The Nursing Role in Restoring and Maintaining the Health of Children and Families With Physiologic Disorders
Chapter 40
Nursing Care of a Family When a Child Has a Respiratory Disorder

KEY TERMS
- adventitious sounds
- anoxia
- arterial blood gases
- aspiration
- atelectasis
- clubbing
- cyanosis
- expiration
- hypoxemia
- hypoxia
- inspiration
- paroxysmal coughing
- percussion
- pneumothorax
- rales
- retraction
- steatorrhea
- stridor
- tachypnea
- tracheostomy
- tracheotomy
- vibration
- wheezing

OBJECTIVES
After mastering the contents of this chapter, you should be able to:

1. Describe common respiratory disorders in children.
2. Identify National Health Goals related to children with respiratory disorders that nurses could help the nation achieve.
3. Use critical thinking to analyze ways nursing care for a child with a respiratory disorder could be more family centered.
4. Assess a child with a respiratory disorder.
5. Formulate nursing diagnoses related to respiratory disorders in children.
6. Identify expected outcomes that address the priority needs of a child with a respiratory disorder.
7. Plan nursing care for a child with a respiratory disorder.
8. Implement nursing care for a child with a respiratory disorder such as administering oxygen to a child.
9. Evaluate expected outcomes for achievement and effectiveness of care.
10. Identify areas related to care of children with respiratory disorders that could benefit from additional nursing research or application of evidence-based practice.
11. Integrate knowledge of respiratory disorders in children with nursing process to achieve quality maternal and child health nursing care.

Michael is a 4-year-old who is brought to the emergency department by paramedics after responding to an emergency call by his grandmother at his home. He has a sharp, barking cough, is crying loudly, and is obviously short of breath. “He can’t breathe!” his grandmother shouts at you. “I gave him some chocolate. Is he allergic to that?” his grandmother asks. Michael is diagnosed as having laryngotracheobronchitis (croup) and admitted to an ambulatory care unit.

Previous chapters described the growth and development of well children. This chapter adds information about the dramatic changes, both physical and psychosocial, that occur when children develop respiratory disorders.

What emergency care does Michael need? What about Michael’s action would lead you to believe his airway is not yet completely obstructed?
Respiratory disorders are among the most common causes of illness and hospitalization in children. Overall, respiratory dysfunction in children tends to be more serious than in adults because the lumens of a child’s respiratory tract are smaller and therefore more likely to become obstructed. Because respiratory disorders range from minor illnesses such as a simple upper respiratory tract infection to life-threatening lower respiratory tract diseases, such as pneumonia, and because the level of acuity can change quickly, respiratory disorders are often difficult for parents to evaluate. Both a child and parents need a great deal of breathing becomes labored. Early diagnosis and treatment are essential in preventing a minor problem from turning into a more serious one (Merelle et al., 2009).

Because respiratory disorders are such a common cause of childhood illness and hospitalization, National Health Goals have been established for children with respiratory illnesses (Box 40.1).

Several National Health Goals focus on respiratory illness in children:

- Reduce the rate of asthma deaths in children aged 5 to 14 years from a baseline of 3.3 per million to a target level of 0.9 per million.
- Reduce the rate of hospital emergency department visits for children with asthma younger than 5 years from a baseline of 150 per 10,000 to 80 per 10,000.
- Reduce the rate of cigarette use by adolescents from a baseline of 35% to a target of 16%; cigar use from 18% to 8%, oral tobacco use from 8% to 1%, and bidis use from 4% to 2%.
- Reduce the incidence of invasive pneumococcal infections in children younger than 5 years from a baseline of 76 per 100,000 to a target of 46 per 100,000.
- Reduce the incidence of tuberculosis from a baseline of 6.8 per 100,000 cases yearly to a target level of 1.0 per 100,000 (http://www.nih.gov).

Nurses can help the nation achieve these goals by teaching children to avoid beginning cigarette smoking, including the use of bidis (chocolate-flavored tobacco products), teaching children ways to help avoid respiratory infections such as good hand washing, and reminding parents to come for child health maintenance visits so that children can receive pneumococcal immunization or screening for tuberculosis, as appropriate.

Additional nursing research is needed about the accuracy of parents in self-reading and interpreting tuberculosis screening tests and information required by new parents to better manage respiratory illness in infants and young children.

**Box 40.1 Focus on National Health Goals**

**Nursing Process Overview**

*For a Child With a Respiratory Disorder*

**Assessment**

Respiratory illness can begin as early as moments after birth if a newborn has difficulty initiating a first breath or establishing regular respirations. Rating a newborn using an Apgar score can help to quickly identify a newborn who may be experiencing respiratory difficulty at this early stage.

As a nurse in an emergent care or health maintenance organization, you are often the first health care provider to talk to a parent about a child’s respiratory illness. It is important to establish both the onset and duration of the problem so that its seriousness can be rapidly determined. An episode of sudden coughing is suggestive of an acute respiratory disorder. Infants who cannot finish a bottle feeding because of exhaustion or rapid breathing or children who cannot run with other children because they do not have enough breath should be suspected of having a chronic respiratory disorder.

A child admitted to the hospital with a respiratory disorder is usually in an acute stage of the illness. A child’s condition may worsen rapidly in the first few hours until a prescribed medication, such as an antibiotic or bronchodilator, begins to take effect. Nursing assessment that a child is developing tachypnea or retractions may be the first indication of a child’s worsening condition.

**Nursing Diagnosis**

Nursing diagnoses established for children with respiratory disorders focus both on the alteration in mechanisms of breathing and on the emotional distress such problems can create. “Ineffective airway clearance” is a common diagnostic category used in this area. The problem may be related to any one of a variety of factors, such as ineffective cough, fatigue, weakness, viscous secretions, pain, aspiration (inhalation of a foreign object into the airway), or lack of knowledge about the importance of coughing.

The diagnostic categories “Impaired gas exchange” and “Ineffective breathing pattern” also may be used, although because a nurse does not generally prescribe definitive treatment for these problems (except when caused by hyperventilation), it may be more appropriate for a nursing diagnosis to focus on the effects of impaired gas exchange or ineffective breathing on daily activities and psychosocial health. Examples of nursing diagnoses are:

- Activity intolerance related to insufficient oxygenation
- Fatigue related to impaired gas exchange
- Fear related to inability to breathe without effort
- Impaired social interaction related to difficulty in keeping up with physical activities of peers
- Deficient knowledge related to need for continued treatment

**Outcome Identification and Planning**

If a child is experiencing an acute respiratory problem, the expected outcomes and plan of care will focus on supporting the child and family through prescribed therapy and
keeping parents informed about their child’s health status and response to treatment. Often the treatment period for respiratory illness is prolonged, so parents of children with chronic conditions need to learn how to continue therapy at home. Helping parents to plan programs of exercise and teaching chest physiotherapy and the actions of prescribed medications are important nursing activities. Parents also need to understand that their approach to these programs must change as their child grows older. With an infant, they simply need to perform the prescribed procedures. A game might be a good way to get a toddler or preschooler to breathe deeply ("Simon says, cough. Simon says, take five deep breaths"). Parents need to plan exercise programs for school-age children and adolescents around their school day. Otherwise, children may have difficulty carrying out the program or carry it out only sporadically. If parents include other family members, such as older siblings (within reason) or grandparents, in a respiratory therapy program, this can help to diffuse the burden of care and also to unite the family in working toward a common goal. Helpful Web sites for parents to consult about respiratory illnesses are http://www.kidshealth.org and http://www.everydayhealth.com. Some organizations to recommend as support to parents of the child with a respiratory disorder include American Lung Association (http://www.lungusa.org), National Asthma Education and Prevention Program (http://www.nhlbi.nih.gov), National Easter Seal Society (http://www.easterseals.com), and Cystic Fibrosis Foundation (http://www.cff.org).

Implementation

Collaborative nursing interventions in the care of a child with respiratory dysfunction include suctioning to remove respiratory secretions, administering oxygen, and providing humidification and expectorant therapy to help maintain clear airways. Some of the most important nursing interventions in this area are independent nursing functions: placing a child in an upright position to help the child cough more effectively; providing an interesting game to teach a child the importance of strengthening chest muscles; supporting a child and family through the anxiety created when a child is not breathing normally; and teaching parents of a child with chronic respiratory dysfunction the basics of percussion or chest physiotherapy techniques. All of these interventions require sound nursing judgment and skill to carry out or teach effectively.

Outcome Evaluation

An acute respiratory illness such as pneumonia is extremely frightening for parents as well as the child. After the child has recovered, talk with the parents to determine whether they have come to terms with their fear and can treat the child as a well child again. Otherwise, overprotection of a child by the parents may result in a well but dependent child. This pattern is one that nursing evaluation can help to prevent.

Expected outcomes for a child with chronic respiratory disease will change as a child grows and develops. No matter what the specific concerns are, however, evaluation should always include examination of how well a child individually and the family as a whole have adapted to managing the limitations imposed by the disorder while maintaining a lifestyle that fosters growth and development for all family members.

Examples of expected outcomes that would indicate achievement of goals are:

- Infant, at 3 months, maintains respiratory rate of at least 30 breaths per minute.
- Child describes a reduced program of school activities he will maintain to reduce fatigue.
- Child’s P O2 is maintained at 80 to 100 mm Hg in room air.
- Child lists steps she will take if breathing becomes impaired while at school.
- Parents demonstrate correct techniques for performing respiratory therapy at home.

ANATOMY AND PHYSIOLOGY OF THE RESPIRATORY SYSTEM

The respiratory system can be separated into two divisions: the upper respiratory tract, composed of the nose, paranasal sinuses, pharynx, larynx, and epiglottis; and the lower tract, composed of the bronchi, bronchioles, and alveoli. Through inspiration (breathing in), the respiratory system delivers warmed and moistened air to the alveoli, transports oxygen across the alveolar membrane to hemoglobin-laden red blood cells, and allows carbon dioxide to diffuse from red blood cells back into the alveoli. Through expiration (breathing out), carbon dioxide–filled air is discharged to the outside. Levels of oxygen and carbon dioxide in the lungs, blood, and body cells are shown in Figure 40.1.

The respiratory center is located in the medulla of the brain. Peripheral receptors located in the aortic arch and carotid arteries sense diminished P O2 levels and respond by increasing the respiratory rate. Central respiratory receptors in the medulla sense increased P CO2 levels along with body acidity, temperature, and blood pressure as another stimulus to respiration. Depth of respiration is influenced by proprioceptors located in the lung periphery that register lung fullness. An inhibitory center in the pons halts inspiratory impulses before the lungs become overextended. Often children with chronic lung disease such as cystic fibrosis have adapted so well to a chronically high P CO2 level that central receptor sites no longer register this as abnormal. In these instances, the main stimulus for respiration is a low oxygen level. In such children, administering high levels of oxygen can be dangerous because it alleviates oxygen want or their main respiratory stimulus.

Respiratory Tract Differences in Children

Embryologic development of the respiratory tract is discussed in Chapter 9. Because the respiratory tract continues to mature during childhood, children have several important differences in respiratory anatomy and physiology than adults. The ethmoidal and maxillary sinuses are present at birth; the frontal sinuses (the sinuses most frequently involved in sinus infection) and the sphenoidal sinuses do not develop until 6 to 8 years of age. Due to rapid growth of lymphoid tissue, tonsillar tissue is normally enlarged in early school-age children.
Respiratory mucus functions as a cleaning agent by moving invading organisms or other particles out of the lungs. However, newborns produce little respiratory mucus, which makes them more susceptible to respiratory infection than older children. Excessive production of mucus in children up to 2 years of age can actually lead to obstruction because the bronchial lumens are so small in children of this age.

After 2 years of age, the right bronchus is noticeably shorter, wider, and more vertical than the left. This is the reason that inhaled foreign bodies most often lodge in the right bronchus. Infants’ chest muscles are not fully developed, so they use their abdominal muscles to assist in inhalation. The change to thoracic breathing begins at 2 to 3 years of age and is complete at 7 years. Because accessory muscles are used more in children than in adults, weakness of these muscles from disease may more easily result in respiratory failure in children than in adults.

In infants, the walls of the airways have less cartilage than in older children and adults and so are not as strong and more likely to collapse after expiration. An advantage of immature development is that a lessened amount of smooth muscle in the airway means an infant does not develop bronchospasm as readily as an older child or adult. Therefore, wheezing (the sound of air being pushed through constricted bronchioles) may not be a prominent finding in infants even when the lumen of the airway is severely compromised.

**ASSESSING RESPIRATORY ILLNESS IN CHILDREN**

Assessment of respiratory illness in children includes an interview, physical examination, and laboratory testing. If the child is in acute distress, the interview and health history may cover only the most important details: when the child first became ill and what symptoms are present. It is important, however, to get as accurate a picture as possible, because the problem could be the result of a variety of circumstances (Box 40.2).

Symptoms of hypoxemia (deficient oxygenation of the blood), for example, are often insidious. Peripheral vasoconstriction (a mechanism to save the available oxygen for central life-sustaining body organs) leads to a pale appearance. Tachypnea and tachycardia (efforts to oxygenate cells better) can lead to anxiety and confusion (caused by limited cerebral...
perfusion). A poor feeding pattern may be one of the first signs noted in the infant because an infant cannot suck and breathe rapidly at the same time. Cardiac arrhythmia may occur because of inadequate cardiac tissue perfusion. Always ask about home remedies that may have been used in an attempt to increase breathing space or effort.

Physical Assessment

Physical assessment of a child with a respiratory disorder includes observation of symptoms such as cough, cyanosis, or pallor, as well as evaluation of respirations and breath sounds (Hueston, 2008). Breath sounds are best heard if an infant or child is not crying. Spending time comforting a child to prevent crying is time well spent.

Cough

A cough reflex is initiated by stimulation of the nerves of the respiratory tract mucosa by the presence of dust, chemicals, mucus, or inflammation. The sound of coughing is caused by rapid expiratory air movement past the glottis. Coughing is a useful procedure to clear excess mucus or foreign bodies from the respiratory tract. It only becomes harmful and needs suppression when there is no mucus or debris to be expelled and the amount of coughing becomes exhausting. This might occur with respiratory tract inflammation. **Paroxysmal coughing** refers to a series of expiratory coughs after a deep inspiration. Commonly, this occurs in children with pertussis (whooping cough) or those who have aspirated a foreign body or a liquid they attempted to drink.

Although helpful in removing mucus, coughing increases chest pressure and so may decrease venous return to the heart. This lowers cardiac output and can lead to fainting (syncope). Paroxysmal coughing may increase the pressure in the central venous circulation to such an extent that bleeding into the central nervous system (CNS) can result. Because young children often vomit after a series of coughs, they may be suspected initially of having a gastric disturbance even though their main illness is respiratory.

Rate and Depth of Respirations

**Tachypnea** (an increased respiratory rate) often is the first indicator of airway obstruction in young children. When assessing respiratory rate, particularly in infants, try to count respiratory rate before waking them, because crying distorts respiratory rate. Assess also the depth and quality of respiration, as these also reveal anoxia or lack of oxygen in body cells.

Retractions

When children must inspire more forcefully than normally to inflate their lungs because of an airway obstruction or stiff, noncompliant lungs (as in newborns with pulmonary dysplasia), intrapleural pressure is decreased to the point that the nonrigid parts of the chest (the intercostal spaces) draw inward, creating retribuctions (Fig. 40.2). Retractions occur more commonly in newborns and infants than in older children because the intercostal tissues are weaker and less developed in younger children. Retraction of upper chest muscles (supraclavicular or suprasternal) suggests upper airway obstruction; retraction of intercostal or subcostal muscles suggests lower airway obstruction.

Cyanosis

**Cyanosis** (a blue tinge to the skin) indicates hypoxia. It becomes apparent when the $P_{O_2}$ is under 40 mm Hg or the level of unoxygenated hemoglobin increases to over 3 g/100 mL (because incompletely oxygenated red blood cells in the circulation are what give blood a dark color). If children have a low red blood cell count, cyanosis may not be apparent because there are not enough red blood cells to give the arterial blood its blue tinge. This occurs at hemoglobin levels below 5 g/100 mL. The degree of cyanosis present, therefore, is not always an accurate indication of the degree of airway difficulty. When children have accompanying peripheral vasoconstriction caused by shock, cyanosis of the extremities also may or may not be apparent.

As the $P_{O_2}$ drops and cyanosis results, children increase their respiratory effort in an attempt to supply more oxygen to their tissues. When they do this, the difference in pressure between the intralumen of a not yet fully developed trachea and the surrounding tissue becomes so great that the trachea may collapse, compounding the obstruction problem.
Clubbing of Fingers

Children with chronic respiratory illnesses often develop clubbing of the fingers, a change in the angle between the fingernail and nailbed because of increased capillary growth in the fingertips (Fig. 40.3). The increased capillary growth occurs as the body attempts to supply more oxygen routes (more capillaries) to distal body cells.

Adventitious Sounds

Normal breath sounds are reviewed in Chapter 34. Adventitious sounds (extra or abnormal breathing sounds) are caused by pathologic conditions and can be heard on lung auscultation in children with respiratory disorders. Normally, on chest auscultation, the inspiratory sound is softer and longer than the expiratory sound. This is referred to as vesicular breathing. If you listen over the trachea, this pattern in terms of length of inspiration and expiration is reversed. This is bronchial or tubular breathing. If you hear bronchial breath sounds in the periphery of the lungs, where normally you would expect to hear a vesicular pattern, it indicates that gas exchange in peripheral alveoli is so compromised (as in pneumonia) that you are listening to transmitted tracheal sounds.

Accessory sounds of respiration result from the vibrations produced as air is forced past obstructions such as mucus. If the obstruction is in the nose or pharynx, the noise produced is a snoring sound (rhonchi). If the obstruction is at the base of the tongue or in the larynx, you will hear a harsh, strident sound on inspiration. This is laryngeal stridor. It is often most marked when a child is sitting upright. If an obstruction is in the lower trachea or bronchioles, it is most noticeable on expiration. An expiratory whistle sound (rhonchotraezing) occurs. If alveoli become fluid-filled, fine crackling sounds (rales) are heard. Diminished or absent breath sounds occur when the alveoli are so fluid-filled that little or no air can enter them.

Chest Diameters

With chronic obstructive lung disease, children may be unable to exhale completely, allowing air to be chronically trapped in lung alveoli (hyperinflation). This produces an elongated anteroposterior diameter of the chest, sometimes termed a “pigeon breast.” There is an accompanying tympanic or hyper-resonant (loud and hollow) sound heard on percussion (see later discussion on chest physiotherapy) over lung spaces.

Laboratory Tests

Several laboratory tests can be used to confirm or rule out the presence of a respiratory disorder and to help identify the cause and severity of the problem. These include analysis of arterial blood gases, nasopharyngeal culture, and sputum analysis.

Blood Gas Analysis

Blood gas analysis is an invasive method for determining the effectiveness of ventilation and acid–base status. The normal values of arterial blood gases (ABGs)—the amount of oxygen and carbon dioxide in the blood—are shown in Table 40.1. Blood gas analysis provides important information about oxygenation of the blood, as values may indicate not only whether the arterial partial pressure of oxygen (PaO2) is adequate but also whether the oxygen saturation of hemoglobin is adequate. The oxygen saturation level will fall if adequate oxygen cannot reach the bloodstream because of respiratory distress or if the hemoglobin is defective and cannot carry a full complement of oxygen (as with sickle cell anemia or thalassemia major). If a child has a severe anemia, the saturation level may be adequate (95% to 100%), but body cells may still not be receiving enough oxygen because of the limited number of red blood cells carrying oxygen. With increased Pco2 or decreased PaO2, a low pH, or decreased temperature, the ability of hemoglobin to accept oxygen diminishes so again, cells may become hypoxic.

Pco2 measures the efficiency of ventilation. In children who are hypoventilating (breathing very shallowly), Pco2 will be increased because they cannot blow off CO2; in children who are hyperventilating (breathing deeply), Pco2 will be decreased because children are blowing off too much. When children cannot evacuate accumulated CO2 because of an obstruction or hypoventilation, the partial pressure of CO2 in the arterial blood rises and the concentration of carbonic acid (formed when carbon dioxide dissolves in H2O in plasma) also rises. This leads to acidosis (a decrease in serum pH or an increase in acidity).

The body can compensate for developing acidity for a long time by gradually increasing the amount of bicarbonate in the bloodstream by decreasing the amount of bicarbonate excreted by the kidneys. When respiratory distress is relieved (by removal of an obstruction or by assisted ventilation), the amount of bicarbonate present in the bloodstream may ex-
ceed the amount of acid produced at that point, and the
child’s condition may change from acidosis to alkalosis. With
alkalosis, the respiratory rate decreases as the child tries to
conserve CO₂. As a result, periods of apnea may occur.
Children require close observation during this time, includ-
ing frequent blood gas and electrolyte determinations to en-
sure prompt treatment to detect and reverse these changes.
Respiratory alkalosis and respiratory acidosis are compared in
Table 40.2. Box 40.3 shows steps for evaluating ABGs.

To analyze blood gases, arterial blood rather than venous
blood must be used (arterial blood will reflect how well the
lungs are oxygenating the blood, whereas venous blood
will reflect only the oxygenation of the particular extremity
from which the blood was drawn). In the young infant, the
temporal artery may be used as a site for blood gasses; in
newborns, an umbilical artery catheter can be used. In older
children, the radial artery is the site of choice because of the
collateral circulation present at the wrist. (If clotting should
occur in the radial artery, the hand would still be well
nourished by collateral circulation; see the Allen test in
Box 40.4.)

For an ABG assessment, a specimen is withdrawn into a
heparinized syringe (to prevent clotting). After any arterial
puncture, always firmly compress the site. Otherwise, blood
from the punctured vessel can seep into subcutaneous tissue,
possibly causing a large hematoma and obscuring the site for
further assessment. If frequent specimen collections are re-
quired, an arterial catheter, inserted either peripherally or cen-
trally, may be used. Doing so allows frequent specimen collec-
tions without the trauma of additional punctures. Be sure to
apply dressings over the area where an arterial catheter exits the
skin to help prevent a young child from fussing or playing with
the site. Soft restraints, such as an elbow or hand restraint, may
be needed to keep a child from dislodging the catheter.

