CHAPTER

16

The Child With Altered Respiratory Status

Do you remember the Diaz family from Chapter 9, in which Jose has trouble taking his asthma medication, and in Chapter 4, in which Jose’s little sister, Lela, expresses her personality even as a newborn? Jose is 4 years old and was diagnosed with asthma this past fall, about 6 months ago. Since that time Claudia, his mother, has noticed several factors that trigger his asthma including getting sick, pollen, and cold air.

One evening following a warm early-spring day, Jose is outside playing as the sun sets and the air cools. When he comes inside he begins to cough. Claudia sets up his nebulizer and gives him a treatment of albuterol, which lessens his coughing. Within an hour, Jose is coughing constantly again and wheezing. After one hard coughing fit, Jose has a hard time catching his breath; he looks pale and ashen, and his wheezing is very pronounced. Claudia tells her husband, Ignacio, that she thinks they should go to the emergency room. They leave Lela, the baby sister, with Claudia’s mother, Selma, and head to the hospital.

At the hospital the emergency department nurse observes Jose sitting cross-legged and leaning forward on his hands. His mouth is open and he is breathing hard with an easily audible inspiratory wheeze. He is using his subclavicular accessory muscles with each breath. His respiratory rate is 32 breaths per minute, his pulse is 112 beats per minutes, and he is afebrile. Claudia explains that he was fine; he was outside running and playing, and then came in and began coughing and wheezing, and she gave him an albuterol treatment. The nurse places a pulse oximeter probe on his finger, which takes a few minutes to establish reliability but settles down, vacillating between 89% to 90%. After reporting her assessment and receiving orders, the nurse adjusts the oxygen flow to 30% and places a simple oxygen face mask on Jose.
CHAPTER OBJECTIVES

1. Describe the developmental and biologic variances in children’s respiratory systems that predispose them to respiratory problems.
2. Describe the common alterations in health patterns within the respiratory system in children in terms of etiology, pathophysiology, clinical manifestations, and interdisciplinary interventions.
3. Describe the nursing assessment of the child with compromised respiratory function.
4. Discuss the nursing care responsibilities associated with diagnosis of respiratory difficulties in children.
5. Select the treatments that are most effective for specific respiratory conditions.
6. Select nursing care interventions to support the child with an acute or chronic respiratory illness.

See the Point for a list of Key Terms.

Respiratory conditions, both acute and chronic, are the leading causes of morbidity in children. Compromises to the respiratory system are the most common types of problem encountered by the nurse caring for infants, children, and youth. Respiratory conditions during childhood can be acute or chronic, life threatening, and can present as either the primary clinical problem or a secondary complication (also called a comorbid condition). Respiratory infectious conditions, such as influenza, are widely recognized as major causes of respiratory mortality and morbidity for young healthy children.

Growth and maturation of the respiratory system during childhood is characterized by changes in its physiologic and anatomic features. The physiologic processes of respiratory control and gas exchange in children, although immature, are determined by respiratory mechanisms similar to those of adults. However, anatomic structural variations in the respiratory tracts of infants and young children from those of adults result in substantial differences in the manifestations of respiratory disturbances. A key aspect of providing respiratory care in pediatric patients is recognizing these similarities and differences. Note these variations when identifying normal versus abnormal symptoms.

Assessment of the respiratory system is critical in pediatric care. Key functions of the nurse in the acute or ambulatory healthcare settings involve identifying changes in respiratory status and quickly instituting corrective measures if needed. In respiratory care, developing and refining assessment skills is essential to providing age-appropriate care for children. Therefore, the skilled nurse must have an excellent working knowledge and a keen understanding of the clinical importance of these unique anatomic and physiologic features of children’s respiratory systems. Because respiratory system infections are relatively common in children and are a leading etiology in respiratory morbidity, understanding how infections can affect the respiratory system is important.

Knowledge of both acute and chronic respiratory conditions helps the nurse provide appropriate care throughout the child’s life span.

DEVELOPMENTAL AND BIOLOGIC VARIANCES

The child’s respiratory system differs in many ways from that of the mature adult. The child is physically smaller and functionally immature; thus, the pediatric respiratory system has much less reserve capacity. Children are more vulnerable to respiratory illnesses and complications than adults. Infants and children develop respiratory distress (impaired respiratory function) and respiratory failure (respiratory impairment in which the arterial oxygen tension falls below 60 mm Hg, carbon dioxide tension rises to more than 50 mm Hg, and the arterial pH drops to less than 7.35) much more readily. Unique differences in the size, structure, and function of the respiratory system in children are shown in Figure 16–1.

This section summarizes variances in major structures and provides suggestions regarding ways to modify assessment skills and intervention techniques to provide optimal care to the child with altered respiratory status.

Central Nervous System Control

Respiratory rate and depth are controlled by central and peripheral chemoreceptors located in the circulatory system. Although these receptors are present at birth, fewer exist in the infant and young child than in the mature adult. Term infants and young children respond to hypoxemia (inadequate oxygen in the blood) and hypercarbia (excessive carbon dioxide in the blood) as an adult does, by increasing the rate and depth of respiration to normalize blood gas concentrations of oxygen and carbon dioxide. The premature infant, however, may respond to low blood oxygen levels initially with an increased rate of respiration, followed by a slowing respiratory rate, apnea, or both. Conditions such as bronchopulmonary dysplasia (BPD), pneumonia, and bronchiolitis put premature infants at especially high risk for developing hypoxia and apnea, so nursing care must focus on careful monitoring of blood gases.

Airways

The pediatric airway is much smaller in diameter and shorter in length than the adult airway. During childhood, the airways continue to grow in both diameter and length. For example, in newborns the trachea is 4 cm long, and in 18-month-old infants it is 7 cm long. In adults, it is 12 cm long. Airway inflammation or a small amount of mucus can produce a critical decrease
in the airway diameter and increases the resistance to airflow dramatically, leading to substantial respiratory distress or even failure (Fig. 16–2). The pediatric tongue is larger in proportion to other structures than the adult tongue, and therefore causes airway obstruction more readily.

The pediatric larynx is funnel shaped because of a narrowing at the cricoid cartilage, with the narrowest portion at the level of the cricoid ring (Fig. 16–3).

The cartilage surrounding the entire larynx is quite soft and can be compressed easily, subsequently causing airway occlusion when the neck is flexed or hyperextended. Maintaining an optimal neck position (sometimes called the sniffing position) by placing a towel under the occipital area of the head is an important nursing consideration for the pediatric patient. The right mainstem bronchus, a common location for aspirated foreign bodies, arises from the trachea at a wide angle in children (versus the much sharper angle of the left mainstem bronchus).

Chest Wall and Respiratory Muscles

The cartilaginous chest wall is twice as compliant and flexible as the bony chest wall of the adult. Thus, with respiratory difficulty, children may display chest retractions, a visible clinical phenomenon in which the bones...
and cartilage structures of the chest become more prominent with inspirations (see Fig. 8–8). Chest retractions increase the work of breathing and reduce the efficiency of ventilation.

The shape of the chest and the angle of rib articulation relative to the sternum and vertebrae are other anatomic variations of the chest wall that adversely affect the mechanical efficiency of breathing in the infant and young child. Until the child reaches 7 or 8 years of age, the ribs are horizontal in orientation, in contrast to the 45-degree angle present in the older child and adult. This orientation accounts for the barrel-shaped appearance of the chest in the infant and young child. Because of this horizontal orientation of the ribs, the intercostal muscles do not have the leverage necessary to lift the ribs and aid in chest expansion during respiration. Young infants and children with diagnoses such as pneumonia must be assessed carefully and frequently for the development of respiratory fatigue and subsequent respiratory failure as a result of these variations.

The muscles important for efficient and effective respirations include the diaphragm, the intercostal muscles, and the muscles supporting the head and the upper and lower airways. These muscles are relatively underdeveloped in pediatric patients. They lack the tone, strength, and coordination necessary to prevent and effectively manage episodes of respiratory distress.

The diaphragm, which is the main muscle of respiration in patients of all ages, is located higher in the thorax in infants and young children and is inserted horizontally, versus obliquely, as in adults. Any condition that impedes diaphragmatic movement, such as abdominal distention caused by accumulation of air or fluid, can substantially compromise respiratory status. In addition, the intercostal muscles are underdeveloped and function only to stabilize, rather than actually lift, the chest wall. Because of these important variations in the respiratory muscles, children with neuromuscular weakness or paralysis secondary to disorders such as muscular dystrophy or Werdnig-Hoffmann syndrome may exhibit respiratory compromise or distress as one of the first presenting symptoms of their disease.

**Lung Tissue**

The ability of lung tissue to inflate and deflate gradually increases throughout childhood, as the tissue grows and matures. Many factors affect lung tissue in individuals of all age groups. For example, the presence or absence of surfactant (a material secreted by the alveoli), and the number and character of elastic fibers in the lung tissue can affect the ability of the lung tissue to expand and deflate. Infants born prematurely lack surfactant, which develops relatively late during intruterine development and contributes to the stability of the alveolar surfaces. Without surfactant, the lung tissue’s ability to inflate and deflate is greatly decreased, and lack of surfactant leads to severe respiratory distress and even death.

Children also have less elastic tissue in the alveoli than adults. This variation tends to cause the alveoli to lose patency, leading to higher incidences of pulmonary edema, pneumomediastinum, and pneumothorax. Minimal elastic recoil properties cause a higher incidence of atelectasis (partial or complete pulmonary collapse) in pediatric patients than in adults. In addition, poorly developed pathways of collateral ventilation can lead to rapid small airway obstruction and significant respiratory distress. Because of all these variations, neonates are especially susceptible to the development of pulmonary edema.

**ANSWER:** As Jose gets older, larger, and stronger, his symptoms may decline. He may continue to have some reactive airway disease, but his larger airways, stronger musculature, and more mature lung tissue will result in less dramatic symptoms.

**ASSESSMENT OF THE CHILD WITH ALTERED RESPIRATORY STATUS**

Collecting the health history and performing the physical assessment of the child with a respiratory system disturbance is the first step in the nursing process. During the history, the child and family have an opportunity to tell their story about the illness and what prompted them to seek care from the healthcare team. Make the assessment a more positive experience by allaying the child’s fears and discomfort, and establishing a relationship of trust and communication with the child and parents.

**Focused Health History**

**QUESTION:** Review Focused Health History 16–1. Analyze the information in the case study and identify the information regarding the Diaz family that is missing. Integrate the information you have about the Diaz family. What are some unique characteristics of the Diaz family that you will incorporate into your collection of a health history?

When taking a history, begin with the reason for the visit or hospitalization. When possible, use the child’s or parents’ own words to document all descriptions of the child’s symptoms (Focused Health History 16–1). When taking a history of a respiratory system problem, follow general history-taking guidelines (see Chapter 8), but also include questions about the environment—things that make the symptoms worse (sometimes called triggers)—and potential comorbid conditions or symptoms. As with general history taking, remember that clear and detailed information about the current illness as well as other factors (environment, family, and so forth) helps you to formulate an initial plan of care and directs further questioning to confirm or refute any hypothesis regarding diagnosis.
### FOCUSED HEALTH HISTORY 16–1

#### The Child With Altered Respiratory Status*

<table>
<thead>
<tr>
<th>Current history</th>
<th>Chest pain with breathing</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Shortness of breath relative to activity level</td>
</tr>
<tr>
<td></td>
<td>Difficulty eating</td>
</tr>
<tr>
<td></td>
<td>Cough (duration, onset, intermittent or continuous, paroxysmal, worse at night, production of sputum)</td>
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<tr>
<td></td>
<td>Nasal congestion</td>
</tr>
<tr>
<td></td>
<td>Runny nose (color of mucus)</td>
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<tr>
<td></td>
<td>Sore throat</td>
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<tr>
<td></td>
<td>Airway noise (barking cough, dry cough, stridor, or wheeze)</td>
</tr>
<tr>
<td></td>
<td>Easy fatigability</td>
</tr>
<tr>
<td></td>
<td>Other persons in the household who are ill</td>
</tr>
<tr>
<td></td>
<td>Allergies (animals, plants, other allergens or irritants, foods, medicines)</td>
</tr>
</tbody>
</table>

**Current Medications**
- Medications (including over-the-counter medications) or complementary and alternative medical practices and home remedies related to current treatment of any current or chronic respiratory problems
- Medications (including any of those listed earlier) unrelated to current or chronic respiratory problems

<table>
<thead>
<tr>
<th>Past medical history</th>
<th>Prenatal/Neonatal History</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Apgar score, spontaneous breathing at birth</td>
</tr>
<tr>
<td></td>
<td>Meconium-stained amniotic fluid</td>
</tr>
<tr>
<td></td>
<td>Prematurity</td>
</tr>
<tr>
<td></td>
<td>Required mechanical ventilation</td>
</tr>
<tr>
<td></td>
<td>Premature</td>
</tr>
<tr>
<td></td>
<td>Maternal smoking history; marijuana, heroin, cocaine use</td>
</tr>
</tbody>
</table>

**Previous Health Challenges**
- History of respiratory illness such as strep throat, tonsillitis
- Number of colds per year including “typical course”; coughing, wheezing, or other noisy breathing associated with colds
- History of otitis media
- History of tuberculosis
- History of previous respiratory diseases (asthma), frequency of colds
- History of known allergies or asthma

**Immunizations**
- Status of current immunizations (including influenza)
- Date of past tuberculosis test and results

**Nutritional assessment**
- **Weight loss**
  - Failure to gain weight between office visits
  - Decrease in physical activity
  - Decrease in appetite
  - Changes in bowel patterns and appearance of feces

**Family medical history**
- Family history of allergies, asthma, tuberculosis, pertussis, cystic fibrosis
- Focus on sibling history of respiratory illness

**Social history**
- Cultural (any customs that may affect treatment)
- Number of persons living in the household and whom child’s primary caregiver

**Environmental history**
- Home environment (age and type of dwelling, condition of home [water damage may indicate mold exposure], sources of heating/cooling)
- Types of household products used (e.g., chemicals, pesticides, cleaning supplies, paint fumes, hobby supplies)
- Environmental exposures such as plant allergens, animal allergens (pets, rodents, insects), powders, aerosols, household irritants

(Continued)
The child’s past medical history, including birth history, previous health problems, childhood illnesses, immunizations (routine and yearly, including yearly flu vaccines), and allergies, helps put the current illness into perspective. For example, a child presenting with paroxysmal coughing episodes may cause the nurse to consider foreign body aspiration (FBA), croup, bronchitis, or pneumonia, depending on the presence of other accompanying symptoms. However, if the child was never immunized against pertussis, has not been screened recently for tuberculosis, or has recently visited or lived in another country, additional possibilities for the symptoms must be considered. Focus on birth weight, gestational age, and any complications involved with the child’s birth. Lungs develop in utero; therefore, premature infants, whose lungs do not have time to develop fully, may have respiratory complications throughout the life span.

Ensure that family medical history includes any inherited (e.g., genetically linked), chronic, or infectious respiratory conditions. Also include a careful environmental assessment, taking into account where the child usually resides (home) and other places in the child’s daily environment (e.g., school, child care setting, and relatives’ home). Using the environmental history, you can examine relationships between known exposures and symptoms, provide anticipatory guidance to prevent further exposure, empower parents to seek information about environmental issues, and give parents the knowledge and skills to advocate for their children’s health and well-being.

**Answer:** The case study does not include information regarding Jose’s birth history, his immunization history, and nutritional assessment; as well as family, social, and environmental history. His medications are covered in more depth in the Chapter 9 case study. The Diaz family is Mexican American and, although both parents are bilingual, there may be aspects of the health history that the couple struggle to explain adequately in English and could relay with more accuracy and detail in Spanish. Be attuned to the potential need for a medical translator. It is also appropriate to ask if any cultural remedies have been used with Jose.

**Focused Physical Assessment**

**Question:** Which techniques has the nurse used to assess Jose? What additional information do you anticipate the nurse will identify as the physical assessment is completed?

Use the techniques of observation, inspection, auscultation, palpation, and percussion when performing a physical assessment of the respiratory system in infants, children, and youth. Focused Physical Assessment 16–1 summarizes possible physical assessment findings and highlights abnormalities and their implications.

Note the shape, size, and symmetry of the thoracic cavity. Notice the type and quality of breathing, and the depth and regularity of respirations. In the child younger than 7 years, respirations are diaphragmatic, and the abdomen rises with inspiration; later, the breathing becomes thoracic. Note respiratory effort and appearance of retractions, nasal flaring, and use of accessory muscles. Breathing should be quiet and unlabored, at a respiratory rate normal for age (see Appendix D), with an inspiratory phase.
# Focused Physical Assessment 16–1

## The Child With Altered Respiratory Status

<table>
<thead>
<tr>
<th>Assessment Parameter</th>
<th>Alterations/Clinical Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>General appearance</td>
<td>Fretting, lethargy, agitation, distress, or weakness is common with hypoxia. Presence of tachypnea, dyspnea, or orthopnea indicates respiratory compromise. Underweight, linear growth below average, frequently is the result of growth retardation with chronic respiratory conditions (e.g., cystic fibrosis). Unusual positioning: Position of comfort with head elevated may indicate hypoxia; refusal to lie flat because of respiratory compromise in that position. Fever may indicate bacterial or viral illness.</td>
</tr>
<tr>
<td>Integumentary system (skin, hair, nails)</td>
<td>Observe color at rest. Cyanosis indicates inadequate oxygenation. Mottling of the chest may indicate severe hypoxemia. Mottling and cyanosis may also be related to vasoconstriction or polycythemia. Digital clubbing (tissue proliferation on terminal phalanges) indicates chronic hypoxemia (commonly seen in children with cystic fibrosis).</td>
</tr>
<tr>
<td>Head and neck</td>
<td>Tenderness, swollen glands indicate infection. Nasal flaring (bilateral widening on respiration) is associated with the child's attempt to improve oxygenation. Tenderness upon palpation of sinuses indicates sinusitis. Exudate on the tonsillar surface, hypertrophy of tonsils, or substantial erythema is seen in tonsillitis. Erythema in back of throat is seen with sore throat.</td>
</tr>
<tr>
<td>Face, nose, and oral cavity</td>
<td></td>
</tr>
<tr>
<td>Thorax and lungs</td>
<td>Observe the shape, size, and symmetry of the thoracic cavity. Palpate chest for chest expansion, tenderness, pulsations, and masses. A round chest in an older child usually indicates chronic lung disease. Observe breathing pattern, rate, and exertion. Abdominal breathing in an older child may indicate a respiratory disorder or a fractured rib. Prolonged expiratory phase may indicate an obstructive respiratory disorder, such as asthma. Prolonged inspiratory phase may indicate an upper airway obstruction, such as croup. Retractions are associated with both obstructive and restrictive lung diseases. Absent or diminished breath sounds are associated with obstruction or pneumothorax. Adventitious breath sounds, including rales, rhonchi, and wheezes, are associated with fluid, secretions, obstruction or narrowing of the airway, pulmonary edema, inflammation, exudate, tumors, and foreign bodies.</td>
</tr>
<tr>
<td>Cardiovascular system</td>
<td>Tachycardia is noted in respiratory distress. Capillary refill longer than 3 seconds may indicate cardiovascular compromise.</td>
</tr>
<tr>
<td>Abdomen</td>
<td>Distended abdomen may occur if child is breathing rapidly and swallowing air.</td>
</tr>
<tr>
<td>Musculoskeletal system</td>
<td>Pectus excavatum or pectus carinatum (asymmetric deformities of the chest) may compromise lung expansion.</td>
</tr>
<tr>
<td>Neurologic system (behavior and development, reflexes, motor and sensory)</td>
<td>Decreased sensorium may indicate hypoxia. When the child assumes the “tripod” position, refuses to lie down, prefers to sit upright, and leans forward indicate epiglottitis or acute asthma attack.</td>
</tr>
</tbody>
</table>
slightly longer than or equal to the expiratory phase. Count the respiratory rate for a full minute, ideally when the child is asleep or quiet. **Tachypnea** (rapid breathing or panting) may be observed in the presence of fever, anxiety, or stress. Prolonged tachypnea may be an indicator of respiratory distress.

The color of the face, trunk, nail beds (and the shape of the nail beds) also can provide clues to respiratory status. Skin and mucous membranes should be pink. Nail beds should be pale or pink, and the nails should be flat, with the angle between the nail and the nail base at approximately 160 degrees.

While observing respiratory status, assess also for speech patterns (shortness of breath can be seen in quick, short sentences) and activity level.

During auscultation, assess the quality and intensity of the breath sounds as well as noting the area of the chest where they are heard (see Table 8–6). **Vesicular** breath sounds are low-pitched, soft sounds (heard more during inspiration than during expiration) audible throughout lung field. **Bronchovesicular** breath sounds are moderately pitched, harsh sounds (inspiration = expiration) heard over the manubrium. **Bronchotubular** breath sounds are high-pitched, hollow sounds (inspiratory sounds greater than expiratory sounds) heard over the trachea. Adventitious (abnormal) breath sounds that can be auscultated include wheezes, crackles (rales), and rhonchi (Focused Physical Assessment 16–2).

Listen for audible abnormalities including stridor and grunting. Stridor is a harsh, grating, whistling sound heard on inspiration and is produced by turbulent airflow through laryngeal or tracheal obstruction. It is usually more pronounced when the child is crying or agitated. Grunting is a noise the infant may make as he or she attempts to provide a self-induced positive end-expiratory pressure. By grunting, the infant closes the glottis and applies positive pressure to the airway to increase the resting volume of the lung.

Palpate the chest to assess for chest expansion, tenderness, pulsations, and masses in the thoracic region. **Subcutaneous emphysema** (crepitus) is a manifestation of

### FOCUSED PHYSICAL ASSESSMENT 16–2

**Adventitious Breath Sounds**

<table>
<thead>
<tr>
<th>Sound</th>
<th>Description</th>
<th>Pathology and Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crackles</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fine</td>
<td>Intermittent, high-pitched, soft popping sounds. Heard late in inspiration. Sound similar to hair rolling between fingers. Not cleared by coughing.</td>
<td>Fluid in alveoli (pneumonia)</td>
</tr>
<tr>
<td>Medium</td>
<td>Intermittent and medium-pitched sounds that are loud and coarse sounding. Heard early or during mid inspiration.</td>
<td>Fluid in bronchioles and bronchi (pulmonary edema)</td>
</tr>
<tr>
<td>Coarse</td>
<td>Loud, bubbling, low-pitched sounds. Heard on expiration. Cleared by coughing.</td>
<td>Fluid in bronchioles and bronchi that is resolving (bronchitis)</td>
</tr>
<tr>
<td>Friction rub</td>
<td>Superficial, coarse, low-pitched, grating sound. Sounds similar to two pieces of leather rubbing together. Heard on inspiration and expiration.</td>
<td>Pleural inflammation from loss of normal lubricating fluid (pleuritis)</td>
</tr>
<tr>
<td>Rhonchus</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sonorous</td>
<td>Continuous, snoring, low-pitched, moaning, vibrating sound that clears with coughing. Heard throughout respiratory cycle.</td>
<td>Air flow obstruction (mucus) in large bronchi and trachea (bronchitis, upper respiratory tract infection)</td>
</tr>
<tr>
<td>Wheezes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sibilant</td>
<td>Continuous, high-pitched, musical, hissing sound. Heard predominantly during mid to late expiration.</td>
<td>Air flow through narrowed passageway because of inflammation, collapse, secretions, or tumors (asthma)</td>
</tr>
<tr>
<td>Audible without stethoscope: inspiratory</td>
<td>Sonorous, musical sounds are heard on inspiration.</td>
<td>High obstruction (croup)</td>
</tr>
<tr>
<td>Audible without stethoscope: expiratory</td>
<td>Whistling, sighing sounds are heard on expiration.</td>
<td>Low obstruction (bronchial foreign body)</td>
</tr>
</tbody>
</table>
free air that has leaked from the respiratory system into the subcutaneous tissue, most commonly resulting from a pneumomediastinum or pneumothorax. It can usually be palpated over the neck, shoulders, and upper chest. Assess and palpate for symmetry of chest wall excursions, especially in a child in whom trauma is suspected. Trauma to the rib cage can result in fractures and a “flail chest” (nonsymmetric movement of the chest) with decreased movement of the affected side. The position of the trachea may deviate from the normal midline in the presence of atelectasis and with pneumothorax, so palpating this structure is important.

Use percussion to identify areas of consolidation or other internal changes within the lung. Percuss with a gentle motion to achieve sufficient tones, keeping in mind that the pediatric patient’s thinner chest wall will produce a more resonant tone. A normal percussion finding includes dullness over the heart and resonance over the lung fields. If a consolidation such as pneumonia is present, the resonance over the lungs will change to a dull sound.

**ANSWER:** The nurse has used inspection but not auscultation. Did you anticipate that Jose’s breath sounds may be difficult to assess because of the loud inspiratory stridor? The nurse does not hear air moving well in the lower lobes, but is not certain if the sound is masked by the stridor or if Jose is truly not moving air well.

**Diagnostic Criteria**

**QUESTION:** Of the four groups of diagnostic tests identified in the following pages, three are typically used to evaluate a child’s condition with asthma. One is already in use: the pulse oximeter. Which diagnostic test will most fully reflect the respiratory status of the child?

Four major groups of diagnostic tests and procedures used in the evaluation of the respiratory system and respiratory disorders in children include (1) measurement of lung volumes and flow rates (pulmonary function tests and peak flow measurement), (2) direct or indirect blood and body fluid analysis (arterial blood gases, fluid cultures, sweat chloride test), (3) imaging techniques (radiographs, fluoroscopy, bronchography, computed tomographic scan, scintigraphy, magnetic resonance imaging), and (4) direct visualization of the respiratory tree (laryngoscopy, bronchoscopy). These diagnostic tests, used alone or in combination with others, may yield information necessary in the diagnosis and treatment of acute and chronic lung disease. Tests and Procedures 16–1 describes the purpose, findings, and indications of individual diagnostic tests, as well as the specific responsibilities and considerations for the healthcare provider.

