cavity. The child spontaneously holds his or her breath when the thorax is struck, accounting for the involuntary closing of the glottis. The pressure increase is transferred to the alveoli, causing them to burst. A single burst alveolus may be able to seal itself off, but with the destruction of many alveoli the lung collapses.

A tension pneumothorax is a life-threatening emergency that results when the air leaked on inhalation cannot be vented to escape during exhalation. Internal pressure builds, compressing the chest contents and collapsing the lung. A mediastinal shift occurs when venous return to the heart is impaired as the trachea, heart, vena cava, and esophagus are compressed toward the unaffected lung, leading to decreased cardiac output.

Clinical Manifestations

With an open pneumothorax, 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). The child with a closed pneumothorax may have breath sounds decreased or absent on the injured side, and the child may be in respiratory distress. Signs of tension pneumothorax include increasing respiratory distress, absent breath sounds, cardiovascular instability, and a tracheal shift to the unaffected side.
Immediate treatment for an open pneumothorax is covering the wound with an airtight seal, however, a gloved hand can be used until a bandage is prepared. With a closed pneumothorax, a thoracostomy is performed and a chest tube inserted. A closed drainage system is attached to help remove the air and reinflate the lung by reestablishing negative pressure. 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 care focuses on airway management and maintaining lung inflation. The child usually arrives on the nursing unit with a chest tube and drainage system in place. Continued close observation for respiratory distress is essential. Vital signs are carefully monitored. When the chest tube is removed, the site is covered with an occlusive dressing and the child’s respiratory status is carefully monitored for signs of respiratory distress.

Complications of chest tube placement 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).

Acute respiratory problems are the most common cause of illness requiring hospitalization in infants and children under 10 years of age and a leading cause of hospitalization in children between 10 and 15 years of age.

The child’s airway is shorter and narrower than an adult’s. These differences create a greater potential for obstruction. The lungs have no muscles of their own, so respiration is powered by the diaphragm and intercostal muscles.

Foreign-body aspiration is most often caused by small objects that make their way into the child’s mouth, such as foods, small toy parts, or household objects like beads, safety pins, coins, or buttons.
Signs of impending respiratory failure in infants and children include worsening respiratory distress, irritability, lethargy, cyanosis, and increased respiratory effort such as dyspnea (difficulty breathing), tachypnea (increased respiratory rate), nasal flaring, and retractions.

Apnea, by definition, is cessation of respiration lasting longer than 20 seconds, or any pause in respiration associated with cyanosis, marked pallor, hypotonia, or bradycardia.

Three types of apnea are noted in neonates: central apnea in which there is complete cessation of breathing; obstructive apnea in which there is an absence of nasal airflow when respiratory efforts are present; and mixed apnea in which a central respiratory pause either precedes or follows airway obstruction.

Obstructive sleep apnea syndrome is a disorder of breathing during sleep that in children is commonly caused by enlarged tonsils and adenoids. Children have symptoms of sleep deprivation such as daytime sleepiness, poor attention, increased activity, aggression or acting-out behavior, and poor school performance.

Sudden infant death syndrome (SIDS), a leading cause of death in infants, is the sudden death of an infant under 1 year of age that remains unexplained after a complete autopsy, a death scene investigation, and review of the history.

Laryngotraceobronchitis (LTB) is a viral croup syndrome with signs of an upper respiratory illness, hoarseness, tachypnea, inspiratory stridor, and a seal-like barking cough. Fever may or may not be present.

Epiglottitis is caused by bacterial invasion of the soft tissue of the larynx causing inflammation and edema of the tissues and the epiglottis that can result in life-threatening airway obstruction. Classic signs of epiglottitis include dysphonia, dysphagia, drooling, and distressed respiratory effort. Fortunately, the number of cases of epiglottitis has decreased significantly because of the Hib vaccine.

Neonatal respiratory distress syndrome is the most common cause of respiratory failure and death in newborns, accounting for 20% to 30% of preterm newborn deaths.