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**TABLE 40.1  Arterial Blood Gas Values**

<table>
<thead>
<tr>
<th>Measure</th>
<th>Definition</th>
<th>Normal Value</th>
<th>Clinical Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>PO₂</td>
<td>Partial pressure of oxygen in arterial blood</td>
<td>80–100 mm Hg</td>
<td>Decreased if child cannot inspire adequately</td>
</tr>
<tr>
<td>PCO₂</td>
<td>Partial pressure of carbon dioxide in arterial blood</td>
<td>35–45 mm Hg</td>
<td>Increased if child cannot expire adequately</td>
</tr>
<tr>
<td>O₂ saturation</td>
<td>The percentage of hemoglobin carrying oxygen</td>
<td>95%–100%</td>
<td>Decreased if O₂ cannot reach red blood cells, if un oxygenated cells are being mixed with oxygenated ones, or if hemoglobin is defective</td>
</tr>
<tr>
<td>pH</td>
<td>The hydrogen ion concentration of blood</td>
<td>7.35–7.45</td>
<td>Decreased if CO₂ is being retained as carbonic acid in blood</td>
</tr>
<tr>
<td>HCO₃</td>
<td>The bicarbonate concentration in blood</td>
<td>22–26 mEq/L</td>
<td>Increased in respiratory alkalosis; decreased in respiratory acidosis</td>
</tr>
<tr>
<td>Base excess</td>
<td>Bicarbonate available for buffering</td>
<td>−2.5 or +2.5 mEq/L</td>
<td>(+) = alkaline excess; (−) = alkaline deficit</td>
</tr>
</tbody>
</table>

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**TABLE 40.2  Comparison of Respiratory Alkalosis and Respiratory Acidosis**

<table>
<thead>
<tr>
<th>Acid–Base Condition</th>
<th>Cause</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Respiratory alkalosis</td>
<td>Hyperventilation</td>
<td>Rapid, deep breathing &lt;br&gt;Confusion, unconsciousness &lt;br&gt;Elevated plasma pH (above 7.45) &lt;br&gt;Elevated urine pH (above 7) &lt;br&gt;Decreased PCO₂, (below 40 mm Hg) &lt;br&gt;Plasma bicarbonate &lt;br&gt;–Initially normal &lt;br&gt;–Compensated: below 20 mEq/L &lt;br&gt;Base excess: 0 or a negative reading such as −4</td>
</tr>
<tr>
<td>Respiratory acidosis</td>
<td>Hypoventilation trapping carbon dioxide in alveoli</td>
<td>Shallow breathing; inability to expire freely &lt;br&gt;Confusion, disorientation &lt;br&gt;Decreased plasma pH (below 7.35) &lt;br&gt;Decreased urine pH (below 6) &lt;br&gt;Elevated PCO₂ (over 40 mm Hg) &lt;br&gt;Plasma bicarbonate &lt;br&gt;–Initially normal or elevated &lt;br&gt;–Compensated: above 25 mEq/L &lt;br&gt;Base excess: 0 or a positive reading such as +4</td>
</tr>
</tbody>
</table>
**BOX 40.3 ✩ Quick Assessment of Arterial Blood Gases**

*Use a systematic format to assess ABGs quickly:*

1. Evaluate the pH: Normally, pH falls between 7.35 and 7.45. A pH below 7.35 denotes acidemia; one above 7.45 reflects alkalemia. If the patient has more than one acid–base imbalance at work, the pH identifies the process in control.

2. Evaluate PCO2: The partial pressure of arterial CO2 (PCO2) normally ranges between 35 and 45 mm Hg. A PCO2 greater than 45 mm Hg indicates ventilatory failure and respiratory acidosis from CO2 accumulation. A PCO2 less than 35 mm Hg indicates alveolar hyperventilation and respiratory alkalosis.

3. Evaluate HCO3: A bicarbonate (HCO3-) less than 22 mEq/L or a base excess (BE) less than –2 mEq/L denotes metabolic acidosis. A bicarbonate level greater than 26 mEq/L or a BE greater than 2 mEq/L reflects metabolic alkalosis. If the two measurements conflict, the BE is the better indicator of metabolic status.

4. Determine which is the primary and which is the compensating disorder: Often, two acid–base imbalances coincide; one is primary, the other is the body’s attempt to return the pH to normal. When both the PCO2 and the HCO3- are abnormal, one denotes the primary acid–base disorder and the other denotes the compensating disorder.

   a. To decide which is which, check the pH. *Only a process of acidosis can make the pH acidic; only a process of alkalosis can make the pH alkaline.* For example, if steps 2 and 3 indicate that the patient has respiratory acidosis and metabolic alkalosis and the pH is 7.25, the primary disorder must be respiratory acidosis. The remaining disorder is compensating for the primary problem.

   b. When pH rises (becomes alkalotic), PCO2 decreases in amount (will be below 35 mm Hg). When pH decreases (becomes acidotic), PCO2 increases (will be above 45 mm Hg). When an opposite problem exists this way (pH increased; PCO2 decreased), the problem is respiratory in origin.

   c. pH and HCO3 normally move in the same direction (when pH is elevated, HCO3 is elevated). When these two measurements correspond this way (pH decreased, HCO3 decreased), then the cause of the problem is metabolic in origin.

   d. Three states of compensation are possible: noncompensation, reflected in an alteration of only PCO2 or HCO3; partial compensation, in which both PCO2 and HCO3 are abnormal and, because compensation is incomplete, the pH is also abnormal; and complete compensation, in which both PCO2 and HCO3 are abnormal but, because compensation is complete, the pH is normal. To identify the primary disorder when compensation is complete, consider a pH between 7.35 and 7.40 indicative of primary acidosis and a pH between 7.40 and 7.45 indicative of primary alkalosis.

5. Evaluate oxygenation: Normally Po2 remains between 80 and 100 mm Hg. A Po2 between 60 and 80 mm Hg reflects mild hypoxemia; between 40 and 60 mm Hg, moderate hypoxemia; and below 40 mm Hg, severe hypoxemia.

6. Interpret the findings: Your final analysis should include the degree of compensation, the primary disorder, and the oxygenation status; for example, “partially compensated respiratory acidosis with moderate hypoxemia.”

**BOX 40.4 ✩ Allen Test**

Before obtaining an ABG from the radial artery, it is important to establish that a child has collateral circulation to the hand. Otherwise, the needle puncture may block the artery and block blood flow to the hand.

To prove that there is collateral circulation, compress both the radial and ulnar arteries on the inner side of the wrist and elevate the hand until color disappears. Release the pressure over the ulnar artery and observe for a color change in the hand. If the hand does not pinken (proof the blood has flowed into the hand), the radial artery on that wrist should not be used for catheter insertion.

In small infants, when it is impossible to obtain arterial blood directly, heel or finger punctures may be used. If the heel or finger is warmed for about 20 minutes with a warm compress before the procedure, local blood flow increases so much that the blood gas levels of the capillaries approach those of arteries.

Be certain to note the use of oxygen, if any, and its liter flow on laboratory slips for ABG assessments. Also note the site where the specimen was obtained. While being transported to the laboratory, ABG specimens should be kept on ice to ensure accurate results (CO2 levels decline in room air).

The oxygen saturation of hemoglobin can also be obtained noninvasively using pulse oximetry and transcutaneous oxygen monitoring.

**Pulse Oximetry.** Pulse oximetry is a noninvasive technique for measuring oxygen saturation. For the measurement, a sensor and a photodetector are placed around a vascular bed, most often a finger in a child or a foot in an infant (Fig. 40.4). Infrared light is directed through the finger from the sensor to
the photodetector. Because hemoglobin absorbs light waves differently when it is bound to oxygen than when it is not, the oximeter can detect the degree of oxygen saturation (SaO₂) in the hemoglobin.

Oxygen saturation is closely aligned with PO₂ (Fig. 40.5). When SaO₂ is 95%, the PO₂ is within the normal range of 80 to 100 mm Hg. When SaO₂ has fallen to 90%, the PO₂ is 60 mm Hg. An easy rule to remember concerning the relationship between SaO₂ and PO₂ is the 60 to 30, 90 to 60 rule: when SaO₂ is 60, PO₂ is 30; when SaO₂ is 90, PO₂ is 60. Any SaO₂ reading under 90, therefore, is a cause for concern.

One advantage of pulse oximetry is that it is noninvasive. A second advantage is that the continuous monitoring provided by a pulse oximeter allows you to modify your care appropriately. If an oxygen level should begin to fall while you are handling an infant, for example, you could immediately stop care until the infant’s PO₂ again returns to normal. A disadvantage is that the sensor is small and must be checked frequently to see that it remains in place. Excess light in a room can distort the reading. Therefore, the sensor may need to be covered with a blanket in a neonatal intensive care unit or brightly lit nursery for readings to be accurate. Young children also tend to remove the sensors just as they frequently remove adhesive bandages from their fingers.

Transcutaneous Oxygen Monitoring. Transcutaneous monitoring is another means of continuous, noninvasive measurement of oxygen saturation. For this determination, electrodes heated to 44° C are attached to an infant’s chest. The heat causes vasodilation underneath the skin and brings the peripheral arterial blood to the surface to be read for oxygen content. This is converted to mm Hg for a monitor readout. The oxygen saturation level read by this method correlates with intraarterial PO₂, the same as with pulse oximetry. Transcutaneous monitoring has a disadvantage compared with pulse oximetry because the probe position needs to be changed about every 3 to 4 hours to prevent a burn to the skin, and sensor recalibration is necessary with each position change.

Nasopharyngeal Culture

When done efficiently, nasopharyngeal cultures cause little discomfort and reveal a great deal of information about the microorganisms causing a disease. However, most children are terribly frightened by having something placed in their noses or throats and so may resist accordingly. Firm, calm support during the procedure while you touch a moistened swab to the mucus membrane of the nose or throat is essential. Nasal and throat cultures can reveal only the organisms present in the upper respiratory tract. As a result, they may not show organisms causing a lower respiratory tract infection. A throat culture will miss pathogenic organisms if the culture tip is not touched to the infected aspect of the pharynx.

Respiratory Syncytial Virus Nasal Washings

Nasal washings are obtained to diagnose an infection by the respiratory syncytial virus (RSV). For this, a child is placed...
in the supine position, and 1 to 2 mL sterile normal saline is dropped with a sterile needleless syringe into one nostril. The nose is then aspirated using a small, sterile bulb syringe. The secretions removed are placed in a sterile container to be sent to the laboratory for analysis. Nasal washings are even more uncomfortable for children than nasal swabbing because of the saline that is instilled. Provide comfort to a child afterward and assure the child the specimen collection is over.

**Sputum Analysis**

Because they cannot raise sputum with a cough, sputum collection is rarely feasible in children younger than school age. Older children, however, are able to cough and raise sputum. Teach them exactly what you want (a specimen of what they are coughing up, not just clearing from the back of their throat). Then ask them to breathe in and out several times, cough deeply and spit mucus they have raised into a sterile specimen jar.

**Diagnostic Procedures**

In addition to cultures, several other diagnostic procedures are used to identify respiratory disorders in children. Many of these procedures are also used with adults, with modifications to account for the physical and developmental differences of children. Bronchoscopy (visualization of the bronchi through a bronchoscope) is discussed in Chapter 37.

**Chest Radiography**

Chest x-ray films will show areas of infiltration or consolidation in the lungs; if a foreign body is opaque, an x-ray study will show its location. Chest x-ray films are more difficult to obtain in infants than in older children, because infants cannot take a breath and hold it when instructed. It is therefore difficult to picture the lungs at their most expanded position. Computed tomography (CT) scans may be ordered for children with chronic lung disease because this technique can best mark disease progress.

**Bronchography**

On a chest radiography, the air-filled larynx, trachea, and major bronchi are revealed as dark spaces. Any obstruction or distortion in the organs is apparent. For further definition of structures, a radiopaque solution may be introduced into the respiratory tract by an ultrasonic nebulizer or by a catheter inserted into the trachea before the x-ray study is performed. Children may require conscious sedation for this because nebulization or having a catheter passed into the airway can be frightening. Afterward, children may have increased mucus production from bronchial irritation by the procedure. Observe them carefully after such a procedure for possible respiratory obstruction from accumulating mucus.

**Pulmonary Function Studies**

The process of ventilation, or the work of breathing, involves three main forces: (a) an inertial force that must be overcome to change the speed and direction of air when the lungs change from exhalation to inhalation; (b) an elastic force to help the lungs expand with inhalation; and (c) the flow resistance force or resistance to the movement of air through the bronchial tree that must be overcome. Flow resistance must be at a minimum for best ventilation. It becomes increased when the bronchioles are narrowed or plugged with mucus. Pulmonary function tests measure the forces of inertia, elasticity, and flow resistance. Peak flow, a commonly used measure, is the amount of air that can be moved out of the lungs with a forceful breath.

The alveoli of the lungs are never completely empty at the end of expiration because the bronchioles collapse, trapping air in the alveoli before alveoli are completely empty. In contrast, alveoli are never completely filled on inspiration because their potential for expansion exceeds that necessary for good respiratory function. Children with obstructive lung diseases such as asthma or bronchiolitis have some difficulty moving air into the lungs, but they have even more difficulty moving air out of the lungs. Even if they do expire the same amount of air as the average child, they expire it over a longer period. Children with restrictive ventilatory disorders, such as neuromuscular disorders, have equal difficulty with inspiration and expiration.

Several lung capacity studies can be done to determine the degree of obstruction or restricted ventilation ability. For these studies, the child breathes into a spirometer, a device that records the force of air exchange.

Children younger than 4 years of age are usually unable to participate in pulmonary function tests because these tests require their cooperation. All children need good preparation and teaching for these tests because they must breathe forcefully through the mouth into a mouthpiece on cue. Some tests require the nose be closed by a clamp or clip or an assistant’s hand while the child blows out. This can be a frightening feeling for children with respiratory disease. They may need some trial runs to assure themselves that they can breathe with the clamp in place. Without good orientation to the equipment, they may become so anxious about their performance that they develop tachypnea or fail to inhale or exhale at their full capacity, so the test results are skewed.

Common pulmonary function tests are outlined in Table 40.3. The results of pulmonary function studies help determine the nature and extent of a child’s respiratory problem and the best methods for achieving more effective ventilation.

**HEALTH PROMOTION AND RISK MANAGEMENT**

Several ways to promote respiratory health are available for parents and children. The common cold is the most common respiratory disorder seen in children. Children as young as toddlers can be taught to help avoid spreading colds through their family by washing their hands, properly disposing of tissues, and covering their mouth while coughing. These measures need to be stressed again with school-age children to help prevent them from contracting or spreading germs through their schoolroom. The incidence of *Haemophilus influenzae* type B (HIB), the cause of bronchiolitis, as well as influenza can be reduced by ensuring that children receive their routine immunizations against these (HIB and influenza vaccine). Children with chronic respiratory illnesses also should receive the pneumococcal vaccine. Reducing respiratory irritation by reducing secondary smoke can help prevent upper
respiratory infections, reduce the incidence of asthma attacks, as well as otitis media (middle ear infection).

**THERAPEUTIC TECHNIQUES USED IN THE TREATMENT OF RESPIRATORY ILLNESS IN CHILDREN**

The primary goal of nursing interventions in the care of children with respiratory disorders is to maintain or re-establish the airway to help ensure that adequate oxygen reaches the blood. Often this includes interventions aimed at liquefying and removing mucus secretions so they do not clog the bronchial pathways. Such clogging prevents adequate oxygenation and contributes to the development of bronchial and alveolar infections.

**Expectorant Therapy**

Any irritation of the respiratory tract causes the production of large amounts of mucus. The amount produced can become so great that the natural mechanisms for clearing it (coughing and upward cilia action) are no longer adequate. If a child is breathing rapidly because of respiratory distress, the frequent passage of air over the mucus tends to dry it and make it more viscid, compounding the removal problem. Several measures may be used to liquefy dried mucus and help raise it.

**Liquefying Agents**

Pharmacologic agents (Expectorants) such as guaifenesin (Robitussin), given orally, are designed to liquefy mucus in the trachea and bronchi. Instilling saline nose drops or using saline nasal sprays can be effective in moistening and loosening dried mucus in the nose (Karch, 2009).

**Humidification**

Humidification is the provision of moisture to the airway. Common methods of delivering moisture include vaporizers and nebulizers.

**Vaporizers**. Vaporizers emit a stream of air moistened by fine droplets of water into a room, providing either a cool or a warm mist to the entire room. Caution parents when using warm mist that a serious scald burn can result if children accidentally pull a vaporizer over on themselves. To avoid this type of accident, they should be certain the vaporizer is placed up, out of reach of the child. Although cool mist can create a clammy atmosphere in a room, this can be advantageous for a child who also has a fever, helping to cool and moisten the whole environment. Caution parents to clean vaporizers thoroughly after use to prevent the growth of *Pseudomonas* or other pathogenic organisms.

**Nebulizers**. Nebulizers are mechanical devices that provide a stream of moistened air directly into the respiratory tract. Most are hand-held masks that fit over the nose and mouth and are attached to an electrical pump as a power source (Fig. 40.6). Ultrasonic nebulization delivers such minuscule droplets into the respiratory tract that even the smallest bronchioles can be moistened. Nebulizers also serve as an important means for the delivery of respiratory tract medications (Subramanian, 2008). Drugs such as antibiotics or bronchodilators can be combined with the nebulized mist and sprayed into the lungs.

Many children find nebulizer treatments uncomfortable because the feeling of the mist in their upper respiratory tract can be frightening or irritating. Assure them that aerosol administration is the most effective route for moisture and medication to reach and cause an effect in the respiratory tract.

**TABLE 40.3 Pulmonary Function Tests**

<table>
<thead>
<tr>
<th>Test</th>
<th>Measurement</th>
<th>Clinical Implications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vital capacity (VC)</td>
<td>The maximum amount of air expelled after a maximum inspiration</td>
<td>Decreased if bronchial lumens are narrowed or obstructed</td>
</tr>
<tr>
<td>Tidal volume (TV)</td>
<td>The amount of air inhaled and exhaled in a normal respiratory movement</td>
<td>Decreased if bronchial lumens are constricted</td>
</tr>
<tr>
<td>Residual volume</td>
<td>The amount of air remaining in the lungs after a normal expiration</td>
<td>Increased if there is air trapping in alveoli, as in obstructive lung disease</td>
</tr>
<tr>
<td>Functional residual capacity (FRC)</td>
<td>The volume of air remaining in the lungs after 1 second expiration</td>
<td>Increased if ability to breathe out is impaired</td>
</tr>
<tr>
<td>Forced expiratory volume (FEV)</td>
<td>The amount of air expired in 1 second</td>
<td>Decreased in obstructive disease that prevents free expiration</td>
</tr>
<tr>
<td>Peak flow</td>
<td>The strength of air expired in a forceful expiration</td>
<td>Decreased in obstructive disease that prevents free expiration</td>
</tr>
</tbody>
</table>

**FIGURE 40.6 Child using a nebulizer.**
During aerosol medication administration, watch carefully for signs of both local tracheal or bronchial effect (spasm or edema) that might result from airway irritation as well as systemic symptoms that might result from absorption of a medication by the membrane.

Coughing

As a rule, encourage coughing rather than suppress it in children because it is an effective method of raising mucus. Changing a child’s position and suggesting mild exercise can help initiate coughing. If a cough is caused by mucus dripping from the nose because of nasal congestion, a decongestant such as pseudoephedrine (Sudafed) will best halt the draining mucus and therefore the cough. Caution parents not to give cough syrup routinely to children. Several of these contain codeine in doses that may be too high for a child’s weight. Others produce little effect and the risk of overdose, incorrect dosing, and adverse events is greater than the benefit of the syrup (Ryan, Brewer, & Small, 2008). Because of this, cough and cold remedies are no longer recommended for children under 2 years of age (DHHS, 2008).

Mucus-Clearing Devices

A mucus-clearing device (a Flutter device) can be used to aid in the removal of mucus. This device looks like a small plastic pipe. A stainless-steel ball inside the device moves when the child breathes out, causing vibrations in the lungs (Fig. 40.7). This vibration helps loosen mucus so that it can be moved up the airway and expectorated. This device is used most frequently with children who have cystic fibrosis or pneumonia to help remove mucus from the lungs.

Chest Physiotherapy

Simply changing a child’s position helps mucus to move, initiate a cough reflex, and be expelled. When a child is positioned so the chest is lower than the abdomen, gravity aids in the removal of mucus from the lower lobes and bronchi. When a child sits upright, gravity aids drainage from the upper lobes into the bronchi. When lying supine, anterior alveoli drain; when prone, posterior alveoli drain. Frequent changes of position are important, therefore, to prevent mucus from pooling in certain lung areas. If a child has a localized mucus problem, lying predominantly in one position can encourage drainage of that lung segment. When the child is repositioned and the mucus drains into new bronchi, this will often cause a cough from irritation caused by this new drainage.

Three techniques are involved with chest physiotherapy (CPT) to further loosen mucus for expectoration: postural drainage, percussion, and vibration. Each technique can be used alone, but they are usually more effective at moving mucus toward the mainstem bronchi when performed together.

CPT is best scheduled before meals or at least an hour after a meal so the subsequent coughing does not cause vomiting. Techniques are described in Box 40.5 and summarized below. Limit CPT to approximately 30 minutes each time, because these techniques are tiring. Modifications in the techniques or shortening of the time periods may be necessary, depending on a child’s ability to tolerate the position changes and the techniques. For example, before breakfast, the upper right and the left upper and lower lobes might be done; before lunch, the right lower lobe and right middle lobe might be done; before supper or at bedtime, the upper and lower lobe on both sides might be done.

Common postural drainage positions for the infant are shown in Figure 40.8. An infant may be positioned on your lap, whereas a slant board or other surface is needed for postural drainage with an older child. Not all positions are tolerated well. Be ready to modify the positions used depending on the child’s condition and tolerance.

Percussion involves striking a cupped or curved palm against the chest to determine the consistency of tissue beneath the surface area. This technique causes a loud, thumping noise that sounds as if it hurts, but you can assure parents it does not. In infants and some small children, a specialized device, a nipple, or a small oxygen mask may be used as the palm of the hand is too big (Fig. 40.9). These devices concentrate the motion and may increase the amount of mucus removed.

Vibration is done by pressing a vibrating hand against a child’s chest during exhalation. Like percussion, it mechanically loosens and helps move tenacious secretions upward. Vibration also may be accomplished by a mechanical vibrator or a vibrating vest.

Position a child so the lobe of the lung to be drained is in a superior position. Apply vibration or percussion. After each position, ask the child to cough. Children cough best if you
**Box 40.5 Nursing Procedure**

**Chest Physiotherapy**

**Purpose:** To encourage the loosening and raising of mucus from the respiratory tract through the use of postural gravity drainage and percussion (clapping) and vibrating techniques.

**Procedure**

1. Wash your hands; identify child; explain procedure to child.

2. Assess child as to status; analyze appropriateness of procedure; modify plan as necessary.

3. Assemble supplies: pillow or slant board, disposable tissues (sputum cup if specimen for culture is desired); percussion device (if infant); nebulizer with correct fluid and medicine if prescribed.