Measurement of arterial blood gases is considered one of the most useful diagnostic tests when a child presents with respiratory distress, impending cardiopulmonary failure, or both. Therefore, knowing normal arterial blood gas values for children is important for the nurse assessing and evaluating the child (Tests and Procedures 16–2). Pulse oximetry and apnea monitors are examples of noninvasive and portable methods to detect respiratory compromise in the pediatric patient. Pulse oximetry is primarily used in inpatient and outpatient clinical settings by healthcare providers (Fig. 16–4). Apnea monitors are used in both clinical and home settings as both a diagnostic tool to assess for apnea and a system to alert care providers that a child is experiencing an apneic event and intervention may be warranted (see the Point for Procedures: Pulse Oximetry and Apnea Monitoring for supplemental information).

**ANSWER:** Pulse oximetry can read the oxygen saturation of Jose’s hemoglobin, but it cannot detect an increase in carbon dioxide or pH changes. An arterial blood gas measurement, although invasive, relays information that cannot be obtained readily through a noninvasive alternative.

**TREATMENT MODALITIES**

Respiratory illnesses in children, both acute and chronic conditions, require aggressive and immediate intervention. Respiratory failure is one of the leading causes of cardiopulmonary arrest in children (American Heart Association, 2005). A thorough assessment of the child’s status, followed by quick actions that support oxygenation and ventilation, can serve to avert an impending arrest situation. In the case of acute respiratory problems, children generally respond well and promptly to the simple administration of oxygen and medications. For children with a chronic respiratory condition, oxygen, medications, airway clearance techniques (ACTs), and nutritional support can assist them through exacerbations of the illness and provide them with the strength to maintain a high level of wellness despite their chronic conditions. Some conditions may require use of artificial airways, mechanical ventilation, or tracheostomy.

**Administration of Oxygen**

**QUESTION:** Examine the various modes that oxygen can be delivered in Nursing Interventions 16–2. Why was a simple mask used to deliver oxygen to Jose instead of nasal cannula?
### Tests and Procedures 16–1 Evaluating Respiratory Status

<table>
<thead>
<tr>
<th>Diagnostic Test or Procedure</th>
<th>Purpose</th>
<th>Findings and Indications</th>
<th>Healthcare Provider Responsibilities</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pulmonary function tests</strong></td>
<td>Measures airway function, lung volumes, and gas exchange.</td>
<td>Abnormalities of particular measurements may occur in different diseases. Restrictive diseases cause decreased VC and TLC. Obstructive diseases may cause an increase in TLC and RV, decreased VC, and decrease in FEV₁ and forced expiratory flow between 25% and 75% VC (FEF₂₅%–₇₅%).</td>
<td>Most results are effort dependent. Emphasize the need for maximum cooperation during the test to achieve valid results. Some tests require that the child’s nose be clamped. Child should not have eaten immediately prior to examination: coughing required during the test sometimes stimulates vomiting. Test may be performed before and after bronchodilator therapy.</td>
</tr>
<tr>
<td>(spirometry, gas dilution, and body plethysmography)</td>
<td>Used to determine the presence, nature, and extent of pulmonary disease. Does not indicate the cause of the dysfunction.</td>
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</tr>
<tr>
<td><strong>Bronchoprovocation tests</strong></td>
<td>Used as an attempt to provoke mild bronchospasm in patients in a controlled setting. Substances such as histamine and methacholine are introduced to determine whether the child’s airways constrict.</td>
<td>Positive test is diagnostic for airway hyperresponsiveness (a characteristic feature of asthma) and can determine severity of asthma. Negative test may help rule out asthma.</td>
<td>The morning of the test the child should not take any asthma medications and should avoid caffeinated beverages, chocolate, extremely hot or cold environments and exercise. The child should be free of any respiratory illnesses at time of tests. At the end of the test, a bronchodilator may be given to reverse any constriction of the airways. Test must be performed by a trained individual.</td>
</tr>
<tr>
<td><strong>Peak flow measurement</strong></td>
<td>Used to measure the greatest flow velocity during a forced expiration. Child exhales forcefully and quickly into the meter while taking maximal deep inhalation (TLC).</td>
<td>Peak flow rate decreases as airway obstruction increases. Values should be compared with the individual child’s baseline or “personal best” vs. average predicted normal values.</td>
<td>Child must be developmentally able to follow instructions (generally older than 4 years of age). May not be appropriate if child is in severe respiratory distress. Accurate peak flow measurement is effort dependent.</td>
</tr>
<tr>
<td><strong>Arterial blood gases</strong></td>
<td>Used to measure and analyze PaO₂, PaCO₂ retention, and alterations in the pH.</td>
<td>The PaCO₂ measurements indicates adequacy of ventilation. PaO₂ is used to detect altered gas exchange, pH indicates whether hypoxia or hyperventilation is chronic or acute.</td>
<td>Air should not be allowed to enter the syringe with the sample; doing so can alter the findings. Firm pressure should be applied to the puncture site for 5 minutes after draw to prevent hematoma or bleeding. Most reliable when obtained from an indwelling arterial catheter. Arterial puncture is painful and may be associated with altered findings if child has been crying or screaming for a prolonged period.</td>
</tr>
<tr>
<td>Diagnostic Test or Procedure</td>
<td>Purpose</td>
<td>Findings and Indications</td>
<td>Healthcare Provider Responsibilities</td>
</tr>
<tr>
<td>--------------------------------------</td>
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<td>-----------------------------------------------------------------------------------------</td>
<td>---------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Pulse oximetry</td>
<td>Monitors oxygen saturation (SaO₂). Can also detect and provide a digital display of the pulse rate.</td>
<td>SaO₂ can be used to estimate PaO₂ using the oxyhemoglobin dissociation curve. Used to evaluate respiratory function and check for hypoxemia. Healthy children have a saturation of 98% to 100%.</td>
<td>Information enables continuous monitoring and evaluation of SaO₂ (see the Point for Procedures: Pulse Oximetry).</td>
</tr>
<tr>
<td>Apnea monitor</td>
<td>Used to detect pauses of breathing lasting 5 to 20 seconds.</td>
<td>May indicate child has apnea of prematurity, apnea of infancy, or an apparent life-threatening event.</td>
<td>Unless otherwise ordered, the apnea monitor should be used continuously, except during bathing or at times when the infant is involved in interactive activities with the caregiver (see the Point for Procedures: Apnea Monitors).</td>
</tr>
<tr>
<td>Sputum culture/tracheal aspiration</td>
<td>Used to detect presence of and identify bacterial, viral, fungal, or other respiratory pathogens.</td>
<td>Presence of pathogens usually indicates infection. Observe sputum for color, consistency, and odor. Thick yellow or green sputum indicates infection. Infection with <em>Pseudomonas aeruginosa</em> causes the sputum to have a distinct “sweet” odor.</td>
<td>Specimen should be collected within 3 to 7 days after onset of signs and symptoms and before antimicrobial therapy is initiated, unless the culture is being completed to examine the effectiveness of therapy. The specimen should be placed in a sterile container for culture or a tube with appropriate medium. Specimen must be from bronchial tree, not just saliva from mouth. Specimens should not be frozen and should be transported as soon as possible.</td>
</tr>
<tr>
<td>Throat culture (throat swab)</td>
<td>Used to determine viral or bacterial cause in pharyngitis. Reliable method to differentiate infection with group A beta-hemolytic <em>Streptococcus pyogenes</em> from infection with viral organisms.</td>
<td>Positive throat culture for <em>S. pyogenes</em> indicates “strep throat.”</td>
<td>Specimens should be obtained from the posterior pharynx and each tonsillar area. Any white patch or inflamed area should be cultured. Results take 24 to 48 hours to obtain. Special test kits are available for strep throat that can yield results in 7 minutes.</td>
</tr>
<tr>
<td>Nasal and nasopharyngeal culture or washing</td>
<td>Preferred method used to detect bacterial, viral, and other respiratory pathogens, because large number of ciliated epithelial cells are essential for optimal recovery of the pathogens.</td>
<td>Able to detect <em>Bordetella pertussis</em>, <em>Candida albicans</em>, <em>Cornebacterium diphtheriae</em>, <em>Neisseria meningitidis</em>, <em>Haemophilus influenzae</em>, and others. Coagulase-positive staphylococcus may be present in 50% of people who have nasopharyngeal cultures done.</td>
<td>For a culture, the flexible swab should be inserted into the nose and rotated against the anterior hairs for a good specimen. For a washing, normal saline should be instilled into the nostril and then immediately suctioned with a catheter into a specimen container.</td>
</tr>
</tbody>
</table>

(Continued)
<table>
<thead>
<tr>
<th>Diagnostic Test or Procedure</th>
<th>Purpose</th>
<th>Findings and Indications</th>
<th>Healthcare Provider Responsibilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sweat chloride test</td>
<td>Used in diagnosis of cystic fibrosis. Measures amount of sodium and chloride content in the sweat.</td>
<td>Sweat chloride of &gt;60 mEq/L indicates positive test for cystic fibrosis. Levels of 40 to 60 mEq/L are highly likely to be positive.</td>
<td>Test takes about an hour for enough sweat to be collected. A positive reading requires the sweat test to be performed at an approved cystic fibrosis center.</td>
</tr>
<tr>
<td>Lung biopsy and/or thoracentesis</td>
<td>A needle is inserted through an intercostal space into lung tissue to obtain a lung aspirate specimen for histology and culture.</td>
<td>Purulent fluid indicates infection (empyema). Presence of lymphocytes with chyle indicates chylothorax. Presence of lymphocytes may indicate malignancy, and bloody fluid may indicate hemothorax.</td>
<td>Bleeding and pneumothorax are potential complications.</td>
</tr>
<tr>
<td>Chest radiograph</td>
<td>The best initial imaging technique to detect abnormalities of the pulmonary, mediastinal, and musculoskeletal structures of the thorax.</td>
<td>Air or fluid in the pleural space indicates a pleural effusion or pneumothorax. Hyperinflation often implies air trapping seen in bronchiolitis or asthma. Atelectasis, infiltrates, or both may indicate pneumonia.</td>
<td>Determine whether adolescent female patients may be pregnant. Anteroposterior view more appropriate for children younger than 2 years.</td>
</tr>
<tr>
<td>Fluoroscopy</td>
<td>Related to chest radiographs, but image is continuous on a television monitor and enables continuous observation of chest movements during inspiration and expiration.</td>
<td>Useful in assessing diaphragmatic movement. Can detect air trapping and presence of pulsation in intrathoracic masses.</td>
<td>Child should be immobilized. Determine whether adolescent female patients may be pregnant. Lead shields are used to protect radiosensitive areas, such as gonads and thyroid gland.</td>
</tr>
<tr>
<td>Bronchography</td>
<td>Uses a contrast medium instilled directly into the tracheobronchial tree to visualize the bronchi for narrowing, obstruction, dilation, or malformation of the bronchial tree.</td>
<td>Provides information about the most peripheral bronchioles. Chronic distal bronchial obstruction and dilation indicate bronchiectasis.</td>
<td>Signed consent required. Child must be NPO 6 to 12 hours before test and after test until gag reflex returns. Important to check whether child has any loose teeth prior to test. Usually performed with child under general anesthesia.</td>
</tr>
<tr>
<td>Computed tomographic scan</td>
<td>A sequence of radiographs that show a cross-sectional view of the thorax. Used to detect masses or locate lesions.</td>
<td>Presence of mediastinal mass may indicate tumor; hilar adenopathy may indicate infection with tuberculosis.</td>
<td>Sedation or immobilization of child usually required. NPO 3 to 4 hours prior to examination because IV contrast media may be used to further visualize cardiac chambers and vessels.</td>
</tr>
<tr>
<td>Radionuclide scintigraphy, lung scan (V/Q scan)</td>
<td>A nuclear medicine scan performed to detect alterations or defects in perfusion (Q), inequalities in ventilation (V), or both.</td>
<td>Scintigraphy is able to detect noninfectious inflammatory diseases, presence of pulmonary emboli, pulmonary complications of HIV infection, and tumors.</td>
<td>Signed consent required for injection of radionuclides intravenously. Young or uncooperative child may be sedated and thus should be NPO 4 hours before procedure. If sedation is not used, it is not necessary to keep child NPO.</td>
</tr>
</tbody>
</table>
enhance elimination of carbon dioxide, or to accelerate removal of nitrogen from air-containing spaces such as a pneumothorax.

Oxygen can be delivered by mask (Fig. 16–5), nasal cannula, oxygen hood, oxygen tent, or mechanical ventilation (see Procedures: Oxygen Administration for supplemental information). The mode of oxygen delivery used is based on the concentration or percentage of oxygen desired and on the child’s ability to cooperate with therapy. To ensure patient safety, measure and monitor the concentration of inspired oxygen carefully and document response during oxygen therapy. Oxygen therapy in children should use the least amount of oxygen required to normalize PaO₂ (more than 60–80 mm Hg) and arterial hemoglobin saturation (SaO₂) (more than 93%). When oxygen is administered through an artificial airway such as an endotracheal tube or a tracheostomy tube, the gas must be artificially heated and humidified.

### CareReminder

To decrease the risk of mucociliary dysfunction, injury to the respiratory epithelium, and thickening of secretions, children receiving oxygen therapy through an artificial airway for more than 1 to 2 hours should receive warmed, humidified oxygen.

The use of oxygen therapy in the home is becoming more prevalent. Teaching Intervention Plan (TIP) 16–1 describes care of the child receiving home oxygen therapy and the educational needs of the family.

### Medications

Medications are an important component of treating respiratory disorders in children. Routes of administration are oral, inhaled, intravenous, and injectable (subcutaneous or intramuscular). Inhaled medications are used most often to increase respiratory tract absorption and to decrease systemic absorption.

### Classes of Medications

The main classes of medications used for respiratory disorders include bronchodilators, corticosteroids, and leukotriene modifiers/mast cell stabilizers. Other groups of medications often used in conjunction with these include, but are not limited to, antibiotics, antivirals, mucolytics and expectorants, decongestants, antihistamines, and diuretics. The pharmaceutical agents used for particular respiratory disorders are addressed in the appropriate sections. Principles of inhalation therapy and aerosolized medications are addressed here.
Aerosol Therapy

**Question:** Jose uses a nebulizer at home. Evaluate the other methods of aerosol therapy. What supportive rationale can you offer for why this method of medication delivery is an appropriate choice for Jose?

Bronchodilators, corticosteroids, and mast cell stabilizer medications are delivered by inhalers or nebulizers. However, bronchodilators and corticosteroids are also available in oral and intravenous forms. Administering medications by inhalation is effective, because the medication reaches the small airways and works directly on the lungs. Medications are nebulized or aerosolized by using compressed air or oxygen. A variety of machines (compressors) are

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**Tests and Procedures 16–2 Pediatric Arterial Blood Gases**

<table>
<thead>
<tr>
<th>Normal Values</th>
<th>pH</th>
<th>PaCO₂ (mm Hg)</th>
<th>PaO₂ (mm Hg)</th>
<th>HCO₃⁻ (mEq/L)</th>
<th>Causes of Imbalance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preterm infant</td>
<td>7.11–7.36</td>
<td>27–40</td>
<td>55–85</td>
<td>21–28</td>
<td></td>
</tr>
<tr>
<td>Term infant</td>
<td>7.35–7.45</td>
<td>27–41</td>
<td>54–95</td>
<td>21–28</td>
<td></td>
</tr>
<tr>
<td>Child</td>
<td>7.35–7.45</td>
<td>35–45</td>
<td>80–100</td>
<td>21–28</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Abnormal Values</th>
<th>pH</th>
<th>PaCO₂ (mm Hg)</th>
<th>PaO₂ (mm Hg)</th>
<th>HCO₃⁻ (mEq/L)</th>
<th>Causes of Imbalance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Respiratory acidosis (acute alveolar hypoventilation)</td>
<td>&lt;7.30</td>
<td>&gt;50</td>
<td>WNL or &lt;80</td>
<td>WNL</td>
<td>Chronic lung disease (chronic bronchitis, asthma), respiratory depression from drugs or anesthesia, pneumonia, respiratory distress</td>
</tr>
<tr>
<td>Respiratory alkalosis (acute alveolar hyperventilation)</td>
<td>&gt;7.50</td>
<td>&lt;30</td>
<td>WNL</td>
<td>WNL</td>
<td>Anxiety, fear, pain, improperly adjusted ventilator (overventilation), salicylate toxicity, fever, hyperventilation, hypoxia, tetany, head trauma, gram-negative sepsis</td>
</tr>
<tr>
<td>Metabolic acidosis</td>
<td>&lt;7.30</td>
<td>WNL</td>
<td>WNL</td>
<td>&lt;21</td>
<td>Severe diarrhea, kidney failure, diabetic ketoacidosis, shock, burns, malnutrition, ingestion of salicylates</td>
</tr>
<tr>
<td>Metabolic alkalosis</td>
<td>&gt;7.50</td>
<td>WNL</td>
<td>WNL</td>
<td>&gt;28</td>
<td>Loss of HCO₃⁻ by intestines, severe vomiting, cystic fibrosis, gastric suctioning, severe diarrhea, renal failure, diuretics</td>
</tr>
<tr>
<td>Respiratory acidosis with compensation (chronic alveolar hypoventilation)</td>
<td>WNL</td>
<td>&gt;50</td>
<td>WNL or &lt;80</td>
<td>WNL</td>
<td>Kidneys try to retain more HCO₃⁻ by increasing retention</td>
</tr>
<tr>
<td>Respiratory alkalosis with compensation (chronic alveolar hyperventilation)</td>
<td>WNL</td>
<td>&lt;30</td>
<td>WNL</td>
<td>WNL</td>
<td>Kidneys try to reduce HCO₃⁻ by increasing excretion</td>
</tr>
<tr>
<td>Metabolic acidosis with compensation</td>
<td>WNL</td>
<td>&lt;30</td>
<td>WNL</td>
<td>WNL</td>
<td>Lungs try to reduce PCO₂ by increasing excretion</td>
</tr>
<tr>
<td>Metabolic alkalosis with compensation</td>
<td>WNL</td>
<td>&gt;50</td>
<td>WNL</td>
<td>WNL</td>
<td>Lungs try to increase PCO₂ slightly by hypoventilation</td>
</tr>
</tbody>
</table>

HCO₃⁻, bicarbonate; PaCO₂, arterial carbon dioxide; PaO₂, arterial oxygen pressure; WNL, within normal limits.
available for use with a handheld nebulizer, often for use in the home. The handheld nebulizer has the advantages of being able to aerosolize almost any drug available in liquid form, allowing modification of dose volume and concentration, and requiring minimal patient coordination. The child or infant usually uses a mask attached to the nebulizer cup, which is held over the nose and mouth. The medication is dispersed as a mist. Older children can use the mouthpiece and should be instructed to take slow, deep breaths through the mouth during the treatment (Fig. 16–6). Nebulizers are effective for most children younger than 5 years of age and older children who have difficulty coordinating a metered dose inhaler (MDI).

Another device for inhalation is the drug–powder inhaler. The drug–powder inhaler, which is similar to the MDI, consists of a suspension of microfine, solid particles of drug contained in a small MDI-sized device with a mouthpiece.

A third type of device for administering inhaled medications is breath-activated inhalers. With these devices, medication is delivered as the patient takes a breath. The child must seal their lips around the device before inhaling and should hold their breath for 10 seconds. Evaluate the child’s ability to perform this technique properly before he or she uses the device on a daily basis.

If the infant or child is receiving aerosol or inhalation therapy, assess response to the treatment. Assess breath sounds and respiratory effort before and after the treatment for effectiveness. For the child receiving bronchodilators (beta-adrenergic agents), assessing the heart rate is also important, because tachycardia is a common side effect of these medications.

Be sure to have the child rinse out the mouth or wash the face after using an inhaled corticosteroid to decrease the chance of systemic absorption and side effects related to the medications.

Jose is 4 years old. The nebulizer is very simple to use and requires no special skills. Simply breathing in and out deeply will allow the medication to work directly on the lung tissue.

The airway clearance process may be dysfunctional, leading to retained secretions, or there may be hypersecretion of mucus in the airways. Accumulation of secretions in the airways leads to partial or total obstruction. Ventilation and gas exchange are altered, producing a favorable environment for infection. For example, children with conditions such as cystic fibrosis (CF), bronchiectasis, or dysfunctional motility of cilia; those receiving mechanical ventilation; and those with acute problems after general anesthesia can benefit from ACTs.
**TIP 16-1 A Teaching Intervention Plan for the Child on Home Oxygen Therapy**

**Nursing diagnoses and outcomes**

**Deficient knowledge**
- Home management with oxygen therapy

**Outcome**
- Parents/caregivers will verbalize the need for oxygen, care of the infant/child while receiving oxygen therapy and safety precautions; parents/caregivers will demonstrate care of the child and use of the oxygen.
- Risk for injury related to use of oxygen in the home and fire hazards

**Outcome**
- Parents/caregivers will verbalize the need for oxygen, care of the infant/child while receiving oxygen therapy and safety precautions; parents/caregivers will demonstrate care of the child and use of the oxygen.
- Risk for injury related to use of oxygen in the home and fire hazards

**Teach the Child/Family**

**Physiology and Need for Oxygen**
- Discuss with parents/caregivers how oxygen enters the body and how it is used by the body. Explain the need/rationale for oxygen for their child.

**Use of Oxygen**
- Explain and demonstrate how to place/change the nasal cannula under the nose and over the ears, with the portion with the holes positioned under the nose, and how to attach the cannula to the flowmeter on the tank.
- Show parents/caregivers how to open the oxygen device and how to regulate the flow (depends on device being used in the home).

**Physical Care**
- Provide appropriate skin care on the face. Use hypoallergenic tape or skin protectant on the areas where the cannula is secured on the face.
- Provide humidity with oxygen if flow is more than 1 L/minute, or instill normal saline drops to nares, as needed; oxygen can be drying to the nares.
- Provide nasopharyngeal suctioning to nares with bulb syringe as needed to keep nares patent and to allow adequate flow of oxygen to child.
- Do not use petroleum-based creams or ointments or oil-based products on the child (they are combustible).

**Health Maintenance**
- Describe and have parents/caregivers identify “normal” color and respiratory status for their infant/child.
- Teach parents/caregivers how to detect changes in color (blueness of lips/nail beds, pale, or dusky) and respiratory status (retractions, nasal flaring, accessory muscle use, and increased respiratory rate). Instruct caregivers on need to notify physician if these changes are present.
- Stress importance of regular follow-up visits with healthcare provider.

**Home safety and modifications**
- Ensure that family has the following available in the home:
  - Notification sticker (OXYGEN IN HOME) for fire department (place on front window where easily visible)
  - Fire extinguisher and label for area where kept
  - Smoke detector
  - Battery-operated flashlight on hand in child’s room in event of power failure
  - List of emergency numbers posted by all phones
- Do not allow smoking in the home. Post NO SMOKING signs. Do not burn incense, candles, or fires in the home. Keep the oxygen tank more than 5 feet away from the heater or any other heat sources.
- Reduce static electricity of clothes by using fabric softener.
- Keep oxygen source upright and secured in holder at all times.
- If traveling, keep portable oxygen source in upright position and secure at all times. Keep window open slightly in car to allow ventilation. Avoid places that allow smoking.

**Contact the Healthcare Provider if:**
- Child experiences respiratory distress
Suctioning the trachea and nasopharyngeal airway is a method to enhance airway clearance by removing secretions that cannot be removed by the child’s spontaneous cough. Suctioning may also be used to obtain secretions for diagnostic purposes (see Procedures: Nasotracheal Suctioning for supplemental information).

Traditionally, chest physiotherapy (also called postural drainage and percussion) has been the primary intervention for pulmonary conditions with hypersecretion or retained bronchial secretions. However, more therapy options for airway clearance exist now than were available in the recent past. Ongoing research to match the most effective therapy with the individual will improve quality of life in this rapidly expanding area. Nursing Interventions 16–1 summarizes information on these techniques as well as traditional ACTs. Advantages and disadvantages of the new techniques are also addressed, along with age indicators.

Determining the appropriateness of these newer interventions for a particular patient requires assessing the severity and type of lung disease, physical ability to perform the technique, effectiveness of the particular technique, and age. Other psychosocial factors to be considered are motivation to learn, adherence to treatment, cost, and payer or reimbursement. These techniques should be performed 30 minutes before mealtimes, as a safety measure to avoid vomiting and aspiration, and to promote comfort (Fig. 16–8).

**Artificial Airways and Mechanical Ventilation**

Noninvasive measures such as oxygen therapy and ACTs may sometimes not meet the needs of all children who require oxygenation and ventilation. When respiratory effort is increased but inadequate to maintain gas exchange because of airway obstruction, intrapulmonary pathophysiology, neuromuscular disease, or other factors, artificial or mechanical ventilation may become necessary.

Several methods are available to provide artificial ventilation. A bag-and-mask unit, or Ambu bag, is used to manually ventilate a child who has not been intubated (had an endotracheal tube placed). Effective bag-and-mask ventilation is best provided with a self-inflating bag and a mask that fits properly over the child’s nose and mouth.