Meconium aspiration syndrome occurs in 33% of newborns born with meconium-stained amniotic fluid. The meconium causes a chemical inflammation of the airway that results in pulmonary edema and cellular death. Some newborns progress to develop pulmonary hypertension with persistent fetal circulation.

Although many bacterial and mycoplasmal organisms may cause bronchiolitis, infection with respiratory syncytial virus (RSV) is the most common cause. Bronchiolitis is a major cause of hospitalization in infants under 6 months of age.

Symptoms of pneumonia in infants and children include elevated temperature, rales, crackles, wheezes, cough, dyspnea, tachypnea, restlessness, and decreased breath sounds if consolidation occurs.

In children, the risk of developing tuberculosis is increased in those under 2 years of age. Clinical manifestations of tuberculosis in infants include a persistent cough, fever, and weight loss or failure to gain weight. Wheezing and decreased breath sounds may be present. Older children may be asymptomatic.

Bronchopulmonary dysplasia (BPD) is often a consequence of neonatal respiratory distress syndrome and inflammatory changes in the airway. Treatment with mechanical ventilation causes further inflammation and damage to the bronchioles, resulting in fibrosis and edema of the bronchioles and smooth muscle hypertrophy.

Asthma affects about 5 million children in the United States and, for those children, results in about 10 days of school absenteeism and 20 days of restricted activity per year. Asthma mortality in children has increased from 1.8 to 3.3 per 1 million children between 1980–1981 and 1998–1999.

Status asthmaticus is persistent severe respiratory distress and bronchospasm in an asthmatic child that persists despite medications and supportive interventions. Without aggressive and immediate intervention the child may progress to respiratory failure and die.

In cystic fibrosis, defective chloride-ion transport across the exocrine and epithelial cells results in an abnormal accumulation of viscous, dehydrated mucus that affects the respiratory, gastrointestinal, and reproductive systems.

Signs of smoke inhalation injury in children include burns of the face and neck, singed nasal hairs, soot around the mouth or nose, and hoarseness with stridor or voice change.

Pulmonary contusion occurs in the majority of children with nonpiercing chest trauma. Although the child may appear initially asymptomatic, respiratory distress often develops within a few hours.

A pneumothorax may become life threatening if internal pressure from a closed pneumothorax is not vented. Air leaking into the chest cavity during inspiration cannot escape during expiration, increasing compression. Venous blood return to the heart is impaired as the mediastinum shifts toward the unaffected lung.
UNIT VI  Nursing Care of Specific Health Conditions

CRITICAL THINKING IN ACTION

INTRODUCTION

Return to the scenario at the beginning of the chapter. Once Emily and her mother arrive at the emergency department, she is assessed for current respiratory status and moved into one of the short-stay unit rooms.

DESCRIPTION

Emily’s respiratory signs and symptoms have not changed substantially from those present in the primary care provider’s office. Suctioning is needed to clear secretions from the airway. Secretions are sent for a culture and sensitivity. The pulmonary specialist orders a chest radiograph. Nebulizer treatments via the tracheostomy tube will begin as soon as Emily returns from the diagnostic imaging department.

DISCUSSION

1. Describe the signs that would indicate Emily’s respiratory status is worsening. Consider the information the mother might be able to contribute. What laboratory studies will contribute to the assessment? Develop a nursing care plan to respond to those worsening conditions.

2. Identify historical information that should be obtained about the mother’s home management plan for Emily’s care. Describe how this information can be used to partner with the family and integrate needed changes into the home care plan as a result of this episode.

3. Identify Emily’s stage of development and recommend appropriate toys or activities that the mother may use to promote Emily’s development.

4. Emily’s chest radiograph reveals pneumonia and hospitalization is planned. Develop the nursing care plan for Emily’s hospital care.

EXPLORE MediaLink

NCLEX review, case studies, and other interactive resources for this chapter can be found on the Companion Website at http://www.prenhall.com/ball. Click on Chapter 25 to select the activities for this chapter.

For animations, more NCLEX review questions, and an audio glossary, access the accompanying CD-ROM in this book.

http://www.prenhall.com/ball

REFERENCES


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