4. Select a drainage position (see Fig. 40.8). Position child appropriately but comfortably. Auscultate and percuss lung area for baseline determinations.

5. Use percussion and clapping technique (see figure) for 1–2 min and vibrate during 4 or 5 exhalations the section of chest indicated for the position. Observe child closely for respiratory distress.

6. Ask child to deep breathe and cough to raise secretions. Auscultate lung section to ascertain clearing of secretions.

7. Reposition; percuss and vibrate the chest areas in additional drainage positions as prescribed. Continue to observe for signs of respiratory distress. Provide rest as necessary between positions.

8. At finish of prescribed positions, return child to bed. Provide mouthwash if desired (and age-appropriate); discard used tissues.

9. Evaluate effectiveness, cost, comfort, and safety of procedure. Plan health teaching as necessary, such as benefits of procedure.

10. Record procedure, description of sputum raised, and child’s reaction to procedure. If sputum specimen is obtained, send to laboratory for analysis.

**Principle**

1. Handwashing prevents spread of microorganisms. Identifying the child ensures that you are performing the procedure on the right child. Explaining the procedure beforehand promotes child’s understanding and adherence and helps to minimize anxiety.

2. Chest physiotherapy is physically exhausting; can increase intracranial pressure when head is lowered in dependent position. Wait 1 h after meals to avoid inducing vomiting with coughing.

3. Organizing care increases efficiency and helps prevent tiring child. Nebulization before postural drainage may be prescribed to promote bronchodilation, dilute mucus, and aid mobility of secretions.

4. Positions aid in the gravity drainage of secretions.

5. Percussion and vibration loosen bronchial mucus and allow it to be coughed from the respiratory tract. As mucus moves, it may plug a bronchus; observe for cyanosis, tachypnea, dyspnea, and violent coughing as signs of this.

6. Coughing also helps move secretions.

7. Position changes allow for loosening and drainage in other lung segments. Child may grow tired after repeated percussion/vibration.

8. Coughed sputum may taste unpleasant. Use standard infection precautions to avoid touching soiled tissues.

9. Evaluation allows for determining effectiveness of the procedure and need for modifications for future treatments. Health teaching is an independent nursing action always included in nursing care.

10. Documentation provides evidence of nursing care, child’s status, and effectiveness of interventions.

Demonstrate the proper technique by taking a deep breath, blowing it out, taking a second deep breath, blowing that out, taking a third deep breath, and then coughing. The irritation of mucus in the major airway by the third breath makes a cough happen almost spontaneously.

Formerly, CPT was done in hospital settings by respiratory therapists. However, in today’s health care climate of managed care, nurses are now often the health care provider who perform CPT and teach it to parents. One or both parents may need to learn the technique before their child is discharged so that it can be continued conscientiously at home. The technique is used most frequently with children with bronchiolitis or cystic fibrosis (van der Schans, Prasad, & Main, 2009).
What if... Michael needs to cough to raise bronchial mucus. What if he refuses to? How can you get him to cough?

Therapy to Improve Oxygenation

Improving oxygenation almost automatically relieves breathing distress.

Oxygen Administration

Oxygen administration elevates the arterial oxygen saturation level by supplying more oxygen to red blood cells through the respiratory tract. Oxygen may be delivered to infants by flooding an incubator or by using a plastic hood, mask, or cannula. Plastic oxygen hoods are tight-fitting enclosures that can keep oxygen concentration at nearly 100% (Fig. 40.10). Always check that a hood fits snugly over the infant’s head, making sure it does not rub against the infant’s neck, chin, or shoulders. Be sure the gas does not blow directly into the infant’s face.

Although a nasal catheter or nasal prongs can be used for infants, they are usually reserved for older children. These provide a concentration of approximately 50% with an oxygen flow of 4 L/min. Most children do not like nasal prongs or catheters because they are intrusive. Assess their nostrils carefully when using these as the pressure of prongs can cause areas of necrosis, particularly on the nasal septum.

A snug-fitting oxygen mask is a method for supplying nearly 100% oxygen and is the method frequently used in
emergencies (Fig. 40.11). Masks, like prongs or catheters, are often not well tolerated by children because they tend to slip and obstruct their view. If necessary, let them hold a mask rather than strapping it in place to allow them more control.

Regardless of the delivery method used, oxygen must be administered warmed and moistened. Without proper humidification, oxygen dries mucous membranes and thickens secretions, compounding breathing difficulty. Oxygen, like any other drug, requires careful administration and follow-up assessment. If concentrations are too low, oxygen is not therapeutic; in concentrations greater than those desired, it can be toxic. If newborns are subjected to oxygen concentrations over 100 mm Hg for an extended time, retinopathy of prematurity can occur (see Chapter 26). In any child, administering oxygen concentrations of 70% to 80% for an extended period may lead to a thickening of the lung alveoli and a loss of lung pliancy (oxygen toxicity or bronchopulmonary dysplasia). For these reasons, oxygen should not be given in high concentrations for long periods unless adequate facilities for blood gas analysis are available (Marino, 2007).

When caring for a child with any form of oxygen equipment, follow good safety rules. Because oxygen supports combustion, keep open flames away from oxygen and minimize the risks of sparks. Since oxygen is humidified, oxygen equipment is a good source of microbial contaminants. Change equipment according to your agency’s policy, but at least once a week to keep bacterial counts within safe limits. Monitor and record a child’s oxygen saturation level via pulse oximetry or transcutaneous pulse oximetry as indicated. Obtain ABG measurements with any change in condition or oxygen flow or as otherwise ordered.

**Pharmacologic Therapy**

Children notice difficulty with exchange of air when their airways become obstructed because of unusual mucus production, bronchoconstriction, or inflammation. Several drugs may be used in children to reverse these processes. Nasal sprays such as normal saline can be administered to...
moisten and loosen nasal secretions. Antihistamines given by this route can reduce mucus production and thereby enlarge the airway. Decongestants cause vasoconstriction, leading to shrinkage of the mucous membranes, which expands breathing space. Decongestants such as guaifenesin (Robitussin) help to raise mucus. Most of these agents also cause drowsiness, so their doses must be regulated, especially in adolescents who will be driving. Bronchodilators such as albuterol (Ventolin), terbutaline (Brethine), and levalbuterol (Xopenex) are examples of drugs used to open the lower airway (Box 40.6). Antibiotics may be given intravenously, intramuscularly, orally, or inhaled through nebulization to reduce infection and limit purulent mucus and inflammation. Corticosteroids taken either orally or by inhalation enlarge the airway by reducing further inflammation (Deglin & Vallerand, 2008). Caution parents not to give cough and cold medications to children under 2 years of age unless specifically prescribed by their health care provider (DHHS, 2008).

**Metered-Dose Inhalers.** A metered-dose inhaler (MDI) is a hand-held device that provides a route for medication administration directly to the respiratory tract. The child inhales while pressing a trigger on the apparatus. Some devices include a spacer device attached to the apparatus, a plastic extension tube or chamber that helps better coordinate inhalation with the medication delivery. For successful use, children need to follow five general rules: shake the canister, exhale deeply, activate the inhaler as they begin to inhale, take a long slow inhalation, and then hold their breath for 5 to 10 seconds. They should take only one puff at a time, with a 1-minute wait between puffs (Karch, 2009). Metered-dose inhalers require that children trigger the inhaler at the same time they breathe in (Fig. 40.12A). Because it is difficult for children younger than approximately 12 years to do this, placing a spacer tube between the inhaler and the mouthpiece better coordinates inhaling and trigger release (Fig. 40.12B).

### Incentive Spirometry

Incentive spirometers are devices that encourage children to inhale deeply to aerate the lungs fully or move mucus. Although manufactured in different configurations, a common type consists of a hollow plastic tube containing a brightly colored ball or dome-shaped disk that will rise in the tube when a child inhales through the attached mouthpiece and tubing. The deeper the inhalation, the higher the ball rises in the tube.

Children need instruction on how to use this type of device, because their first impression is that they should blow out against the mouthpiece rather than inhale (Fig. 40.13A). Incentive spirometry is effective with children because the device and procedure resemble a game more than an actual treatment.

### Breathing Techniques

Some children need exercises prescribed to help them better inflate alveoli or more fully empty alveoli. Blowing a piece of cotton or a plastic ball across a table, blowing through a straw, or blowing out with the lips pursed are effective techniques for better emptying alveoli (see Fig. 40.13B). Yet another method for increasing aeration is to ask a child to blow up a balloon, as this requires the child to take a deep inhalation. For best results, make these activities a game or contest rather than an exercise.

### Tracheostomy

A **tracheostomy** is an opening into the trachea to create an artificial airway to relieve respiratory obstruction that has occurred above that point (Yu, 2008). The procedure to create the airway is called a **tracheotomy**; the resultant airway is the tracheostomy. Tracheostomies also may be used as a route for suctioning mucus when accumulating mucus causes lower airway obstruction. A danger of tracheostomies is that they eliminate the warming and filtering action of the nose and pharynx, making children more susceptible to infection. For these reasons, endotracheal intubation, not tracheostomy, has become the method of choice to relieve airway obstruction and for short-term oxygenation. The exception to this is obstruction in the pharynx, because it is often impossible to pass an endotracheal tube beyond obstruction at this point. Tracheostomies are also still used for long-term home care.

### BOX 40.6 Focus on Pharmacology

**Albuterol Sulfate (Proventil, Ventolin)**

**Classification:** Albuterol is a beta-2–adrenergic agonist.

**Action:** Acts selectively to cause bronchodilation and vasodilation for relief of bronchospasm (Karch, 2009).

**Pregnancy risk category:** C

**Oral Dosage:**
- Children older than 14 years—2 or 4 mg, 3 or 4 times daily; not to exceed 32 mg/day
- Children ages 6 to 14 years—2 mg, 3 or 4 times daily; not to exceed 24 mg/day
- Children ages 2 to 6 years—0.1 mg/kg, 3 times daily, not to exceed 2 mg/day; gradually increasing to 0.2 mg/kg, 3 times daily, not to exceed 4 mg/day

**Inhaled Dosage:** Children 12 years of age and older—2 puffs every 4 to 6 hours: 2.5 mg (0.5 mL of 0.5% solution diluted with 2.5 mL of 0.9% sodium chloride) OR 3 mL of 0.083% solution, 3 or 4 times daily

**Possible adverse effects:** Restlessness, apprehension, anxiety, fear, nausea, cardiac arrhythmias, paradoxical airway resistance with repeated, excessive use of inhalation preparations, sweating, pallor, and flushing

**Nursing Implications**
- Instruct parents and child in method to administer drug. Teach child and parents about use and care of nebulized solution or metered-dose inhaler and spacer devices, if ordered.
- Caution child and parents not to exceed the number of ordered puffs, to prevent possible tolerance to drug.
- If more than one inhalation is ordered, advise child to wait 1 to 2 minutes before taking the second puff.
- If the child is also receiving an inhaled corticosteroid, advise the child and parents to have the child use the albuterol first to open the airways and then wait approximately 5 minutes before using the corticosteroid, to maximize its effectiveness.
Emergency Intubation. Few medical emergencies are as frightening to a child or parents as an acute obstruction of a child’s upper airway requiring a tracheotomy or endotracheal intubation. The child suddenly becomes limp and breathless, with color changing quickly to systemic cyanosis. Tracheotomies are done more easily on a treatment room table than on a bed or crib, so it is generally best to carry a child immediately to a treatment room for the procedure. If a child cannot be moved quickly, however, because of accessory equipment, do not lose time in transport. For tracheotomy, the cricoid cartilage of the trachea is swabbed with an antiseptic; if readily available, a local anesthetic may be injected into the cartilage ring. (This is not necessary in the unconscious child.) An incision is made just under the ring of cartilage and a tracheostomy tube with its obturator in place is inserted into the opening (Fig. 40.14A). When the obturator is removed, the child can breathe through the hollow tracheostomy tube (see Fig. 40.14B). Have suction equipment available for immediate use to clear any blood caused by the incision (this is minimal) and any obstructing mucus from the trachea.

The color change in children after tracheostomy is usually dramatic. They inhale deeply several times through the tube, and color returns to normal. A few sutures may be necessary at the tube insertion site to halt bleeding or to reduce the size of the incision so the tube fits snugly.

As children begin to breathe normally and, if unconscious, regain consciousness, they often thrash and push at people around them, both from oxygen deficit and from fright. They call for a parent but can make no sound, adding...
to their fright. Assure children that everything is all right, even though they cannot speak. A school-age child can understand a simple explanation such as, “You can’t speak right now because of the tube in your throat.” As soon as children’s respirations are even and they are no longer experiencing acute respiratory distress, show them how, by placing a finger over the tracheostomy tube opening, air will again flow past the larynx and they can speak. If this causes a child to become short of breath, supply a paper and pencil or chalkboard for communication.

Be certain parents understand why the tube is in place and how important it is that it remain patent. Assure them that it is a temporary measure to provide oxygen (provided this is true). If they were not present in the room for the procedure, encourage them to visit the child as soon as possible to assure themselves their child is again all right. Children have difficulty relaxing enough to accept this strange new way of breathing until their parents can relax and accept it also. Some children hyperventilate, not because of respiratory difficulty, but because of this fear.

**Suctioning Technique.** Most tracheostomy tubes used with children today are plastic. They do not include an inner cannula that would require removal and regular cleaning. Most children, however, do require frequent suctioning (perhaps as often as every 15 minutes) to keep their airway free of mucus. Use sterile technique to prevent introducing microorganisms, and suction gently yet thoroughly. Ineffective suctioning does not remove obstructive mucus and because of irritation can actually cause more mucus to form. Be certain you know how deeply to suction. Some children need to be suctioned only the length of the tracheostomy tube so that the catheter does not touch and irritate the tracheal mucosa. Others need to be deeply suctioned to reduce the possibility that mucus will become so copious or so thickened that it obstructs the trachea below the tube.

Tracheostomy suctioning technique is shown in Box 40.7. Because suctioning removes air as well as secretions from the trachea, children may become oxygen-deprived during the procedure. Although not evidence-based, preoxygenating them by “bagging” or administering oxygen for approximately 5 minutes before the procedure may help reduce this problem (Pritchard, Flenady, & Woodgate, 2009). Occasionally, a child may have such thick mucus that it is necessary to insert a drop or two of normal saline into the tracheostomy tube before suctioning. This should not be routine, however, as fluid running into the trachea produces a frightening, suffocating feeling.

Young children may need to wear elbow restraints while being suctioned to keep their hands away from the sterile catheter. In addition, restraints may be necessary at all times when they are alone to prevent them from fussing with the tracheostomy tube and accidentally removing it.

Check frequently on children with tracheostomies to assess for possible respiratory difficulty. Spend time playing with them or just sitting and rocking them so they can think of you in ways other than as the person who comes to suction them. If parents cannot stay with the child, assure them that you check on their child more frequently than what is necessary for suctioning alone, so they can feel confident if the child should...
**Box 40.7 Nursing Procedure**  
**Tracheostomy Suction**

**Purpose:** To remove mucus from the trachea.

**Procedure**

1. Wash hands; identify child; explain procedure to child.

2. Assess child, especially breath sounds; analyze appropriateness of procedure. Plan ways to modify care based on individual circumstances.

3. Assemble supplies: suction source and tubing, sterile suction catheter (#12 or 14F) or sterile suction kit, sterile gloves, bottle of sterile normal saline, sterile medicine dropper or syringe, manual resuscitator. Plan method to keep child from touching sterile catheter (placing a restraint, distraction, or asking assistance from another nurse).

4. Open the bottle of sterile normal saline and suction catheter or kit. Pour a small amount of saline solution into disposable container included in kit. Prepare syringe or dropper with small amount of sterile normal saline; put on sterile gloves.

5. Hold suction catheter with one gloved hand, suction tubing with other gloved hand, and attach tubing to sterile catheter; dip tip of catheter into normal saline and suction a small amount through catheter.

6. If necessary, instruct assistant to hyperoxygenate child with manual resuscitator.

**Principle**

1. Handwashing minimizes the risk for spread of microorganisms; identifying the child ensures that you are performing the procedure on the right child; explaining the procedure helps to encourage cooperation and minimize anxiety.

2. Assessment prior to procedure provides a baseline for future evaluation. Modifications enhance individualization of nursing care based on client need.

3. Organizing supplies will increase efficiency of procedure.

4. Sterile technique is important to prevent introducing microorganisms.

5. Proper handling of equipment using sterile technique reduces the risk of contamination because once a sterile glove touches suction tubing, it is no longer sterile. Using sterile normal saline to suction through the catheter and tubing ensures patency.

6. Hyperoxygenation prevents child from developing hypoxia during suctioning.
have another episode of acute obstruction, someone will be nearby. If the tracheostomy tube is to be left in place after discharge from the hospital, be certain parents have enough experience with changing tubes if that will be necessary or suctioning so they can safely care for their child at home.

Tracheostomy tubes are held in place by cloth ties that fasten at the back of the child’s neck. Change ties when they become soiled or loose, and check them frequently to be certain they remain tied. Children may fuss with and untie such things, whereas adults will not. Assess that the ties fit snugly but allow for one finger to be inserted underneath them so they do not rub and cause pain. For preschoolers or younger children, it is a good idea to cover the tracheostomy opening with a gauze square tied to the child’s neck like a bib while they eat. This prevents crumbs or spilled liquids from entering the tracheostomy opening. Do not give children small toys that could fit into the lumen of the tube and cause obstruction (Box 40.8).

Each child is considered individually regarding when it is time to remove a tracheostomy tube. Tubes are generally sealed off partially by adhesive tape or a commercial occlusion device for a day or two before removal; then they are completely occluded (but not removed) for another day. This provides a weaning period where suctioning is still possible if it is needed. Occasionally, children cough so forcefully that they dislodge a tracheostomy tube. You might be with a child when this occurs, or you might walk into the room and find the tube lying beside the child on the bedclothes. As long as the child is

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**Box 40.8 Focus on Family Teaching**

**Preventing Aspiration in a Child With a Tracheostomy**

**Q.** A parent whose child has had a tracheostomy asks you, “How can we prevent something from falling into our child’s tracheostomy tube”?

**A.** Use the following to help prevent aspiration:

- Use a bib tied loosely over the tracheostomy tube when your child is eating to prevent food from entering the tube.
- Avoid buying toys with small parts that could be removed and dropped into the tube.
- Inspect stuffed toys to be certain they are intact and do not shed (fur or stuffing could enter the tube).
- Supervise play with other children to be certain they do not place anything in the tube.
- Stay with your child in the bathtub, to be certain water does not splash into the tube.
- Keep use of sprays such as perfume or room fresheners to a minimum, because they can be irritating to the trachea.
- Avoid cold air, because it can cause tracheal spasm (cover the child’s throat with a loose fleece scarf when out in cold weather).
not in distress, this is not an emergency. Because the incision site usually does not close completely to occlude the tracheal opening when a tube is dislodged, the child still has a patent airway. Always keep a new tube and inserter (obturator) at the bedside in case replacement is necessary. Slide the obturator into the tube and gently replace it in the tracheal opening. Remove the obturator and secure the new tube in place. If you do this quickly yet calmly, the average child is not alarmed and so will not protest. If, however, a child senses your excitement or if you indicate that something is terribly wrong, a child may begin to cry and turn away, making it difficult to replace the tube without assistance.

Endotracheal Intubation

Endotracheal intubation (nasal or oral intubation) is the preferred means of bypassing upper airway obstruction and allowing free entry of air to the trachea. There is little difference in efficiency between oral and nasal methods (Spence & Barr, 2009). However, since intubation tubes cause edema and local irritation, they cannot be left in place as a permanent solution. As with tracheostomies, children cannot speak while intubated. Supply those old enough to write with a pencil and paper for effective communication. Preschoolers can point to pictures to indicate what they need. Providing simple drawings or photos (a drink, a straw, a blanket, the television turned on, a urinal) to make needs known is helpful. Endotracheal tubes are held in place by being taped to the face. Make sure tubes are carefully secured, because children can easily dislodge them. As much as possible, limit the number of tape changes to protect the skin on the child’s cheeks.

A capnometer is a device that measures the amount of CO₂ in inhaled or exhaled breaths. It uses infrared technology and is attached to the distal end of the endotracheal tube. By measuring the percentage of CO₂ in expired air, the arterial CO₂ (PaCO₂) can be estimated. Used in this way, a capnometer can reduce the number of arterial punctures needed for ABG analysis.

Assisted Ventilation

When it is not possible to improve oxygen saturation to sufficient levels by the methods described above, assisted ventilation may be necessary (Carpenter et al., 2008). Positive-pressure machines deliver moistened or nebulized air or oxygen to the lungs under enough pressure and with appropriate timing to produce artificial, periodic inflation of alveoli; they rely on the elastic recoil of the lungs to empty the alveoli.

Depending on the type of ventilator, the inspiration–expiration cycle is determined by a timed interval, a volume limit, or a pressure limit, depending on the child’s condition. Ventilators can supply high tidal volumes at a low frequency rate or low tidal volumes at rates as high as 200 to 300 breaths per minute. Hyperinflation of lungs can occur with high-frequency ventilation because there is not enough time for expiration to occur. For this reason, some high-frequency ventilators are set so air is sucked out of the lungs rather than depending on the normal elastic recoil of the lungs. Some commonly used terms associated with ventilator therapy are shown in Table 40.4.

Children who need respiratory assistance are frightened. A great many fight ventilators or refuse to lie quietly and let the ventilator breathe for them. Pancuronium (Pavulon) may be administered intravenously to a point of abolishing spontaneous respiratory action to overcome resistance and allow mechanical ventilation to be accomplished at lower pressures because without normal respiratory action, there is no normal muscle resistance to overcome (Box 40.9). Clearly, children who receive pancuronium have no spontaneous respiratory function and need critical observation and frequent ABG analysis because they depend totally on caregivers at that point.

Mechanical ventilation for a prolonged period requires that children either have a tracheotomy performed or have an endotracheal tube passed (Fig. 40.15). A cuffed tube is used with ventilators so the seal at the trachea is airtight. Infants need a nasogastric tube inserted to prevent stomach distention from air entering the esophagus. Providing adequate nutrition may be difficult for children on ventilators. Enteric (nasogastric) feedings or total parenteral nutrition solves this problem. Providing a balance of rest, stimulation, and assurance for the child is a challenge for nursing personnel and parents.