To provide an open airway, extend the infant’s or child’s neck slightly in the sniffing position and lift the jaw (Fig. 16–9). The jaw thrust maneuver is used in the pediatric trauma victim with possible spinal injury or in infants for whom overextending the neck can occlude the airway. Place the mask, held in your nondominant hand, over the nose and mouth to create a seal. With your dominant hand, compress the bag rhythmically and in synchrony (or slightly faster) with the child’s spontaneous respiratory efforts, if present, compressing the bag only enough to make the chest rise and fall. Aggressive ventilating will lead to gastric distention. Ensure that the bag is connected to an oxygen source, with oxygen delivered at a flow rate of 10 to 15 L/minute.

When prolonged artificial ventilation is needed because of respiratory failure or anesthesia, or when the airway is obstructed, intubation—placement of an artificial airway—is necessary, and mechanical ventilation is provided. Endotracheal intubation is the insertion of an artificial airway (an endotracheal tube) through either the nose (nasotracheal) or the mouth (orotracheal) into the trachea (Fig. 16–10). Another less invasive device for mechanical ventilation (used most commonly in the operating room) is the laryngeal mask airway.

Mechanical ventilation replaces the work of breathing and involves inflating the lungs with compressed gas, applied by either positive or negative pressure. Positive-pressure ventilators are more commonly used than negative-pressure machines. They work by creating pressure at the airway opening that is greater than the intra-alveolar pressure, thus forcing pressurized gas into the lungs. This flow of compressed gas improves gas exchange and inflation of poorly ventilated portions of the lungs. Negative-pressure machines are more cumbersome and are primarily used for long-term ventilation in persons with respiratory failure caused by neuromuscular diseases. The machine works by creating intermittent negative pressure around the thorax, causing the chest to be drawn outward and inspiration to occur. Negative-pressure
### Airway Clearance Techniques (ACTs)

<table>
<thead>
<tr>
<th>Airway Clearance Technique and Description</th>
<th>Benefits/Advantages</th>
<th>Disadvantages/Problems</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Postural drainage and percussion:</strong> Mobilizes secretions by using dependent positioning, gravity, and percussion</td>
<td>Gold standard&lt;br&gt;Localize therapy to involved segment&lt;br&gt;Can be assisted with mechanical percussor&lt;br&gt;Used for all ages, especially infants, toddlers, and preschool children who may be unable to cooperate with the controlled breathing techniques</td>
<td>Time-consuming&lt;br&gt;Usually needs another person to do all lobes&lt;br&gt;Difficult to apply in some settings&lt;br&gt;Difficult to tolerate with oxygen dependency, gastroesophageal reflux, and implanted venous access devices&lt;br&gt;Head-down position contraindicated for infants because of the risk for increased gastroesophageal reflux&lt;br&gt;Monitor oxygen saturation levels, particularly with the Trendelenburg position, which may be poorly tolerated by children with respiratory compromise&lt;br&gt;Does not foster independence&lt;br&gt;Adherence problems&lt;br&gt;Carpal tunnel syndrome reported by some caregivers</td>
</tr>
<tr>
<td><strong>Autogenic drainage (self-drainage):</strong> Controlled method of breathing using three different lung volumes</td>
<td>Effective&lt;br&gt;Needs no external devices&lt;br&gt;Enables independence</td>
<td>Labor- and time-intensive to teach and learn&lt;br&gt;Must be able to take directions&lt;br&gt;Child must be older than 12 years</td>
</tr>
<tr>
<td><strong>Active cycle of breathing technique:</strong> Breathing technique that combines three methods: thoracic expansion exercises, breathing control, and forced expiratory techniques in a set cycle</td>
<td>Enables independence&lt;br&gt;Absence of desaturation or compromise during therapy&lt;br&gt;No costly equipment</td>
<td>Not useful for infants and young children</td>
</tr>
<tr>
<td><strong>Positive expiratory pressure:</strong> Child breathes out 10 to 20 times through a flow resister, creating positive pressure in airway to about 15 to 20 cm H₂O during exhalation, followed by two to three “huff” coughs&lt;br&gt;Cycle repeated up to 20 minutes</td>
<td>Enables independence&lt;br&gt;Not reported to cause compromise with desaturation&lt;br&gt;Can be done by children older than 3 years</td>
<td>Potential complication of pneumothorax</td>
</tr>
<tr>
<td><strong>High-frequency chest compression:</strong> High-frequency oscillation to chest wall delivered by a vest</td>
<td>Enables older children to be independent&lt;br&gt;Possible future application for younger children</td>
<td>Trial time needed to determine effectiveness before rental or purchase&lt;br&gt;Patients may not tolerate the feeling from the compression&lt;br&gt;Equipment must be rented or purchased&lt;br&gt;Requires storage space&lt;br&gt;Requires concentration&lt;br&gt;May be uncomfortable if child has venous access device that is being used during the respiratory treatment</td>
</tr>
</tbody>
</table>
machines do not require an artificial airway. Another mode of providing mechanical ventilation is called high-frequency ventilation. This machine works by delivering oxygen under high pressures at a rapidly cycling rate. Closely monitor the respiratory and cardiovascular status of the child receiving mechanical ventilation. Many children are sedated while intubated and all will have a nasogastric tube in place to decompress the stomach (see Tradition or Science 16–1). Perform suctioning based on the presence of adventitious breath sounds, increased respiratory effort or distress, or both. Chest physiotherapy may be ordered to further promote removal of secretions. Provide oral care and ensure the intubation tube is not causing skin irritation around the mouth or nares. Ensure the ventilator alarms are on and set within acceptable parameters to provide early notification of distress. Assist the family and, as appropriate, the child to understand

<table>
<thead>
<tr>
<th>Airway Clearance Technique and Description</th>
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</thead>
<tbody>
<tr>
<td><strong>Exercise:</strong> Any activity that requires physical exertion, endurance, and upper body strengthening</td>
<td>May not cost anything May apply in many situations Socially acceptable May also improve cardiovascular fitness, self-esteem, and general health</td>
<td>May cost for membership to clubs or gyms; depends on climate Limited to physical ability Children with preexisting conditions such as asthma (with exercise component) may need to observe special precautions when exercising (e.g., premedicate) Requires purchase of the device</td>
</tr>
<tr>
<td><strong>Flutter valve:</strong> Small pipelike device with a metal ball rotating freely within pipe Patients inhale and actively exhale through the pipe, which generates positive pressure to about 15 to 25 cm H₂O. Oscillations are transmitted to airways. Done for 5 to 15 breaths, followed by two to three huffs through flutter until lungs are clear, or for 20 minutes.</td>
<td>Enables independence Requires cooperation</td>
<td>Requires purchase of the device</td>
</tr>
</tbody>
</table>

**Figure 16–8.** Postural drainage and percussion is used to assist with expulsion of mucus from the airway.

**Figure 16–9.** Child being ventilated using the bag-and-mask technique.
the rationale for the use of mechanical ventilation. As appropriate, provide medications to help the child remain calm and quiet while being ventilated, which will ensure optimal respiratory outcomes.

**Tracheostomy**

A tracheostomy consists of the surgical placement of an artificial airway directly into the trachea below the larynx. Many conditions that can cause upper airway obstruction, respiratory failure, or prolonged intubation in children may have to be managed by placing a tracheostomy tube. Emergencies such as epiglottis or foreign body aspiration (FBA) may require a tracheostomy for more short-term management. In some clinical conditions such as laryngotracheomalacia, subglottic stenosis, or vocal cord paralysis, the tracheostomy may be long term, until the condition is outgrown or corrected. Moreover, with some cases, such as in chronic respiratory failure with long-term mechanical ventilation, the tracheostomy may be permanent.

Tracheostomy tubes are made of Silastic, silicone, or metal and are available in various sizes and lengths. The appropriate size is determined by patient age and size. Single-cannula tracheostomy tubes are most commonly used in pediatric patients, because they have a smaller inner diameter and are usually made of Silastic, which conforms better than other materials to the shape of the trachea. For older children, a tracheostomy tube with an inner cannula may be used. The inner cannula is removed for cleaning, while the outer cannula is left in place. Additionally, some tracheostomy tubes have external cuffs. Most pediatric tubes do not have an external cuff because of the child’s small airway diameter and the increased risk of trauma to the airway caused by the cuff. Because cuffless single-cannula tracheostomy tubes are used in most children, explanation of the nursing care focuses on these.

While the child is hospitalized, nursing care involves preparing child and family preoperatively, providing skilled nursing care and observation postoperatively, and facilitating a successful discharge plan for home management if the tracheostomy will be long term. Preoperatively, explain to the child and parents why the tracheostomy tube is needed, what the basic anatomy and physiology of the airway are, how breathing will be different, what to expect postoperatively, and how the child will look when he or she returns from surgery. If possible, allow the family to see a tracheostomy tube and supplies to help decrease anxiety about what to expect.

Focus postoperative nursing care on close observation to maintain a patent airway and to monitor for possible complications such as hemorrhage, edema, subcutaneous emphysema, pneumothorax, and accidental decannulation. Because infants and children are at greater risk for tracheostomy obstruction related to the relatively smaller airway, they should be initially managed in an intensive care or close observation unit postoperatively.

Respiratory assessments include vital signs and examination of the child’s color, respiratory rate and effort, breath sounds, and type and amount of secretions. For the first 5 to 6 days, until the tracheocutaneous tract is well formed, long sutures (stay sutures) attached to the trachea are taped to the chest. The sutures can be used to

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**Tradition or Science 16–1**

Does infant position affect outcomes of newborn infants receiving mechanical ventilation?

In patients of different ages undergoing mechanical ventilation, research has indicated that particular positions, such as the prone position, may improve respiratory parameters. Clinical trials assessing the position of neonates receiving mechanical ventilation have not substantiated that any particular body position during mechanical ventilation produces sustained and relevant improvements in oxygenation. The prone position has been found to slightly improve oxygenation in neonates receiving mechanical ventilation; however, more research is needed to determine the various risks and benefits associated with different laying positions for this population of ventilated patients (Baloguer, Escribano, & Roque, 2003).

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**Alert!** All children with a tracheostomy should have an extra tracheostomy tube of the same size available at the bedside in case the tube in place is dislodged or becomes obstructed and cannot be cleared.

Respiratory assessments include vital signs and examination of the child’s color, respiratory rate and effort, breath sounds, and type and amount of secretions. For the first 5 to 6 days, until the tracheocutaneous tract is well formed, long sutures (stay sutures) attached to the trachea are taped to the chest. The sutures can be used to
keep the stoma open in the event of an accidental decanulation. The surgeon removes the sutures when the tract in the trachea is formed.

The airway must remain patent to prevent obstruction and possible complications. The child may require frequent suctioning for several hours immediately after the procedure, because excessive and sometimes bloody secretions are common. Provide suctioning on an as-needed basis thereafter to prevent occlusion of the tracheostomy tube by secretions and mucous plugs. To prevent complications of suctioning, such as hypoxemia, hypotension, bradycardia (vasovagal responses), laryngospasm, bronchospasm, atelectasis, and trauma to the airway, gauge the suction pressure (should be 80–100 mm Hg), limit the time for suctioning (no longer than 4–5 seconds) and the number of suction passes, monitor the depth of the suction catheter (\( \frac{1}{4} \text{–} \frac{1}{2} \) inch [0.635 to 1.27 cm] beyond the tip of the length of the airway), and provide manual ventilation with oxygen, rest time between suction passes, or both.

**cAREminder**

Do not instill saline prior to suctioning. Studies do not demonstrate the efficacy of normal saline in thinning mucous secretions. Studies have shown that instilling saline before suctioning has an adverse effect on oxygen saturation, which may last up to 5 minutes. Also, instilling saline during suctioning dislodges bacteria into the lower airway.

The functions of warming, filtering, and humidifying inspired air that the upper respiratory tract normally performs are bypassed in a child with a tracheostomy. Therefore, the inspired air must be humidified and warmed to maintain loose secretions, prevent occlusion of the tube by secretions, and prevent drying of the tracheal mucosa. Nursing care is directed toward maintaining appropriate humidification via a mist collar. In addition, promoting adequate fluid intake to keep the child well hydrated is important. To prevent infection and irritation of the skin around the tracheostomy tube, provide stoma care to keep the skin clean and dry. Gently remove the secretions around the stoma, using gauze pads soaked with half-strength hydrogen peroxide followed by gauze pads soaked with sterile water. Keep the tracheostomy ties clean and dry, and change them daily and as needed when soiled.

The schedule of tracheostomy tube changes varies depending on the institution or physician preference. The first tube change usually is done by the surgeon about 5 days after the tracheotomy is performed. Subsequent tube changes are generally performed once a week in the child with a well-healed tracheostomy stoma, usually before a feeding or meal to avoid stimulation that could cause emesis.

Because many children go home with tracheostomy tubes, it has become necessary to teach parents or other primary caregivers how to care for the child at home (Fig. 16–11). TIP 16–2 outlines a teaching plan for the child who has had a tracheostomy tube placed. It is also helpful to ensure that visiting nursing is provided after discharge to assist the family with routine care.

**NURSING PLAN OF CARE FOR THE CHILD WITH ALTERED RESPIRATORY STATUS**

**Question:** One nursing diagnosis for Jose is: Ineffective breathing pattern related to respiratory disease process. Based on the information in the case study, what is another important nursing diagnosis?

Health promotion and disease prevention activities are essential for infants, children, and adolescents with acute and chronic respiratory conditions. These activities should focus on promoting a child’s growth and development, and on adequate home management. Preventive care, monitoring and early detection of symptoms, adequate management (home vs. hospital), and health education are critical components of respiratory care for children. For example, sedentary lifestyles and obesity have grown to epidemic proportions in this country. Health promotion and disease prevention activities that focus on developing and encouraging healthy lifestyles can lead to improvements in overall health, as well as specifically enhancing respiratory functioning. Therefore, nursing care in these areas can reduce the risk for complications, exacerbations of respiratory conditions (e.g., asthma attacks), morbidity (e.g., hospitalizations, emergency room visits, school days missed), and development of comorbid conditions related to the child’s preexisting condition. It can also reduce or prevent the recurrence of respiratory illnesses.

Multiple nursing diagnoses may be used to address altered respiratory function and status (Nursing Plan of Care 16–1). For example, ineffective breathing pattern
**A Teaching Intervention Plan for the Child Receiving Home Tracheostomy Care**

**Nursing diagnoses and outcomes**
- Risk for injury related to management of tracheostomy

**Outcome**
- Family will verbalize and identify factors in handling an airway emergency with a tracheostomy.

**Deficient knowledge**
- Home maintenance management of tracheostomy

**Outcome**
- Family will identify and demonstrate all aspects of home care of the child prior to discharge.

**Teach the Child/Family**

**Suctioning**
- Identify need for suctioning, such as sound of mucus in the tracheostomy tube, breathing sounds “rattled,” child is restless or appears anxious, child’s color is pale or dusky, or there is difficulty feeding.
- Wash hands thoroughly before and after each suctioning procedure. Alcohol or disinfectant foam is an acceptable substitute when soap and water are not available. Nonsterile gloves should be worn for the protection of the caregiver who is not a family member or by anyone who is concerned about infection.
- Connect suction catheter to suction tubing and be careful not to touch tip of catheter. Insert the suction catheter to the predetermined depth (depending on tracheostomy tube size) and place thumb over port to apply suction. Pull back catheter while twirling catheter between thumb and index finger.
- Rinse mucus from catheter with sterile saline, and repeat as necessary.
- Clean the catheters.
  - Wash and flush used catheters with hot, soapy water.
  - Disinfect catheters by soaking in vinegar and water solution or commercial disinfectant.
  - Rinse catheters inside and out with clean water and allow to air dry.

**Stoma Care**
- Perform daily site care and observe for signs of infection, skin breakdown, or complications around the tube site and the neck.
- Keep skin and stoma site clean and dry. Gently clean skin and stoma with a clean, wet washcloth. Use half-strength hydrogen peroxide to remove thicker, crusted secretions if necessary.
- Change tracheostomy ties daily and as needed when soiled or wet.

**Daily care and home environment**

**Tracheostomy Tube Change**
- Perform routine tracheostomy tube change once a week or more often as needed or ordered by the physician.
- Gather all supplies, wash hands thoroughly, and prepare child for procedure. Have a second person to assist with positioning of the child. Position child with neck slightly extended; may use a towel roll placed under the shoulders.
- Suction child to minimize secretions. Cut old ties while holding tracheostomy tube in place. Remove old tube from stoma and gently insert new tracheostomy tube with obturator into the stoma using a downward and forward motion following the curve of the trachea.
- Quickly remove the obturator, assess for adequacy of ventilation, and secure the tracheostomy ties.
- Take caution when feeding the infant or child so that food or formula does not get into the tracheostomy. If this should occur, suction the tracheostomy immediately. Never prop a bottle or leave the infant or child unattended while feeding.
- Bathe the child in a tub, being sure to keep the water shallow and not allowing water to get into the tracheostomy tube. Never leave the child unattended in the tub, and do not put the child in a shower. Avoid use of talcum and baby powders on the infant or child.
- Encourage normal play both indoors and outdoors as much as possible. Avoid toys that are fuzzy or have small, removable parts. On cold and windy days outside, cover the tracheostomy with a mask or 100% cotton scarf. Avoid playing in sandboxes or in or around pools, lakes, and oceans; and avoid participating in rough contact sports.
- Avoid buying clothes with high, tight necklines that may cover the tracheostomy opening.
- Do not permit smoking in the child’s home or around the child.
Safety and emergency care

- Change or replace the tracheostomy tube immediately if accidental dislodgment or occlusion of the tube should occur.
- Keep all emergency telephone numbers by the telephone and a copy with the family at all times.
- Have all necessary equipment (e.g., extra tracheostomy tube with ties, suction machine, catheters, Ambu bag) with child when traveling or going on “outings” outside the home.
- Keep flashlight handy in case of power failure, and notify electric and telephone companies that there is a child with special healthcare life-sustaining needs in the home.
- Keep all immunizations up to date.
- Check tension on tracheostomy ties daily. Tracheostomy ties should be tight enough to allow the smallest finger to be slipped underneath. Twist tape tracheostomy ties can stretch after being initially secured, so recheck in 1 to 2 hours for appropriate tightness.

Contact Healthcare Provider if:
- Child develops fever more than 101 °F (38.3 °C)
- Child is having difficulty breathing or the breathing pattern changes
- Child’s lips or nail beds become bluish or dusky
- Child has increase in secretions or change in color, odor, or consistency of the secretions
- Blood (greater than a teaspoon) is leaking from the tracheostomy
- There is difficulty inserting the tube with a routine tracheostomy tube change
- There is a rash, drainage, or unusual odor around the tracheostomy stoma, or food or formula is coming through the tracheostomy tube

ALTERATIONS IN RESPIRATORY STATUS

Respiratory conditions are among the most common maladies affecting children, ranging from those that develop in utero, such as malformations of the palate and trachea, to chronic conditions such as asthma. Respiratory health directly affects children’s stamina and their ability to engage in activities in settings that are conducive to safe air exchange. The nurse plays a primary role in educating children and their families about ways to safeguard their respiratory health. In addition, the nurse plays a critical role in determining if and when a child’s respiratory condition may place other children at risk for infection. Thus, the role of the nurse is both to collaborate in improving the health of children with a respiratory condition and to protect the health of children who may be exposed to contagious respiratory conditions.

CONGENITAL ABNORMALITIES OF THE RESPIRATORY SYSTEM

Congenital abnormalities or malformations of the respiratory systems are fortunately rare. These disorders result in respiratory dysfunction primarily caused by airway obstructions or collapse. Congenital conditions include choanal atresia (a unilateral or bilateral bony or membranous septum between the nose and pharynx), Pierre Robin syndrome (abnormally small jaw with upper airway obstruction [resulting from tongue prolapse into the pharyngeal airway] and cleft palate; Fig. 16–12), laryngomalacia (weakness and poor tone of the larynx), and tracheomalacia (weakness and poor tone of the trachea).

These abnormalities are generally diagnosed at birth or shortly thereafter, when the child exhibits varying degrees of respiratory distress. The presence of cyanosis (bluish skin color caused by inadequate oxygenation of the blood) is a key finding. The treatment is largely supportive; the primary goal of treatment is to maintain a patent airway. Surgical interventions to relieve the obstruction (such as for choanal atresia) or structurally support the airway (such as for severe tracheomalacia) may be necessary. Adequate nutritional support to promote
Nursing Plan of Care 16–1: Care of the Child With Altered Respiratory Status

Nursing Diagnosis: Ineffective airway clearance related to excess thick secretions, obstruction, or infection

Interventions/Rationale
- Conduct a complete respiratory assessment with each routine vital sign check and as indicated by the child’s condition.
  Enables early detection and correction of abnormalities. Thick secretions increase hypoxia and will be reflected by changes in respiratory status. Colored or odorous secretions may indicate bleeding or infections.
- Encourage child to cough, especially after respiratory treatments. Teach effective cough techniques.
  Ineffective cough may be caused by respiratory muscle fatigue, severe bronchospasm, and/or thick, tenacious secretions.
- Provide humidified oxygen as ordered.
  Decreases viscosity of secretions.
- Encourage increased fluid intake (clear liquids; avoid dairy products) if no contraindications, such as cardiac or renal disease, are present.
  Fluid intake prevents dehydration from insensible losses through mouth breathing and increased respiratory rate. Assists to decrease viscosity of secretions and increase ciliary action to remove secretions.
- Administer prescribed medications and intravenous fluids; monitor for response and side effects.
  Steroids may help reduce bronchial inflammation, antibiotics may be used to treat infection or sepsis, and bronchodilators may be useful to enhance airway clearance.

Expected Outcomes
- Child’s airway will be free of secretions, as evidenced by normal or improved breathing, normal arterial blood gases, and/or oxygen saturation 92% or greater on pulse oximetry.

Nursing Diagnosis: Ineffective breathing pattern related to effects of respiratory disease process

Interventions/Rationale
- Conduct a complete respiratory assessment with each routine vital sign check and as indicated by the child’s condition.
  Enables early detection and correction of abnormalities. Hypoxemia, hypercapnia, and hypoxia will cause breathing pattern changes as the autonomic nervous system attempts to maintain homeostasis.
- Provide oxygen as needed to the child to maintain oxygen saturation at more than 92% or within parameters defined as child’s personal best.

Oxygen therapy may be required to increase oxygen saturation. A decrease in saturation indicates ineffective oxygenation, which in turn increases the work of breathing.
- Place child in an upright position to optimize ventilation.
  Partial pressure of arterial oxygen may increase in the prone position.
- Provide reassurance to the child and allay anxiety. Keep child as calm as possible.
  Increased restlessness and anxiety indicate insufficient oxygenation. Increased work of breathing may lead to fatigue. Energy expenditures increase the child’s oxygen demands.
- Administer prescribed medications and intravenous fluids; monitor for response and side effects.
  Steroids may help reduce bronchial inflammation, antibiotics may be used to treat infection or sepsis, and bronchodilators maybe useful to enhance airway clearance.

Expected Outcomes
- Child will demonstrate an effective respiratory rate, rhythm, and effort, and will experience improved gas exchange in the lungs, as evidenced by blood gases within child’s normal parameters.
- Child will verbalize ability to breathe comfortably without sensations of dyspnea and related feelings of fear or anxiety resulting from shortness of breath.

Nursing Diagnosis: Impaired gas exchange related to consequences of underlying respiratory disease process

Interventions/Rationale
- Conduct a complete respiratory assessment with each routine vital sign check and as indicated by the child’s condition.
  Signs of hypoxia, such as changes in level of consciousness, cyanosis, effortful breathing, ventilation (rate, quality, pattern, and depth), and vital signs indicate impaired gas exchange and compensatory efforts to manage these physiologic changes.
- Closely monitor oxygen saturation levels via pulse oximetry and arterial blood gases, and note changes.
  Pulse oximetry provides an estimate of oxygen saturation; blood gases (arterial or capillary) are objective indications of oxygenation status. Progressive hypoxemia is apparent on serial blood gases despite increased concentrations of inspired oxygen.
- Provide oxygen as needed to the child to maintain oxygen saturation at more than 92% or in parameters defined as child’s personal best.
Oxygen therapy may be required to increase oxygen saturation. A decrease in saturation indicates ineffective oxygenation, which may indicate that the child’s condition is worsening.

- Anticipate the need for intubation and mechanical ventilation. Assist with these procedures as needed.
  Intubation is indicated in the presence of impending respiratory failure. Mechanical ventilation provides supportive care to maintain adequate oxygenation and ventilation parameters to the child.

**Expected Outcomes**
- Child will demonstrate improved gas exchange in the lungs, as evidenced by blood gases within child’s normal parameters and an alert, responsive mental status or no further reduction in mental status.

**Nursing Diagnosis:** Decreased cardiac output related to consequences of respiratory distress and failure

**Interventions/Rationale**
- Perform a complete assessment of cardiovascular status including vital signs, hemodynamic pressures, urine output, skin temperature, peripheral pulses, and respiratory effort.
  Decreasing cardiac output will be reflected by changes in blood pressure, decreasing strength of peripheral pulses, decreased urine output, cool extremities, and changes in ventilation that may necessitate changes in positive end-expiratory pressure.
- Administer prescribed medications and intravenous fluids; monitor for response and side effects.
  Intravenous fluids are administered to maintain fluid balance without causing edema.
  Inotropic agents may be used to increase cardiac output. Sedatives and analgesics are used to relieve pain and agitation. Neuromuscular blocking agents may be needed if the child is ventilated, to promote synchronous breathing. Intravenous fluids are administered to maintain fluid balance without causing edema.

**Expected Outcomes**
- Child will demonstrate adequate cardiac output, as evidenced by strong peripheral pulses; normal vital signs; urine output greater than 2 mL/kg/hour; and warm, pink, dry skin.