Once children become accustomed to assisted ventilation, it can be difficult to discontinue a device, even when there is no longer a clinical indication for it. This is most pronounced

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**TABLE 40.4**  Terms Commonly Used With Ventilator Therapy

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
<th>Clinical Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>IMV</td>
<td>Intermittent mandatory ventilation</td>
<td>Number of mandatory breaths the ventilator will deliver each hour. A child may breathe most of the time without assistance, but a set (mandatory) number of breaths per minute is delivered to ensure adequate lung expansion and oxygenation.</td>
</tr>
<tr>
<td>PEEP</td>
<td>Positive end-expiratory pressure</td>
<td>Pressure delivered to lungs at the end of each expiration to keep alveoli from collapsing on expiration and to ensure adequate oxygenation.</td>
</tr>
<tr>
<td>Sigh</td>
<td>A deep inhalation delivered by the ventilator</td>
<td>Method used to fully inflate the lungs several times each minute.</td>
</tr>
<tr>
<td>CPAP</td>
<td>Continuous positive airway pressure</td>
<td>A constant pressure exerted on the alveoli to keep them from collapsing on expiration.</td>
</tr>
<tr>
<td>FiO₂</td>
<td>Concentration of oxygen the child is receiving (inspiring)</td>
<td>A child on oxygen therapy will have an FiO₂ from 22% to 100%</td>
</tr>
</tbody>
</table>
Pancuronium Bromide (Pavulon)

**Classification:** Pancuronium bromide is a neuromuscular blocking agent.

**Action:** Relaxes skeletal muscles during assisted mechanical ventilation or endotracheal intubation (Karch, 2009).

**Pregnancy risk category:** C

**Dosage:** 0.03–0.04 mg/kg intravenously initially, then 0.03–0.1 mg/kg intravenously, repeated every 30 to 60 minutes as needed.

**Possible adverse effects:** Prolonged dose-related apnea; tachycardia, excessive salivation, and sweating.

**Nursing Implications**

- Keep in mind that the child’s respiratory muscles do not function after administration; maintain assisted ventilation.
- Know that the drug’s action peaks in approximately 2 to 3 minutes and lasts approximately 1 hour (longer in children with poor renal perfusion).
- Remember that the drug does not alter state of consciousness. Anticipate the need for sedation or analgesia for procedures.
- Keep equipment for emergency resuscitation (Ambu bag) at bedside in case of a power or mechanical ventilator failure.
- Be sure to explain all events and procedures to the child; even though the respiratory muscles may be paralyzed, the child can still hear. Also encourage the parents to talk to the child when they visit.
- Be prepared to reverse the effects of the drug by administering atropine and neostigmine methylsulfate (Prostigmin).
- Monitor all physiologic parameters, including vital signs, heart rate, and blood pressure. Obtain electrolyte levels as ordered, because electrolyte imbalances can potentiate neuromuscular effects.

As with any organ transplantation, children need continued immunosuppression therapy with drugs such as cyclosporine or azathioprine (Imuran) following a lung transplant to decrease cell-mediated immunity. Although this level of immunosuppression is the key to successful transplantation, it also makes posttransplant children susceptible to fungal, bacterial, and viral lung infections. In addition, families experience a tremendous psychosocial toll as they wait to see whether the new transplant will be rejected. Children may need to have chest physiotherapy or use a portable spirometry device daily to help mobilize secretions resulting from loss of nerve innervation or a reaction to accumulating mucus in the transplanted lung.

**Lung Transplantation**

Lung transplantation is a possibility for children with a chronic respiratory illness such as cystic fibrosis (Visner & Goldfarb, 2007). The transplant may involve a single lung, or it can be done in conjunction with heart transplantation if chronic respiratory disease has caused ventricular hypertrophy of the heart. The donor lung can be from a live donor or a cadaver.

**Choanal Atresia**

Choanal atresia is congenital obstruction of the posterior nares by an obstructing membrane or bony growth, preventing a newborn from drawing air through the nose and down into the nasopharynx (Kelley et al., 2008). It may be either unilateral or bilateral.

Newborns up to approximately 3 months of age are naturally nose-breathers. Infants with choanal atresia, therefore,
develop signs of respiratory distress at birth or immediately after they quiet for the first time and attempt to breathe through their nose. Passing a soft no. 8 or 10 French catheter through the posterior nares to the stomach is a part of birthing room procedure in many health care facilities. If such a catheter will not pass bilaterally, the diagnosis of choanal atresia is confirmed immediately at birth.

Choanal atresia can also be assessed by holding the newborn’s mouth closed, then gently compressing first one nostril, then the other. If atresia is present, infants will struggle as they experience air hunger when their mouth is closed. Their color improves when they open their mouth to cry. Atresia is also suggested if infants struggle and become cyanotic at feedings because they cannot suck and breathe through the mouth simultaneously.

The treatment for choanal atresia is either local piercing of the obstructing membrane or surgical removal of the bony growth. Because infants with choanal atresia have such difficulty with feeding, they may receive intravenous fluid to maintain their glucose and fluid level until surgery can be performed. Some infants may need an oral airway inserted so they can continue to breathe through their mouths. Following surgery, children have no further difficulty or symptoms.

**Checkpoint Question 40.1**

Suppose Michael was born with choanal atresia. What would be the best way to assess if this is present?

- a. Observe if a newborn can breathe while lying on his stomach.
- b. Close the infant’s mouth to see if he can breathe through his nose.
- c. Assess if the infant’s palatine tonsils are blocking his airway.
- d. Listen for the sound of either stridor or wheezing on inhalation.

**Acute Nasopharyngitis (Common Cold)**

The common cold is the most frequent infectious disease in children—in fact, toddlers have an average of 10 to 12 colds a year. School-age children and adolescents have as many as four or five yearly. The incubation period is typically 2 to 3 days. Most occur in the fall and winter (Kelley et al., 2008).

They are caused by one of several viruses, most predominantly by rhinovirus, coxsackievirus, RSV, adenovirus, and parainfluenza and influenza viruses. Children are exposed to colds at school or while playing with other children. If they are in ill health from some other cause, or if their immune system is compromised, they are more susceptible than others to the cold viruses. Although difficult to prove, stress factors also appear to play a role in the development of common colds in children.

**Assessment**

Symptoms begin with nasal congestion, a watery rhinitis, and a low-grade fever. The mucous membrane of the nose becomes edematous and inflamed, constricting airway space and causing difficulty breathing. Posterior rhinitis, plus local irritation, leads to pharyngitis (sore throat). Upper airway secretions that drain into the trachea lead to a cough. Cervical lymph nodes may be swollen and palpable. The process lasts about a week and then symptoms fade. In some children, a thick, purulent nasal discharge occurs because bacteria such as streptococci invade the irritated nasal mucous membrane and cause a secondary purulent infection.

Infants can be critically ill yet not develop a fever because their temperature-regulating system is still immature. With the common cold, they often develop a fever elevated out of proportion to the symptoms, possibly as high as 102° to 104°
serve as a reservoir for microorganisms.

izer, including proper cleaning, must be stressed or it can vaporizers is questionable, however, and safe use of a vapor­ loosen nasal secretions if they wish. The efficiency of home suppressants are not necessary either as coughing raises secre­ tion to an appreciable degree with the common cold. Cough causing increased obstruction.

If they insert the bulb syringe first, then depress the bulb, compress the bulb first, then insert it into the child’s nostril. This can lead to dehydration. Older children rarely develop as high a fever, rarely above 102° F (38.8° C). Because older children can breathe through their mouth, nasal congestion does not seem as acute.

Therapeutic Management

There is no specific treatment for a common cold. Although many parents ask to have antibiotics prescribed, because colds are caused by a virus, antibiotics are not effective unless a secondary bacterial invasion has occurred. If a child has a fever, it can be controlled by an antipyretic such as acetaminophen (Tylenol) or children’s ibuprofen (Motrin). Help parents understand that these drugs are effective only in controlling fever symptoms; they do not reduce congestion or “cure” the cold. Therefore, they should not be given unless the child has a fever, generally defined as an oral temperature over 101° F (38.4° C). You may need to remind parents that children younger than 18 years should not be given acetylsalicylic acid (aspirin) because this is associated with the development of Reye syndrome, a potentially fatal neurologic disorder (see Chapter 49).

If infants have difficulty nursing because of nasal congestion, saline nose drops or nasal spray may be prescribed to liquefy nasal secretions and help them drain. Removing nasal mucus via a bulb syringe before feedings also allows infants to breathe more freely and be able to suck more efficiently. If infants have difficulty nursing because of nasal congestion, saline nose drops or nasal spray may be prescribed to liquefy nasal secretions and help them drain. Removing nasal mucus via a bulb syringe before feedings also allows infants to breathe more freely and be able to suck more efficiently. Caution parents that if they use a bulb syringe, they must compress the bulb first, then insert it into the child’s nostril. If they insert the bulb syringe first, then depress the bulb, they will actually push secretions further back into the nose, causing increased obstruction.

There is little proof that oral decongestants relieve congestion to an appreciable degree with the common cold. Cough suppressants are not necessary either as coughing raises secre­ tions, preventing pooling of secretions and the danger of con­ sequent lower respiratory infection. Guaifenesin is an example of a drug that loosens secretions but does not suppress a cough so is safe to use. Parents may use a cool mist vaporizer to help loosen nasal secretions if they wish. The efficiency of home vaporizers is questionable, however, and safe use of a vaporizer, including proper cleaning, must be stressed or it can serve as a reservoir for microorganisms.

Pharyngitis

Pharyngitis is infection and inflammation of the throat (Kamienski, 2007). The peak incidence occurs between 4 and 7 years of age. It may be either bacterial or viral in origin. It may occur as a result of a chronic allergy in which there is constant postnasal discharge that results in secondary irritation. At least a slight pharyngitis usually accompanies all common upper respiratory infections.

Viral Pharyngitis

The causative agent of pharyngitis is usually an adenovirus (Levin & Weinberg, 2008). The symptoms are generally mild: a sore throat, fever, and general malaise. On physical assessment, regional lymph nodes may be noticeably enlarged. Erythema will be present in the back of the pharynx and the palatine arch. Laboratory studies will indicate an increased white blood cell count.

If the inflammation is mild, children rarely need more than an oral analgesic such as acetaminophen or ibuprofen for comfort. Warm heat applied to the external neck area using a warm towel or heating pad also can be soothing. By school age, children are capable of gargling with a solution such as warm water to help reduce the pain. Before this age, children tend to swallow the solution unless the procedure is well explained and demonstrated to them.

Because children’s throats feel so sore, they often prefer li­ quids to solid food. Infants, especially, must be observed closely until the inflammation and tenderness diminish to be certain that they take in sufficient fluid to prevent dehydration.

Streptococcal Pharyngitis

Group A beta-hemolytic streptococcus is the organism most frequently involved in bacterial pharyngitis in children. All streptococcal infections must be taken seriously because they can lead to cardiac and kidney damage from the accompanying autoimmune process (Ogle & Anderson, 2008).

Assessment. Streptococcal infections are generally more severe than viral infections. The fact that symptoms are mild, how­ ever, does not rule out streptococcal infection. With a strepto­ coccal pharyngitis, the back of the throat and palatine tonsils are usually markedly erythematous (bright red); the tonsils are enlarged and there may be a white exudate in the tonsillar

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crypts. Pettechiae may be present on the palate. A child typically appears ill with a high fever, an extremely sore throat, difficulty swallowing, and overall lethargy. Temperature is usually elevated to as high as 104°F (40°C). The child often has a headache. Swollen abdominal lymph nodes may cause abdominal pain. A throat culture, often completed as a quick office procedure, confirms the presence of the Streptococcus bacteria.

**Therapeutic Management.** Treatment consists of a full 10-day course of an oral antibiotic such as penicillin G or clindamycin. Cephalosporins or broad-spectrum macrolides such as erythromycin may be prescribed if resistant organisms are known to be in the community. Help parents understand the importance of completing the full prescribed days of therapy. The recommended treatment days are necessary to ensure the streptococci are eradicated completely. If they are not, the child may develop a hypersensitivity or autoimmune reaction to group A streptococci that can result in rheumatic fever (although the chance of rheumatic fever occurring is probably as low as 1%) or glomerulonephritis.

Symptoms of acute glomerulonephritis (blood and protein in urine) appear in 1 to 2 weeks after the pharyngitis. For this reason, 2 weeks after treatment, children may be asked to return to the health care facility with a urine specimen to be examined for protein so that developing acute glomerulonephritis can be detected (Steer, Danchin, & Carapetis, 2007).

To ensure that a child receives the full antibiotic course, help parents make a reminder sheet to place on a cabinet or refrigerator door. In addition, instruct them about measures for rest, relief of throat pain, and maintaining hydration, the same actions as for a common cold. Because it is impossible to prevent life-threatening illnesses, a child with pharyngitis always should be examined by health care personnel.

**Checkpoint Question 40.2**

Suppose Michael is diagnosed as having a streptococcal pharyngitis. The chief danger of such an infection is:

- a. Lymph nodes will swell and obstruct the airway.
- b. Infection may spread and cause a tooth abscess.
- c. A small number of children develop kidney disease.
- d. Four of five children will develop lung abscesses.

**Retropharyngeal Abscess**

In infants, the lymph nodes that drain the nasopharynx are located just behind the posterior pharynx wall. These nodes may become infected following an acute nasopharyngitis or pharyngitis. Since these nodes disappear by preschool age, the problem is usually limited to young infants (Page, Bauer, & Lieu, 2008).

**Assessment.** Typically, infants have an upper respiratory tract infection or sore throat for a few days. Suddenly, they refuse to eat. They develop a high fever and may drool because they cannot swallow saliva past the obstruction in the back of their throat. They “snore” with respirations as the pharynx becomes further occluded. To allow themselves more breathing space, they may hyperextend the head, a very unusual position for infants.

Physical assessment reveals enlargement of the regional lymph nodes. The mass in the posterior pharynx may not be visible if it is below the point of vision. An ultrasound or x-ray study using a swallowed contrast medium will reveal the bulging tissue in the pharynx. Laboratory studies will reveal leukocytosis.

**Therapeutic Management.** Because the most common cause of retropharyngeal abscess is group A beta-hemolytic streptococcus, benzathine penicillin G or penicillin V is effective. As a result of their poor swallowing, infants’ mouths may need to be suctioned to remove secretions. Be careful not to touch the suction catheter to the posterior pharynx because this might rupture the abscess, possibly leading to aspiration of the abscess contents (producing respiratory obstruction or a pneumonia caused by the aspirated purulent material). Blood vessels invade some retropharyngeal abscesses, so rupture of the structure also could lead to profuse bleeding (dangerous to the child both because of the loss of blood from major arteries such as the carotid artery and because the blood could be aspirated).

Place infants in a side-lying position to allow difficult-to-swallow mouth secretions to drain forward. Limit oral intake to fluids. A hard food such as a toast crust (a food often recommended for teething) could rupture the abscess with its hard edges.

Although some postpharyngeal abscesses resolve on their own, some need to be incised by a surgeon to promote drainage. This is done with the child in a Trendelenburg position so that drainage from the abscess can be suctioned away to prevent aspiration. After surgery, maintain the child in a Trendelenburg or a side position as prescribed to encourage further drainage and prevent aspiration. Monitor vital signs closely. Observe any drainage from infants’ mouths to detect fresh bleeding. Frequent swallowing is also a sign of postpharyngeal bleeding. Increased respiratory rate suggests airway obstruction.

Oral fluid is introduced as soon as an infant’s swallowing and gag reflexes are intact after surgery. Although the throat is undoubtedly still sore, most infants such eagerly and need supplemental intravenous fluid administration following surgery for only a short time.

On admission to the hospital, parents may have been thoroughly frightened by the extent of the child’s symptoms (gurgling or snoring sound, high temperature, dyspnea). Allow parents to give care while in the hospital to help them allay their fears and regain confidence in their ability to care for the child again.

**Tonsillitis**

“Tonsillitis” refers to infection and inflammation of the palatine tonsils. “Adenitis” refers to infection and inflammation of the adenoid (pharyngeal) tonsils.

Tonsillar tissue is lymphoid tissue that filters pathogenic organisms from the head and neck area. The palatine tonsils are located on both sides of the pharynx; the adenoids are in the nasopharynx. Tubal tonsils are located at the entrance to the eustachian tubes. Lingual tonsils are located at the base of the tongue. All of the tonsils, referred to collectively as Waldeyer’s ring, are easily infected because of the bacteria that pass through or are screened through them with lymph.
Assessment

Infection of the palatine tonsils presents with all of the symptoms of a severe pharyngitis. Children drool because their throat is too sore for them to swallow saliva. They may describe swallowing as so painful it feels as if they are swallowing bits of metal or glass. In addition, they usually have a high fever and are lethargic. Tonsillar tissue appears bright red and may be so enlarged the two areas of palatine tonsillar tissue meet in the midline. Pus can be detected on or expelled from the crypts of the tonsils (Millar et al., 2007).

In addition to fever, lethargy, pharyngeal pain, and edema, the symptoms of adenoidal tissue infection also include a nasal quality of speech, mouth breathing, difficulty hearing, and perhaps halitosis or sleep apnea. The mouth breathing, change in speech, and apnea result from the postpharyngeal obstruction by the enlarged tissue. The difficulty with hearing occurs because of eustachian tube obstruction. Long-term obstruction of this way can further cause serous or acute otitis media.

Tonsillitis occurs most commonly in school-age children. The responsible organism is identified by a throat culture. In children younger than 3 years of age, the cause is often viral. In school-age children, the organism is generally a group A beta-hemolytic streptococcus (Steer, Danchin, & Carapetis, 2007).

Therapeutic Management

Therapy for bacterial tonsillitis includes an antipyretic for fever, an analgesic for pain, and a full 10-day course of an antibiotic such as penicillin or amoxicillin. If the cause is viral, no therapy other than comfort or fever reduction strategies is necessary. Although the pain of the infection will subside a day or two after the antibiotic administration is begun, remind parents that children need the full 10-day course of antibiotic to eradicate streptococci completely from the back of the throat. After a tonsillar infection, tonsillar tissue may remain hypertrophied, or it may atrophy and appear smaller than it did previously.

Tonsillectomy: Tonsillectomy is removal of the palatine tonsils. Adenoidectomy is removal of the pharyngeal tonsils. In the past, tonsillectomy was a common procedure following an episode of tonsillitis, but today it is not recommended unless all other measures to prevent frequent infections prove ineffective. Tonsillar tissue is removed by ligating the tonsil or by laser surgery. Because sutures are not placed, the chance for hemorrhage after this type of surgery is higher than after surgery involving a closed incision. The danger of aspiration of blood at the time of surgery and the danger of a general anesthetic compound the risk.

Chronic tonsillitis is about the only reason for removal of palatine tonsils. Adenoids may be removed if they are so hypertrophied they cause obstruction or sleep apnea. At one time, adenoids and palatine tonsils were always removed together; today, depending on the symptoms and the extent of hypertrophy and infection, children may have a tonsillectomy, an adenoidectomy, or both.

Tonsillectomy or adenoidectomy is never done while the organs are infected, because an operation at such a time might spread pathogenic organisms into the bloodstream, causing septicemia. Parents often ask why an operation to remove tonsils must be delayed until the child is well again. They think that as long as the tonsils are sore, they should be immediately removed. Help them understand why it is safer to schedule surgery for a later date. Most parents report an improvement in their child’s general health and performance after tonsillectomy surgery, as this ends the chronic infections.

Nursing Diagnoses and Related Interventions

<table>
<thead>
<tr>
<th>Nursing Diagnosis</th>
<th>Outcome Evaluation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Risk for fluid volume deficit related to blood loss from surgery</td>
<td>Child’s pulse and blood pressure remain normal for age; there is absence of extensive bleeding; intake and output are within acceptable parameters.</td>
</tr>
</tbody>
</table>
If hemorrhage occurs after tonsillectomy, it can be acute and intense. Because children will swallow any blood that is oozing from the surgical site, a child can be bleeding heavily and yet little blood is apparent. To detect bleeding, assess for subtle signs of hemorrhage, such as an increasing pulse or respiratory rate, frequent swallowing, throat clearing, or a feeling of anxiety. A child’s first line of defense against hemorrhage is a nurse who recognizes these subtle signs of bleeding before the bleeding becomes so intense that signs of shock occur.

If you find that the surgical site is bleeding, elevate the child’s head to reduce vascular pressure on the operative site. Use a good light to inspect the posterior throat. Have a dental mirror available so the surgeon can thoroughly inspect the bleeding area. If the surgical area is bleeding heavily, the child may need to be returned to surgery for a suture or two to halt bleeding.

The most dangerous periods for a child after a tonsillectomy are the first 24 hours, when the clots covering the denuded surgical area are forming, and days 5 to 7, when the clots begin to lyse or dissolve. If new granulation tissue is not yet present when the clots dissolve, hemorrhage from the denuded surface can occur.

If children have no complications from surgery, are able to swallow fluids, and have voided, they are discharged later the same day of surgery. Parents need careful instructions concerning the danger signs to watch for during the first day home (frequent swallowing, clearing the throat, increasing restlessness). They are usually advised to restrict their child’s activity (no gymnastics, swimming) until after the seventh day, when firm healing should have taken place. The child needs a return appointment to a health care facility approximately 2 weeks after surgery for follow-up assessment to make sure the surgical area has healed without complication.

**Nursing Diagnosis:** Pain related to surgical procedure

**Outcome Evaluation:** Child states level of pain is tolerable.

Tonsillectomy is an uncomfortable and painful procedure for children. Be sure they receive good preparation for the procedure and for the sensations they will experience afterward. Although tonsils are removed, it is better to talk about tonsils being “fixed” rather than taken out; children may be extremely frightened to know that a body part will be removed, however small it is.

Children’s throats are extremely sore following a tonsillectomy. Liquid analgesics are better tolerated than pills or tablets because they are easier to swallow. Rectal administration is a possibility for very young children. Occasionally, a child may require intravenous pain relief.

Most children are thirsty immediately after surgery, and drinking is helpful because swallowing fluid causes active pharyngeal movement, increasing the blood supply to the area and reducing edema and pain. Children commonly are promised by well-meaning people they can have all the ice cream they want after a tonsillectomy. However, because milk products form tenacious secretions that are difficult to swallow, ice cream is not a food of choice. Offer instead frequent sips of clear liquid, Popsicles, or ice chips. Avoid acid juices because these sting the denuded tissue. Carbonated beverages also can irritate the area unless they stand for a time to become “flat.” Avoid red fluid such as Kool-Aid, which if vomited can be mistaken for swallowed blood.

Children can then gradually advance after 24 to 48 hours to a diet of soft foods such as gelatin, mashed potatoes, soups, and cooked fruits. They should continue to eat only soft foods for the first week (no toast crusts or other foods that could cause pharyngeal irritation if not chewed well). Be certain parents know whom they should call (clinic, hospital, or pediatrician) if they have a question or concern about their child’s condition or care. Caution parents that some children develop a mild earache after tonsillectomy for the first week, probably caused by shifting pressure on the eustachian tube.