**Nursing Diagnosis:** Risk for infection related to pooling of lung secretions, ineffective cough and contagious nature of condition

**Interventions/Rationale**
- Conduct a complete assessment to monitor for respiratory infection, including auscultating breath sounds; evaluating for changes in sputum; and observing for fever, chills, increase in cough, shortness of breath, nausea, vomiting, diarrhea, and decreased appetite.
  Early assessment of signs of infection will facilitate early intervention. Bronchial breath sounds and rales may indicate pneumonia. Sputum changes such as an increase in production, changes in consistency, and changes in color may indicate presence of infection.
- Evaluate child’s and family’s understanding of techniques to prevent infection, such as careful hand hygiene, adequate rest and nutrition, avoiding contact with sick individuals, and so forth. Provide additional education as needed.
  Increased knowledge and subsequent implementation of activities to prevent infection will reduce infection risk.
- Follow standard infection control precautions during all contact with the child.
  Standard precautions reduces the risk of transmission of microorganisms.
- Encourage child to cough and expectorate secretions frequently. Encourage strict handwashing and infection control practices for the child, family members, and all care providers.
  Retained secretions provide an environment for bacterial growth.

**Expected Outcomes**
- Child will be free from infection, and the parents will demonstrate adequate knowledge of risk for infection, signs/symptoms of infection, and measures to reduce infection risks.

**Nursing Diagnosis:** Imbalanced nutrition: Less than body requirements related to underlying chronic lung disease and increased work of breathing

**Interventions/Rationale**
- Assess child’s nutritional status, including height, weight, body mass index percentile, diet history, child’s ability to eat, and possible causes for poor appetite.
  Assessment provides baseline data to assist in determining interventions. Increased metabolic needs caused by increased work of breathing will require greater caloric intake. Work of breathing may leave little energy for other activities, including eating.
- Assist child/parents to plan well-balanced meals that incorporate child’s food preferences and dietary limitations imposed by disease process (e.g., low-to-moderate fat, high-protein, high-calorie meals for the child with cystic fibrosis). Encourage small feedings of nutritious soft foods and liquids. Add nutritional supplements as ordered.
  These measures minimize metabolic expenditures while providing nutritious high-calorie foods that are appealing and easy to digest.
- Ensure frequent oral care is provided.
  Dry mucous membranes and poor oral hygiene may contribute to decreased appetite and worsening nutritional status.

**Expected Outcomes**
- Child will demonstrate adequate nutritional intake for age, and parents will identify steps to achieve and maintain ideal body weight.
optimal weight gain is a key intervention. These conditions improve with growth, and in the absence of other congenital anomalies, the prognosis for normal respiratory function is good.

Alert! The infant with Pierre Robin syndrome must be maintained in the prone position as much as possible to prevent the tongue from obstructing the pharynx and causing respiratory distress. Improper positioning can quickly result in complete obstruction and death.

Early and ongoing support and education of the parents is of utmost importance. A diagnosis of a congenital anomaly creates a crisis for the family. Reinforce the concept that in most cases the cause of the defect is unknown and not the fault of the parents. Also educate the family about appropriate positioning and feeding techniques to ensure adequate intake of formula or breast milk (either by actual breast-feeding or breast milk expressed into a bottle) and solid foods as the infant reaches the appropriate age for introducing them. Routine infant healthcare is administered. Parents need to be informed that the infant’s symptoms may worsen during respiratory illnesses. If they have any concern about worsening respiratory distress, instruct them to seek assistance from their healthcare professional. Parents should also be instructed in CPR.

UPPER RESPIRATORY INFECTIONS AND OBSTRUCTIONS

Upper respiratory tract infections are extremely common in infants and young children. The upper respiratory tract, or upper airway, consists primarily of the nose, mouth, and oropharynx. For purposes of this book, infections of the epiglottis, larynx, and trachea are considered in the upper respiratory tract as well. Infections of this area of the respiratory system are usually viral and self-limiting. Although the respiratory tract is equipped with several natural defense mechanisms, invading organisms frequently gain access to these structures, resulting in respiratory conditions that range from mild to life-threatening. When infection occurs, organisms travel freely among the structures of the upper airway, including through the eustachian tubes to the inner and middle ears. The severity of resulting illness depends on age, organism, and the integrity of the child’s immune response. Some infections can lead to inflammation or obstructions of the airway; obstruction can also result from noninfectious causes. Most upper respiratory conditions are treated in the home or in ambulatory care settings.

Allergic Rhinitis

Allergic rhinitis is a condition characterized by sneezing; nasal itching; thin, watery rhinorrhea; and nasal congestion. The conjunctivae and posterior pharynx may also be involved. Allergic rhinitis may be seasonal, with symptoms that correspond to specific pollen peaks in the spring or fall, or may be perennial (year-round symptoms). Some children have perennial symptoms with additional flares during pollen seasons. Allergic rhinitis is the most common of all allergic disorders, affecting 10% to 20% of the population. Allergic rhinitis accounts for 2 million days lost from school, 28 million days of restricted activity, and a cost of more than $3.3 billion for physician visits annually (Blaiss, 2004; Gleason et al., 2006, Hayden, 2007, Salib et al., 2008). The prognosis for allergic rhinitis is good if symptoms are controlled with treatment.

Pathophysiology

Airborne allergens come into contact with mast cells and basophils at mucosal surfaces. Mast cells have immunoglobulin E (IgE) receptors on their membrane surfaces that bind to IgE in serum. Exposure to the appropriate airborne allergens cross-links the mast cell IgE receptors and triggers the release of chemical mediators. This mediator release causes an immediate reaction, which includes sneezing, itching, nasal congestion, and mucus secretion accompanied by nasal mucosa edema. Four to 12 hours later, a late-phase reaction occurs, causing a second, more prolonged period of nasal congestion.

Assessment

Diagnosis of allergic rhinitis is based on clinical history, family history, physical findings, and laboratory (skin test) evaluation. Assess for complaints of nasal congestion, pruritus, clear rhinorrhea, and paroxysms of sneezing. The nasal congestion may be bilateral, unilateral, or variable and is often worse at night. Chronic rhinitis symptoms may lead to irritability and fatigue, which can cause inattentiveness and difficulty concentrating in school. Parents may tell you that their children sniff,
Medical management involves the use of oral or intranasal antihistamines, decongestants, intranasal corticosteroids, leukotriene modifiers, mast cell stabilizers, and allergen-specific immunotherapy (Blaiss, 2004; Gleason et al., 2006). Antihistamines are used to block histamine from binding at its H1 receptor site, thereby preventing the vasodilatation, sneezing, and hypersecretion it causes. Decongestants may be helpful in reducing nasal obstruction via vasoconstriction, but the suitability of over-the-counter preparations for the younger child should be verified through the healthcare professional. Nasal corticosteroids are used to decrease inflammation in the nasal passages. For moderate to severe cases of allergic rhinitis, leukotriene modifiers and mast cell stabilizers may be used. In children with more severe symptoms, immunotherapy may be used (Berguer, 2004; Blaiss, 2004). As with any medication, educate parents and children regarding the uses and side effects of these medications. Medications for rhinitis include sedating and nonsedating forms. The availability of over-the-counter cold preparations for children changes; therefore, instruct parents to read the package label carefully.

ANSWER: Although not all children who have allergic rhinitis also have asthma, a significant portion of children who do have asthma also have allergies. The allergies can act as a trigger for their asthma, and therefore controlling their allergic response also helps to control their asthma. What is difficult for many families is maintaining a preventative medication regime when the child does appear sick.

### Sinusitis

Sinusitis in children is usually seen as a viral or bacterial infection in the paranasal sinus structures. On the average, children have about six to eight colds per year and, of these, 0.5% to 5% will develop into acute sinusitis (Ramaden, 2004). Sinusitis characteristically responds well to antibiotic therapy, although prolonged courses may be required. Complications can occur as a result of local extension of the disease, such as orbital cellulitis. Intracranial infection, with associated neurologic symptoms, is also a potential sequela of sinusitis. Prompt, appropriate antibiotic therapy usually prevents the onset of these potentially life-threatening ophthalmologic and neurologic complications.

### Pathophysiology

The paranasal sinuses, which encompass the ethmoid, maxillary, sphenoid, and frontal sinuses, are hollow areas in the skull beneath the turbinate in the nasopharynx. Ethmoid and maxillary sinuses are present at birth. The sphenoid sinuses are formed by 5 years of age, and frontal sinuses continue developing until adolescence (Figure 16–13). The various functions of the sinuses include warming and humidifying inspired air, trapping inspired particles, secreting mucus, and reducing the weight of the skull.

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**TABLE 16-1**

<table>
<thead>
<tr>
<th>Symptoms</th>
<th>Allergic Rhinitis</th>
<th>Common Cold</th>
</tr>
</thead>
<tbody>
<tr>
<td>Family history of atopy</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Conjunctival pruritus</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Fever</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Pharyngitis/laryngitis</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Purulent secretions</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Sinus pain</td>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
</table>
The sinuses are prone to infection most frequently after a viral upper respiratory tract infection because the sinus cavities in children are smaller in area than in the adult. Inflammation and edema of the mucous membranes during an upper respiratory tract infection can lead quickly to obstruction of the opening to the nasopharynx. The normally sterile sinus cavity is then invaded by bacteria. Bacterial pathogens in acute sinusitis are the same as those found in acute otitis media, with *Streptococcus pneumoniae* and *Haemophilus influenzae* predominating. *Moraxella catarrhalis* is also a common cause of acute sinusitis in children (American Academy of Pediatrics, 2001; Lindbaek, 2004).

**Home and School Environmental Control of Allergies**

_Suggestions for eliminating or reducing triggers can be provided to families, and may include_

**Home**

- Do not allow smoking in the home or car; encourage smokers to always smoke outside. Refer family members who are smokers to local smoking cessation programs (e.g., American Lung Association, American Cancer Society, Local Smoking Quitline).
- Encase mattresses, box springs, and pillows with airtight hypoallergenic covers. The child should avoid sleeping or lying on rugs or upholstered furniture. Use synthetic materials for all bedding, and wash bed linens weekly in hot water (130 °F[54.4°C]). Place stuffed toys in the clothes dryer (on air fluff) at least once a week to reduce dust mites.
- Remove clutter (dust collectors) including knick-knacks, pictures, wall hangings, trophies, and stuffed toys from the child’s bedroom. Wet dust and clean the child’s bedroom twice a week.
- Use shades, vertical blinds, or curtains that are washable in hot water (130 °F[54.4°C]). Wash curtains every 1 to 2 weeks.
- Hardwood floors are preferable to carpeting. If able, remove carpeting from the child’s room. If unable, vacuum twice a week with the windows open to increase ventilation and reduce dust collection. The child should be out of the room or house during vacuuming.
- Do not allow pets, particularly dogs and cats, in the child’s bedroom. Wash the pet weekly. Ideally, the pet should be kept outdoors.
- Avoid painting or using cleaning products around the child. The child should not be in the house when these chemicals are being used. Consider using natural cleaning products like dilute white vinegar, useful in removing mold, mineral deposits, and crayon marks; baking soda can be used as a general cleaner; and club soda is a good spot remover. Avoid perfumes, powders, aerosol sprays and hairsprays around child.
- Clean and dust the kitchen floor and cabinets 1 to 2 times a week to remove cockroach allergen present in house dust (especially in apartment buildings).

**School**

- Ensure cleaning of chalkboards when students are not in the classroom; clean erasers outside.
- Replace paint and marker caps when they are not in use to control strong fumes.
- If possible, include nonfur-bearing pets such as fish or snakes, which are preferable in classrooms to reduce allergen exposure from furry pets. Wet-dust bookshelves weekly.
- Avoid upholstered furniture. Furniture should be made of vinyl, leather, or wood.
- Bare wood or tile floors are best. If possible, remove rugs and keep floors clean.
- Consider placing small rugs and carpets (without rubber backs) in clothes dryer (on air fluff) at least weekly to reduce dust mites and soil collection. Carpets can trap dust and soil.
- Opening windows to allow fresh air exchange is good, but check pollen and pollution levels first.
- Wet-dust fan blades and air exchange vents at least monthly.
- Clean or change window air conditioner filters at least monthly.
- Use air conditioners or a dehumidifier to keep relative classroom humidity at 35% to 45%.
- Have teachers and staff avoid perfumes, scented talcum powder, and hairsprays.
- Use liquid rather than bar soap (mild or unscented) for handwashing.
- More EPA guidelines and strategies for healthy school environments can be found at http://www.epa.gov/schools/
Assessment

Children with sinusitis have various clinical manifestations and histories. Ask questions to elicit any evidence of the two most common symptoms of sinusitis: headache and toothache. The infant or younger child may exhibit fever and irritability after a viral upper respiratory tract infection. The older child may have symptoms such as purulent rhinorrhea, malodorous breath, headache, anorexia, sore throat, a feeling of fullness or pain in the face (especially over the sinuses), cough, and a disturbed sense of smell.

History of symptoms and physical examination are needed to diagnose sinusitis in children younger than 6 years. A positive history for sinusitis would include symptoms that last more than 10 days without evidence of improvement.

Clinical diagnostic testing (e.g., radiography, computed tomography) for sinusitis is usually not indicated in children younger than 6 years of age. For older children, history of symptoms, physical examination, and clinical diagnostic testing (radiography, computed tomography, and cultures) are required.

Interdisciplinary Interventions

Antimicrobial therapy and symptomatic relief measures are the main interventions for sinusitis. Antibiotics are usually given orally, and in complicated cases may be required for as long as 6 weeks. Hospitalization for sinusitis is rarely required, although on rare occasions, children with sinusitis may develop an advanced infection or complication that requires hospitalization for more intense neurologic monitoring and parenteral antibiotic therapy. Decongestants and antihistamines, although their use is not supported by research (American Academy of Pediatrics, 2001; Lindback, 2004), have been used to promote drainage from the sinuses. Encourage parents to administer additional clear liquids during the acute phase to promote hydration and sinus drainage.

Nasopharyngitis and Pharyngitis

Nasopharyngitis (common cold) and pharyngitis (throat infections) are among the most frequently encountered complaints in the pediatric ambulatory care setting. One group of researchers reported that during the first years of life, daycare attendance and having siblings significantly increased the likelihood of contracting respiratory syncytial virus (RSV) and rhinovirus, and increased the risk of rhinovirus-induced wheezing (Copenhaver et al., 2004). These inflammatory syndromes of the nasopharynx and oropharynx are attributed predominantly to infectious agents or, less commonly, to secondary involvement in systemic or noninfectious illnesses.

Pathophysiology

The nasopharynx and oropharynx consist of mucous membrane layers composed of stratified squamous epithelium; the inflammatory process is initiated in these structures by viruses or bacterial pathogens. The lymphatic drainage system is involved secondarily. Excessive drying of the mucous membranes during the winter months and passive or active smoking are other potential contributing factors, because they irritate the mucous membranes and increase susceptibility to infection. The virulence of viral or bacterial pathogens depends on mucosal cell wall antigens. Viral particles are transmitted by air, by direct contact, and sometimes by food-borne transmission (Anon, 2003; Park et al., 2006).

When the mucous membranes are involved, infection can spread through the lymphatic drainage system and...
saliva to other parts of the oral cavity and respiratory tract. The uvula and epiglottis may become inflamed. Unresolved nasopharyngitis and pharyngitis, combined with fever, decreased appetite, and reduced fluid intake, can dehydrate an infant rapidly. Complications such as otitis media, lymphadenitis, and peritonsillar abscess may also occur if the infection is not self-resolved (for viral conditions) or treated effectively with antibiotics (for bacterial infections).

Viral upper respiratory infections constitute nearly all cases of pharyngitis and nasopharyngitis. Rhinovirus, respiratory syncytial virus, coronavirus, and adenovirus are the most common pathogens in children younger than 3 years of age. Influenza, parainfluenza, Epstein-Barr virus, and coxsackievirus A are among the more prevalent causative agents in older children and adolescents. Pharyngitis is most commonly attributed to group A beta-hemolytic streptococci (GABHS). Other etiologic agents include *Corynebacterium diphtheriae*. Infection with diphtheria was common at the turn of the century; immigrant and other nonimmunized populations in the United States remain at risk for contracting this organism today. *Mycoplasma pneumoniae* can also cause pharyngitis that is clinically indistinguishable from GABHS, most commonly in the adolescent population. Gonococcal pharyngitis may be seen in sexually active or sexually abused children. Table 16–2 compares pharyngitis caused by viral versus bacterial agents.

### Assessment

Observe for the hallmark symptoms of nasopharyngitis: clear rhinorrhea, nasal stuffiness, cough (usually worse at night because of postnasal drip), generalized malaise, and irritability. Extreme throat discomfort is the chief complaint in most cases of pharyngitis (Fig. 16–14). With GABHS, white exudate, petechiae, or both may be visible on the posterior palate and tonsils. High fever, scarlet fever rash, and tender cervical lymphadenopathy may also be present in bacterial pharyngitis. Dysphasia, hoarseness, and laryngitis may accompany either pharyngitis or nasal pharyngitis.

### Interdisciplinary Interventions

Pharyngitis and nasal pharyngitis are treated in the home by the parents, often in collaboration with the healthcare professional. Bacterial pathogens can be identified by throat culture and treated with the appropriate antibiotics. Parents need instructions to monitor carefully for signs of complications or disease progression and to seek medical attention promptly if they occur. Parents may also be advised to position the infant in an infant seat or with the head of the bed elevated for comfort and to facilitate drainage of nasal secretions. A bulb syringe may also be used to clear nasal passages before feedings, especially for infants, to promote feeding and nippling.

### Table 16–2

**Comparison of Viral and Bacterial Pharyngitis**

<table>
<thead>
<tr>
<th>Viral Pharyngitis</th>
<th>Streptococcal Pharyngitis</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Signs and symptoms</strong></td>
<td></td>
</tr>
<tr>
<td>WBC usually normal</td>
<td>WBC count elevated (15,000–20,000/mm³)</td>
</tr>
<tr>
<td>Gradual onset</td>
<td>Abrupt onset</td>
</tr>
<tr>
<td>Headache, low-grade fever</td>
<td>Headache, fever up to 104 °F (40°C)</td>
</tr>
<tr>
<td>Rhinitis, cough, and hoarseness common; abdominal discomfort uncommon</td>
<td>Common complaints are sore throat, abdominal discomfort, and trouble swallowing; rhinitis, cough, and hoarseness uncommon</td>
</tr>
<tr>
<td>Slightly red pharynx with moderately enlarged tonsils</td>
<td>Erythema and enlargement of tonsils with white exudate on posterior pharynx and tonsils</td>
</tr>
<tr>
<td>Absent marked cervical lymphadenopathy</td>
<td>Firm, tender cervical lymph nodes present</td>
</tr>
<tr>
<td><strong>Treatment</strong></td>
<td></td>
</tr>
<tr>
<td>Symptomatic treatment only</td>
<td>Antibiotics to eradicate organisms, either penicillin or erythromycin for 10 days, plus symptomatic treatment</td>
</tr>
<tr>
<td><strong>Complications</strong></td>
<td></td>
</tr>
<tr>
<td>Few complications</td>
<td>Complications include otitis media, sinusitis, peritonsillar abscesses, acute cervical adenitis, rheumatic fever, meningitis, and acute glomerulonephritis</td>
</tr>
<tr>
<td><strong>Duration</strong></td>
<td></td>
</tr>
<tr>
<td>Usually self-limiting, lasting 5 to 7 days</td>
<td>Without antibiotics, child may be acutely ill for 2 weeks. If left untreated, group B streptococcus may lead to further complications, including rheumatic fever, acute poststreptococcal glomerulonephritis</td>
</tr>
</tbody>
</table>

WBC, white blood cell count.
Community Care

Supportive care, including rest, nutritious foods, and cool fluids, is the primary intervention. General fever reduction methods should be used for children with temperatures higher than 101 °F (38.3 °C). Acetaminophen, the drug of choice for reducing fever, may be alternated with nonsteroidal anti-inflammatory drugs for temperatures more than 102.2 °F (39.0 °C) in children older than 3 years of age. Comfort measures such as cool fluids and ice pops may be given, and warm saline throat irrigations (saltwater gargle) may be comforting for the older, cooperative child. The most common carrier of infection is the human hands. Frequent handwashing by the child and caregiver is needed to reduce spread of the infection. Symptoms generally resolve in 5 to 7 days.

Tonsillitis

Tonsils and adenoids are important to the normal development of the body’s immune system, because they serve as part of the body’s defense against infection, but they may become a site of acute or chronic infection (tonsillitis). The tonsils are located on either side of the pharyngeal cavity. The palatine, or faucial, tonsils enlarge when infected and are readily seen behind the faucial pillars at the sides of the oropharynx. Adenoids are the nasopharyngeal tonsils, which are located adjacent to the palatine tonsils on the posterior wall of the nasopharynx. Tonsillar tissue increases in size during childhood as a result of acute nasopharyngeal infections that commonly occur in the school-aged child (Fig. 16–15). Tonsils reach their maximum size between 8 and 12 years of age and then begin to involute, or shrink, during adolescence.

Tonsillitis most often affects school-aged children. About 7 per 1,000 people are estimated to be managing symptoms of tonsillitis at any one time. The condition is not limited to the pediatric population.

Pathophysiology

Repeated acute infections centered in lymphoid tissue such as the tonsils draw the body’s defenses to that location, causing the tissue to swell. The acute infectious process inflames the tissues of the tonsils and may cause exudate to form on the tonsils. Enlarged tonsils and adenoids impinge on the pharyngeal opening of the eustachian tube, preventing it from ventilating and draining the middle ear, thus contributing to incidence of otitis media as a sequela to tonsillitis. Other symptoms include reddened pharynx and tonsils, sore throat, dysphagia, fever, and swollen lymph nodes in the neck region.

Acute tonsillar infection is thought to result largely from infection with group A beta-hemolytic streptococci (GABHS), although other organisms can cause tonsillitis, including H. influenzae, pneumococcal infection, and viral agents. GABHS is particularly problematic because it cannot be identified by rapid strep test. GABHS may be obtained by throat culture, although cultures are difficult to obtain and are at times inconclusive. Children generally recover from tonsillitis, but if it is caused by GABHS that is not completely eradicated, sequelae such as rheumatic fever or acute glomerulonephritis may occur.

Chronic tonsillitis is a common affliction of childhood; however, its exact incidence is unknown.

Assessment

Children with acute or chronic tonsillitis present with clinical signs and symptoms similar to those of pharyngitis.
Inspect for inflammation of the tonsils and surrounding tissues, accompanied by varying degrees of soreness of the mucosa. This soreness may cause the child to refuse to eat or drink because of discomfort on swallowing. Additional clinical manifestations include exudate on the tonsillar surface, substantial erythema, recurrent or persistent sore throat, and possible obstruction to swallowing or breathing caused by hypertrophied tonsils or adenoids. Occasionally, the throat may be dry and irritated, and the breath may be offensive. If the tonsils and adenoids are hypertrophied, determine whether they are obstructing the upper airway. This complication, although rare, can cause respiratory distress, with chronic hypoxia and the development of pulmonary hypertension. Children with tonsils or adenoids that are so enlarged that they partially obstruct the upper airway often present as “mouth breathers” and often snore during sleep. Consider a sleep apnea evaluation for such children.

Hypertrophy or acute infection of the tonsils must be carefully evaluated. Many apparently enlarged tonsils are, in fact, normal in size. The misinterpretation arises from the fact that, because of frequent nasopharyngeal infections, tonsils are normally larger during early childhood years than later in life. Tonsils may virtually meet in the midline in some normal, asymptomatic children, especially when the child gags. Ascertain whether hypertrophy, if present, is chronic or the result of a recent acute infection. Tonsils can increase in size tremendously with an acute infection and recede after the infection subsides.

Inspect an older child’s tonsils simply by asking the child to say “aaah.” If the child is unable to hold the tongue down, use a tongue blade lightly to help. Younger children consider the examination of the mouth and throat intrusive and may be uncooperative. Infants and young children whose cooperation cannot be gained will usually open their mouths during crying to allow a good view of the oropharynx. If a tongue blade is needed, use it cautiously and quickly.

**Interdisciplinary Interventions**

When tonsillitis is present, it is necessary to screen for GABHS by culturing the tonsillar surface that may contain the exudate. A throat culture can be best obtained using the same techniques as those for inspecting the throat. Identifying the causative organism is helpful in determining the antibiotic course that will be used. The recommended treatment for acute tonsillitis secondary to GABHS is usually penicillin, unless a contraindication (i.e., penicillin allergy) exists. In cases of penicillin allergy, cephalosporins may be used. Antibiotics are generally administered orally or intramuscularly; the oral dose should be given for 10 days. Teach the parent that administering the complete course of antibiotic is essential because, although symptoms may subside in 24 to 72 hours, the full course is necessary to prevent complications such as rheumatic fever and glomerulonephritis.

Tonsillectomy and adenoidectomy are controversial surgical interventions for chronic tonsillitis. Recurrent throat infections (documented with positive throat cultures) remain one of the leading indications for surgery. Tonsillectomy has been documented to decrease the number of infections in children with recurrent tonsillitis; however, the number of throat infections also declines in many children who have not had tonsillectomies. Chronic upper airway obstruction is also a major indication for surgery. Symptoms of upper airway obstruction are more prominent during sleep and include mouth breathing, loud snoring, and, in extreme cases, apnea. The child with upper airway obstruction extensive enough to warrant tonsillectomy may also exhibit sleep disturbances and enuresis. Patients with severe obstruction improve after surgery; many patients with mild to moderate symptoms improve without it. Before considering tonsillectomy, healthcare professionals, in collaboration with parents, should carefully document that sore throats are caused by GABHS and are frequent (more than five per year), symptomatic (fever, exudate, erythema, adenitis), and costly in terms of missed school and work days and medical expenses.

Tonsillectomy and adenoidectomy surgeries usually are performed on an outpatient basis 2 to 3 weeks after acute infection. The nurse prepares the child and family for the surgery, and teaches both child and family the postoperative care protocol.

Observe for potential hemorrhage during the postoperative period. An ice collar is applied externally around the neck. As soon as the child is awake, he or she may suck on ice chips. The most comfortable and safe position is prone (on the abdomen) with the head turned to the side so that mouth drainage can be observed. Small amounts of bright-red blood may be present soon after the surgery. It is normal for the child to have one emesis of old blood after the surgery and small amounts of blood-streaked mucus within the first few hours after the surgery.

**CaReMinder**

Perform any needed suctioning with caution, to avoid trauma to the oropharynx and surgical site. Instruct the child to avoid coughing, talking, clearing the throat, or blowing the nose after surgery, to prevent disturbing the surgical site.

If the child spits up bright-red blood frequently or has repeated emesis of old blood from the stomach, or if he or she becomes tachycardic (heart rate >120 beats per minute), pale, and restless, notify the surgeon immediately. Occasionally, it may be necessary for the child to return to surgery to ligate a bleeding vessel. If no bleeding occurs, ice chips and water may be given soon after surgery, after the child is fully alert. Advance the diet from clear liquids to full liquids, as tolerated. Give pain medication, in the form of a liquid or syrup if available, within the first 2 hours after surgery. The child should receive pain medication every 4 hours during the first 24 to 48 hours to control pain and to make swallowing fluids more comfortable.
The child may be discharged on the day of surgery or the following day, but should convalesce at home for several days. TIP 16–3 highlights key instructions for care of the child at home.

**Community Care**

The child with uncomplicated acute tonsillitis is usually managed on an ambulatory basis. The symptoms of a sore throat may be treated in the home with acetaminophen (nonsteroidal anti-inflammatory drugs for children older than 6 months), throat lozenges or hard candies, cool fluids, ice chips or ice pops, and saltwater gargles to keep the throat moist. Discourage the use of topical anesthetics sprays, because their efficacy in young children is unproved and because of the risk of systemic absorption and allergic sensitization. Stress the importance of clear liquids to encourage hydration (diary products should be avoided, because they promote thickening of mucous).

Occasionally, the throat swelling is severe, symptoms indicate epiglottitis, or the child may become severely dehydrated and therefore require hospitalization for treatment with intravenous fluids, parenteral antibiotics, and emergency equipment available in case of airway obstruction.

**Croup**

Croup is one of the most common acute respiratory conditions seen during early childhood (6 months–6 years of age) and the most common cause of upper airway obstruction (Cherry, 2005; Leung, Keller & Johnson, 2004). The term *croup* represents several distinct disorders that cause a characteristic clinical syndrome of hoarseness, inspiratory stridor, a “croupy” or barking cough, and varying degrees of respiratory distress.

Croup syndromes are generally more common in boys than in girls and occur more often in the late autumn through early winter months. Although croup is generally a benign condition resulting in minimal airway obstruction, some forms of croup can be life threatening, resulting in respiratory failure. Young children are particularly at risk, because inflammation and narrowing in their small airways can easily result in obstruction. Croup syndromes are usually described according to the primary anatomic area of inflammation: acute epiglottitis (supraglottitis), laryngotracheobronchitis (LTB; inflammation of one or more of the following structures: vocal cords, larynx, subglottic tissue, trachea, bronchi, bronchioles), spasmodic croup (larynx), and bacterial tracheitis (trachea).
Croup syndromes may be infectious or noninfectious. Noninfectious croup syndromes, such as spasmodic croup, may be caused by asthma or allergic reactions, or they may follow endotracheal extubation or foreign body aspiration (FBA). This section focuses on croup syndromes with infectious etiologies.

### Acute Epiglottitis (Supraglottitis)

Epiglottitis is a rare, acute inflammation of the supraglottic structures, the epiglottis and aryepiglottic folds. It characteristically does not involve the subglottic and tracheal regions. Epiglottitis constitutes one of the true pediatric emergencies. If treatment is delayed, it may rapidly progress to complete airway obstruction, cardiovascular arrest, and a potentially fatal outcome. When prompt diagnosis and coordinated, well-organized management occur, the prognosis for full and uncomplicated recovery is excellent.

The incidence of epiglottitis is unknown. Although it has been estimated to be fewer than 10 per 10,000 pediatric hospital admissions. Epiglottitis is commonly seen in children in all age groups, including infants, but occurs most often in children 2 to 7 years of age, with 80% of the cases occurring before 5 years of age (Leung, Kellner, & Johnson, 2004). It occurs year-round, but is more common during winter and early spring.

Epiglottitis most commonly results from infection of the supraglottic structures by *H. influenzae* type B (HIB), GABHS, *S. pneumoniae*, and, rarely, other bacteria and some viruses have also been reported. The infecting organism can be isolated from the upper airway as well as from the blood. Direct invasion by HIB causes inflammation of the supraglottic structures, with subsequent edematous swelling of these structures and bacteremia. Since 1985, with the licensing of the HIB vaccines, the incidence of disease caused by *H. influenzae* has declined. Still, pediatric health professionals should not dismiss the risks of epiglottitis and its consequences, however, because organisms such as streptococci have risen as causes of epiglottitis (Faden, 2006). All patients who have the clinical picture of this disease must be managed with the same cautious approach.

### Assessment

Diagnosis of epiglottitis is made primarily from clinical signs. Consider epiglottitis in any child with acute upper airway obstruction and respiratory distress, including stridor, of sudden onset (developing over a few hours) accompanied by high fever (more than 102.2°F [39°C]), sore throat, hoarseness, dysphagia, and drooling. Often these symptoms are preceded by symptoms of an upper respiratory infection. Epiglottitis seldom causes the “barking” cough characteristic of other croup syndromes. Agitation, characterized by irritability and restlessness, is almost always present. Observe whether the child assumes the “tripod” position, the hallmark of epiglottitis—the child refuses to lie down, preferring to sit upright and lean forward, mouth open, to attain the best airway possible and to allow secretions to run out of the mouth. As the obstruction increases, cyanosis may occur and retractions of the supravcicular and substernal area may be present. Parents are usually very fearful and anxious as they witness and describe rapid onset of symptoms.

Never attempt direct visualization of the upper airway in any child with symptoms of epiglottitis. Direct visualization of the upper airway may precipitate complete airway obstruction and respiratory arrest. It should be attempted only by a person skilled in intubation and with all necessary equipment present at the bedside. Upon visualization, the epiglottis is cherry red, and it and the surrounding tissues are extremely swollen. The laryngeal orifice may be severely narrowed, and pooling of mucous secretions often occurs.

A lateral neck radiograph is a useful diagnostic technique. It shows the epiglottis as a large, rounded soft mass below the base of the tongue.

### Interdisciplinary Interventions

Skilled pediatric personnel should carefully monitor children for whom the diagnosis of epiglottitis is suspected at all times and in a controlled medical environment (e.g., hospital room or emergency room with airway equipment appropriately sized for pediatric use). The child and the parents are usually extremely anxious, and the most important interdisciplinary intervention is keeping the child quiet and undisturbed until endotracheal intubation is performed. Minimize episodes of crying by allowing the child, if possible, to sit upright in the parent’s arms. Never force the child into a supine position, because this position may cause the inflamed epiglottis to obstruct the airway, compromise diaphragmatic excursion and air movement, or enable the child to choke on swallowed secretions.

Respiratory status, including rate and depth of respirations and the presence of retractions, nasal flaring, and stridor, must be carefully monitored. Give humidified oxygen by face mask and keep the head of the bed elevated at all times. Monitor SaO2 levels using pulse oximetry. Intravenous antibiotics (usually ampicillin or cefuroxime) must be given as soon as possible. Upon strong suspicion or confirmation of the diagnosis, intubation should be performed, ideally in the operating room under general anesthesia. Intubation sometimes is not possible because of laryngospasm or severe swelling, and in these cases, placement of a tracheostomy is required (see Treatment Modalities earlier in the chapter).

Other important interventions include administering and monitoring sedative medication, because the risk of accidental extubation is high. Mild sedation also allows the child to breathe spontaneously, making mechanical ventilation unnecessary. Assess for possible respiratory complications, monitor body temperature, and provide...
adequate fluid and calorie intake. The child must have nothing by mouth during the acute phase of the illness, and oral fluids and soft foods should not be provided until the child has demonstrated ability to tolerate extubation (Clinical Judgment 16–1).

As with any hospitalization, parental anxiety is high, especially if the child is admitted in acute respiratory distress. During this period, provide calm, factual, step-by-step information. Repeat this information as the family’s stress level decreases and they are able to formulate questions. Initial information should include the course of events in the immediate future—for example, when and where the child will be intubated; where the family may wait; when they may first visit the child after airway management is accomplished; how the child will be given nutrition, hydration, and medication; and how long they should expect he or she will need to remain intubated and sedated.

Recovery from epiglottitis is usually rapid, with endotracheal extubation occurring in 2 to 3 days as the fever dissipates, the child can handle secretions, and airway narrowing is resolved. Reassuring and supporting the parents is key during this recovery phase, because the rapid progression and critical nature of this disorder render it extremely frightening. Nurses and social workers can assist families by providing frequent, accurate education and updates on the child’s condition, and allowing parental visitation or “rooming in” as much as possible. Tell parents when they should expect the child to resume normal dietary habits and when discharge from the hospital is expected. Begin teaching about administration of oral antibiotics at home (to complete a 7-day course) when the intravenous line is discontinued.

**Community Care**

Urge immunization with the HIB capsular polysaccharide vaccine for the patient and all siblings of appropriate age (see Chapter 8), if they are not already immunized. Prophylaxis with rifampin by mouth is recommended for all household contacts, if at least one contact is younger than 4 years, regardless of immunization status. Daycare and nursery school contact groups should be managed on an individual basis. The HIB vaccine and rifampin prophylaxis can both be obtained from the county public health agency in many states.

**Laryngotracheobronchitis (LTB)**

LTB is the most common type of croup syndrome. The peak incidence of this illness is in the 6-month to 3-year-old age group, but LTB can be seen in children as young as 3 months and as old as 15 years of age (Leung, Keller, & Johnson, 2004). LTB usually occurs during the fall and winter months.

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**Clinical Judgment 16–1**

**The Drooling Child**

Jimmy, a 5-year-old child, presents in the emergency room with respiratory stridor upon inspiration and a temperature of 102.5 °F (39.2°C). He is drooling and prefers to sit forward with his chin slightly protruded. His mother states that he developed the difficulty breathing “so suddenly,” and both mother and child appear anxious.

**Questions**

1. What additional data would you collect during your initial assessment?
2. Is this an upper or lower respiratory problem?
3. What actions would your initial interventions include?
4. Is obtaining a throat culture indicated at this time? Why or why not?
5. What interventions should be implemented to maintain a patent airway in this child?

**Answers**

1. Heart rate, duration of fever, and other signs of respiratory illness. Is the child voiding? When did he last eat or drink (to assess for dehydration and shock)? No visual inspection of the oral cavity is ever indicated if epiglottis is suspected.
2. An upper respiratory problem, as distinguished by inspiratory stridor resulting from an obstruction. In this case, the obstruction is a swollen cherry-red epiglottis.
3. Interventions include establishing and maintaining an airway. Keep the child with his mother to help reduce anxiousness and allow him to remain in the “tripod position,” because this helps maintain an open airway. Provide oxygen via mask or blow-by oxygen. If respiratory distress becomes severe, ventilate with a bag–valve mask.
4. A throat culture should not be obtained, because manipulation of the oropharynx for visualization or when obtaining a culture may precipitate airway (trachea) spasm and obstruction from the swollen epiglottis.
5. The primary therapy is to maintain the airway. Therefore, provide oxygen support via face mask or bag–valve mask ventilation as needed until the physician is ready to intubate the child.
Infectious agents associated with LTB croup are usually viral and affect the subglottic region. Parainfluenza 1 and 2 account for many cases of LTB. Other viral agents associated with LTB include influenza, respiratory syncytial virus (RSV), adenovirus, rhinovirus, enterovirus, and, more rarely, measles virus and herpes simplex virus (Braden, 2006; Leung, Keller, & Johnson, 2004).

Pathophysiology

The underlying pathophysiology of LTB is inflammation and edema of the larynx, trachea, and bronchi; laryngeal muscle spasm; and production of mucus that further obstruct the airway. Inflammation in LTB narrows the subglottic region, the smallest portion of the upper airway in children, thus producing the classic symptoms of upper airway obstruction found in children with croup. Hoarseness occurs because the vocal cords swell; the barking cough is caused by inflammation of the larynx tissues.

Assessment

The incubation period for LTB is usually 2 to 6 days and is typically preceded by a mild upper respiratory infection with symptoms of rhinorrhea, mild cough, and low-grade fever. Children presenting with LTB look ill and appear to be in acute respiratory distress. Listen for hoarseness, inspiratory stridor, and the characteristic “barking” or brassy cough. The history typically reveals a mild upper respiratory infection, followed within 2 to 6 days by symptoms of LTB. Clinical signs, depending on the severity of airway obstruction, may include suprasternal, subternal, and intercostal retractions; intermittent cyanosis during coughing; and altered mental status related to hypoxia and carbon dioxide retention. A thorough respiratory assessment is important, because the child with upper airway obstruction with mild hypoxia develops muscle fatigue and hypoventilation that can result in severe hypoxemia and hypercapnia. Rarely, endotracheal intubation is necessary because of complete airway obstruction or respiratory distress.

A characteristic concern in children with LTB is parental anxiety, which is usually high. However, the degree of anxiety depends on many factors, including parental experience with previous croup episodes, lack of sleep from child’s “barking,” and the severity of the child’s respiratory distress and degree of anxiety and irritability.

Interdisciplinary Interventions

Treatment of children with LTB depends on its severity and may include general supportive care, corticosteroids, nebulized epinephrine, supplemental oxygen, or some combination of these therapies. Rarely, emergency measures for ventilation (endotracheal intubation) are required. General supportive measures for the child include hydration, fever reduction measures, and maintaining a calm and reassuring atmosphere for the parents. As with any respiratory condition, hydration is an important nursing action. Encourage clear fluids, particularly fluids the child prefers, unless respiratory distress is severe, in which case the child should have nothing by mouth and should be hydrated intravenously. Give antipyretics if the child is febrile (fever higher than 101 °F [38.3 °C]). Ensure that parents understand the distinction between bacterial and viral illnesses, so they are not distressed when antibiotics are not prescribed.

LTB is generally a self-limiting illness in which children’s symptoms subside in 3 to 5 days, and full recovery without complications is the norm.

Children who present with respiratory distress symptoms such as cyanosis and who are severely hypoxic, fatigued, in respiratory distress, or unable to drink sufficient fluids are hospitalized to receive intravenous fluid, oxygen, and airway support. Observe for any deterioration of respiratory status and monitor vital signs, including rate, rhythm, and depth of respirations, and cardiac rate and rhythm. Tachycardia, cardiac arrhythmias, or both may be seen with hypoxia. Ensure that equipment for intubation and tracheostomy is readily available.

Mist therapy (croup/mist tents or mist via mask or nasal cannula), widely used in the past, has questionable efficacy for treating LTB (Bradin, 2006). Current therapy relies on aerosol inhalation therapy with medications such as racemic epinephrine. Racemic epinephrine is believed to work via topical alpha-adrenergic stimulation, which causes mucosal vasoconstriction and leads to decreased edema in the subglottic region. Facilitate the administration of respiratory inhalation treatments at the prescribed frequency, to disrupt regular feeding and sleep patterns as little as possible.

Community Care

Two of the most important interventions are to minimize anxiety and maximize opportunities for rest. Providing a comfortable environment free from noxious stimuli lessens respiratory distress. Encourage children to engage in quiet play that provides diversion and reduces anxiety. Coloring books, watching favorite videos and DVDs, listening to music, reading stories, and doing puzzles are some examples.

Nutritional supports for children with croup are generally short term. Encourage oral intake of clear fluids, especially fluids the child prefers. Diary products should be avoided until respiratory status is stable. When solid food is resumed, the child may find frequent, small nutritious snacks more appealing than an entire meal.

Teach parents and other caregivers about medications, respiratory inhalation treatments, and ways to assess their child’s respiratory status. Although most children recover without complications, caregivers must be able to recognize and describe signs of impending respiratory failure and know how to access emergency services. A home health referral may be indicated if the parent’s assessment ability is in question and the child’s condition does not warrant hospitalization. The child should be afebrile and free from cough before returning to school or daycare.

During the acute phase of the illness, parental anxiety may be very high. Provide information and support, emphasizing the short-lived nature of the illness. For the child who remains at home, help the parents to mobilize their extended family and community resources, to
relieve them of some care responsibilities and provide them opportunities for adequate rest.

**Bacterial Tracheitis**

Bacterial tracheitis is an uncommon, but potentially life-threatening, acute bacterial infection of the mucosa of the upper trachea. It is also called membranous laryngotracheitis or membranous croup. Although it is a very rare disease, it may be seen in children between 1 month and 5 years of age; the peak incidence is in the fall and winter months (Cha et al., 2006). This condition is unrelated to ethnicity, gender, or socioeconomic status. Bacterial tracheitis is a serious cause of airway obstruction, severe enough to cause respiratory arrest. The overall mortality rate is 4%. With early recognition and treatment, outcomes are generally very good. The most common causative organisms are *Staphylococcus aureus*, *H. influenza*, *Streptococcus pyogenes*, and other anaerobic bacteria (Cha et al., 2006).

**Assessment**

The child with bacterial tracheitis usually appears quite ill and presents with a history of a prior upper respiratory tract infection, viral croup, or both, followed by a high fever, cough, and increasing inspiratory stridor unaffected by position. The trachea is inflamed and appears erythematous and edematous, with thick, tenacious, purulent secretions. Respiratory distress is a key symptom in bacterial tracheitis and requires immediate medical attention. The physician uses laryngoscopy or bronchoscopy to confirm the diagnosis. Tracheal cultures are obtained during the endoscopic procedure (Cha et al., 2006).

**Interdisciplinary Interventions**

Vigorous management, including early recognition of bacterial tracheitis and prompt attention to the airway, is necessary to prevent the airway from being obstructed by the thick secretions. The child should be hospitalized, and appropriate emergency airway management equipment should be available. Frequent tracheal suctioning is necessary to keep the airway patent, and often the child has an artificial airway (endotracheal tube) in place. This management is especially important in the younger child, who is at risk for abrupt airway obstruction. Additionally, the child requires humidified oxygen, parenteral broad-spectrum antibiotics (for 10–14 days), and antipyretics for fever and discomfort.

**Apnea**

Apnea is cessation of airflow in to and out of the lungs. Apneic episodes lasting longer than 20 seconds, and shorter respiratory pauses associated with cyanosis, bradycardia, pallor (paleness), or limppness, are considered pathologic apnea. This definition is simply a description of a characteristic clinical syndrome, not a specific disease process. Three general types of apnea occur:

1. **Central apnea** is an impairment of the mechanisms that control breathing, which results in absence of nasal airflow and ventilatory effort.
2. **Obstructive apnea** is usually caused by anatomic abnormalities and occurs when nasal airflow is absent despite normal or exaggerated respiratory effort. Obstructive apneas include obstructive sleep apnea (OSA), which is the most common type of sleep apnea.
3. **Mixed apnea** includes central and obstructive components and may require multiple treatment methods.

Although apnea can occur at any age, the premature infant is at a greater risk. The incidence of apnea among children younger than 1 year of age has been estimated at between 0.5% to 6% (Hall & Zalman, 2005). Normal respiratory system development is such that the lungs and respiratory center of the brain are designed to breathe and control respiration at term, although they are capable of breathing air by 23 weeks’ gestation. Therefore, the lungs and respiratory center of the premature infant have not fully matured, leading to disruptions in the regularity of respiration.

**Apnea of prematurity** (AOP) is the occurrence of pathologic apnea and periodic breathing in an infant of less than 37 weeks’ gestation. AOP is a common, natural consequence of immaturity and need not be viewed as a disease (Stokowski, 2005).

**Apnea of infancy** (AOI) describes episodes of breathing cessation or respiratory pauses in a previously healthy infant of at least 37 weeks’ gestation.

**Apparent life-threatening events** (ALTEs) is the current term for more severe disturbances of a frighteningly serious nature. These episodes have been formerly called near-miss sudden infant death syndrome (SIDS) episodes; however, the term ALTE is believed to more accurately describe the occurrence. An ALTE is defined as an event in which an infant has a convincing history of an episode of apnea that is sudden in onset, considered frightening to the observer, and is characterized by color change (cyanosis, pallor, or erythema), marked change in muscular tone (limpness, rarely stiffness), and choking, gagging, or both. It requires substantial intervention (vigorous shaking, mouth-to-mouth breathing, or full CPR) to revive the infant and restore normal breathing (American Academy of Pediatrics, 2003).

Studies of sudden infant death syndrome (SIDS) have indicated that AOP or AOI is not a precursor or predictor of subsequent SIDS death (American Academy of Pediatrics, 2003). Healthcare professionals should promote preventive practices to decrease the risk of SIDS. Specific interventions include supine positioning for sleep, safe sleeping environments, and elimination of smoke exposure.

Acute apneic episodes with cyanosis in term infants can have a variety of treatable causes including seizures; infection; breath-holding spells; congenital heart disease; cardiac dysrhythmia; electrolyte imbalances; congenital central hypoventilation syndrome; brain stem compression; anemia; or exposure to alcohol, sedatives, and narcotics. ALTE can also be the result of a profound central nervous system insult or depression involving structural damage to the brain stem (as in trauma, infection, or
edema) or interference with cerebral metabolic function (e.g., drug overdose, hypotension, severe hypoxia). The prognosis for these infants depends on the etiology and treatment of the underlying cause.

**Assessment**

Apnea may present simply as a parental report of prolonged asymptomatic respiratory pauses during sleep or as dramatically as a witnessed complete cessation of breathing and absence of a heart rate. Because apneic episodes, regardless of their severity, typically occur away from the view of the medical team, the significance of the event is based largely on the caregiver’s recollection of the event. A single mild episode that required little or no intervention does not necessitate an extensive diagnostic evaluation or aggressive therapy and has little prognostic importance. The healthy infant who presents with a history of AOI or an ALTE for whom the obvious treatable causes have been ruled out presents a greater challenge in evaluation and management.

Infants usually appear entirely normal by the time they reach medical attention after an ALTE. The most important element of assessment is, therefore, to obtain a careful history from the person who witnessed the event. Interview the witness to determine the color of the child when found (pale, or blue/cyanotic), whether the child had any respirations, and whether the child was limp. Determine whether there was evidence of vomiting. Ascertain whether the apneic episode occurred when the child was asleep or awake. Collaborate with other healthcare personnel to gain as much detail as possible about the event itself, the physical condition of the infant before and after the event, and circumstances surrounding its occurrence. Assess the reliability of the historian and look for any signs of child abuse or neglect; also evaluate the potential for sepsis. OSA may occur in children of any age. Symptoms include snoring, periods of observed apnea, heavy breathing, broken or restless sleep, bad dreams, and failure to eat. Sequelae of OSA may include inattentiveness, developmental disorders, mood disorders, or excessive daytime sleepiness.

One of the primary diagnostic tests in apnea is the polysomnographic study (PSG, or sleep study). Other diagnostic tests may include but are not limited to arterial or capillary blood gases (persistent acidosis indicates a severe event or a chronic metabolic disorder); complete blood counts (anemia may precipitate apnea, polycythemia reflects chronic hypoxia), elevated white blood cell count indicates infection); and serum electrolyte, glucose, and blood urea nitrogen levels (numerous abnormalities, such as hypocalcemia and hypoglycemia, may contribute to the development of apnea).

The primary diagnostic test for OSA is the nocturnal PSG. Many healthcare professionals diagnose OSA based on physical examination and nocturnal pulse oximetry.

**Interdisciplinary Interventions**

Optimal care of infants who have had an episode of apnea accompanied by color change or who present with a serious ALTE includes hospitalization for observation, monitoring by healthcare personnel, a thorough evaluation for possible causes, and parent training (see the Point for Care Paths: An Interdisciplinary Plan of Care for the Child With Apnea). Continuous cardiorespiratory monitoring and frequent assessment of color, breathing patterns and effort, and tone are appropriate healthcare interventions.

The preterm infant who continues to exhibit symptomatic apnea during the hospital stay should also be evaluated carefully for hypoxia or anemia, which can cause apnea in the premature infant. In the absence of hypoxia or anemia, preterm infants who are still having clinical episodes of apnea can be discharged with home apnea and bradycardia monitoring equipment.

Agents such as theophylline, aminophylline, or caffeine are sometimes useful in decreasing the severity and frequency of apneic episodes. These medications are central nervous system stimulants that act on the respiratory center of the brain and therefore are sometimes effective in treating central apnea only. Besides stimulating the respiratory center, these drugs also act on the kidney, heart, and skeletal and smooth muscles. Side effects include tachycardia and increased diuresis. Parents and caregivers must be taught to draw up and administer the medications and observe for toxic side effects (tachycardia, vomiting, excessive irritability). Teach them to monitor for therapeutic drug levels and to report toxic levels.

Treatment of OSA primarily focuses on tonsillectomy, adenoidectomy, or both. Other options include weight reduction, inhaled corticosteroids, or positive-pressure airway breathing (including continuous positive airway pressure).