**Checkpoint Question 40.3**

Suppose Michael’s 4-year-old roommate spits up dark-red blood following her tonsillectomy. Your best action in relation to this would be:

a. Suction the back of her throat.
b. Encourage her to cough vigorously.
c. Perform a subdiaphragmatic thrust.
d. Continue to observe her for bleeding.

**Epistaxis**

Epistaxis (nosebleed) is extremely common in children and usually occurs from trauma, such as picking at the nose, from falling, or from being hit on the nose by another child (Burton & Dorée, 2009). In homes that lack humidification, the hot dry environment causes children’s mucous membranes to dry, feel uncomfortable, and be susceptible to cracking and bleeding. In all children, epistaxis tends to occur during respiratory illnesses. It also may occur after strenuous exercise, and it is associated with several systemic diseases, such as rheumatic fever, scarlet fever, measles, or varicella infection (chickenpox). It can occur with nasal polyps, sinusitis, or allergic rhinitis. Some families show a familial predisposition.

Nosebleeds are always frightening because of the visible bleeding and a choking sensation if blood should run down the back of the nasopharynx. The fear is generally out of proportion to the seriousness of the bleeding.

Keep children with nosebleeds in an upright position with their head tilted slightly forward to minimize the amount of blood pressure in nasal vessels and to keep blood moving forward, not back into the nasopharynx. Apply pressure to the sides of the nose with your fingers (Fig. 40.18). Make every effort to quiet the child and to help stop crying, because crying increases pressure in the blood vessels of the head and prolongs bleeding. If these simple measures do not control the bleeding, epinephrine (1:1000) may be applied to the bleeding site to constrict blood vessels. A nasal pack may be necessary to provide continued pressure.

Every child has an occasional nosebleed. Chronic nasal bleeding, however, should be investigated to rule out a systemic disease or blood disorder.
Sinusitis

Sinusitis is infection and inflammation of the sinus cavities. It is rare in children younger than 6 years of age because the frontal sinuses do not develop fully until age 6. It can occur as a primary infection or a secondary one in older children when streptococcal, staphylococcal, or *H. influenzae* organisms spread from the nasal cavity (Revai et al., 2007). Children develop a fever, a purulent nasal discharge, headache, and tenderness over the affected sinus. A nose and throat culture will identify the infectious organism.

Treatment for acute sinusitis consists of an antipyretic for fever, an analgesic for pain, and an antibiotic for the specific organism involved. Oxymetazoline hydrochloride (Afrin), supplied as nose drops or a nasal spray, shrinks the edematous mucous membranes and allows infected material to drain from the sinuses and relieve pain. To avoid a rebound effect, this type of nasal spray should be used for only 3 days at a time; otherwise, it actually causes more nasal congestion than was present originally. Warm compresses to the sinus area may also encourage drainage and relieve pain. Some children need acetaminophen (Tylenol) for pain.

Sinusitis is considered by many adults to be a minor illness. It needs to be treated, however, because it can have serious complications if the infection spreads from the sinuses to invade the facial bone (osteomyelitis) or the middle ear (otitis media). Chronic sinusitis can also interfere with school and social interactions because of the constant pain.

Laryngitis

Laryngitis is inflammation of the larynx. It results in brassy, hoarse voice sounds or inability to make audible voice sounds. It may occur as a complication of pharyngitis or from excessive use of the voice, as in shouting or loud cheering. Laryngitis is as annoying for children as it is for adults. Sips of fluid (either warm or cold, whichever feels best) offer relief from the annoying tickling sensation often present. The most effective measure, however, is for the child to rest the voice for at least 24 hours, until inflammation subsides. For infants with laryngitis, attempt to meet their needs before they have to cry for things. Simply caution older children not to speak. Provide them with a paper and pencil or chalkboard for communication.

**Congenital Laryngomalacia/Tracheomalacia**

Congenital laryngomalacia means that an infant’s laryngeal structure is weaker than normal and collapses more than usual on inspiration (Richter et al., 2008). This produces laryngeal *stridor* (a high-pitched crowing sound on inspiration) present from birth, possibly intensified when the infant is in a supine position or when sucking.

**Assessment**

The infant’s sternum and intercostal spaces may retract on inspiration because of the increased effort needed to pull air into the trachea past the collapsed cartilage rings. Many infants with this condition must stop sucking frequently during a feeding to maintain adequate ventilation and to rest from their respiratory effort, which is exhausting.

**Therapeutic Management**

Most children with congenital laryngomalacia need no routine therapy other than to have parents feed them slowly, providing rest periods as needed. The condition improves as infants mature and cartilage in the larynx becomes stronger at about 1 year of age. When parents wake at night and listen in a quiet house to the sound of stridor, it seems unbearably loud. This makes it difficult for them to believe it is safe for them to care for the infant at home.

Many parents sleep at night with the child’s crib next to their bed or with one hand resting on the infant’s chest so they can be assured during the night the child is continuing to breathe. At health care visits, assess whether the parents are receiving enough sleep and are not becoming too exhausted to be able to continue their daily activities. Showing them a weight chart that demonstrates their child is growing and thriving despite this problem can be reassuring.

Be certain parents know the importance of bringing the child for early care if signs of an upper respiratory tract infection develop. If not, laryngeal collapse will be even more intense during these times, and complete obstruction of the trachea could occur. If stridor becomes more intense, advise parents to have the infant seen by their primary care provider, because generally this indicates beginning obstruction and probably the beginning of an upper respiratory tract infection. As parents become more accustomed to the sound their infant makes while breathing, they will become astute reporters of change in their infant’s condition; listen to them carefully when they report a change to prevent overlooking this important information.

**Croup (Laryngotracheobronchitis)**

Croup (inflammation of the larynx, trachea, and major bronchi) is one of the most frightening diseases of early child-
hood for both parents and children. In children between 6 months and 3 years of age, the cause of croup is usually a viral infection such as parainfluenza virus. In previous years, the most common cause was H. influenzae. However, since immunization against this organism has been included in a routine immunization series, the incidence of croup from this cause has declined by 90% (Kerby et al., 2008).

Assessment

With croup, children typically have only a mild upper respiratory tract infection at bedtime. Temperature is normal or only mildly elevated. During the night, they develop a barking cough (croupy cough), inspiratory stridor, and marked retractions. They wake in extreme respiratory distress. The larynx, trachea, and major bronchi are all inflamed. These severe symptoms typically last several hours and then, except for a rattling cough, subside by morning. Symptoms may recur the following night. Cyanosis is rarely present, but the danger of glottal obstruction from the laryngeal inflammation and hypoxemia is very real. Pulse oximetry and transcutaneous SaO₂ monitors are helpful measures to document whether hypoxemia is occurring.

Therapeutic Management

One emergency method of relieving croup symptoms is for a parent to run the shower or hot water tap in a bathroom until the room fills with steam, then keep the child in this warm, moist environment. If this does not relieve symptoms, parents should bring the child to an emergency department for further evaluation and care. When a child is seen at an emergency room, cool moist air with a corticosteroid such as dexamethasone, or racemic epinephrine, given by nebulizer, reduces inflammation and produces effective bronchodilation to open the airway. Intravenous therapy may be prescribed to further evaluation and care. When a child is seen at an emergency department for croup is either bacterial or viral in origin. H. influenzae type B has been replaced as the most common bacterial cause of the disorder by pneumococci, streptococci, or staphylococci. Echovirus and RSV also can cause the disorder.

Assessment

Symptoms begin as those of a mild upper respiratory tract infection. After 1 or 2 days, as inflammation spreads to the epiglottis, the child suddenly develops severe inspiratory stridor, a high fever, hoarseness, and a very sore throat. Children may have such difficulty swallowing that they drool saliva. They may protrude their tongue to increase free movement in the pharynx.

If a child’s gag reflex is stimulated with a tongue blade, the swollen and inflamed epiglottis can be seen to rise and allow the airway to open. It occurs most frequently in children from 2 to about 7 years of age (Ogle & Anderson, 2008).

Epiglottitis can be either bacterial or viral in origin. H. influenzae type B has been replaced as the most common bacterial cause of the disorder by pneumococci, streptococci, or staphylococci. Echovirus and RSV also can cause the disorder.

Assessment

Symptoms begin as those of a mild upper respiratory tract infection. After 1 or 2 days, as inflammation spreads to the epiglottis, the child suddenly develops severe inspiratory stridor, a high fever, hoarseness, and a very sore throat. Children may have such difficulty swallowing that they drool saliva. They may protrude their tongue to increase free movement in the pharynx.

If a child’s gag reflex is stimulated with a tongue blade, the swollen and inflamed epiglottis can be seen to rise in the back of the throat as a cherry-red structure. It can be so edematous, however, that the gagging procedure causes complete obstruction of the glottis and shuts off the ability of the child to inhale. Therefore, in children with symptoms of epiglottitis (dysphagia, inspiratory stridor, cough, fever, and hoarseness), never attempt to visualize the epiglottis directly with a tongue blade or obtain a throat culture unless a means of providing an
Michael is a 4-year-old who is brought to the emergency department by paramedics who responded to an emergency call by his grandmother at his home. He has a sharp, barking cough, is crying loudly, and is obviously short of breath. His grandmother shouts at you. “I gave him some chocolate. Is he allergic to that?” Michael is diagnosed as having laryngotracheobronchitis (croup) and admitted to an ambulatory care unit.

**Family Assessment** ✽ Child lives with two parents in four-bedroom suburban home. Father works as a bartender at local restaurant; mother works part-time as a beautician. Parents are out of town on vacation. Were notified of child’s condition and gave oral permission for therapy by telephone to W. Burton, M.D. (witnessed by C. Finacca, R.N.); will fax consent and signatures from vacation hotel.

**Client Assessment** ✽ Child was born with choanal atresia. Is allergic to seafood, especially shrimp (develops hives and shortness of breath). Age-acceptable parameters for height and weight. Has had a “slight head cold” for last 2 days; woke from nap this afternoon gasping for breath. Has audible stridor. Tympanic temperature 102.2° F (39.0° C); pulse 146; respirations 40. Nasal flaring and intercostal retractions noted. Sharp, frequent, nonproductive cough.

**Nursing Diagnosis** ✽ Fear related to inability to breathe without effort, heightened by absence of parents.

**Outcome Criteria** ✽ Respiratory rate, oxygen saturation, and arterial blood gas levels are within age-acceptable parameters without the use of supplemental oxygen. No stridor is present on auscultation. Child states he can breathe more easily; is aware parents are concerned although absent.

### Box 40.10 ✽ Focus on Nursing Care Planning

**A Multidisciplinary Care Map for a Child With Laryngotracheobronchitis (Croup)**

<table>
<thead>
<tr>
<th>Team Member Responsible</th>
<th>Assessment</th>
<th>Intervention</th>
<th>Rationale</th>
<th>Expected Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nurse</td>
<td>Assess if child is able to complete any self-care despite fatigue and shortness of breath.</td>
<td>Place the child in a semi-Fowler’s to high Fowler’s position. Reposition the child frequently.</td>
<td>An upright position facilitates breathing and promotes optimal lung expansion by lowering diaphragm. Frequent repositioning prevents pooling and stasis of secretions.</td>
<td>Child cooperates with procedures to extent possible, given degree of fatigue and fear.</td>
</tr>
<tr>
<td>Nurse practitioner</td>
<td>Assess if anesthesiologist is available.</td>
<td>Consult with anesthesiologist about the possibility that intubation or tracheostomy may be necessary.</td>
<td>If tracheolaryngeal edema occludes airway, intubation or tracheostomy can be life-saving.</td>
<td>Anesthesiology team examines child; prepares equipment for emergency intubation if necessary.</td>
</tr>
<tr>
<td>Nurse</td>
<td>Assess temperature by tympanic thermometer.</td>
<td>Administer acetaminophen liquid orally as prescribed.</td>
<td>Oral temperature would be inaccurate because of rapid respirations.</td>
<td>Child’s temperature decreases one degree per hour until it reaches 98.6° F.</td>
</tr>
<tr>
<td>Nurse</td>
<td>Assess if child has experience with vital sign procedures or breath sound assessment.</td>
<td>Assess pulse, respirations, and lung sounds every 15 minutes.</td>
<td>An increasing pulse or respiratory rate or increased stridor can signal decreasing oxygenation.</td>
<td>Child agrees to allow chest leads to be applied to monitor heart rate. Pulse and respiratory rate do not increase any further.</td>
</tr>
</tbody>
</table>
### Chapter 40: Nursing Care of a Family When a Child Has a Respiratory Disorder

<table>
<thead>
<tr>
<th>Nurse</th>
<th>Assess if child has ever received medicine by nebulizer or humidifier.</th>
<th>Administer racemic epinephrine by nebulizer every 3 hours as prescribed. Keep room infused with cold humidification.</th>
<th>Epinephrine causes bronchodilation, widening lumen of airway. Cold moisture helps reduce inflammation and moisten mucus.</th>
<th>Child cooperates with nebulizer therapy to extent possible, given fear. Respiratory rate and stridor decrease following treatment.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nurse</td>
<td>Assess which method of oxygen administration (face mask or nasal prongs) would be most acceptable to child.</td>
<td>Administer humidified oxygen at prescribed rate. Obtain arterial blood gases (ABGs) as ordered and monitor oxygen saturation levels via pulse oximetry.</td>
<td>Humidified oxygen improves ventilation without drying the mucous membranes, to reduce hypoxemia. ABGs and pulse oximetry provide objective evidence of the child’s oxygenation.</td>
<td>Child chooses method for oxygen administration; cooperates with oxygen administration; PO2 and SaO2 improve to adequate levels.</td>
</tr>
</tbody>
</table>

#### Nutrition

| Nurse | Assess what is child’s favorite fluid to drink. | Offer the child sips of fluid frequently. Maintain intravenous fluid as prescribed. | Dehydration can occur from rapid respirations. Adequate hydration can help keep mucus moist. | Child drinks 80% of fluid offered; IV is maintained at correct rate. |

#### Patient/Family Education

| Nurse | Assess grandparent’s knowledge of child’s condition. | Review that croup is a viral infection, not an allergic disorder. | Understanding why a disease occurs can help grandparent to cooperate with therapy. | Grandparent states that she understands the cause of croup, its usual course, and its prognosis. |

#### Psychosocial/Spiritual/Emotional Needs

| Nurse/nurse practitioner | Assess if child has had prior experiences with hospitalization. Ask child to state if he feels afraid or anxious of procedures. | Use play to encourage child to cough, deep breathe, and drink fluid. Involve the grandparent in these activities. | Games and play are effective methods for encouraging fluid intake in a child. Involving the grandparent promotes participation in child’s care. | Child states he understands the nebulizer, oxygen mask, etc. are to help him breathe, not punishment for eating candy. |

#### Discharge Planning

<table>
<thead>
<tr>
<th>Nurse</th>
<th>Assess if grandparent is comfortable with taking child home.</th>
<th>Review child’s condition and careful watching grandparent will need to continue.</th>
<th>Croup is a frightening illness. Grandparent needs good preparation to continue care at home.</th>
<th>Grandparent states she is prepared to take child home; will telephone if child’s symptoms return.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nurse</td>
<td>Assess if grandparent knows action to take if child should develop croup again.</td>
<td>Review how to flood bathroom with warm moist steam.</td>
<td>Warm steam can help reduce airway inflammation.</td>
<td>Grandparent states she is prepared to initiate home therapy if a second incidence of croup should occur. Knows to call 911 if child’s condition does not improve.</td>
</tr>
</tbody>
</table>
artificial airway, such as tracheostomy or endotracheal intuba-
tion, is readily available. This is especially important for
the nurse who functions in an expanded role and performs
physical assessments and routinely elicits gag reflexes.

When epiglottitis is present, laboratory studies will show
leukocytosis (20,000 to 30,000 mm\(^3\)), with the proportion
of neutrophils increased. A blood culture to evaluate for sep-
ticemia and ABGs to evaluate respiratory sufficiency may be
ordered. However, because excessive crying can precipitate
entrapment of the epiglottis and obstruction, such tests may
be delayed in preference to a lateral neck x-ray film or ultra-
sound, which will show the enlarged epiglottis. Do not allow
a child with possible epiglottitis to go to these departments
accompanied only by parents or a nursing aide, in case ob-
struction occurs in the radiograph or ultrasound room.

**Therapeutic Management**

Children need moist air to reduce the epiglottal inflam-
ma
tion. If cyanosis is present, they need oxygen. An antibiotic,
such as a third-generation cephalosporin such as cefotaxime,
may be prescribed until a throat culture indicates a specific
antibiotic drug. Because they cannot swallow, children need
intravenous fluid therapy to maintain hydration. They may
need a prophylactic tracheostomy or endotracheal intubation
to prevent total airway obstruction, although it is often diffi-
cult to intubate children with epiglottitis because the tube
cannot be passed beyond the edematous epiglottis. After an-
tibiotic therapy begins, the epiglottal inflammation recedes
rapidly. By 12 to 24 hours, it has reduced enough that the
airway may be removed. Antibiotic administration will con-
tinue for a full 7 to 10 days. Siblings of the ill child may be
prescribed prophylactic antibiotic therapy to prevent them
from developing the same symptoms.

Initially, the symptoms of epiglottitis are not unlike those
of croup. As a result, parents may not realize the extent of the
occlusion in their child, especially if the child has had croup
on other occasions. They may question why a prophylactic
tracheostomy was necessary this time when it was not used
when the child had croup. Explain to them the difference be-
tween the two diseases (Table 40.5).

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**TABLE 40.5**  
Comparison of Laryngotracheobronchitis (Croup) and Epiglottitis

<table>
<thead>
<tr>
<th>Assessment</th>
<th>Laryngotracheobronchitis</th>
<th>Epiglottitis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Causative organism</td>
<td>Usually viral</td>
<td>Usually pneumococci or streptococci</td>
</tr>
<tr>
<td>Age of child</td>
<td>6 mo–3 years</td>
<td>3–6 years</td>
</tr>
<tr>
<td>Seasonal occurrence</td>
<td>Late fall and winter</td>
<td>None</td>
</tr>
</tbody>
</table>
| Onset pattern          | Preceded by upper respira-
|                        | tion infection; cough be-
|                        | comes worse at night      |
| Presence of fever      | Low grade                 | Elevated to about 102° F |
| Appearance             | Retractions and stridor,  | Dribbling; very ill-
                        | prolonged inspiratory    | appearing; neck hyper-
                        | phase of respirations;   | extended to breathe.  (Do
                        | not very                 | (Do not attempt to view   |
                        | ill-appearing             | enlarged epiglottis, or  |
| Cough                  | Sharp, barking            | immediate airway obstruc-
                        |                          | tion can occur.)         |
| Radiographic findings  | Lateral neck radiograph   | Muffled cough         |
|                        | showing subglottal         |
|                        | narrowing                  |
| Possible complications | Asphyxia because of subglottic obstruction | Asphyxia because of supraglottic obstruction |

---

Some infants with epiglottitis die because obstruction oc-
curs before a tracheotomy can be accomplished. If this
should happen, parents can be assured they could not real-
ize the seriousness of their child’s symptoms. This may make
them overcautious, bringing other children to health care
settings repeatedly for symptoms that are obviously not seri-
oun. It will take time for them to regain confidence in them-

---

**Checkpoint Question 40.4**

Michael has a barking cough, sore throat, and high fever. You
want to see if his throat looks sore. Your best procedure to do
this would be:

a. Gag him with a tongue blade to inspect his tonsils.
b. Ask him to press down on his tongue with a finger.
c. Elicit a gag reflex using only one gloved finger.
d. Inspect his throat visually only.

---

**Aspiration**

Aspiration (inhalation of a foreign object into the airway) oc-
curs most frequently in infants and toddlers. When a child as-
spires a foreign object such as a coin or a peanut, the imme-
diate reaction is choking and hard, forceful coughing. Usually,
this dislodges the object. However, if the airway becomes so
obstructed that coughing is impossible (no sound with cough),
or if there are signs of increased respiratory difficulty accom-
panied by stridor, some intervention is essential. A series of
subdiaphragmatic abdominal thrusts are recommended for
children, the same as for adults. This recommendation does
not extend to infants, however, because of the great risk of rup-
turing the liver (American Heart Association, 2008).

For this maneuver, stand behind the child and place a
fist just under the child’s diaphragm (a point immediately
below the anterior rib cage). Embrace the child, grip your
fist with your other hand, and pull back and up with a rapid
thrust. The pressure created by this action of pushing up on
the diaphragm forces the aspirated material out of the tra-
chea (Fig. 40.19).
CHAPTER 40 Nursing Care of a Family When a Child Has a Respiratory Disorder

If a child is lying on his or her back at the time of the aspiration, stand at the head of the bed or table, place your hands in the same position as described above, and exert the same inward and upward thrust. A subdiaphragmatic abdominal maneuver may cause a child to vomit as well as expel an aspirated object. Turn the child’s head to the side to prevent aspiration of vomitus.

For infants, use back thrusts to dislodge an aspirated object. Turn the infant prone over your arm and administer up to five quick back blows forcefully between the infant’s shoulder blades, using the heel of the hand (Fig. 40.20A). If the object is not expelled, turn the infant while carefully supporting the head and neck and hold the infant in a supine position draped over your thigh. Be sure to keep the infant’s head lower than his or her chest. Provide up to five quick downward thrusts in the lower third of the sternum (Fig. 40.20B; American Heart Association, 2008). This is generally enough to dislodge the foreign object. However, if this does not occur, rescue breathing may then be attempted.

Bronchial Obstruction

The right main bronchus is straighter and has a larger lumen than the left bronchus in children older than 2 years of age. For this reason, an aspirated foreign object that is not large enough to obstruct the trachea may lodge in the right bronchus, obstructing a portion or all of the right lung. The alveoli distal to the obstruction will collapse as the air remaining in them becomes absorbed (atelectasis), or hyperinflation and pneumothorax may occur if the foreign body serves as a ball valve, allowing air to enter but not leave the alveoli (see later discussion on disorders of the lower respiratory tract).

Assessment

After aspirating a small foreign body, the child generally coughs violently and may become dyspneic. If the article is not expelled, hemoptysis, fever, purulent sputum, and leukocytosis will generally result as infection develops. Localized wheezing (a high whistling sound on expiration made by air passing through the narrowed lumen) may occur. Because this is localized, it is different from the generalized wheezing of a child with asthma.

A chest radiograph will reveal the presence of a radiopaque object. Objects most frequently aspirated include bones, popcorn, nuts, and coins. As a rule, nuts or popcorn should not be given to children younger than school age. These objects are coated with oil, and as they swell with moisture in the respiratory tract, they cause not only obstruction but also lipid pneumonia, a persistent and difficult-to-treat type of pneumonia. Foreign bodies that are inhaled this deeply are rarely coughed
up spontaneously, despite the severe coughing that ensues. Because objects such as plastic and nuts cannot be visualized well on x-ray film, an x-ray study may be inconclusive.

**Therapeutic Management**

Children who are seen in emergency departments after aspirating a foreign body are in distress from pain and are choking and coughing. Their parents are frightened by the degree of distress. Parents may feel bad about having offered the child (or allowed the child to reach) a food such as a peanut. Children need quick orientation to the treatment environment, as they move from the emergency department to radiography and then possibly to surgery or a treatment room. If possible, allow the parents to go with them. Throughout, be vigilant in observing the child for coughing up the foreign body or developing increasing respiratory distress.

A bronchoscopy may be necessary to remove the foreign body (Rosbe, 2008). Children are often given conscious sedation for a bronchoscopy (for details of a bronchoscopy procedure and conscious sedation, see Chapter 37). After bronchoscopy, assess the child closely for signs of bronchial edema and airway obstruction that occurs from mucus accumulation because of the bronchus manipulation. Obtain frequent vital signs (increasing pulse and respiratory rates suggest increased edema and obstruction).

Keep a child NPO for at least an hour after a bronchoscopy. Check for return of the gag reflex. Once the gag reflex is present, offer the first fluid cautiously to prevent additional aspiration. Cool fluid may feel more soothing than warm fluid and also helps to reduce the soreness in the throat. Breathing cool, moist air or having an ice collar applied may further reduce edema.

Obviously, parents need to be cautioned about the dangers of aspiration to keep this from happening again. Do not lecture them, however. Parents whose child has just been through this experience already recognize the danger of aspiration and realize they need to be more careful in the future.

**DISORDERS OF THE LOWER RESPIRATORY TRACT**

The structures of the lower respiratory tract are subject to infection by the same pathogens that attack the upper respiratory tract. Inflammation and infection of the lungs or bronchi is particularly troublesome: it occurs in various forms and is caused by several organisms. Other illnesses that occur in the lower respiratory tract, such as bronchiastasis, can lead to secondary pneumonia infections and chronic illness.

**Influenza**

Influenza involves inflammation and infection of the major airways. It is caused by the orthomyxovirus influenza type A, B, or C. It is marked by a cough, fever, fatigue, aching pains, a sore throat, and often accompanying gastrointestinal symptoms such as vomiting or diarrhea. The disease spreads readily through a home or a classroom because children are contagious on the day before symptoms appear and for about the next 5 days.

Children usually need an antipyretic such as acetaminophen (Tylenol) to control fever. Oseltamivir (Tamiflu), a new antiviral drug that halts viral proliferation, can be taken by children over 1 year of age (Deglin & Villerand, 2008). Because Tamiflu only halts virus replication, and does not kill viruses, it needs to be taken at the first sign of illness before replication can begin. Although most children recover without incident, influenza can lead to bronchitis or pneumonia. The condition can be largely prevented by yearly influenza vaccine. Because the influenza virus mutates yearly, the influenza vaccine is specific for only that year and must be readministered yearly (Zimmerman, 2007).

**Bronchitis**

Bronchitis, or inflammation of the major bronchi and trachea, is one of the more common illnesses affecting preschool and school-age children. It is characterized by fever and cough, usually in conjunction with nasal congestion. Causative agents include the influenza viruses, adenovirus, and *Mycoplasma pneumoniae*, among others.

**Assessment**

Children usually have a mild upper respiratory tract infection for 1 or 2 days; they then develop a fever and a dry, hacking cough, which is hoarse and mildly productive in older children. The cough is serious enough to wake a child from sleep. These symptoms may last for a week, with full recovery sometimes taking as long as 2 weeks.

On auscultation, rhonchi and coarse crackles (the sound of rales) can be heard. A chest radiograph will reveal diffuse alveolar hyperinflation and some markings at the hilus of the lung.

**Therapeutic Management**

Therapy is aimed at relieving respiratory symptoms, reducing fever, and maintaining adequate hydration. An antibiotic is prescribed for bacterial infections. If mucus is viscid, an expectorant may be necessary to help the child raise sputum. It is important that children with bronchitis cough to raise accumulating sputum. Cough syrups to suppress coughing, therefore, are rarely indicated.

**Bronchiolitis**

Bronchiolitis is inflammation of the fine bronchioles and small bronchi. It is the most common lower respiratory illness in children younger than 2 years, peaking in incidence at 6 months of age. The infection occurs most often in the winter and spring. Many children who develop asthma later in life have numerous instances of bronchiolitis during their first year of life. Viruses, such as adenovirus, parainfluenza virus, and RSV, in particular, appear to be the pathogens most responsible for this illness (Quintero & Gershan, 2007).

**Assessment**

Typically, infants have 1 or 2 days of an upper respiratory tract infection, then suddenly begin to demonstrate nasal flaring, intercostal and subcostal retractions on inspiration, and an increased respiratory rate. They may have a mild fever, leukocytosis, and an increased erythrocyte sedimentation rate, indicating the amount of bronchial inflammation present. Both accumulating mucus and inflammation block the small bronchioles, so air can no longer enter or leave alve-
Feeding is often a problem because infants tire easily and therefore cannot finish a feeding. Intravenous fluids may be needed in the first hour, and the infant took in an adequate oral intake.

Therapeutic Management

For children with less severe symptoms, antipyretics, adequate hydration, and maintaining a watchful eye for progression to more serious illness is all that is necessary. Hospitalization is warranted for children in severe distress such as when an infant is tachypneic, has marked retractions, seems listless, or has a history of poor fluid intake.

Antibiotics are not commonly used in the treatment of bronchiolitis, because bacteria are rarely a causative factor (Spurling et al., 2009). Children with chronic pulmonary disease may receive anti-RSV immunoglobulin if RSV (respiratory syncytial virus) was identified as the causative agent.

If symptoms are severe, children need humidified oxygen to counteract hypoxemia and adequate hydration to keep respiratory membranes moist. Nebulized bronchodilators, epinephrine, and anti-inflammatory medications such as nebulized budesonide (a glucocorticoid steroid) may be used, although there is little evidence they make a major difference in reducing symptoms. Some children need ventilatory assistance to achieve adequate ventilation. All infants with bronchiolitis need to be carefully observed because if RSV is the cause, apnea may occur. In some infants, extracorporeal membrane oxygenation (the same as that used for heart surgery) is necessary to maintain adequate oxygenation.

Feeding is often a problem because infants tire easily and therefore cannot finish a feeding. Intravenous fluids may be given for the first 1 or 2 days of illness to eliminate the need for oral feeding.

**Respiratory Syncytial Virus Bronchiolitis**

RSV is a pathogenic RNA virus that is the most common cause of bronchiolitis in young children. Symptoms begin as a mild upper respiratory infection that quickly extends to include the bronchioles. The infant becomes lethargic and possibly cyanotic. Dehydration occurs as the child becomes too fatigued to suck. Respiratory distress with nasal flaring, retractions, grunting, rales, rhonchi, and expiratory wheezing noted on auscultation occur. All infants with an RSV infection must be monitored closely because the virus tends to cause apnea or periodic halting of respirations. The diagnosis is confirmed by throat or nasal culture.

Therapy is supportive (supplemental oxygen and hydration therapy), although life-threatening apnea may require ventilatory support with mechanical ventilation. Ribavirin, an antiviral agent, is effective against RSV, but ribavirin aerosol treatment is controversial as the drug is teratogenic.
and could be harmful to pregnant caregivers (Ventre & Randolph, 2009). Because RSV infection spreads readily from one child to the next, infants should be isolated for care. Nursing care should be organized so nurses do not care for other infants than those infected with RSV.

The disease peaks in severity between 48 to 72 hours. Recurrent apneic episodes are rare, so home monitoring for apneic episodes is usually not necessary. Two products are available for the prevention of RSV infection: RSV immune globulin intravenous (RSV-IGIV), made from RSV antibody–positive donor serum, and Palivizumab, a humanized monoclonal antibody produced by recombinant DNA technology. These may be given prophylactically to premature infants during the winter months (Kerby et al., 2008).

Asthma

Asthma, an immediate hypersensitivity (type I) response, is the most common chronic illness in children, accounting for a large number of days of absenteeism from school and many hospital admissions each year. It tends to occur initially before 5 years of age, although in these early years it may be diagnosed as frequent occurrences of bronchiolitis rather than asthma (Table 40.6). The condition may be intermittent, with symptom-free periods, or chronic, with continuous symptoms.

Asthma tends to occur in children with atopy or those who tend to be hypersensitive to allergens. Mast cells release histamine and leukotrienes that result in diffuse obstructive and restrictive airway disease because of a triad of inflammation, bronchoconstriction, and increased mucus production. Most children with asthma can be shown to have sensitization to inhalant antigens such as pollens, molds, or house dust. Food also may be involved. Severe bronchoconstriction can also occur because of exposure to cold air or irritating odors, such as turpentine or smog, as well as inhalation of a known allergen. Air pollutants such as cigarette smoke may lower the threshold for hypersensitivity reactions and worsen the condition. Although there may be a seasonal factor responsible for a particular child’s symptoms, most children have multiple sensitivities and are affected all year long. Aspirin can be a trigger, so caution adolescents with asthma that if they begin to take aspirin as an adult, it may initiate an attack.

Mechanism of Disease

Asthma primarily affects the small airways and involves three separate processes: bronchospasm, inflammation of bronchial mucosa, and increased bronchial secretions (mucus). All three processes act to reduce the size of the airway lumen, leading to acute respiratory distress. Bronchial constriction occurs because of stimulation of the parasympathetic nervous system (cholinergic mediated system), which initiates smooth muscle constriction. Inflammation and mucus production occur because of mast cell activation to release leukotrienes, histamine, and prostaglandins. Once viewed as a long-term, poorly controlled disorder, newer therapy makes this a reversible or manageable disorder (Boguniewicz, 2008).

Assessment

The word *asthma* is derived from the Greek word for “panting,” a description of the child’s distress. Typically, after exposure to an allergen or trigger, an episode begins with a dry cough, often at night as bronchoconstriction begins. Because bronchioles are normally larger in lumen on inspiration than expiration even with bronchoconstriction, children may inhale normally or have little difficulty. They develop increasing difficulty exhaling, however, as it becomes more and more difficult to force air through the narrowed lumen of the inflamed bronchioles filled with mucus. This causes the typical dyspnea and wheezing (the sound caused by air being pushed forcibly past obstructed bronchioles) typically associated with the disorder. Wheezing is heard primarily on expiration. However, when severe, it may be heard on inspiration as well. Hearing it on inspiration means a child is having extreme breathing difficulty. If a child coughs up mucus, it is generally copious and may contain white casts bearing the shape of the bronchi from which it was dislodged.

History. Assessment should include a thorough history of the development of a child’s symptoms—for example, what the child was doing at the time of the attack, and what actions were taken by the parents or child to decrease or arrest the symptoms. When an acute attack has passed, ask the parent or child to describe the home environment, including any pets, the child’s bedroom, outdoor play space, classroom environment, and type of heating in the house, to see whether more environmental control could reduce future occurrences.

Physical Assessment. A physical assessment includes examining the specific symptoms of asthma. In many children, the initial wheezing is so loud it can be heard without a stethoscope. In others, it is evident only by auscultation. Asthma affects all lobes of the lungs, so although the wheezing may be more prominent in one lobe than in another, it is generally audible in all lung fields. Audible wheezing in only one lobe suggests that only one bronchus is plugged, which suggests that a foreign body such as a peanut is more likely responsible than asthma. Cyanosis may be present. The eosinophil count is elevated.

Bronchospasm leads to CO2 trapping and retention; therefore, arterial oxygen saturation monitored by a pulse oximeter will begin to decrease because of the child’s inability to fully aerate the lungs. The child becomes frightened because of an acute feeling of suffocation. A peak flow meter shows decreased ability to exhale (Fig. 40.21).

Air-filled lungs are hyperresonant to percussion or they make a louder, hollower noise on percussion than usual. With normal respiration, the inspiration phase of breathing is longer than the expiration phase. During an asthma attack, however, a child must work so hard to exhale that the expiration phase becomes longer than the inspiration phase. Time the two phases to demonstrate this. Also observe for retractions (the chest wall is drawn inward with breaths) because children have to use intercostal accessory muscles to achieve full breaths.

As constriction becomes acute, the sound of wheezing may decrease because so little air can leave the alveoli. Hypoxemia and possibly cyanosis will become severe. When blood gases show an increased pCO₂ level and the sound of wheezing suddenly stops, respiratory failure is imminent.

During attacks, children with asthma are generally more comfortable in a sitting or standing position rather than lying down. If seated in a chair, they lean forward and raise their shoulders to give themselves more breathing space. Do not urge children to “lie down and relax,” as this can cause severe anxiety and increased difficulty in breathing. Children who
FIGURE 40.21 Here a child with asthma practices using a peak flow meter to track her peak expiratory flow readings on a daily basis.

Pulmonary Function Studies

Good pulmonary function depends on good ventilation (both drawing adequate air into the lungs and expelling it again), adequate transfer of gases across the alveolar capillary membranes, and adequate volume and distribution of pulmonary capillary blood flow to transport oxygen to body cells. In children with asthma, the vital capacity (air that they are able to exhale) may be low or the capacity may be normal, but, because of narrowed bronchioles as a result of bronchospasm, the expiratory rate will be abnormally long (more than 10 seconds, rather than the normal 2 or 3 seconds). If a child has bronchial plugging, the vital capacity will be low because of air absorption behind blocked bronchi. A gross measure of vital capacity is to ask a child to blow out a match. A child with an average vital capacity should be able to do this when the match is held at 6 inches. Children with asthma may not have the expiratory pressure to do this.

Peak Expiratory Flow Rate Monitoring. Children with asthma often use a home peak flow meter daily to measure gross changes in peak expiratory flow over time and help in planning an appropriate therapeutic regimen (Fig. 40.21). Children with asthma should be able to tell you their usual reading and personal best score.

To use a peak flow meter, a child places the indicator on the apparatus at the bottom of the numbered scale, and takes a deep breath. A child then places the meter in the mouth and blows out as hard and fast as possible. The child then repeats this two more times and records the highest number achieved as the peak flow meter result. During a 2-week period when a child feels well, this should be done daily. The highest number achieved during this time is recorded as the child’s personal best.

Children are assigned “zones” to rate their expiratory compliance:

- Green zone (80% to 100% of their personal best) means no asthma symptoms are present, and they should take their routine medications.
- Yellow zone (50% to 80% of personal best) signals caution. An episode of asthma may be beginning.
- Red zone (below 50% of personal best) indicates an asthma episode is beginning. Children should immediately take their prescribed medication such as an inhaled beta-2-agonist, then repeat the peak flow assessment. If the second reading is not in the green zone, their parents should alert their primary care provider of the impending asthma attack.

Therapeutic Management

Therapy for children with asthma involves planning for the three goals of all allergic disorders: avoidance of the allergen by environmental control; skin testing and hyposensitization to identified allergens; and relief of symptoms by pharmacologic agents. Parents need good instructions to be able to continue to address all three concerns over an extended period of time (McMullen et al., 2007).

Cough suppressants are contraindicated with asthma because, as a rule, as long as children can continue to cough up mucus, they are not in serious danger. When they stop coughing up mucus, thick plugs form that then may lead to pneumonia, atelectasis, and further acidosis.

A child with mild but persistent asthma usually is prescribed an inhaled anti-inflammatory corticosteroid such as fluticasone (Flovent) daily. Children who have moderate persistent symptoms usually are prescribed a long-acting bronchodilator at bedtime in addition to the inhaled anti-inflammatory daily corticosteroid. Children who have severe persistent asthma symptoms take a high dose of both an oral corticosteroid and an inhaled corticosteroid daily as well as a long-acting bronchodilator at bedtime. In addition, children may be prescribed a short-acting beta-2-agonist bronchodilator, such as albuterol or terbutaline, to use if an attack should begin (see Box 40.6). Cromolyn sodium is a mast cell stabilizer given by a nebulizer or metered-dose inhaler (see Figures 40.6 and 40.12A,B). This can prevent bronchoconstriction and thereby prevent the symptoms of asthma (Box 40.12). Cromolyn sodium is not effective once an attack has begun.

Another group of drugs used in the treatment of asthma are leukotriene receptor antagonists such as montelukast (Singulair) (Scow, Luttermoser, & Dickerson, 2007). These drugs are used for prophylaxis and chronic treatment of
and also provide a route for emergency drug administration. A venous line is established to supply continuous fluid therapy.

Avoid milk or milk products because they cause thick mucus. Ask about favorite beverages and offer small sips of them.

Obstruction. Encourage children to continue to drink fluids because they are coughing, or coughing makes them vomit and parents stop offering fluid) as well as increased in- 

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As a result, overdose from constant use of nebulizers or metered-dose inhalers can occur.

Bronchodilators.

If children are to receive medication by nebulizer or inhaler, be certain they know how to use these properly. It is easy for children to take this type of medication lightly (the belief it is “not really medicine” because it is not swallowed). As a result, overdose from constant use of nebulizers or metered-dose inhalers can occur.

Dehydration occurs rapidly in children during an asthma attack because they have decreased oral intake (children stop drinking because they are coughing, or coughing makes them vomit and parents stop offering fluid) as well as increased insensible loss that occurs from tachypnea. Dehydration may contribute to increased mucus plugging and further airway obstruction. Encourage children to continue to drink fluids (ask about favorite beverages and offer small sips of them).

Avoid milk or milk products because they cause thick mucus and difficulty swallowing. In an emergency setting, an intravenous line is established to supply continuous fluid therapy and also provide a route for emergency drug administration.

**Cromolyn Sodium (Intal)**

**Classification:** Cromolyn sodium is a mast cell inhibitor.

**Action:** Inhibits the release of histamine, slow-releasing substance of anaphylaxis, and leukotriene, thereby decreasing the overall allergic response. In asthma, it is used prophylactically to prevent severe bronchospasms (Karch, 2009).

**Pregnancy risk category:** B

**Dosage:** Initially, 20 mg inhaled (via spinhaler inhalant or as nebulized solution) 4 times daily at regular intervals; one ampule orally 4 times daily 1/2 hour before meals and at bedtime (ampule is not recommended for use in children under the age of 5 years)

**Possible adverse effects:** Dizziness, headache, nausea, dry and irritated throat, cough, nasal congestion, epistaxis, sneezing

**Nursing Implications**

- Instruct parents and child that this drug is not effective in an acute attack.
- Caution child and parents to take the drug exactly as prescribed and to continue other agents, such as bronchodilators.
- Instruct child and parents in the use of metered-dose inhaler or nebulizer for administration of cromolyn sodium.
- If the oral form is prescribed, instruct parents to open the ampule and pour the contents into a glass of water and to wait for the medication to dissolve. Caution parents not to substitute the oral form for the inhalant form and vice versa.
- Instruct parents and child to watch for a possible recurrence of asthma symptoms if dosage is decreased.
- Know that this drug is only given once the acute episode is over and the child’s airway is clear, to prevent a further episode.
- Caution child and parents not to exceed the number of ordered puffs via inhaler, to prevent possible tolerance to drug.
- If more than one inhalation is ordered, advise child to wait 1 to 2 minutes before taking the second puff.
- If the child is also receiving an inhaled bronchodilator, advise the child and parents to have the child use the bronchodilator first to open the airways and then wait approximately 5 minutes before using the cromolyn sodium, to maximize its effectiveness.

**Asthma**

Asthma in children over 6 years of age. They are not effective in an acute attack.

If children are to receive medication by nebulizer or inhaler, be certain they know how to use these properly. It is easy for children to take this type of medication lightly (the belief it is “not really medicine” because it is not swallowed). As a result, overdose from constant use of nebulizers or metered-dose inhalers can occur.

Dehydration occurs rapidly in children during an asthma attack because they have decreased oral intake (children stop drinking because they are coughing, or coughing makes them vomit and parents stop offering fluid) as well as increased insensible loss that occurs from tachypnea. Dehydration may contribute to increased mucus plugging and further airway obstruction. Encourage children to continue to drink fluids (ask about favorite beverages and offer small sips of them). Avoid milk or milk products because they cause thick mucus and difficulty swallowing. In an emergency setting, an intravenous line is established to supply continuous fluid therapy and also provide a route for emergency drug administration.

period of wondering why their child was always tired and had episodes of difficulty with breathing. After diagnosis, parents may be afraid to allow a child to sleep overnight away from them or leave the child alone with a babysitter. Help parents find a middle ground: to allow a child enough freedom for growth and development while still being certain the child is safe. Taking steps to slow breathing, better emptying alveoli through pursed-lip breathing, and administering medications to prevent symptoms are key measures for children to learn. Many children have long periods without attacks. When a new one occurs after a long absence, it is almost as frightening as the original attack because everything seems so new again.

**Nursing Diagnosis:** Health-seeking behaviors related to prevention of and treatment for asthma attacks

**Outcome Evaluation:** Parents and child accurately state triggers that cause an attack; child correctly demonstrates breathing exercises, use of inhaler, and peak expiratory flow meter. Children need to learn how to avoid possible triggers through environmental control. If foods are a trigger, children need to learn to be responsible for their own diets so they can avoid these foods. Children as young as 6 years can learn what foods they cannot eat and can take responsibility for telling a friend’s parent or a schoolteacher that they must not eat certain foods. They must learn to use a metered-dose inhaler or nebulizer if prescribed. At the same time, they must not become inhaler-dependent or use the inhaler constantly, afraid to go anywhere without it. This will invariably result in their using the inhaler much more often than is necessary.
To prevent children with asthma from losing chest mobility and to decrease their tendency to develop a barrel chest, they can be taught several breathing or mobility exercises to do daily at home. Such exercises are aimed at increasing expiratory function (diaphragmatic or side expansion breathing). Recommended activities include bending side to side, bending forward and touching the left foot with the right hand, and swinging the arms rhythmically in front of the body like a windmill (jumping jacks). These exercises can be incorporated into a bedtime or after-school routine. (Parents [and nurses] who do mobility exercises with children find the exercises are helpful to them as well, as they help tighten the abdominal muscles.) Using an incentive spirometer daily is another method for children to use to exercise the lungs and keep chest muscles supple.

The prognosis in children who develop asthma is good if they adhere to their treatment regimen. Children do not outgrow asthma, although most of them may become symptom-free as adults, probably because the lumens of major airways enlarge with adulthood.