**Community Care**

Parental anxiety is characteristically the foremost psychosocial issue challenging nurses and other members of the healthcare team in working with the infant and family after admission to the hospital with an apneic episode or after an ALTE. Much guidance and reassurance is needed, in conjunction with education, to increase parental confidence and problem-solving skills.

Because no specific treatment currently exists for infants with AOI or ALTE of unknown etiology, home apnea and bradycardia monitoring is the primary therapy. Ongoing therapy can be equally anxiety producing as the initial ALTE for parents and families. Home monitors serve only to alert the caregiver that an apneic episode is occurring. The parent or caregiver must then respond and act to evaluate and terminate the apneic episode. Most parents feel the need to use the monitor at all times when the infant is
not being directly observed. Home apnea monitoring often adversely affects parents' ability to work, socialize, nurture their other children, and generally maintain their former life functions because of their obsessive focus on the monitor and its every nuance.

Before initiating home apnea monitoring, and while the infant is still hospitalized, conduct a thorough review of the family's living arrangements and verify that appropriate resources are present to successfully support a home apnea monitoring program. Minimum environmental requirements include electricity, a telephone in the home, and availability of caregivers trained to respond to the apnea alarm. This inpatient evaluation of the family system is crucial in determining the teaching plan and coordinating follow-up. It may be necessary to contact community resources when appropriate, according to the family's needs.

Parental education for home apnea and bradycardia monitoring includes information on monitor use, alarms, indications for help, and CPR. Parents and caregivers are also taught to keep a log or diary of all apnea and bradycardia alarms, especially those requiring any intervention. If both parents work outside the home, alternative caregivers (extended family members, daycare providers, and so on) must also receive this education (see Chapter 14 for Care Paths: An Interdisciplinary Plan of Care for the Child with Apnea).

Most infants with ALTE require 4 to 6 months of home monitoring. The decision to discontinue the apnea monitor should be made jointly between the family and the healthcare professionals. If the decision is made to end monitoring, give the parents a clear statement of the status of the problem and explain that it appears to have resolved, and that the infant can be expected to grow and progress normally. Monitoring is discontinued using a similar protocol as that used in persistent AOP, in that the monitor may be safely discontinued after 2 to 3 months without apnea or bradycardia spells that require intervention (American Academy of Pediatrics, 2003). Because of the diligence required for successful home monitoring, many parents find it difficult to stop home monitoring when it is no longer required for their infant. The caregiver has learned to rely on the monitor to provide a comforting reassurance that the child is well.

**Foreign Body Aspiration (FBA)**

FBA remains a persistent problem and an important cause of morbidity and mortality in the pediatric age group. Foreign bodies retained in the airway can be potentially life threatening and can produce severe lung damage.

Quantifying the overall incidence of FBA is difficult, because nearly all foreign bodies aspirated into the respiratory tract are probably expelled immediately by spontaneous coughing and never require medical intervention. However, FBA remains a common cause of mortality and morbidity among children during the first 3 to 4 years of life.

Most episodes occur during eating or play. Commonly aspirated objects include foods such as hot dogs, peanuts, other nuts and seeds, grapes, popcorn, and carrots as well as items such as small plastic toys, marbles, buttons, earrings, and latex balloons. Factors related to a young child's physical and developmental status predispose him or her to the risk of FBA (see Chapters 4 and 5). Young children (particularly those 6 months–2 years of age) explore the environment by putting objects in their mouth and are at highest risk for aspiration. They also have insufficient size and number of teeth to thoroughly chew foods. In addition, they may seek relief from the teething process by chewing on hard objects. Exposure to certain foods thus may be inappropriate for a young child's cognitive and dental stage of development, and may lead to choking and aspiration.

**Pathophysiology**

The pathophysiology of FBA varies depending on the size of the foreign body, the location of the object in the respiratory tract, and the acute or chronic nature of the condition. If an object is too large or of a shape that does not allow it to be expelled by coughing, respiratory symptoms result. Foreign bodies in the upper airway often cause a mechanical or partial obstruction that results in nonspecific respiratory signs and symptoms such as cough, wheeze, stridor, dyspnea (labored or difficult breathing resulting from air hunger), voice changes, cyanosis, retractions, and hemoptysis (coughing blood). At times, a carefully assessed history reveals an episode of coughing, choking, or breathing difficulty that can be traced back to an aspiration event, but on many occasions, the discovery of an FBA is made without ever obtaining such a history.

**Assessment**

The location of the foreign body is a key factor in determining the signs, symptoms, and physical assessment findings (Table 16–3). Although nearly all children who have aspirated a foreign body exhibit a chronic cough, a history of an acute coughing episode, or both, other symptoms vary according to where in the respiratory tract the object is lodged.

Perform a respiratory assessment. The child with a foreign body that lodges in the upper airway, such as the larynx or trachea, usually presents with an acute and rather fierce onset of stridor and respiratory distress necessitating immediate intervention to dislodge the foreign body. A foreign body lodged in the bronchus may act as a ball valve, obstructing the airway perhaps partially on inspiration and completely on expiration. Wheezing localized to one side of the chest on inspiration and diminished breath sounds on expiration result. In children with an esophageal foreign body, the distended esophagus compresses the nearby trachea, thus causing respiratory distress. Physical assessment findings may reveal asymmetry of chest wall movement, and wheezing or diminished breath sounds in a localized area of the lungs. If the obstruction is located in the upper airway, stridor is common.

Radiographs may be normal, may allow clear visualization of the presence of a foreign body, or may show changes related to the foreign body directly or caused by secondary inflammatory changes. Abnormalities are less likely to be noted on chest radiograph for foreign bodies
located above the bifurcation of the mainstem bronchus. Lateral neck films are obtained when this location is suspected.

“Chronically” retained foreign bodies can lead to a marked inflammatory response in the respiratory tract and, possibly, death. The right mainstem bronchus is a common site for foreign body lodgment because of its angle. Airway inflammation and narrowing secondary to edema often occurs. Materials such as nuts, which contain fats, cause an especially intense inflammatory response. Recurrent infections such as lipoid pneumonia or a lung abscess may ensue. Chronic obstruction of air exchange to the alveoli could mimic obstructive emphysema on chest radiographs. Foreign bodies that have been dislodged by coughing can lead to involvement as described here in different lung segments.

**Interdisciplinary Interventions**

Emergency treatment for the choking child includes the use of abdominal thrusts (the Heimlich maneuver) in the child older than 1 year of age and use of back blows and chest thrusts in the infant younger than 1 year. Use these methods in situations in which the aspiration was witnessed or strongly suspected and the child has an ineffective cough with increasing stridor and respiratory distress or has become unconscious and apneic.

In many cases, the object is not coughed up spontaneously and is lodged farther down in the respiratory tree; therefore, the foreign body has to be removed as soon as possible to prevent further airway damage. Rigid bronchoscopy to remove the foreign body after aspiration is the most common medical intervention. This procedure is very safe and effective when carried out by an experienced physician. Rigid bronchoscopy enables removal of the object and any associated inflammatory material; it also provides a means of assessing the condition of the airway.

Nursing care responsibilities for the infant or child undergoing rigid bronchoscopy focus on preoperative preparation and postoperative monitoring. Explain the reason for the procedure to the family. Intravenous hydration, emptying of stomach contents, and preoperative assessment of respiratory status are fundamental nursing interventions. Postoperatively, frequently assess quality and symmetry of breath sounds, vital signs, color, and respiratory effort. Atelectasis, bronchospasm, and pneumothorax all are possible postbronchoscopy complications.

**Community Care**

The psychosocial consequences of an FBA incident vary in intensity, depending on the severity of the event. The most dramatic scenario involves the infant or child with a complete airway obstruction who is experiencing respiratory arrest and requires immediate resuscitation. This experience is extremely terrifying for both the child and the caregivers. Asphyxiation with subsequent brain damage or even death may occur. The grief and guilt that parents and caregivers experience in this situation are tremendous and often incapacitating. Extensive support and counseling services are crucial for these families. Less severe episodes of FBA may also raise feelings of guilt or embarrassment about inadequate supervision or about not recognizing symptoms.

The most effective “therapy” for FBA is prevention. Anyone who works with children should be certified in CPR, including airway obstruction management. Education for parents and other caregivers of infants and young children regarding aspiration risk factors is an essential role for all pediatric healthcare providers. Information on common items aspirated, age groups especially at risk, and developmental and environmental considerations can help parents be more aware of potential dangers and take proper precautions.

Environmental factors such as a high degree of distraction during play and mealtimes, and insufficient adult supervision may also contribute to FBA. Remind parents that watching television during meals can be a dangerous distraction to young children and should be avoided. Caregivers of children at play must be cautioned about being vigilant with small children, to keep them from putting objects in their mouths. Visitors to the home should place purses and other personal items out of reach of the small child. Last, products containing any small, cylindrical components should bear labels discouraging use around young children and should detail the age groups particularly affected.
LOWER RESPIRATORY INFECTIONS AND OBSTRUCTIONS

Lower respiratory infections and obstructions include influenza, bronchiolitis, bronchitis, and pneumonia.

QUESTION: Because Jose has a preexisting condition (asthma), he is at greater risk from respiratory infections. Jose will go to kindergarten next year. What information can the nurse share with Claudia to help her keep Jose from catching lower respiratory infections?

Influenza

Influenza illnesses have been described and defined epidemiologically for centuries. Influenza viral agents were the first proved to be respiratory tract pathogens. Consequently, the terms flu and influenza are perhaps the most overused diagnostic labels for nonspecific infectious conditions in both medical and lay circles. This confusion is probably increased by influenza’s broad range of clinical manifestations and its wide prevalence in the community.

Influenza infection often occurs in epidemics that sweep throughout a community in a matter of 6 to 8 weeks. Thousands of individuals die from influenza infections in the United States each year. Morbidity is highest in susceptible populations, such as infants and persons older than 65 years of age. Children with preexisting conditions such as bronchopulmonary dysplasia (BPD), cystic fibrosis (CF), asthma, and congenital respiratory conditions (e.g., Pierre Robin syndrome) are at increased risk for morbidity and mortality associated with the flu. It is imperative to recognize the elevated vulnerability of this population. The incidence of infection is highest, however, in children of school age.

Pathophysiology

The influenza viruses are large, single-stranded RNA viruses. Influenza viruses have a high affinity for epithelial cells of the respiratory tract mucosa. The virus causes a lytic infection of the respiratory epithelium with a loss of ciliary function, decreased mucus production, and desquamation of the epithelial layer. The incubation period for influenza virus can be as short as 2 to 3 days, and viral replication usually continues for 10 to 14 days after primary infection.

There are three influenza virus types, specific in their protein and antigen composition: influenza A, B, and C. Influenza A and B cause seasonal outbreaks and epidemics. Influenza A causes pandemics (Goldrick & Goetz, 2007). Literally hundreds of subtypes of these categories “shift” their complement of antigens on a regular basis. These mutations largely account for the ability of influenza to produce serious epidemics in populations of people who have been previously immunized or have experienced influenza infection. This regular antigenic shift makes the preparation and distribution of influenza vaccines necessary on an annual basis.

Assessment

Infections with influenza viruses may be manifested by mild, moderate, or severe clinical symptoms. Generally, a child with influenza infection has a more sudden onset of these symptoms than do children with parainfluenza, Respiratory Syncytial Virus or adenovirus infections. Look for fever of sudden onset accompanied by a flushed face, dry throat and nasal mucous membranes with dry cough, sore throat, muscle pain, headache, and malaise. During the acute phase of the illness, the child may be quite ill and require hospitalization if dehydrated or if a secondary infection develops. Fever, sore throat, and headache normally subside in 3 to 5 days, whereas other symptoms, such as fatigue and malaise, may persist for several weeks. Provide supportive interaction to parents to allay anxiety regarding progression of the illness and complications. Children are often disappointed at missing important events and activities, yet they do not have the strength to participate.

Influenza is difficult to distinguish from other respiratory illnesses in children. Most recently, commercial rapid diagnostic tests have been developed that can detect influenza viruses within 30 minutes (Schrag et al., 2006). Diagnostic tests for influenza also include viral culture, serology, rapid antigen testing, polymerase chain reaction, and immunofluorescence assay.

Interdisciplinary Interventions

Community Care 16–2 lists the recommendations for use of inactivated influenza vaccine to prevent influenza in children. The only specific contraindication for the use

COMMUNITY CARE 16–2

Recommendations for Administering the Influenza Vaccine to Children Who Are at High Risk

All Children Age 6 Months to 23 Months

Children with acute or chronic conditions such as

- Chronic pulmonary disease (cystic fibrosis, asthma, bronchopulmonary dysplasia)
- Congenital heart diseases and hemodynamically significant diseases
- Immunosuppression
- Sickle cell disease and other hemoglobinopathies
- Diabetes and other chronic metabolic diseases
- Chronic renal disease
- Symptomatic HIV infection
- Children with cognitive impairments, seizure disorders or neuromuscular conditions

Source: Centers for Disease Control, 2005.
of this inactivated vaccine is anaphylactic hypersensitivity to eggs.

Interventions for children with influenza include supportive care to alleviate or minimize symptoms. Antiviral agents such as zanamivir and oseltamivir may also be used for influenza A or B within certain populations. These agents have shown effectiveness by reducing the influenza course by 1 to 3 days when an early diagnosis is made (Schrag et al., 2006). Administration of acetaminophen every 4 to 6 hours for fever and muscle aches is also beneficial.

Other antipyretic therapies include undressing the child with a persistent fever to permit radiant heat loss and giving tepid sponge baths.

**CaReMinder**

*Do not bathe a shivering child, because the child likely will shiver more and remain febrile.*

Teach parents the signs and symptoms of respiratory deterioration, the signs of dehydration and ways of preventing and treating it, and the reason that aspirin administration is contraindicated in children.

Clear liquids for children and oral rehydration formulas for infants replace losses from fever, tachypnea, and vomiting. Parents should offer oral fluids in small amounts (30–60 mL) on a frequent basis. If the child becomes dehydrated and requires hospitalization, he or she should receive parenteral fluids. Bed rest is important and should be encouraged for the first 3 to 5 days. If the child is home, teach the parents or caregiver what to watch for, such as increased lethargy, excessive vomiting, or respiratory distress that may indicate that the child needs to be seen by a healthcare professional.

**Alert!** Supplemental oxygen may be needed for chronically ill children with an influenza infection because of their poor respiratory reserves and increased propensity to develop hypoxemia.

**CaReMinder**

*Do not bathe a shivering child, because the child likely will shiver more and remain febrile.*

Bronchiolitis is an acute inflammation and obstruction of the bronchioles, the smallest, most distal sections of the respiratory airway network. It generally occurs during the first 2 years of life, with a peak incidence between 2 and 6 months of age. Infant susceptibility may be attributable to the loss of full maternal antibody protection that is universally present at birth and for the first few months of life (Christakis et al., 2005). Premature infants, immunodeficient infants, and those with underlying comorbid conditions such as BPD, CF, or congenital heart disease are extremely vulnerable to respiratory failure and other severe complications of bronchiolitis. Many infants can be managed at home; a few may require hospitalization.

**Pathophysiology**

In bronchiolitis, the bronchioles become narrowed, and some even become totally occluded as a result of the inflammatory process, edema of the airway wall, accumulation of mucus and cellular debris, and smooth muscle spasm. It may also cause thickening of the muscular wall and destruction of ciliated cells. This narrowing of the airway lumen can profoundly decrease airflow. Impaired clearance of secretions and decreased airflow lead to bronchiolar obstruction, atelectasis, and hyperinflation, causing impaired gas exchange that results in hypoxemia. Carbon dioxide retention occurs in the severely affected infant. The illness is self-limiting and generally resolves with adequate intervention.

Acute bronchiolitis most often has a viral cause. In some areas of the United States, bronchiolitis is the most common cause for hospitalization among infants younger than 1 year (Christakis et al., 2005). RSV, which has a high affinity for the respiratory tract mucosa, is the most common cause of bronchiolitis (Cooper, Banasiak, & Allen, 2003; Yorita et al., 2007). This virus is highly contagious and extremely prevalent in communities during the winter and spring months. Nearly all children have been infected with RSV by the age of 2 (Yorita et al., 2007). Respiratory syncytial virus (RSV) is transmitted by direct contact with infected secretions via hands and respiratory droplets. Adults as well as children are infected with RSV disease; thus, the source of viral infection in an infant is usually a family member with a mild respiratory illness. Infections with other viruses, primarily adenovirus, parainfluenza, and influenza, have been associated with bronchiolitis in smaller numbers of cases. In a small percentage of infants with bronchiolitis, suprainfection with a bacterial pathogen can occur.

**Assessment**

Diagnosis of bronchiolitis is made by history and physical examination. Diagnostic criteria include exposure to ill
persons, seasonal timing, and upper respiratory symptoms. The infant with bronchiolitis has typically had an upper respiratory infection for 2 to 3 days. Parents report sneezing and nasal discharge initially, and then the infant develops a harsh, dry cough and low-grade fever. Listen for wheezing on auscultation. The infant may develop increasingly distressed breathing and tachypnea. Inquire about feeding difficulties or loss of appetite caused by nasal congestion and the increased work required to breathe.

Because a major consequence of airway obstruction is impaired gas exchange, the child with bronchiolitis has many of the signs and symptoms of hypoxia and respiratory distress. Note the respiratory rate, which is commonly more than 60 breaths per minute and may be as high as 100 breaths per minute. Look for chest retractions; rhonchi and wheezes or crackles are generally heard in all lung fields. Check for dehydration, which can be severe because respiratory distress often prevents adequate oral fluid intake. In addition, the elevated respiratory rate causes insensible fluid loss (see Chapter 17). When the infant becomes ill during winter months, dry air may further exacerbate the condition.

Hypoxia and hypercarbia result in restlessness and irritability, making the child difficult to console, even by parents. A nasal swab may assist in an RSV diagnosis. A chest radiograph may be done if the child is hypoxic.

**Interdisciplinary Interventions**

The care of a child with bronchiolitis involves respiratory, pharmacologic, and nutritional support (see the Point for Care Paths: An Interdisciplinary Plan of Care for the Child With Bronchiolitis). Infants with moderate to severe respiratory distress caused by bronchiolitis or children experiencing respiratory distress with feeding difficulties are usually hospitalized. Others may require only supportive care at home, although oxygen and bronchodilators may promote ease of breathing. Hospitalized infants with RSV bronchiolitis are at high risk for respiratory failure and may require mechanical ventilation during the acute phase of the illness. Clinical indications for mechanical ventilation include worsening respiratory distress with increased work of breathing, increased heart rate, poor peripheral perfusion, apnea, bradycardia, and hypercarbia. Generally, the most critical phase of the disease is the first 24 to 72 hours.

Because RSV and other causative agents are shed in high titers for days after the onset of the illness, contact isolation to prevent infecting other patients, staff, and family members is strongly recommended. RSV is easily transmitted on hands, clothing, equipment, cribs, and so forth. Limiting child-to-child contact, washing toys between children’s use of them, and careful handwashing are the most effective methods of preventing nosocomial infections.

**Respiratory Support**

Oxygen should be administered to infants with all but the mildest cases of bronchiolitis. The oxygen is optimally humidified and of a concentration sufficient to maintain SaO2 at more than or equal to 92%. The child can be weaned from the oxygen when oxygen saturation levels remain higher than 94% (Cincinnati Children’s Hospital Medical Center, 2006). Continuous pulse oximetry is recommended for infants in acute distress. Take care to document oxygen saturations when the child is awake during quiet time, asleep, and with crying. Desaturations to less than 90% with crying are likely; therefore, close monitoring until saturations return to baseline (more than 92%) is essential. The infant should be suctioned when clinically indicated before feedings, prior to inhalation therapy, and as needed. The use of chest physiotherapy, cool-mist therapy, and aerosol therapy with saline have not been found to be helpful (Cincinnati Children’s Hospital Medical Center, 2006).

**Pharmacologic Support**

Although treatment of bronchiolitis focuses on supportive therapy, pharmacologic interventions may prove effective in certain individuals. These medications include antiviral agents, bronchodilators, and possibly corticosteroids.

Ribavirin (Virazole) is an antiviral agent (also used to treat hepatitis C) that has been demonstrated to reduce the severity of bronchiolitis caused by RSV when administered early during the course of the illness. The drug can be used on the intubated, mechanically ventilated patient as well as the nonintubated patient. In mechanically ventilated infants, most of whom were previously healthy and had no underlying conditions, ribavirin treatment has been demonstrated to be safe and was associated with a reduced need for mechanical ventilation and supplemental oxygen, shorter duration of hospitalization, and cost-effectiveness (Cooper et al., 2003). Other candidates for ribavirin therapy include infants at increased risk for respiratory complications and respiratory failure because of underlying cardiac, lung, or immunodeficiency disease.

**caREminder**

Nurses and respiratory therapists administering ribavirin should wear a specially designed mask to prevent exposure to ribavirin particles released into the air. Although no studies link ribavirin use to defects in human embryos, it is recommended that pregnant personnel wear a mask when in the room of the child receiving ribavirin.

Bronchodilators and corticosteroids have limited effects on a child with bronchiolitis. However, this pharmacologic therapy may assist with respiratory benefits, such as ease of breathing, improved oxygenation, and increased respiratory drive.

Preventive therapies for bronchiolitis are used in limited populations. Children with bronchopulmonary dysplasia (BPD) and congenital heart disease should receive monthly Synagis vaccines during the RSV season.
Nutritional care and Rest

Nutritional care for the infant with bronchiolitis includes supportive fluid and electrolyte replacement. Close monitoring of fluid and electrolyte status, including accurate measurement of intake and output with urine specific gravities, is essential to assess for dehydration.

Reminder

In the case of severe respiratory distress or a respiratory rate of 60 breaths per minute or more, the infant should have nothing by mouth, and fluid should be given intravenously.

Infants hospitalized with acute bronchiolitis are using all their energy to breathe. These infants are too uncomfortable to respond to the social stimuli they are accustomed to, such as television or interaction with siblings. Minimizing energy expenditure and oxygen consumption should remain a primary goal of therapy until oxygen saturation levels are continuously within normal limits. Soothing activities, such as play with musical toys and holding and rocking by parents, will help the infant relax. As the child’s condition improves, quiet play activities may be gradually reintroduced.

Respiratory distress or air hunger creates anxiety in both infant and parents. The irritable, crying, inconsolable infant is unable to drink fluids and is exhausting to care for. Parents are often suffering from frustration and worry, as well as being completely exhausted at the time of admission to the hospital. These parents need the opportunity to express their feelings and receive support. Nurses or social service personnel are the ideal members of the healthcare team to provide these interventions to the family of an ill infant.

Community Care

Caregivers play an active role in health management, because most children are not hospitalized and do not require 24-hour care by the healthcare team. Parental or caregiver education is essential, especially if the child is not hospitalized and is cared for at home. Teach the parents to recognize the signs of increasing respiratory distress, such as grunting, retraction, pallor, and cyanosis, and state appropriate actions to take. Also instruct how to count the respiratory rate for a full minute, during both sleep and awake times. Encourage parents to promote fluid intake, to measure and record the infant’s oral intake during the illness, and to observe for signs of dehydration. Other issues relevant to the care of the infant with bronchiolitis in the home include positioning with the head of the bed elevated for comfort and to facilitate removal of secretions, and quiet play activities as the child’s energy level permits. Encourage parents to call their healthcare provider if they have any doubts about their infant’s respiratory status. Teach families respiratory infection control measures, such as washing hands, avoiding exposure to illness, and staying current with routine immunizations. Additional preventive measures include eliminating exposure to cigarette smoke and limiting contact with crowded areas and other children (e.g., daycare).

Bronchitis

Bronchitis is defined as a transient inflammatory process involving the distal trachea and major bronchi. The pharynx and nasopharynx may also be involved; the laryngeal and subglottic regions are not. Bronchitis can be acute, chronic, or recurrent.

As with most viral respiratory infections, the peak incidence is in winter and early spring. The disease appears to be more common in younger children and in males. In the child with a competent immune system, bronchitis usually has a viral cause.

Pathophysiology

Most episodes of acute bronchitis caused by bacteria occur as secondary infections while airways are vulnerable after a prior viral attack or other insult. Although exposure to irritants such as gastric acid or passive smoke and environmental pollutants can produce acute symptoms, these insults contribute more commonly to symptoms in children with reactive airways (see Asthma). Chronic and recurrent bronchitis in children are conditions that are not clearly understood. Viral or bacterial agents attack the airway mucosa. Pathologic changes commonly seen in chronic bronchitis in childhood include thickened bronchial walls, mucous gland hypertrophy, and chronic inflammation. The ciliated epithelium becomes damaged, mucous gland activity increases, and neutrophils infiltrate the airway wall and lumen. This process accounts for what sometimes appears to be purulent sputum, in the absence of a bacterial infection. Mucociliary transport is disrupted, and this stasis contributes to secondary bacterial infection. Because these characteristics are commonly seen in asthmatic patients as well, a pathologic link between the two conditions is suspected (Table 16–4) (Jartti, Mäkelä, Vanto, & Ruuskanen, 2005).

Chronic bronchitis in children may be a symptom of an underlying pulmonary disorder and may be an important factor in predisposing the child to chronic respiratory symptoms and lung dysfunction even into the adult years.

Assessment

Take a careful history. The onset of viral bronchitis is generally gradual, beginning with upper respiratory symptoms such as rhinitis and a minimal cough. Three to 4 days later, the cough becomes more pronounced. Note the quality of the cough; a bronchial cough begins as dry and nonproductive, and progresses to become looser and more productive. Auscultation of the chest may be unremarkable during the early stages; rhonchi and wheezing may be heard as the cough progresses. Low-grade fever (<101 °F [38.3 °C]) is common. Young children generally swallow the mucus, often resulting in vomiting and paroxysmal coughing. During the recovery phase of the last 7 to 10 days, the cough subsides, and the fever resolves. If
the cough or fever persists beyond 2 weeks, suspect a secondary bacterial infection and refer the child for appropriate medical treatment.