Both heart rate and respiratory rate are elevated. Both oxygen saturation and PO2 are low; P CO2 is elevated because the combination of exhaustion, atelectasis, and respiratory acidosis from bronchial plugging.

Status Asthmaticus
Under ordinary circumstances, an asthma attack responds readily to the aerosol administration of a bronchodilator such as albuterol, terbutaline, levalbuterol (Xopenex), or salmeterol (Serevent). When children fail to respond and an attack continues, they are in status asthmaticus. This is an extreme emergency because, if the attack cannot be relieved, a child may die of heart failure caused by the combination of exhaustion, atelectasis, and respiratory acidosis from bronchial plugging.

Assessment
A child with status asthmaticus is in acute respiratory distress. Both heart rate and respiratory rate are elevated. Both oxygen saturation and PO2 are low; P CO2 is elevated because the bronchi are so constricted the child cannot exhale, resulting in CO2 accumulation. The rising P CO2 rapidly leads to acidosis. In contrast to the loud wheezing initially heard in an asthma attack, children with status asthmaticus may have so little air able to pass in or out of their lungs that breath sounds are limited. Pulse oximetry will reveal the low oxygen saturation level.

Status asthmaticus is often initiated by a respiratory infection, which acts as the triggering mechanism for the prolonged attack. If this occurs, obtain cultures from coughed sputum, and be prepared to administer a broad-spectrum antibiotic until the culture results are available. Be certain the sputum obtained for culture was coughed from deep in the respiratory tract and not just from the back of the child’s throat.

Therapeutic Management
By definition, a child in status asthmaticus has failed to respond to first-line therapy (Mannix & Bachur, 2007).

Continuous nebulization with an inhaled beta-2-agonist and intravenous corticosteroids may be necessary to reduce symptoms. Oxygen is given by face mask or nasal prongs to maintain the PO2 at more than 90 mm Hg. These methods supply good oxygen concentrations and yet leave the child’s face unobscured for easy observation. To prevent drying of pulmonary secretions, always give oxygen with humidification. It is best administered at a concentration of 30% to 40%, not 100%. If concentrations greater than 40% are needed, a Venturi mask that allows for rebreathing may be used. Some children in severe status asthmaticus have such a carbon dioxide buildup (because they cannot exhale properly) that they develop carbon dioxide narcosis with no stimulation for inhalation. The child’s respiratory stimulus, therefore, is hypoxia, or lack of oxygen. If 100% oxygen were administered, the oxygen lack would disappear, and respirations would cease. The idea “if a little is good, a lot is better” does not apply here. After it has been ascertained that the child is not in acidosis (from blood gas and pH studies), oxygen levels may be increased, but for initial therapy, unless prescribed otherwise, keep the level at 40%.

During the acute stage of status asthmaticus, children need increased fluid to combat dehydration and keep airway secretions moist. Drinking tends to aggravate coughing, so an intravenous infusion such as 5% glucose in 0.45 saline is usually prescribed to supply fluid. If a child can drink, do not offer cold fluids because these tend to aggravate bronchospasm.

Monitor intake and output; measure the specific gravity of urine. Under stress, antiuretic hormone is released, so fluid retention and overhydration may occur.

An increasing P CO2 is a danger sign because it indicates the degree of hypoventilation. In severe attacks, endotracheal intubation and mechanical ventilation may be necessary to maintain effective respirations (Carpenter et al., 2008).

Bronchiectasis
Bronchiectasis is chronic dilatation and plugging of the bronchi. It may follow pneumonia, aspiration of a foreign body, pertussis, or asthma.

Children develop a chronic cough with mucopurulent sputum (Kerby et al., 2008). Young infants may have accompanying wheezing or stridor. If a large area of lung is involved, children may have cyanosis. As the disease becomes chronic, children develop symptoms of chronic lung disease, such as clubbing of the fingers and easy fatigability. Their physical growth may become restricted. Their chest may become enlarged from overinflation of alveoli caused by the air trapped behind inflamed bronchi.

Inhaled mucolytic agents or bronchodilators and chest physiotherapy may be necessary to raise the tenacious sputum. An antibiotic will be necessary if infection is present. The cause of the bronchiectasis such as an aspirated seed or nut must be identified and relieved before the chronic process can be relieved. In rare instances, surgery to remove the affected lung portion may be necessary.

Pneumonia
Pneumonia (infection and inflammation of alveoli) occurs at a rate of 2 to 4 children in 100. It may be of bacterial origin (pneumococcal, streptococcal, staphylococcal, or chlamydial) or viral in origin, such as RSV. Aspiration of
lipid or hydrocarbon substances also causes pneumonia. The disease is commonly divided into two types: hospital acquired (pneumococcal or streptococcal pneumonia) and community acquired (chlamydia, viral pneumonias). It is the most common pulmonary cause of death in infants younger than 48 hours of age. It occurs most often in late winter and early spring. Newborns who are born more than 24 hours after rupture of the amniotic membranes and those who aspirated amniotic fluid or meconium during birth are particularly prone to developing pneumonia in their first few days of life (Raab, 2007). When it is known that the fetal membranes have been ruptured for more than 24 hours before birth, prophylactic broad-spectrum antibiotics may be given to prevent pneumonia. The differences between bronchiolitis, asthma, and pneumonia are summarized in Table 40.6. *Pneumocystis carinii* pneumonia, the type seen almost exclusively with HIV/AIDS infection, is discussed in Chapter 42.

### Pneumococcal Pneumonia

The onset of pneumococcal pneumonia is generally abrupt and follows an upper respiratory tract infection. In infants, pneumonia tends to remain bronchopneumonia with poor consolidation (infiltration of exudate into the alveoli). In older children, pneumonia may localize in a single lobe, and consolidation may occur. With this, children may have blood-tinged sputum as exudative serum and red blood cells invade the alveoli. After 24 to 48 hours, the alveoli are no longer filled with red blood cells and serum but fibrin, leukocytes, and pneumococci. At this point, the child's cough no longer raises blood-tinged sputum but thick purulent material.

**Assessment.** Children develop a high fever, nasal flaring, retractions, chest pain, chills, and dyspnea. Some children report the pain as being abdominal. The fever with pneumococcal pneumonia may rise so high and fast a child has a febrile seizure (see Chapter 49).

Children with pneumococcal pneumonia appear acutely ill. Tachypnea and tachycardia develop. Because the lung space is filled with exudate, respiratory function will be diminished. Breath sounds become bronchial (sound transmitted from the trachea) because air no longer or only poorly enters fluid-filled alveoli. Crackles (rales) may be present as a result of the fluid. Dullness on percussion over a lobe indicates that total consolidation has occurred. Chest radiographs will usually show this type of lung consolidation in older children but only patchy diffusion in young children. Laboratory studies will indicate leukocytosis.

**Therapeutic Management.** Therapy for pneumococcal pneumonia is antibiotics (Awasthi et al., 2008). Either amoxicillin or a third-generation cephalosporin is effective against pneumococci. Amoxicillin-clavulanate (Augmentin) may be prescribed for penicillin-resistant organisms. Children need rest to prevent exhaustion. Plan nursing care carefully to conserve the child’s strength. At the same time, turn and reposition a child frequently to avoid pooling of secretions. Intravenous therapy may be necessary to supply fluid, especially in infants, because infants tire so readily with sucking they may not be able to achieve a good oral intake. They may need an antipyretic such as acetaminophen to reduce fever. Humidified oxygen may be necessary to alleviate labored breathing and prevent hypoxemia. Assess oxygen saturation levels frequently via pulse oximetry. Chest physiotherapy encourages the movement of mucus and prevents obstruction. Older children may need to be encouraged to cough so that secretions do not pool and become further infected.

Before antibiotic therapy was available for pneumonia, it was almost always a fatal disease, especially in infants, so parents may be more worried about a child’s condition than is warranted (Box 40.13).

Following pneumonia, children usually have a period of at least a week when they tire easily and need frequent, small feedings. Parents need to be cautioned that this degree of fatigue is an expected outcome and not a complication in itself.

### TABLE 40.6  Comparison of Bronchiolitis, Pneumonia, and Asthma

<table>
<thead>
<tr>
<th>Assessment</th>
<th>Bronchiolitis</th>
<th>Pneumonia</th>
<th>Asthma</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cause</td>
<td>Usually respiratory syncitial virus</td>
<td>Possibly bacterial (pneumococcal, or <em>H. influenzae</em>, viral, or mycoplasmal; possibly secondary to aspiration</td>
<td>Hypersensitivity type I immune response</td>
</tr>
<tr>
<td>Age of child</td>
<td>Under 2 years</td>
<td>All through childhood</td>
<td>Onset 1–5 years</td>
</tr>
<tr>
<td>Onset pattern</td>
<td>Follows upper respiratory infection</td>
<td>Follows an upper respiratory infection</td>
<td>Follows initiation by an allergen</td>
</tr>
<tr>
<td>Appearance</td>
<td>Fatigued, anxious, shallow respirations, increasing anteroposterior diameter of chest</td>
<td>Fatigued, anxious, shallow respirations</td>
<td>Wheezing, exhausted, frightened</td>
</tr>
<tr>
<td>Cough</td>
<td>Paroxysmal, dry</td>
<td>Productive, harsh cough</td>
<td>Paroxysmal, with thick mucus production</td>
</tr>
<tr>
<td>Fever</td>
<td>Low grade</td>
<td>Elevated</td>
<td>None</td>
</tr>
<tr>
<td>Auscultatory sounds</td>
<td>Barely audible breath sounds, rales, expiratory wheezing</td>
<td>Decreased breath sounds, rales</td>
<td>Wheezing</td>
</tr>
</tbody>
</table>

*Note:* This table provides a comparison of the signs and symptoms of bronchiolitis, pneumonia, and asthma. It is important to note the differences in presentation and management strategies for each condition.
Children with chronic illness, those who have had a splenectomy, or those who are immunocompromised should receive a pneumococcal vaccine to prevent pneumococcal pneumonia.

**Chlamydial Pneumonia**

*Chlamydia trachomatis* pneumonia is most often seen in newborns up to 12 weeks of age because the chlamydial organism is contracted from the mother’s vagina during birth. Symptoms usually begin gradually with nasal congestion and a sharp cough; infants fail to gain back their birth weight. Symptoms progress to tachypnea, with wheezing and rales audible on auscultation. Laboratory assessment will show an elevated level of immunoglobulin IgG and IgM antibodies, peripheral eosinophilia, and a specific antibody to *C. trachomatis*. Such an infection is treated with a macrolide antibiotic such as erythromycin with good results (Kerby, 2008).

**Viral Pneumonia**

Viral pneumonia is generally caused by the viruses of upper respiratory tract infection: the RSVs, myxoviruses, or adenoviruses. Symptoms begin as an upper respiratory tract infection. After a day or two, additional symptoms such as a low-grade fever, nonproductive cough, and tachypnea begin. There may be diminished breath sounds and fine rales on chest auscultation. RSV may cause apnea. Chest radiographs will show diffuse infiltrated areas.

Because this is a viral infection, antibiotic therapy usually is not effective. The child needs rest and, possibly, an antipyretic for the fever; intravenous fluid may be necessary if a child becomes exhausted or is dehydrated and refusing fluids. After recovery from the acute phase of illness, a child will have a week or two of lethargy or lack of energy, the same as occurs with bacterial pneumonia. Parents may be confused because their child is not receiving an antibiotic, despite the diagnosis of pneumonia. Explain the difference between viral and bacterial infections so they can better understand their child’s therapy and plan of care.

**Mycoplasmal Pneumonia**

The mycoplasma organisms are similar to yet larger than viruses. Mycoplasmal pneumonia occurs more frequently in older children (over 5 years) and more often during the winter.

The symptoms of mycoplasmal pneumonia make it difficult to differentiate from other pneumonias. The child has a fever and a cough and feels ill. Cervical lymph nodes are enlarged. The child may have a persistent rhinitis.

Mycoplasmal organisms generally are sensitive to erythromycin or tetracycline. Erythromycin is the preferred drug for children younger than 8 years of age, because tetracycline tends to stain teeth brown and possibly stunt long bone growth (Karch, 2009).

**Lipid Pneumonia**

Lipid pneumonia is caused by the aspiration of an oily or lipoid substance. It is much less common than it once was because children are not given oil-based tonics, such as castor oil or cod liver oil anymore, as they were in the past. Today it is most often caused by aspirated oily foreign bodies such as peanuts or popcorn. A proliferative inflammatory response occurs when lung lipases act on the aspirated oil. This is then followed by diffuse fibrosis of the bronchi or alveoli. The area then becomes secondarily infected.

A child may have an initial coughing spell at the time of aspiration. A period follows during which the child is symptomless; then a chronic cough, dyspnea, and general respiratory distress occur. A chest radiograph shows densities at the affected site.

Antibiotic therapy is ineffective unless a secondary bacterial infection has occurred. Surgical resection of a lung portion may be necessary to remove a lung segment if the pneumonia does not heal by itself.

**Hydrocarbon Pneumonia**

Several common household products such as furniture polish, cleaning fluids, turpentine, kerosene, gasoline, lighter fluid, and insect sprays have hydrocarbon bases. These
products are a common cause of childhood poisonings and result in hydrocarbon pneumonia.

Assessment. Children who swallow a hydrocarbon-based product usually exhibit gastrointestinal symptoms such as nausea and vomiting. Next, they become drowsy and develop a cough from inhalation as vapors from the stomach rise and are inhaled. Bronchial edema occurs from irritation and inflammation, respirations become increased and dyspneic.

Physical assessment shows an increased percussion sound caused by the presence of air trapped in the alveoli beyond the point of inflammation. Rales may be heard as air passes through collecting mucus. Because air cannot reach and inflate the alveoli fully, breath sounds may be diminished.

Therapeutic Management. Irritation from fumes of hydrocarbon ingestion may occur when children initially swallow the fluid. If they are given an emetic to induce vomiting, it can cause them to aspirate vomitus or cause additional irritation. Parents should telephone a poison control center to ask for advice if their child has swallowed any poison, rather than induce vomiting to prevent this secondary complication. In the emergency room, gastric lavage may be done by health care personnel with great care to remove the substance from the stomach and help prevent inhalation.

The child is usually admitted to a hospital observation unit for a short time. Obtain vital signs and observe the child’s general appearance carefully for evidence of increased respiratory tract obstruction or increasing drowsiness or other symptoms of CNS involvement from CNS intoxication. Cool, moist air administered by a nebulizer with supplemental oxygen may be prescribed to decrease lung inflammation. If febrile, a child needs an antipyretic. Frequent changes of position will prevent pooling of secretions, which could lead to a secondary infection. Chest physiotherapy will help to move secretions and reduce areas of stasis.

The initial inflammation reaction from hydrocarbon aspiration may lead to such occlusion that emphysema (pocketing of air in alveoli) occurs, causing rupture of the alveoli into the pleural space, with consequent pneumothorax and atelectasis.

Often, children who swallow a household cleaner or other substance are aware they should not have been handling substances kept under the sink. As a result, they cannot help but interpret the hospitalization, blood drawing, and other uncomfortable procedures as punishments for their action. They may benefit from therapeutic play with puppets or dolls that will help alleviate their guilt and anger at being “punished” so severely.

Hydrocarbon pneumonia is slow to resolve, so the child will be ill for some time. After the illness, reinforce with parents the need to keep poisons in a safe place. Offer a listening ear so they can explain they were unaware of the extreme danger of these everyday household products.

Atelectasis

Atelectasis is the collapse of lung alveoli. It may occur in children as a primary or secondary condition. It must be considered as a possibility in all children with respiratory distress.

Primary Atelectasis

Primary atelectasis occurs in newborns who do not breathe with enough respiratory strength at birth to inflate lung tissue or whose alveoli are so immature or so lacking in surfactant that alveoli cannot expand. This is seen most commonly in immature infants or in infants with CNS damage. It may occur if infants have mucus or meconium plugs in the trachea.

When atelectasis occurs, the newborn’s respirations become irregular, with nasal flaring and apnea. After a few minutes, a respiratory grunt and cyanosis may occur. The sound of a respiratory grunt is caused by the newborn’s glottis closing on expiration. At first, this is a helpful action because it increases pressure in the respiratory tract, keeps alveoli from collapsing, and allows for better alveoli exchange surfaces. This action is also tiring, however, and as the infant tires, hypoxemia will increase, and the infant will become hypotonic and flaccid. The Apgar score will invariably be low.

As infants cry or are administered oxygen, more alveoli become aerated and cyanosis may decrease. The cause of the atelectasis must be established, however, so that therapy directed to the specific cause can be initiated.

Secondary Atelectasis

Secondary atelectasis occurs in children when they have a respiratory tract obstruction that prevents air from entering a portion of the alveoli. As the residual air in the alveoli is absorbed, the alveoli collapse. The causes of obstruction in children include mucus plugs that may occur with chronic respiratory disease or aspiration of foreign objects. In some children, atelectasis occurs because of pressure on lung tissue from outside forces, such as compression from a diaphragmatic hernia, scoliosis, or enlarged thoracic lymph nodes (Fig. 40.22).

The signs of secondary atelectasis depend on the degree of collapse. Asymmetry of the chest may be noticed. Breath sounds on the affected side are decreased. If the process is extensive, tachypnea and cyanosis will be present. A chest radiograph will show the collapsed alveoli (a “whiteout”).

Children with atelectasis are prone to secondary infection because mucus, which provides a good medium for bacteria, becomes stagnant without air exchange.

Therapeutic Management. Atelectasis caused by inspiration of a foreign object will not be relieved until the object is removed by bronchoscopy. Atelectasis caused by a mucus plug will resolve when the plug resolves or is moved or expectorated. Children may need oxygen and assisted ventilation to maintain adequate respiratory function until this time (Groeben et al., 2008).

Make certain the chest of a child with atelectasis is kept free from pressure so that lung expansion is as full as possible (to allow as much breathing space as possible). If restraints are being used to keep an infant positioned, make certain that body restraints are not crossing the chest area and interfering with chest expansion. Check clothing to be certain it is loose and nonbinding. Make certain the child’s arms are not positioned across the chest, where their weight could interfere with deep inspiration.

A semi-Fowler’s position generally allows for the best lung expansion because it lowers abdominal contents and increases chest space. Increase the humidity of the child’s environment to prevent further bronchial plugging; suction and chest physiotherapy may be necessary to keep the respiratory tract clear and free of mucus. Observe closely for increased respirations or cyanosis, as these indicate failing oxygenation.
Pneumothorax

Pneumothorax is the presence of atmospheric air in the pleural space; its presence causes the alveoli to collapse (atelectasis) (Fig. 40.23). Pneumothorax in children usually occurs when air seeps from ruptured alveoli and collects in the pleural cavity. It also can occur when external puncture wounds allow air to enter the chest (Chauvin, Chen, & Anthony, 2007).

Pneumothorax occurs in approximately 1% of newborns, probably because of rupture of the alveoli from the extreme intrathoracic pressure needed to initiate a first inspiration. The infant develops tachypnea, grunting respirations, flaring of the nares, and cyanosis. Auscultation reveals absent or decreased breath sounds on the affected side. Percussion may not be revealing, despite the hollow air space; as so much air is present, this may be hyperresonant. A more revealing sign may be the shift of the apical pulse (mediastinal shift) away from the site of the pneumothorax and the resulting atelectasis. A chest film will show the darkened area of the air-filled pleural space.

A child with a pneumothorax needs oxygen therapy to relieve respiratory distress. A thoracotomy catheter or needle may be placed in the pleural space and atmospheric air aspirated or low-pressure suction with water-seal drainage applied to remove accumulated air. In most children with pneumothorax, symptoms are relieved within 24 hours after suction is begun. The use of water-seal drainage with children is discussed in Chapter 41.

If the air in the pleural space is from a puncture wound such as a stab wound, cover the chest wound immediately with an impervious material, such as petrolatum gauze, to prevent further air from entering and help decrease the possibility of atelectasis. In an emergency, an impervious object can be your gloved hand.

Pneumothorax is always a potentially serious respiratory problem. The extent of the symptoms and the outcome will depend on the cause of entry of air into the pleural space and whether it can be removed.

Bronchopulmonary Dysplasia

Bronchopulmonary dysplasia (BPD) is chronic pulmonary involvement that occurs in 10% to 40% of infants who are treated for acute respiratory distress in the first days of life (Yost & Soll, 2009). The condition most often occurs in...
infants who received mechanical ventilation for respiratory distress syndrome at birth. The condition is thought to occur from a combination of surfactant deficiency (decreased from lung trauma), barotrauma (lung damage from ventilator pressure), oxygen toxicity (from high levels needed to counteract the original respiratory distress), and continuing inflammation. It occurs most often in infants born weighing less than 1000 g.

Infants with BPD develop tachypnea, retractions, nasal flaring, tachycardia, oxygen dependence, and abnormal radiograph findings that show areas of overinflation, inflammation, and atelectasis. As the inflamed surfaces heal, they are left with fibrotic scarring. On auscultation, decreased air movement can be detected.

The clinical course ranges from a mild need for increased oxygen requirements that will gradually resolve over a few months to severe disease requiring chronic tracheostomy and mechanical ventilation for as long as the first 2 years of life. A respiratory infection greatly compromises the infant’s ability to breathe.

Administration of a corticosteroid to reduce inflammation and a bronchodilator by nebulizer greatly improves respiratory function. Infants need to be monitored carefully for nutrition and fluid intake, especially if ventilator dependent. Because of the long hospitalization involved, parents need support to continue to visit and care for the child as what seemed to be a miracle at birth (their very small newborn survived) becomes years of specialized and expensive health care.

**Tuberculosis**

Tuberculosis is a highly contagious pulmonary disease. The causative agent is *Mycobacterium tuberculosis* (tubercle bacillus). The mode of transmission is infected droplets. The incubation period is 2 to 10 weeks (Starke, 2007).

Children generally contract this disease from someone in the immediate family. When any member of a family contracts tuberculosis, all family members must be tested (a Mantoux skin test) to screen for the disease. In some children, the contact is not known, and the disease is first detected when symptoms appear. Children who are homeless or severely impoverished or who have chronic illness or malnutrition tend to be more susceptible than others because of their overall susceptibility to infection. It also occurs at a higher incidence in internationally adopted children (Long & Boffa, 2007).

When *M. tuberculosis* invades a child’s lung, there is primary inflammation. The child develops a slight cough. As the disease progresses, anorexia, weight loss, night sweats, and a low-grade fever occur.

Leukocytes and lymphocytes invade the lung area to attack the tuberculosis organism and wall off the primary infection. This wall surrounding the bacteria then calcifies and confines the organism permanently. The development of a primary focus this way is the most usual form of tuberculosis in children. If a child is in poor health or does not have adequate calcium intake for the body to control the infection, tuberculosis may spread to other lung areas or to other parts of the body (miliary tuberculosis). Common body sites that may be affected are bones and joints, lymph nodes, kidneys, and the subarachnoid space (tuberculous meningitis).