**Interdisciplinary Interventions**

Treatment for acute bronchitis is largely supportive. Adequate rest and humidification of room air improve comfort. Exposure to irritants such as cigarette smoke should be strictly avoided. A productive cough is common. Therefore, the use of cough suppressants should be discouraged to enable the child to cough and expectorate. Reserve antibiotics for conditions in which a bacterial infection has been confirmed by culture. Acetaminophen may be administered to help reduce the fever. Bronchodilators, such as albuterol, corticosteroids, or both may be considered to reduce airway inflammation and constriction, and to improve ease of breathing.

Comfort the child with acute bronchitis and monitor for respiratory distress. Focus nutritional support on maintaining adequate hydration. Encourage the child to drink plenty of fluids and eat foods such as ice pops, fruit ices, broth, and Jell-O to prevent dehydration. The child’s appetite for foods is usually diminished, and post-tussive emesis is common. Small frequent feedings (or clear liquids if vomiting is frequent) are appropriate for the acute phase of the illness. As cough diminishes, regular diet may be gradually resumed.

**Community Care**

Quiet activities such as watching television, playing with puzzles, and reading books are recommended for the toddler or school-aged child while recovering from bronchitis. Allowing for adequate rest is an important consideration, because frequent coughing may disrupt sleep. After the first few days, when the child is feeling better, school homework should be resumed. The child may return to school when he or she receives adequate rest at night, is not coughing, and is afebrile. Normal energy level may not be restored for several days to weeks. Teach parents and caregivers that the child must be protected from passive smoke and other environmental pollutants, because such conditions may lead to a
repeated bronchitis episode. Dust and allergy proofing the home environment, especially sleeping quarters, helps prevent subsequent recurrences (see Community Care 16–2).

**Pneumonia**

The term *pneumonia* describes any inflammatory condition of the lung parenchyma, resulting most frequently from infection, in which the alveoli are filled with fluid, blood cells, or both, and oxygen exchange is impaired. Pneumonia can be a primary illness (often called *community-acquired pneumonia* or *CAP*) or can develop as a complication of another respiratory infection or underlying illness. It is distinguished from the more common upper respiratory tract infections by the presence of lower respiratory tract signs and symptoms such as tachypnea, rales, and associated areas of infiltration on chest radiographs.

The annual incidence of pneumonia is 34 to 40 cases per 1,000 in children younger than 5 years of age (Taylor, 2003). Although this incidence is not high, pneumonia is a major cause of morbidity and mortality in children worldwide. Most deaths from pneumonia occur in third world countries, yet pneumonia also remains an important factor in morbidity in developed countries, especially among the chronically ill pediatric population.

The causes of pneumonia in children vary depending on the season and the child’s age and health status. Pneumonia most likely develops when the body is unable to defend against infectious agents. Infectious agents may be viruses, bacteria (Chart 16–1), mycoplasma, fungi, chemicals, foreign substances, or various other organisms or materials. Newborn infants acquire pneumonia pathogens by several means. Transplacental infection, aspiration of organisms during passage through the birth canal, and contact with humans or contaminated equipment immediately after birth are the most common mechanisms. After 1 month of age, viruses become the most common cause of pneumonia. Bacterial pneumonias occur year-round but are most common during the winter months (Cooper, Banasiak, & Allen, 2003).

Children with chronic illnesses, such as asthma, BPD, or CF, often develop recurrent or persistent pneumonias because of respiratory compromise. Immunodeficiencies, congenital heart disease, neuromuscular diseases, and various hematologic and oncologic diseases all are conditions that can render the child compromised in the ability to fight pneumonias and other infections.

Not all inflammation of the lung is infectious in origin. Pneumonia can be caused by aspiration of foreign substances. Gastroesophageal reflux with aspiration, smoke inhalation, hydrocarbon ingestion, aspiration of baby talcum powder, near-drowning, and some autoimmune processes (such as pulmonary hemosiderosis) all can result in a pneumonialike syndrome.

**Pathophysiology**

Although the term *pneumonia* refers to a multitude of disorders that differ widely depending on causative agent, each involves an inflammatory response. The respiratory tract is normally equipped with a variety of natural mechanisms to guard the lungs against infection. The nose filters air, the cough reflex expels objects or organisms in the laryngeal airway, and cilia in the walls of the trachea and bronchi trap small particles and remove them in mucus. When any of these defenses is impaired, pathogens invade and initiate the inflammatory response.

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**CHART 16–1  COMMON VIRAL AND BACTERIAL CAUSES OF PNEUMONIA**

<table>
<thead>
<tr>
<th>Causative Agent</th>
<th>Age</th>
<th>Season</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Viral</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Respiratory syncytial virus</td>
<td>Infants, young preschool</td>
<td>Winter</td>
</tr>
<tr>
<td>Parainfluenza viruses 1 and 2</td>
<td>Preschool</td>
<td>Fall</td>
</tr>
<tr>
<td>Parainfluenza virus 3</td>
<td>Infants and preschool</td>
<td>Spring</td>
</tr>
<tr>
<td>Influenza viruses A and B</td>
<td>Preschool, school age</td>
<td>Winter</td>
</tr>
<tr>
<td>Adenoviruses</td>
<td>All ages</td>
<td>Year-round</td>
</tr>
<tr>
<td><strong>Bacterial</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chlamydia pneumoniae</td>
<td>Acquired during birthing process</td>
<td>Year-round</td>
</tr>
<tr>
<td>Mycoplasma pneumoniae</td>
<td>School age</td>
<td>Year-round with peaks in fall and early winter</td>
</tr>
<tr>
<td>Streptococcus pneumoniae</td>
<td>Acquired during birthing process</td>
<td>Year-round</td>
</tr>
</tbody>
</table>
Viral pathogens enter the upper respiratory tract and spread through the airways. The severity of the inflammatory response and the associated pathophysiology vary. Characteristic features include loss of alveolar cell wall integrity, resulting in accumulation and stasis of fluid and mucus, and smooth muscle contraction. These changes obstruct airflow and cause ventilation-perfusion mismatch, a condition in which the diminished alveolar-capillary gas exchange is no longer adequate for the blood supply, thus resulting in hypoxia and hypercapnia.

Bacteria are introduced into the lungs through the inhalation of infectious droplets or through the bloodstream. Alveolar involvement in bacterial pneumonia is characteristically more intense than that seen in viral infections. The alveoli can fill rapidly with proteinaceous fluid, causing ventilation-perfusion mismatch, or bacterial agents can cause necrosis of intra-alveolar septa, causing abscesses and destruction of lung architecture.

Similar processes occur in aspiration pneumonia. When gastric contents, secretions, blood, or volatile chemical compounds enter the lung, the presence of one or more of these irritants initiates the characteristic inflammatory response. Gastroesophageal reflux is associated with pneumonia when the acidic contents enter the pharynx, where, if protective mechanisms fail, it is aspirated. Baby talcum powder and other fine-particle materials inhaled into the pharynx and lower airways precipitate tissue inflammation. Hydrocarbons (organic solvents found in gasoline, furniture polish, cleaning compounds, lighter fluid, paint thinner, kerosene, and other substances) aspirated into the alveolar space dissolve surfactant lipids and impair surface tension, thereby reducing activity of surfactant. Alveolar cell damage, edema, granulocyte infiltration, hemorrhage, and necrosis can result. Smoke inhalation also can cause chemical irritation, depending on the source of the smoke.

Assessment

Pneumonia, regardless of etiology, is generally distinguished from less severe respiratory tract infections by the type of cough (sputum producing, rather than dry and hacking) and by tachypnea, crackles, and cyanosis. Although distinguishing viral from bacterial pneumonia by clinical manifestations alone usually is not possible, understanding the characteristic presentation of each is important.

Viral pneumonia typically has a gradual onset, beginning with an upper respiratory tract infection of 3 to 4 days’ duration. This initial illness may include low-grade fever and rhinorrhea, with a gradual development of cough and increasing respiratory distress. The child in respiratory distress may manifest cyanosis, grunting respirations, retractions, coarse crackles, or wheezing.

Bacterial pneumonia has a more acute pattern of onset. Suspect bacterial pneumonia in a child with symptoms already listed, plus a cough that produces thick green, yellow, or blood-tinged sputum, and an overall appearance of lethargy and malaise. Chest pain may also be present. Fever and increased respiratory rate are hallmark manifestations of bacterial pneumonia. Check for dehydration stemming from poor oral intake and increased insensible fluid losses from fever and tachypnea, tachycardia, hypotension, and poor perfusion may indicate sepsis and early shock.

The young child with fever, retractions, tachypnea, or grunting will be irritable and difficult to console. Hypoxia and hypercapnia result in decreased level of consciousness in a child of any age. Be ready to help parents cope with anxiety related to the often severe acute onset of respiratory symptoms.

Families of children with chronic conditions live with constant concerns regarding exposure to a potentially fatal infection and may exhibit and act on feelings of guilt and anger upon diagnosis of pneumonia. Counseling and support for these families during acute illness episodes is imperative.

Culture confirms the diagnosis of bacterial pneumonia. Common bacterial pathogens include S. pneumoniae, H. influenzae, S. aureus, group B streptococci, Chlamydia pneumoniae, and M. pneumoniae. Chest radiographs may be used to determine the lung fields affected by the pneumonia or if additional problems exist (e.g., atelectasis, pleural effusions).

Interdisciplinary Interventions

Interventions for pneumonia involve careful assessment of respiratory status and general supportive care (see the Point, for Care Paths: An Interdisciplinary Plan of Care for the Child With Pneumonia). Whether a child with pneumonia requires hospitalization depends on age, general health status, and the suspected organism. Because infants readily develop respiratory distress with accompanying hypoxia, apnea, poor feeding, and dehydration, hospitalization is common.

For the hospitalized child, careful and frequent respiratory assessment, including evaluation of respiratory rate and effort, color, presence and location of retractions, breath sounds, and oxygen saturation levels, is required for the infant or child with pneumonia. Report changes in respiratory status immediately for further medical evaluation. Suplemental oxygen may be needed to keep saturation levels more than or equal to 92%. For some children, continuous pulse oximetry is indicated. Implement chest physiotherapy (percussion, vibration, and postural drainage) to facilitate clearing of secretions, with special attention paid to any identified areas of involvement or infiltration on the chest radiograph (see Treatment Modalities earlier in this chapter).

In most viral pneumonia cases, especially in infants, antibiotics are given because secondary bacterial involvement cannot be ruled out. Many experts consider this approach the safest and most practical, although it may not alter the course of the illness. Infants are generally treated with broad-spectrum antibiotics such as ampicillin and an aminoglycoside. Specific antiviral therapy for RSV (ribavirin) is considered for infants and children with chronic illnesses (see Bronchiolitis).

caREminder

Children in severe respiratory distress should receive nothing by mouth because of the increased work of breathing and the risk of aspiration.
Fluids and medications are administered by the intravenous route. Fever and tachypnea result in insensible fluid loss; thus, the child with pneumonia is at risk for dehydration. Intake and urine output, and urine specific gravity are measured frequently, and skin turgor is assessed to monitor hydration status. Body temperature is monitored, and fevers are treated with acetaminophen, because a high body temperature can increase oxygen requirements and exacerbate insensible fluid loss. As respiratory status improves, the diet can be advanced from clear liquids to regular diet as tolerated. For recurrent aspiration pneumonia, suck and swallow coordination and gastroesophageal reflux may be evaluated to identify risk for aspiration before full oral feedings are resumed. If oral intake is allowed, feedings should be given with caution, to avoid aspiration.

The child and family require constant information and support from all health professionals during an acute pneumonia episode. Social services may provide counseling services or referrals in the event of life-threatening or chronic illness. After the child’s condition becomes more stable, parents, nurses, and child life specialists should collaborate in planning quiet diversionary activities appropriate for age.

Community Care

Home health support for parents who must learn to perform respiratory assessment and administer medication is an option for the older child being treated at home. Children with pneumonia are usually evaluated in an ambulatory care setting 2 to 3 weeks after treatment is completed, to ensure that their respiratory symptoms are fully resolved or, if a chronic condition exists, to ensure that they are being managed effectively at home. Repeat chest radiographs may be completed to evaluate persistent symptoms or confirm complete recovery.

CHRONIC CONDITIONS OF THE RESPIRATORY SYSTEM

Chronic conditions of the respiratory system can have a serious affect on children and adolescents, and may substantially alter their quality of life and physical and social development (see Chapter 12 for a more extensive discussion of the affect of chronic conditions on the child and the family). Such conditions can affect all other aspects of the child’s and family’s physical and emotional health, and can lead to development of comorbid conditions, increased risks for morbidity, and, at times, early death. The most common chronic conditions seen in childhood and adolescence are asthma, BPD, and CF. Chronic pulmonary conditions during childhood and adolescence are characterized by periods of relative wellness interspersed with periods of acute exacerbation, often necessitating healthcare interventions (e.g., ambulatory care visits, emergency room visits, or hospitalization). Although no “cures” exist for these chronic conditions, self-care management is essential. Extensive child and family education is required, related to prevention, recognition of symptoms, early and ongoing medical treatments, and optimization of self-care and home care strategies.

Asthma

Asthma is defined by the National Heart, Lung and Blood Institute (2007) as the following:

A chronic inflammatory disorder of the airways in which many cells and cellular elements play a role; in particular, mast cells, eosinophils, neutrophils (especially in sudden onset, fatal exacerbations, occupational asthma, and patients who smoke), T lymphocytes, macrophages, and epithelial cells. In susceptible individuals, this inflammatory process causes recurrent episodes of coughing (particularly at night or early in the morning), wheezing, breathlessness, and chest tightness. These episodes are usually associated with widespread but variable airflow obstruction that is often reversible either spontaneously or with treatment. (p. 9)

During childhood and adolescence, pediatric asthma can have a profound effect on growth and development, and on the daily lives of families. During the past few decades, assessment, management, and self-care strategies for children and adolescents with asthma have resulted in increased longevity, along with an increased shift from hospital to home care. Significant advances in evidenced-based management guidelines, pharmacologic products, and durable medical equipment have resulted in improved disease outcomes and quality of life for these children and their families. Comprehensive asthma management programs that address important issues such as accurate diagnosis, patient and family education, environmental control, and early treatment of asthma exacerbations have been shown to significantly improve the overall health of children with asthma (Liu and National Institutes of Health, 2004; National Heart, Lung and Blood Institute, 2007). The following discussion of asthma incorporates the most recent management guidelines provided by the National Heart, Lung and Blood Institute. A complete version of the guidelines is available at http://www.nhlbi.nih.gov/guidelines/asthma. The four components of care presented in the guidelines and discussed in this section include

1. Assessment and monitoring
2. Education
3. Control of environmental factors and comorbid conditions
4. Medications

QUESTION: In following discussion, does Jose represent the typical incidence and prevalence of asthma in children?

Pediatric asthma is the single largest public health burden, with more than 6.5 million children and adolescents with asthma in the United States (National Heart, Lung and Blood Institute, 2007). Asthma is the third leading cause of hospitalization among children younger than 15 years of age. It is the leading cause of school absenteeism caused by a chronic condition (Asthma and Allergy Foundation of America, 2008).
Pathophysiology

The pathology of asthma is best described as a condition characterized by reversible (in most cases) changes in the airway that lead to bronchoconstriction, airway hyperresponsiveness, and airway edema. At a cellular level, mast cells in the airways release inflammatory and chemotactic mediators, such as histamine, causing smooth muscle contraction and bronchoconstriction. Increased mucus secretion by goblet cells causes epithelial damage. The increase in mucus secretion then leads to increased permeability and sensitivity to inhaled allergens, irritants, and inflammatory mediators. The result is airway edema, mucus hypersecretion and plugging, and substantial airway narrowing, leading to rapid airway obstruction (Fig. 16–16). This acute reaction, called the early asthmatic response, generally resolves with bronchodilator treatment within 1 to 3 hours.

“Remodeling” or permanent changes in the airway may occur. Persistent changes in the airway structure, such as subbasement fibrosis, mucous hypersecretion, injury to epithelial cells, smooth muscle hypertrophy, and angiogenesis, may occur (National Heart, Lung and Blood Institute, 2007, p. 9).

The physiologic changes that occur during an acute episode contribute to the clinical findings characteristic of asthma exacerbation. Air becomes trapped behind the narrowed airways and the functional residual capacity increases, causing hyperinflation of the lungs, which can be seen on a chest radiograph. This hyperinflation helps keep the airways open that are already narrowed from bronchoconstriction, mucosal edema, and mucus. The accessory muscles of respiration help to maintain the lungs in a hyperinflated state; therefore, the child has chest retractions. Hypoxemia results from ventilation–perfusion mismatch, because areas of the lung are not being well ventilated.

A key development in the study of asthma has been the recognition that a late asthmatic response also occurs. Mediator release from the mast cells causes direct migration and activation of inflammatory infiltrates, predominantly eosinophils and neutrophils, and mast cell degranulation causes the release of leukotrienes and prostaglandins, which leads to further inflammation. Airway response in the form of obstruction can occur 4 to 6 hours later and can last 24 hours or more. The late asthmatic response has a number of features characteristic of chronic asthma: reduced responsiveness to bronchodilators, increased mucus secretion, heightened airway responsiveness, and the development of airway inflammation. With the onset of the late asthmatic response, a vicious self-perpetuating cycle of asthma symptoms ensues.

The precise cause of the inflammatory response seen in asthma is yet to be discovered. Three potential causes include innate immunity, genetics, and environmental factors. Innate immunity refers to the balance between Th1-type and Th2-type cytokine responses in early life. Numerous factors are believed to affect this balance and potentially lead to immune changes in which the Th1 immune response that fights infection is dominated by Th2 cells, leading to the expression of allergic diseases and asthma. It is hypothesized that exposure to other children, less frequent use of antibiotics, and “country living” are factors that enhance the Th1 response and lower the incidence of asthma (National Heart, Lung and Blood Institute, 2007, p. 10).

Scientific evidence exists that asthma is partly hereditary. Studies have shown that the risk of having an asthmatic child is significantly greater when one or both parents have asthma than if neither parent is affected (Ober, 2005). Atopy (an increased predisposition to form antibodies on exposure to common environmental antigens) is present in most patients with asthma. Atopy is at least partially hereditary, although exposure to certain allergens early in life (e.g., pollens, animal dander) may influence the development of asthma in a child who is genetically predisposed.
Food allergens, however, are rarely responsible for airway reactions in children. Although the link between asthma and atopy is not completely clear, exposure to allergens may cause airway inflammation and may lead to increased airway responsiveness.

Other factors felt to be involved in the development of airway reactivity and asthma include respiratory infections and environmental pollutants (many of which may be seasonal in nature; see Tradition or Science 16–2). RSV bronchiolitis, for example, has been causally linked to enhanced airway reactivity, especially in children with a family history of atopy. Indoor air pollutants play a major role in asthma exacerbations, and outdoor air pollutants have been found to reduce lung function in children in cities with high levels of outdoor air pollution (Gauderman et al., 2004).

Assessment

**Question:** The peak expiratory flow rate (PEFR) is an important assessment tool. Why would the nurse assessing Jose in the emergency department not obtain a PEFR?

According to National Heart, Lung and Blood Institute (2007) guidelines, a careful history is one of most important elements in evaluating the child. Historical data can identify possible high-risk patients and assist in planning for appropriate interventions. The key information to compile is listed in Focused Health History 16–2. The history can help to rule out other conditions that may present with cough, wheezing, and shortness of breath. Additionally, if the child presents with recurring episodes, the history can identify possible precipitating factors and treatments that have been effective in the past.

Suspect asthma in a child with wheezing and varying degrees of respiratory distress. And, for many children a history of chronic cough (worse at night) is a classic symptom. The hallmark manifestation of asthma is the result of airway obstruction. The child may present with a worsening cough and wheezing, and may complain of chest tightness (Clinical Judgment 16–2). Because of bronchospasm, airway inflammation, and mucous plugging, expiration becomes increasingly difficult, and there is air trapping. The child with a persistent asthma exacerbation may be unable or unwilling to lie flat because breathing is more difficult in this position.

The National Heart, Lung and Blood Institute (2007) guidelines suggest using multiple measures of the child’s level of current impairment (frequency and intensity of symptoms, low lung function, and limitations of daily activities) and future risk (risk of exacerbations, progressive loss of lung function, or adverse side effects from medications) to assess the child’s status. Some children can be at high risk for frequent exacerbations even if they have few day-to-day effects of asthma. Some children may have early or prodromal signs and symptoms hours to days before an asthma exacerbation.

**EVIDENCE-BASED PRACTICE**

Environmental pollutants such as tobacco smoke have been clearly linked to asthma exacerbations in children (Centers for Disease Control, 2006; Institute of Medicine Committee on the Assessment of Asthma and Indoor Air, Division of Health Promotion and Disease Prevention, 2000). In children with asthma, parental (particularly maternal) smoking has been associated with increases in symptom severity and hospitalizations. Exposure rates among children are high, with approximately 60% of children age 3 to 11 years in the United States exposed to secondhand smoke (Centers for Disease Control, 2006). In 2002, the Centers for Disease Control estimated that more than $157 billion in annual economic costs and more than 440,000 premature deaths were attributable to secondhand smoke. The relationship of secondhand smoke exposure to the development of asthma is less well defined; however, some research has suggested that maternal smoking may cause alteration in the developing lung before birth (Institute of Medicine Committee on the Assessment of Asthma and Indoor Air, Division of Health Promotion and Disease Prevention, 2000).

Focus the physical examination on general health, including growth and development, hydration status, and any signs of drug-related side effects.

Hypoxemia is universal in the child with moderate to severe symptoms. Monitor blood gases. Carbon dioxide retention is also a common finding. Hypoxemia and hypercarbia result from air trapping in the alveoli and ventilation–perfusion mismatch. A PaCO2 level more than 50 mm Hg indicates ventilatory failure unless the child has a preexisting chronic lung disease. Review radiograph reports. Typical radiograph findings in the child with extensive asthma symptoms are hyperexpansion, atelectasis, and a flattened diaphragm. Younger children are particularly prone to develop atelectasis because of their small airways and underdeveloped collateral ventilation. Infiltrates and pneumothoraces are uncommon findings.
Monitor blood pressure. Pulsus paradoxus (a decrease in systemic blood pressure with inspiration) occurs because the negative pleural pressures become more negative as a result of lung hyperinflation. A decrease of 12 mm Hg or more in systolic blood pressure with inspiration rather than with expiration indicates moderate distress. A decrease of 20 mm Hg or more occurs in severe asthma exacerbations. Pulsus paradoxus may be difficult to assess in the young child because of rapid heart and respiratory rates. In the preverbal child, also evaluate the quality of the cry (weak vs. lusty).

Diagnostic studies helpful in evaluating the child with asthma symptoms include spirometry, PEFR, pulmonary function tests, bronchoprovocation (with methacholine, histamine, cold air, or exercise), arterial blood gases, pulse oximetry, and chest radiographs (see Tests and Procedures 16–1 earlier in this chapter). In addition, examination of biomarkers of inflammation are demonstrating promise as useful tools for diagnosis and assessment of asthma. Biomarker assessment includes total and differential cell count; and mediator assays of sputum, blood, urine, and exhaled air (National Heart, Lung and Blood Institute, 2007, p. 12).

Spirometry is used to obtain objective measures of lung function. During the initial assessment, spirometry helps to establish a diagnosis of asthma. Spirometry is also recommended after treatment is initiated and peak inspiratory function is stabilized, during periods of progressive or prolonged loss of asthma control, and finally, as an assessment tool every 1 to 2 years to evaluate response to therapy.

In contrast, peak flow meters are used to measure PEFR and are designed for monitoring purposes rather than diagnostic purposes. PEFR is considered a valuable measurement in assessing asthma severity and in evaluating response to therapy. PEFR is the greatest velocity of
flow that can be generated in forced expiration, starting
with fully inflated lungs. Evaluate PEFR in a serial man-
ner using a peak flow meter and compare it with the base-
line or “personal best” for the individual, rather than
with normal values. PEFR decreases as airway obstruc-
tion and inflammation worsen (Fig. 16–17). Children
younger than 5 years of age are generally not able to per-
form PEFR tests, and they may be too stressful for the
child in severe distress, potentially worsening his or her
status (see the Point4 for Procedures: Use and Care of
Peak Flow Meters and Spacers).

ANSWER: Two rationales support the nurse’s deci-
sion not to try to obtain a PEFR. One is Jose’s level of re-
spiratory distress and the other is Jose’s age. Jose is working
very hard just to ventilate himself. Asking him to focus on a
diagnostic procedure could precipitate a worsening of his re-
spiratory distress. As a 4-year-old, Jose may be able to pro-
vide baseline PEFR values on a good day, and this may be a
valuable daily activity for his mother to track. During a stress-
ful event, children rely on earlier coping skills and asking a
preschooler to perform a complex task at a very stressful time
is unlikely to be successful.

Interdisciplinary Interventions
The National Heart, Lung and Blood Institute (2007, p. 4)
has identified the two primary goals of asthma therapy as

- Reduce impairment (prevent chronic symptoms, require
infrequent use of short-acting beta2 agonist, maintain
[near-] normal lung function and normal activity levels)
- Reduce risk (prevent exacerbations, minimize need for
emergency care or hospitalization, prevent loss of lung
function, prevent reduced lung growth [for children],
have minimal or no adverse effects of therapy)
As previously mentioned, these goals are accomplished through an interdisciplinary plan that includes assessment and monitoring, education, control of environmental factors, and careful selection of medication and delivery devices to meet the child’s needs and individual circumstances. The following section discusses these care components as well as the management and treatment of exacerbations.