**Assessment**

All children should have a tuberculin test as part of basic preventive health care at 9 to 12 months of age, and yearly thereafter if they live in an area in which there is a high risk of tuberculosis. The test should not be done immediately after measles immunization or the test can read falsely negative (a child with tuberculosis will be considered free of the disease). Also, the measles vaccine can cause a primary tuberculosis focus to become miliary; it is important, therefore, to have a negative tuberculin result before administering this vaccine.

For a Mantoux test, also called a purified protein derivative (PPD) test, 5 units of protein derivative vaccine is injected intradermally, usually on the left lower arm. A health care professional inspects the area in 72 hours and notes the reaction. A positive reaction (the formation of 5 to 15 mm of reddened induration) indicates the child has been exposed to tuberculosis or has developed antibodies to the foreign products of the tuberculosis organism. Children with positive reactions need follow-up with a chest radiograph to ascertain the importance of the reaction; that is, whether a current infection exists. Skin testing should not be done on children who are known to have had tuberculosis. Such a child will have such an intense reaction that the skin at the site of the test may slough and necrose.

In the early course of tuberculosis, because the initial focus of the tuberculosis is so small, it may not be evident on a chest radiograph. As local inflammation occurs, however, cloudiness in the inflamed area will be noticeable on the film, as will calcification as it occurs.

To confirm a diagnosis of active disease, sputum may be analyzed. Make certain children understand that you want them to expectorate mucus raised from the lungs, not just from the back of the throat. Have a child demonstrate a deep cough to you so you can be sure you are both talking about the same thing. Infants and children younger than 5 years do not raise sputum but swallow it. In young children, therefore, gastric lavage may be necessary to obtain the sputum specimen (because tuberculosis bacteria are acid-fast, they are not destroyed by gastric secretions). Schedule this test early in the morning before the child eats. This prevents vomiting and also allows for the collection of large numbers of organisms because the child has been coughing sputum and swallowing it all night. To collect the specimen, a nasogastric tube is passed either nasally or orally. The stomach contents are then aspirated and placed in a sterile container for laboratory processing. Analysis is generally done for 3 consecutive days because individual specimens may not contain organisms.

Having a large tube passed into the stomach is uncomfortable, and the concept itself is frightening. Offer support during the procedure. Encourage children to express their feelings about the procedure afterward. They may enjoy playing with a plastic catheter and a doll into which a tube can be inserted after the procedure (therapeutic play). It is revealing to see the force and the anger they use to insert the tube into the doll. This helps you to understand how they envision the procedure.
Children who have primary tuberculosis are not infectious because they have a minimal pulmonary lesion and little or no cough. They need not be isolated. As soon as drug therapy has been started, they can return to regular activities, including school.

Before drug therapy was available, a diagnosis of tuberculosis meant a hospital stay of approximately a year. Parents who believe that tuberculosis is still treated this way will need assurance that it is all right for their child to return home and attend regular school as soon as their child begins taking medication.

Therapeutic Management

Several medications are effective against tuberculosis. Isoniazid (INH) is the drug of choice. INH may produce peripheral neurologic symptoms if pyridoxine (vitamin B6) is not administered concurrently. Rifampin is a secondary drug often used in combination with INH. Para-aminosalicylic acid (PAS) is bacteriostatic to M. tuberculosis and for a long time served as the mainstay of therapy. However, PAS administration may lead to such gastrointestinal disturbances in children that it is not used as much as in the past. If it is prescribed, it should be administered after meals, never on an empty stomach.

Ethambutol is used with older children. It must be used with caution with infants because one side effect is optic neuritis; the inability to do adequate eye examinations in children under school age to discover this side effect can make ethambutol unsafe for long-term use.

In addition to drug therapy, children should ingest a diet high in protein, calcium, and pyridoxine, especially if INH is being used as they help supply nutrients necessary to wall off organisms in lung tissue.

Because tuberculosis therapy can last up to 18 months, a major concern during treatment is that the tuberculosis organism will become resistant to commonly used drugs. Children should have periodic chest radiographs for the rest of their life to make certain their disease does not become active again later in life. A woman who had tuberculosis as a child should tell her primary care provider about this when she becomes pregnant; lung changes that occur in pregnancy as a result of the pressure of the growing uterus against the lungs can break down calcifications and reactivate tuberculosis. Children who develop another chronic disease that interferes with appetite, and therefore with calorie and protein intake, also have a high risk of reactivation of calcium-containing tuberculosis.

Because children will be taking medicine for a long time, they need periodic health care visits to evaluate the extent of drug adherence. Assess that they receive regular childhood immunizations so they do not contract a second disease until they have fully recovered from tuberculosis. It is most important to prevent pertussis (whooping cough) because the paroxysmal cough caused by this illness could easily reactivate tuberculosis lesions.

The Bacille Calmette-Guérin (BCG) vaccine is available against tuberculosis, but it is not used routinely in the United States. A skin test will be strongly positive after effective BCG vaccination. For this reason, most people advocate placing children on prophylactic INH when there is known tuberculosis in the home rather than vaccinating them against tuberculosis. With this method, as long as a repeat PPD test remains negative, you know that they are disease-free. After BCG vaccine is administered, the value of skin testing would be lost.

Cystic Fibrosis

Children with cystic fibrosis (CF) have a generalized dysfunction of the exocrine glands (Gardner, 2007). Mucus secretions of the body, particularly in the pancreas and the lungs, are so tenacious that they have difficulty flowing through gland ducts. There is also a marked electrolyte change in the secretions of the sweat glands (chloride concentration of sweat is two to five times above normal). The cause of the disorder is an abnormality of the long arm of chromosome 7. This results in the inability to transport small molecules across cell membranes; this leads to dehydration of epithelial cells in the airways and pancreas and dried secretions.

The disorder is inherited as an autosomal recessive trait. It occurs in approximately 1 in 2,500 live births. It occurs most commonly in Caucasian children and rarely in black or Asian children. Although the disease can be fatal in early life, as many as 50% of children now live to be more than 30 years of age. With the availability of lung transplants, full life expectancy is possible. Because the gene that causes the disorder can be isolated, choriornion vill sampling or amniocentesis can be done early in pregnancy to detect fetuses who have the disease. All newborns can be screened at birth by a simple heel puncture blood sample for the disorder (Merelle et al., 2009). In the future, it is expected that gene therapy will be available to reverse the effect of the involved gene.

Boys with CF may not be able to reproduce because they have persistent plugging and blocking of the vas deferens from tenacious seminal fluid. Girls may have such thick cervical secretions that sperm penetration is limited. Artificial insemination or in vitro fertilization can be accomplished if they desire to become pregnant.

Pancreas Involvement

The acinar cells of the pancreas normally produce lipase, trypsin, and amylase, enzymes that flow into the duodenum to digest fat, protein, and carbohydrate. With CF, these enzyme secretions become so thickened that they plug the ducts; eventually, there is such back-pressure on the acinar cells that they become atrophied and then are no longer capable of producing the enzymes. The islets of Langerhans and insulin production are little influenced by this process until late in the disease because they have endocrine (ductless) activity.

Without pancreatic enzymes in the duodenum, children cannot digest fat, protein, and some sugars. The child’s stools become large, bulky, and greasy (steatorrhea). The intestinal flora increases because of the undigested food; this, when combined with the fat in the stool, gives the stool an extremely foul odor, often compared to that of a cat’s stool. The bulk of feces in the intestine leads to a protuberant abdomen. Because children are benefiting from only about 50% of the food they ingest, they show signs of malnutrition—emaciated extremities and loose, flabby folds of skin on their buttocks. The fat-soluble vitamins, particularly A, D, and E, cannot be absorbed because fat is not absorbed, so children develop symptoms of low levels of...
these vitamins. These four symptoms—malnutrition, pro- 
tuberant abdomen, steatorrhea, and fat-soluble vitamin 
 deficiencies—are the same four symptoms that are part of 
 celiac disease (malabsorption syndrome), so they are re- 
 ferred to as a celiac syndrome (see Chapter 45).

Meconium in a newborn is normally thick and tenacious. 
 In approximately 10% of children with CF, it may be so 
 thick, because pancreatic enzymes are lacking, that it ob- 
 structs the intestine (meconium ileus). The newborn de- 
 velops abdominal distention with no passage of stool. 
 Meconium ileus should be suspected in any infant who does 
 not pass a stool by 24 hours of life (Juwahaer et al., 2007).

Rectal prolapse from straining to evacuate hard stool is an- 
 other common finding in infants with CF.

Lung Involvement

Thickened mucus pools in bronchioles. Pockets of infection 
 then begin in these secretions. The organisms most fre- 
 quently cultured are Staphylococcus aureus, Pseudomonas 
 aeruginosa, and H. influenzae. Secondary emphysema (over- 
 inflated alveoli) occurs because air cannot be pushed past the 
 thick mucus on expiration, when all bronchi are narrower 
 than they are on inspiration. Bronchiectasis and pneumonia 
 occur. Respiratory acidosis may develop because obstruction 
 interferes with the ability to exhale carbon dioxide. 
 Atelectasis occurs as a result of absorption of air from alveoli 
 behind blocked bronchioles. The child’s fingers become 
 clubbed because of the inadequate peripheral tissue perfu-
 sion. The anterior-posterior diameter of the chest becomes 
 enlarged.

Sweat Gland Involvement

Although the sweat glands themselves do not appear to be 
 changed in structure, the electrolyte composition of perspi-
 ration is changed. The level of chloride to sodium is increased 
 two to five times above normal. Some parents report they 
 knew their newborn had the disease before they had labora-
 tory tests done because when they kissed their child, they 
 could taste such strong salt in the perspiration.

Assessment. If CF is not diagnosed by a screening blood 
 sample at birth, it can be diagnosed by documenting the 
 chromosomal abnormality, or by the history and the combi-
 nation of the abnormal concentration of chloride in sweat, 
 the absence of pancreatic enzymes in the duodenum, the 
 presence of immunoreactive trypsinogen in the blood, 
 and pulmonary involvement.

CF may be suspected in a newborn when a newborn loses 
 the normal amount of weight at birth (5% to 10% of birth 
 weight), but then, because the infant cannot make use of 
 the fat in milk, does not gain it back at the usual time of 7 to 
 10 days and perhaps not until 4 to 6 weeks of age. Nurses 
 often weigh newborn babies and infants at well child health 
 visits so may be the first to detect this lack of weight gain. 
 Nurses may also be the first health care provider to suspect 
 CF because meconium is so tenacious an infant is unable to 
 pass stool (meconium ileus). Chromosome analysis or analy-
 sis of serum immunoreactive trypsin (IRT) in the stool, 
 which is elevated because obstruction in the pancreas occurs 
 as early as during fetal life, confirms the diagnosis.

Children who are not diagnosed at birth may be seen in a 
 health care setting at about 1 month of age because of a feed-
 ing problem. Using only about 50% of their intake because 
 of their poor digestive function, they are always hungry. This 
 causes them to eat so ravenously they tend to swallow air. 
 This leads to colic or abdominal distention and vomiting. 
The appearance of typical CF stools (large and greasy) is an 
 important finding because children with simple colic do not 
 show these changes in stool consistency.

Respiratory infections develop at 4 to 6 months of age. 
 Even at this early stage of the disease, wheezing and rhonchi 
 may be heard on chest auscultation.

By the time a child with CF is a preschooler, a cough is a 
 prominent finding. On percussion, the chest is hyperresonant, 
 reflecting the emphysema present. Rales and rhonchi are 
 heard. Clubbing of the fingers may already be apparent. It is 
 rare for a child to go undiagnosed beyond this time because the 
 symptoms of the illness have become so persistent and evident.

Sweat Testing. Sweat testing is a time-honored method 
 for detecting the abnormal concentrations in sweat in chil-
 dren with CF. Sweat is collected by placing a filter paper on 
 the skin and analyzed for sodium chloride content. With 
 chromosomal determination available, sweat tests are no 
 longer necessary, but parents may ask about the procedure if 
 they hear about it from friends. A normal concentration of 
 chloride in sweat is 20 mEq/L. A level of more than 
 60 mEq/L chloride in children is diagnostic of CF.

Duodenal Analysis. Analysis of duodenal secretions for 
 detection of pancreatic enzymes reveals the extent of the pan-
 creatic involvement. This is done by passing a nasogastric 
 tube into the duodenum and then aspirating secretions for 
 analysis. This test may take a considerable amount of time 
 because the tube is allowed to pass through the pylorus and 
 into the duodenum by natural peristaltic action. You can tell 
 that a tube has passed from the stomach into the duodenum 
 by aspirating secretions from the tube and testing them for 
 pH. Stomach secretions are acid (pH less than 7.0); duode-
 nal secretions are alkaline (pH more than 7.0). The initial in-
 sertion of the tube typically is frightening to children because 
 they may choke and gag as it passes the pharynx. Children, 
 however, are generally surprised that once the initial inser-
 tion is done, the tube is not uncomfortable. They need a 
 great deal of support during the procedure, however, because 
 it is so unusual for them and initially so uncomfortable. 
 Duodenal analysis may also be done by endoscopy; for this, 
 children usually receive conscious sedation (Lee et al., 2008).

The secretions removed from the duodenum are sent to 
 the laboratory for analysis of trypsin content, the easiest pan-
 creatic enzyme to assay. Keep the secretions cold during 
 transport. They should be analyzed immediately for accurate 
 results.

Stool Analysis. Stool may be collected and analyzed for fat 
 content and lack of trypsin, although description of the large 
 greasy appearance may be all that is necessary.

Pulmonary Testing. A chest radiograph generally con-
 firms the extent of the pulmonary involvement (pockets of 
 emphysema and perhaps beginning pneumonia infiltration 
 are present). Pulmonary function tests may be done to deter-
 mine if atelectasis and emphysema are present.

Therapeutic Management. Therapy for children with CF 
 consists of measures to reduce the involvement of the pan-
 creas, lungs, and sweat glands. Because so many organs are 
 involved, care works best if it is a collaborative process 
 (Rideout, 2007).
**Nursing Diagnoses and Related Interventions**

**Nursing Diagnosis:** Imbalanced nutrition, less than body requirements, related to inability to digest fat.

**Outcome Evaluation:** Child’s height and weight follow percentile growth curves; quantity of stool decreases; signs and symptoms of vitamin deficiency are absent.

Children with CF are placed on a high-calorie, high-protein, moderate-fat diet. Water-miscible forms of vitamins A, D, and E are supplemented. Medium-chain triglycerides are used with the diet because these are more readily digested than other oils. During the hot months of the year, extra salt may be added to food to replace that lost through perspiration.

Generally, infants with CF cannot be totally breast-fed because there is not enough protein in breast milk for them (they need large amounts because they cannot make use of all the protein they ingest). Breast-feeding with supplementary formula is required. Some of these children, unfortunately, are initially diagnosed as having a milk allergy and are treated by being placed on a soybean formula. This does not contain enough protein either, and their malnutrition increases greatly while they are taking this formula. A high-protein, moderate-fat diet. Water-miscible forms of vitamins A, D, and E are supplemented. Medium-chain triglycerides are used with the diet because these are more readily digested than other oils. During the hot months of the year, extra salt may be added to food to replace that lost through perspiration.

During the hot months of the year, extra salt may be added to food to replace that lost through perspiration.

**Possible adverse effects:** Nausea, abdominal cramps, diarrhea, hypersensitivity.

**Nursing Implications**
- Administer the drug before or with meals and snacks. Instruct parents and child to do the same.
- Caution child and parents to avoid inhaling powder or spilling it on the hands, because it may irritate the skin or mucous membranes.
- Do not crush or let the child chew the enteric form of the drug.
- Instruct the child and parents about possible adverse effects and encourage them to contact their health care provider should any become severe.

**BOX 40.14 ● Focus on Pharmacology**

**Pancrelipase (Cotazym)**

**Classification:** Pancrelipase is an enzyme replacement.

**Action:** Used to aid digestion in children with cystic fibrosis (Karch, 2009).

**Pregnancy risk category:** C

**Dosage:**
- Children 6 months to 1 year of age: 2000 U orally per meal
- Children 1 to 6 years of age: 4000 to 8000 U orally with each meal and 4000 U with snacks
- Children 6 years to 12 years of age: 4000 to 12,000 U orally with each meal and with snacks

**Possible adverse effects:** Nausea, abdominal cramps, diarrhea, hypersensitivity.

**Nursing Implications**
- Be certain to observe children with CF frequently because their condition can change rapidly. If a portion of a lung becomes obstructed from a plug of mucus, a child can quickly experience respiratory difficulty. The right side of the heart tends to enlarge in children with chronic respiratory disease because the congestion in the lungs increases pressure in the pulmonary artery and the right ventricle. After a period of stress or exercise, children may begin to show signs of cardiac failure because their already enlarged heart cannot compensate any further.

**Humidified Oxygen.** Oxygen is supplied to children by mask, prongs, ventilators, or nebulizers. Mist can be supplied by an ultrasonic compressor and delivered through a nebulizer mask, which makes the
who are not, because the incidence of rectal prolapse decreases with better nutrition.

Nursing Diagnosis: Risk for compromised family coping related to chronic illness in a child

Outcome Evaluation: Family members state they have adequate resources to cope with current circumstances.

The parents of children with CF are asked to assume a great deal of responsibility for care of their child. Begin discharge planning when a child is first admitted to a hospital in terms of what changes need to be made to accommodate the child at home and to familiarize parents with the necessary care measures. For example, many children with this disorder sleep with oxygen by cannula at night when they are at home. Parents need to be taught the functions of oxygen and how to regulate the flow. This type of learning is most effective if a little is taught every day (for example, “Could you turn the oxygen on for me, Mrs. Smith? I’m ready to tuck Brian in to sleep” rather than a sit-down, let-me-tell-you-how-oxygen-works lecture given close to the day of discharge). Teach parents how to do chest physiotherapy the same way.

The family will have to think through how the care of this child will affect their home life. They are going to be spending a great deal of time caring for the child, so they will need to balance work, care of the child, and care of the rest of the family. Many parents become fatigued after the first week of having the child at home; they may believe that if they fall soundly asleep at night, they may not hear their child call to them if in distress. As they grow more confident in their ability to evaluate their child’s condition before bedtime, their apprehension will lessen, but real confidence may not come for months, even years. This may always be a problem for some parents.

Be sure that parents have the telephone number of the health care provider they should call if they feel overwhelmed. Encourage parents to join a support group, so that there are other people available who understand and to whom they can voice their concerns. At these times, one of the most important needs they have is to verbalize to someone what it feels like to be the parent of a child with CF, including feelings of guilt they may be experiencing because the disease is inherited.

Adequate Rest and Comfort. Any child who has compromised lung function has a degree of dyspnea that leads to exhaustion. To counteract this, provide periods of rest during the day, but do not group too many activities or procedures together all at once, as this could exhaust a child. Plan a rest period before meals so that a child is not too tired to eat. Also plan for a long rest period before chest physiotherapy so that a child will be able to tolerate it better. Achieving a balance between allowing periods of rest and yet not doing all procedures at once is not an easy task.

Growth and Development. Children need to be exposed to as many normal life experiences as possible. This may be difficult because it is important not to tire the child out or expose the child to crowds of peo-
Acute nasopharyngitis (common cold) is the most common infectious disease in children. There is no specific therapy for a common cold other than comfort measures.

Infants with respiratory illness need extremely close observation so they can describe oxygen deprivation. Young children do not comprehend the fact that oxygen supports combustion. Observe them more frequently than adults to be certain that no flames, such as birthday candles, are brought within 10 feet of an oxygen source.

Respiratory tract disorders tend to occur more frequently in children than adults, because the lumens of children’s bronchi are narrow and obstruction and infection can occur more easily.

Children should attend regular school if at all possible so they are provided with socialization experiences with other children. If this is not possible, a home tutor can be arranged for them. Urge children to participate to the extent they can in physical fitness activities in school or with friends. Use a reminder sheet as necessary so they can remember to take pancreatic enzymes with them if they are going to be eating lunch in the school cafeteria or outside the home.

Continuing Care. Ensure that children with CF receive periodic health assessments and routine childhood immunizations. It is not unusual for children with a chronic disease to fall behind in routine checkups and immunizations if they are hospitalized at the times these are routinely done. It is particularly important that children with CF receive the pertussis and measles vaccines, because these two infections cause severe respiratory complications. Children also should receive influenza, meningococcal, and pneumococcal vaccines.

As children with CF reach adolescence, they are candidates for lung transplants. Some of these are done as lower lobe transplants from a living donor. People who donate a single lobe in this manner report that they feel little loss of lung capacity afterward. A lung transplant is advantageous for children with CF because the new lung does not possess the defective gene that caused mucus to be so thick. Life span can greatly improve.

Checkpoint Question 40.5

Children with cystic fibrosis take the pancreatic enzyme pancrelipase before each meal. You would prepare this by:

a. Opening the capsule and adding it to warm tea.
b. Adding it to at least 8 ounces of milk to drink.
c. Sprinkling it on a small amount of applesauce.
d. Teaching the child how to swallow large capsules.

CRITICAL THINKING EXERCISES

1. Michael is the 4-year-old you met at the beginning of the chapter. His grandmother brought him to the emergency room because his respirations were rapid and he had a sharp, barking cough. He is diagnosed as having laryngotracheobronchitis (croup). He was crying loudly. What about Michael’s actions would lead you to believe his airway is not yet extremely constricted? Would you encourage him to lie down and rest? What emergency care does Michael need?

2. One of Michael’s observation unit roommates has a permanent tracheostomy tube in place from pulmonary dysplasia as an infant. Her parents are going to enroll her in kindergarten starting next month. What
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precautions would you want to review with her parents to keep this experience safe?
3. When the 4-year-old in the ambulatory bed next to Michael returns from tonsillectomy surgery, what observations would be most important to make? Why is the 7th day after tonsillectomy surgery a particularly important day for close observation?
5. Examine the National Health Goals related to respiratory disorders in children. Most government-sponsored funds for nursing research are allotted based on these goals. What would be a possible research topic to explore pertinent to these goals that would be applicable to Michael’s family and also advance evidence-based practice?

CRITICAL THINKING SCENARIO

Open the accompanying CD-ROM or visit http://thePoint.lww.com and read the Patient Scenario included for this chapter, then answer the questions to further sharpen your skills and grow more familiar with NCLEX style questions related to respiratory disorders in children. Confirm your answers are correct by reading the rationales.

REFERENCES


**SUGGESTED READINGS**