Effective asthma management enables children to pursue active lifestyles both at home and at school, and to enjoy sleep uninterrupted by asthma symptoms. However, attaining this goal requires special attention to children’s unique physiologic states (different from the adult), growth and development, and maturing self-care abilities in light of the tasks of effective asthma management. These tasks must also be continued while in other environments, such as the school or recreational activity settings.

**Assessment and Monitoring**

**QUESTION:** Does the case study regarding Jose in Chapter 10 provide enough information to classify the severity of his asthma?

Assessment for purposes of diagnosis are discussed in the preceding section. This section discusses the ongoing assessment and monitoring of the child with asthma. Activities associated with assessment and monitoring include assessing the asthma severity to initiate treatment, assessing asthma control and adjusting therapy as needed, and ensuring the child is periodically monitored by the healthcare provider.

Severity classification of asthma is based on symptom frequency, nighttime symptoms, character and frequency of exacerbations, and lung function variability before treatment. When asthma is well controlled, the child’s overall asthma severity is classified as intermittent or persistent (mild, moderate, or severe) and a “stepwise” approach to managing asthma is used to adjust therapy. Therapy is initiated depending on the child’s age group and the assessed degree of impairment and risk. Impairment refers to the frequency and intensity of symptoms and functional limitations being experienced by the child. Risk refers to the likelihood of asthma exacerbations, progressive decline in lung function, or risk of adverse effects of medication (National Heart, Lung and Blood Institute, 2007). Tables 16–5 to 16–10 provide an overview, by age (0–4 years, 5–11 years, and youths ≥12 years) of the National Heart, Lung and Blood Institute guidelines for initiating therapy and adjusting therapy. In addition, the tables provide the stepwise approach to increase therapy (stepped up) or decrease therapy (stepped down) as indicated by the child’s condition.

Assessment of the child with asthma begins by classifying asthma severity. If the child is presenting with symptoms, identify the precipitating factors for the current episodic symptoms (e.g., child was exercising at school, child spent night at friend’s house where cats are present). Determine whether comorbid conditions exist that may affect asthma management, such as sinusitis, obesity, or stress. Last, assess the child’s knowledge and skills for self-management (National Heart, Lung and Blood Institute, 2007).

Monitoring of the child includes an evaluation of the child’s daily peak flow monitoring records and using spirometry to assess current status. Samples of peak flow monitoring charts are provided by National Heart, Lung and Blood Institute or makers of peak flow meters, and can be downloaded from the Internet.

Schedule follow-up visits for the child. The child is seen at 2- to 6-week intervals while gaining control of asthma symptoms, at 1 to 6 months after asthma control is achieved and to ensure control is maintained, and at 3-month intervals if a step-down therapy is anticipated (National Heart, Lung and Blood Institute, 2007).

**ANSWER:** Jose is on albuterol and cromolyn sodium morning and evening. In addition, he has another recent episode of an exacerbation of his asthma. However, we still do not have a clear picture of his incidence of daytime and nighttime symptoms.

**Education**

**QUESTION:** What is the role of the nurse regarding the education about Jose’s asthma?

A primary goal of asthma management is to ensure the child and the family have the tools and knowledge to self-monitor and manage the child’s condition. Education focuses on promoting optimal physical growth and function by minimizing airway obstruction, maximizing physical function despite airway obstruction, and preventing and treating exacerbations and complications of asthma and its therapy. The child should also achieve and maintain normal psychosocial growth and function by maintaining optimal psychosocial development and maximal participation in his or her own healthcare. To promote optimal family functioning, these interventions are integrated into the normal daily lifestyle of the family.

Child and family education must be an integral part of asthma care. Parents and children with asthma often have a poor or incomplete understanding of the disease and its management, and this lack of knowledge may lead to increased need for hospitalization and increased healthcare costs. Self-care management in children and adolescents depends on the individual’s cognitive abilities, maturity, and fine and gross motor skills to manage the daily responsibilities of asthma care. Cognitive and language abilities will affect how well the child is able to perceive and communicate changes in breathing patterns. Both the parents and the child should assess daily for asthma symptoms, such as increased cough, wheezing, shortness of breath, or irritability, then initiate additional therapy as instructed. Beginning in the preschool years,
### Table 16-5

**Classifying Asthma Severity and Initiating Therapy in Children**

<table>
<thead>
<tr>
<th>Components of Severity</th>
<th>Intermittent</th>
<th>Ages 0–4</th>
<th>Ages 5–11</th>
<th>Ages 0–4</th>
<th>Ages 5–11</th>
<th>Ages 0–4</th>
<th>Ages 5–11</th>
<th>Ages 0–4</th>
<th>Ages 5–11</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Symptoms</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nighttime awakenings</td>
<td>0</td>
<td>0–2/week</td>
<td>1–2/week</td>
<td>3–4/week</td>
<td>&gt;1/week</td>
<td>3–4/week</td>
<td>&gt;1/week</td>
<td>&gt;1/week</td>
<td>&gt;1/week</td>
</tr>
<tr>
<td>Short-acting beta-agonist use for symptom control</td>
<td>0</td>
<td>0–2/week</td>
<td>1–2/week</td>
<td>3–4/week</td>
<td>&gt;1/week</td>
<td>3–4/week</td>
<td>&gt;1/week</td>
<td>&gt;1/week</td>
<td>&gt;1/week</td>
</tr>
<tr>
<td>Interference with normal activity</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>Minor limitation</td>
<td>Some limitation</td>
<td>Extremely limited</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Lung Function</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FEV1 (predicted) or peak flow (personal best)</td>
<td>N/A</td>
<td>&gt;80%</td>
<td>&gt;80%</td>
<td>&gt;80%</td>
<td>&gt;80%</td>
<td>&gt;80%</td>
<td>&gt;80%</td>
<td>&gt;80%</td>
<td>&gt;80%</td>
</tr>
<tr>
<td>FEV1/FVC</td>
<td></td>
<td>&gt;85%</td>
<td>&gt;85%</td>
<td>&gt;85%</td>
<td>&gt;85%</td>
<td>&gt;85%</td>
<td>&gt;85%</td>
<td>&gt;85%</td>
<td>&gt;85%</td>
</tr>
<tr>
<td><strong>Risk</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exacerbations requiring oral systemic corticosteroids (consider severity and interval since last exacerbation)</td>
<td>0-1/year (see notes)</td>
<td>2 exacerbations in 6 months</td>
<td>2 exacerbations in 6 months</td>
<td>2 exacerbations in 6 months</td>
<td>2 exacerbations in 6 months</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Relative annual risk may be related to FEV1</td>
<td>Relative annual risk may be related to FEV1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Notes:**

- Level of severity is determined by both impairment and risk. Assess impairment domain by caregiver’s recall of previous 2–4 weeks. Assign severity to the most severe category in which any feature occurs.
- Frequency and severity of exacerbations may fluctuate over time for patients in any severity category. At present, there are inadequate data to correspond frequencies of exacerbations with different levels of asthma severity. In general, more frequent and severe exacerbations (e.g., requiring urgent, unscheduled care, hospitalization, or ICU admission) indicate greater underlying disease severity. For treatment purposes, patients with ≥2 exacerbations described above may be considered the same as patients who have persistent asthma, even in the absence of impairment levels consistent with persistent asthma.

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### TABLE 16—6
Assessing Asthma Control and Adjusting Therapy in Children

<table>
<thead>
<tr>
<th>Key:</th>
<th>EIB, exercise-induced bronchospasm; FEV1, forced expiratory volume in 1 second; FVC, forced vital capacity; ICU, intensive care unit; N/A, not applicable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Notes:</td>
<td>The level of control is based on the most severe impairment or risk category. Assess impairment domain by patient’s or caregiver’s recall of previous 2–4 weeks. Symptom assessment for longer periods should reflect a global assessment, such as whether the patient’s asthma is better or worse since the last visit. Assess risk using the risk scores to correspond frequencies of exacerbations with different levels of asthma control. In general, more frequent and intense exacerbations (e.g., requiring urgent, unscheduled care or ICU admission) indicate poorer disease control.</td>
</tr>
</tbody>
</table>

#### Components of Control

<table>
<thead>
<tr>
<th>Impairment</th>
<th>Well Controlled</th>
<th>Not Well Controlled</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ages</td>
<td>Very Poor</td>
<td>Poor</td>
</tr>
<tr>
<td>0–4</td>
<td>&gt;2 days/week</td>
<td>&gt;2 days/week</td>
</tr>
<tr>
<td>5–11</td>
<td>&gt;2 days/week</td>
<td>&gt;2 days/week</td>
</tr>
<tr>
<td>12–17</td>
<td>&gt;2 days/week</td>
<td>&gt;2 days/week</td>
</tr>
</tbody>
</table>

#### Risk

<table>
<thead>
<tr>
<th>Risk</th>
<th>Treatment-related toxicity effects</th>
<th>Reduction in lung growth</th>
</tr>
</thead>
<tbody>
<tr>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>1–2-year-old</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>3–4-year-old</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>5–6-year-old</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

### Stepwise Approach for Managing Asthma Long Term in Children, 0-4 Years of Age and 5-11 Years of Age

<table>
<thead>
<tr>
<th>Step 1: Immediate asthma</th>
<th>Step 2: Persistent asthma</th>
<th>Step 3: Daily Medication (Low dose CS)</th>
<th>Step 4: Control of nighttime cough</th>
<th>Step 5: Consider consultation at step 2</th>
<th>Step 6: Assess control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oral Succinyl Collidine</td>
<td>Low-dose CS, ICS</td>
<td>Low-dose CS, ICS</td>
<td>ICS, LABA, or LTRA</td>
<td>LABA, or LTRA</td>
<td>LABA, or LTRA</td>
</tr>
</tbody>
</table>

#### Notes
- Stepwise approach is meant to assist, not replace, the clinical decision-making process needed to meet individual patient needs.
- If the clinical benefit is not obtained within 4-6 weeks, and the response is not sustained, the treatment may need to be increased further. If the response still is inadequate, the patient may require specialized consultation. Other therapeutic options, such as biologics, should be considered.
- Children with symptoms persisting for >3 months despite treatment with an ICS and a LABA or LTRA should be referred to a specialist for evaluation.

#### Alternative Medications
- LABA, or LTRA
- ICS, LABA, or LTRA

#### Quick-Relief Medication
- ICS, LABA, or LTRA
- LABA, or LTRA

#### References

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**TABLE 16-7**

Managing Asthma Long Term in Children, 0-4 Years of Age and 5-11 Years of Age
### TABLE 16-8
Classifying Asthma Severity and Initiating Treatment in Youths 12 Years of Age and Adults

Assessing severity and initiating treatment for patients who are not currently taking long-term control medications

<table>
<thead>
<tr>
<th>Components of Severity</th>
<th>Classification of Asthma Severity</th>
<th>≥12 years of age</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Intermittent</td>
<td>Persistent</td>
</tr>
<tr>
<td></td>
<td>Symptoms</td>
<td>Mild</td>
</tr>
<tr>
<td></td>
<td>≤2 days/week but not daily</td>
<td>Daily</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Throughout the day</td>
</tr>
<tr>
<td></td>
<td>Nighttime awakenings</td>
<td>Moderate</td>
</tr>
<tr>
<td></td>
<td>≥2x/month</td>
<td>Daily</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Several times per day</td>
</tr>
<tr>
<td></td>
<td>Short-acting β₂-agonist use for symptom control (not prevention of EIB)</td>
<td>Severe</td>
</tr>
<tr>
<td></td>
<td>≤2 days/week but not daily</td>
<td></td>
</tr>
<tr>
<td></td>
<td>&gt;2 days/week but not daily</td>
<td></td>
</tr>
</tbody>
</table>

**Key:** EIB, exercise-induced bronchospasm; FEV₁, forced expiratory volume in 1 second; FVC, forced vital capacity; ICU, intensive care unit

**Notes:**
- The stepwise approach is meant to assist, not replace, the clinical decisionmaking required to meet individual patient needs.
- Level of severity is determined by assessment of both impairment and risk. Assess impairment domain by patient’s/caregiver’s recall of previous 2–4 weeks and spirometry. Assign severity to the most severe category in which any feature occurs.
- At present, there are inadequate data to correspond frequencies of exacerbations with different levels of asthma severity. In general, more frequent and intense exacerbations (e.g., requiring urgent, unscheduled care, hospitalization, or ICU admission) indicate greater underlying disease severity. For treatment purposes, patients who had ≥2 exacerbations requiring oral systemic corticosteroids in the past year may be considered the same as patients who have persistent asthma, even in the absence of impairment levels consistent with persistent asthma.

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### Table 16-9
Assessing Asthma Control and Adjusting Therapy in Youths ≥12 Years of Age and Adults

<table>
<thead>
<tr>
<th>Impairment</th>
<th>Classification of Asthma Control (≥12 years of age)</th>
<th>Components of Control</th>
<th>ACQ values of 0.76–1.4 are indeterminate regarding well-controlled asthma. Key: EIB, exercise-induced bronchospasm; ICU, intensive care unit.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Well Controlled</td>
<td>Not Well Controlled</td>
<td>Very Poorly Controlled</td>
</tr>
<tr>
<td>Symptoms</td>
<td>≤2 days/week</td>
<td>&gt;2 days/week</td>
<td>Throughout the day</td>
</tr>
<tr>
<td>Nighttime awakenings</td>
<td>≤2x/month</td>
<td>1–3x/week</td>
<td>≤4x/week</td>
</tr>
<tr>
<td>Interference with normal activity</td>
<td>None</td>
<td>Some limitation</td>
<td>Extremely limited</td>
</tr>
<tr>
<td>Short-acting beta-agonist use for symptom control (not prevention of EIB)</td>
<td>≤2 days/week</td>
<td>&gt;2 days/week</td>
<td>Several times per day</td>
</tr>
<tr>
<td>FEV1, or peak flow</td>
<td>&gt;80% predicted/personal best</td>
<td>60–80% predicted/personal best</td>
<td>&lt;60% predicted/personal best</td>
</tr>
<tr>
<td>Validated questionnaires</td>
<td>ATAQ</td>
<td>ACQ</td>
<td>ACT</td>
</tr>
<tr>
<td></td>
<td>0 ≤0.75 ≤20</td>
<td>1–3</td>
<td>≤1/5</td>
</tr>
<tr>
<td></td>
<td>16–19</td>
<td>3–4</td>
<td>N/A</td>
</tr>
<tr>
<td>Risk</td>
<td>Exacerbations requiring oral systemic corticosteroids</td>
<td>0–1/year</td>
<td>&gt;2/year (see note)</td>
</tr>
<tr>
<td>Progressive loss of lung function</td>
<td>Evaluation requires long-term followup care.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Treatment-related adverse effects</td>
<td>Medication side effects can vary in intensity from none to very troublesome and worrisome. The level of intensity does not correlate to specific levels of control but should be considered in the overall assessment of risk.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Notes:**
- The stepwise approach is meant to assist, not replace, the clinical decisionmaking required to meet individual patient needs.
- The level of control is based on the most severe impairment or risk category. Assess impairment domain by patient’s recall of previous 2–4 weeks and by spirometry or peak flow measures. Symptom assessment for longer periods should reflect a global assessment, such as inquiring whether the patient’s asthma is better or worse since the last visit.
- At present, there are inadequate data to correspond frequencies of exacerbations with different levels of asthma control. In general, more frequent and intense exacerbations (e.g., requiring urgent, unscheduled care, hospitalization, or ICU admission) indicate poorer disease control. For treatment purposes, patients who had ≥2 exacerbations requiring oral systemic corticosteroids in the past year may be considered the same as patients who have not-well-controlled asthma, even in the absence of impairment levels consistent with not-well-controlled asthma.

ATAQ = Asthma Therapy Assessment Questionnaire
ACQ = Asthma Control Questionnaire
ACT = Asthma Control Test™

Minimal Important Difference: 1.0 for the ATAQ; 0.5 for the ACQ; not determined for the ACT.

Before step up in therapy:
- Review adherence to medication, inhaler technique, environmental control, and comorbid conditions.
- If an alternative treatment option was used in a step, discontinue and use the preferred treatment for that step.

**Recommended Action for Treatment**
(See "Stepwise Approach for Managing Asthma" for treatment steps.)

- Maintain current step.
- Step up 1 step.
- Step up 1 step, consider alternative treatment options.
- Consider short course of oral systemic corticosteroids.
- Consider short course of oral systemic corticosteroids.
- Reevaluate in 2–6 weeks.
- For side effects, consider alternative treatment options.
- Reevaluate in 1–2 weeks.
- Short up 1–2 steps.
- For side effects, consider alternative treatment options.

---

### TABLE 16-10

**Stepwise Approach for Managing Asthma in Youths ≥ 12 Years of Age and Adults**

<table>
<thead>
<tr>
<th>Step</th>
<th>Preferred</th>
<th>Alternative</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Low-dose ICS</td>
<td>Mebromin, aminophylline</td>
</tr>
<tr>
<td>2</td>
<td>Medium-dose ICS</td>
<td>Low-dose ICS</td>
</tr>
<tr>
<td>3</td>
<td>High-dose ICS</td>
<td>Medium-dose ICS</td>
</tr>
<tr>
<td>4</td>
<td>ICS + LABA</td>
<td>Low-dose ICS</td>
</tr>
<tr>
<td>5</td>
<td>ICS + LABA + either LTRA, theophylline, or zileuton</td>
<td>ICS + LABA</td>
</tr>
<tr>
<td>6</td>
<td>Oral corticosteroids</td>
<td>ICS + LABA</td>
</tr>
</tbody>
</table>

**Key:**
- Alphabetical order is used when more than one treatment option is listed within either preferred or alternative therapy.
- ICS, inhaled corticosteroid; LABA, long-acting inhaled beta-2-agonist; LTRA, leukotriene receptor antagonist; SABA, inhaled short-acting beta-2-agonist.

**Notes:**
- This stepwise approach is meant to assist, not replace, the clinical decision-making required to meet individual patient needs.
- This treatment is used and response is inadequate, step up and use the preferred treatment before stepping up.
- Zileuton is a less desirable alternative due to limited studies as adjunctive therapy and the need to monitor liver function.
- In step 6, before oral corticosteroids are introduced, a trial of high-dose ICS + LABA + either LTRA, theophylline, or zileuton may be considered, although this approach has not been studied in clinical trials.
- Immunotherapy for steps 2–4 is based on Evidence B for house-dust mites, animal danders, and pollens; evidence is weak or lacking for molds and cockroaches. Evidence is strongest for immunotherapy with single allergens.
- Clinicians who administer immunotherapy should be prepared and equipped to identify and treat anaphylaxis that may occur.

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the child should be taught to recognize changes in breathing and to communicate them to a responsible adult. Even the ability to recognize the responsible adult in a given situation should be practiced with a preschool child. Responsibility to recognize changes in breathing patterns, to communicate these changes, and to initiate additional therapies should increase as the child matures. Fine and gross motor abilities of children and adolescents also play a role in these assessment and self-care management strategies. For example, spirometry and peak flow measurements require fine and gross motor skills. Both require the individual to follow verbal instructions closely, hold the mouthpiece without air leakage, then fully inhale and exhale. Incorrect technique in these assessments can lead to misguided prescriptions or management plans. Children younger than 7 years old generally lack the motor skills needed to perform these measures. Therefore, assessment of pulmonary function in these children must rely on other measures, such as parent or child recall of symptom history, auscultation of lung fields, assessment of respiratory effort, or pulse oximetry.

The essential components of a parent and patient education program are outlined in Community Care 16–3. Asthma self-management programs have been developed

## Community Care 16–3

### Components of an Asthma Education Program

<table>
<thead>
<tr>
<th>Topic</th>
<th>Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>Definition of asthma</td>
<td>Emphasize chronic nature of asthma, prognosis, and goals of therapy.</td>
</tr>
<tr>
<td>Signs and symptoms</td>
<td>Discuss main symptoms of an acute episode, variability of symptoms, ways to recognize mild/prodromal symptoms.</td>
</tr>
<tr>
<td>Pathophysiology</td>
<td>Identify symptoms that need immediate treatment.</td>
</tr>
<tr>
<td>Asthma triggers and avoidance of triggers</td>
<td>Offer suggestions for home environment modification (see Community Care 16–1).</td>
</tr>
<tr>
<td>Management of asthma</td>
<td>Establish an asthma action plan:</td>
</tr>
<tr>
<td></td>
<td>• Monitoring of symptoms (frequency, response to medication, or environmental triggers)</td>
</tr>
<tr>
<td></td>
<td>• Need for preventive care and routine monitoring</td>
</tr>
<tr>
<td></td>
<td>• Environmental controls (reduce or eliminate environmental exposures)</td>
</tr>
<tr>
<td></td>
<td>• Medications (dose, frequency, method of delivery, actions, side effects) for each zone (green, yellow, red); encourage daily medications even when well</td>
</tr>
<tr>
<td></td>
<td>• Importance of early treatment of asthma exacerbations</td>
</tr>
<tr>
<td>Written guidelines</td>
<td>Use an asthma action plan for all children:</td>
</tr>
<tr>
<td>Correct use of inhalation devices</td>
<td>• Plan should be posted at home.</td>
</tr>
<tr>
<td>Use of peak expiratory flow meter</td>
<td>• Plan should be shared with child care and school personnel.</td>
</tr>
<tr>
<td>Fears and misconceptions/feelings about asthma</td>
<td>Respond to patient and family concerns regarding medications.</td>
</tr>
<tr>
<td>Communication with child’s school, daycare, camp, and so forth</td>
<td>Clear up any misconceptions (asthma not caused by psychological factors, deaths usually related to undertreatment of asthma, children should maintain active lives).</td>
</tr>
<tr>
<td></td>
<td>Acknowledge negative feelings of having asthma.</td>
</tr>
<tr>
<td></td>
<td>Refer to appropriate self-management programs/community resources.</td>
</tr>
<tr>
<td>Communication with child’s school, daycare, camp, and so forth</td>
<td>Review importance of notifying school of child’s condition, need for medication (especially rescue medications like albuterol) in school, and ability to participate in sports and physical education.</td>
</tr>
</tbody>
</table>
for various settings to promote awareness, knowledge, and treatment adherence. Several of these programs and educational brochures are available through the American Lung Association (Open Airways) or the Asthma and Allergy Foundation of America (Wee Wheezers, Power Breathing) (see the Point, for organizations) and are presented in the National Heart, Lung and Blood Institute (2007) document. Educational programs that focus on self-management skills help shift the often crisis-oriented nature of asthma care to one of proactive intervention and prevention.

Gear any education and materials to the child’s cognitive, affective, and developmental levels. Ensure that the information given to parents and families is also provided to school teachers, the school nurse, coaches, camp counselors, and other community personnel to ensure awareness of asthma, ensure continuity of treatment, and facilitate problem solving if the child has an acute episode. The importance of regular follow-up with a continuous healthcare provider cannot be overemphasized. Progress must be closely monitored in relation to history of acute exacerbations, responses to therapy, and adherence to treatment.

ANSWER: The nurse has an obligation to provide ongoing education to the family about the disease and about the medical system. If Claudia made a good decision about when to access care in a hospital, then that should be made clear to Claudia. One of the greatest problems in the management of childhood chronic disease is the lack of continuity of care. Claudia takes her children to the health department for immunizations, to the pediatrician for problems, and now she and Jose have had their first visit to the hospital emergency department. The nurse can ensure the family leaves with a record of the visit so that the pediatrician can fully understand this exacerbation.

Control of Environmental Factors and Comorbid Conditions

Assessment of the environmental factors and comorbid conditions that affect asthma severity can be completed in several ways. A verbal history provided by the child and parent can determine recent exposures, and a history of the symptoms associated with increasing asthma severity. An assessment of the home may reveal the presence of previously unknown or unsuspected allergens (see Tradition or Science 16–3). Advise the family on ways to reduce exposure to environmental allergens within the home and community that may exacerbate asthma (see Community Care 16–1 earlier in this chapter).

Skin or in vitro testing may also be used to assess sensitivity to allergens. Allergen immunotherapy may be considered for children with persistent asthma when there is clear evidence that the asthma symptoms are related to exposure to specific allergens to which the child is sensitive.

A history and treatment of comorbid symptoms may improve overall asthma control. Conditions that may adversely affect asthma control include allergic bronchopulmonary aspergillosis, gastroesophageal reflux, obesity, obstructive sleep apnea, rhinitis, sinusitis, stress, and depression. Advise children with these conditions to seek or maintain care provided by a medical specialist to ensure that recognition and treatment of these conditions is maintained.

Medications

A stepwise approach is used to select the medication and delivery devices to meet the child’s needs and presenting symptoms (see Tables 16–7 to 16–10). After a diagnosis has been made and therapy has been initiated, the child’s level of asthma control is monitored daily, and therapy is adjusted accordingly. The goal of therapy is to identify the minimum amount of medication required to help the child maintain asthma control.

Medications have two primary roles in the treatment of asthma. The first role of medication use is to provide long-term control by preventing symptoms. The second role of medications is to treat acute symptoms and exacerbations.

Corticosteroids are considered to be the most effective method to achieve long-term control of asthma. These anti-inflammatory agents reduce airway hyperresponsiveness, inhibit inflammatory cell migration and activation, and block late-phase reaction to allergens (National Heart, Lung and Blood Institute, 2007). Inhaled corticosteroids are the most consistently effective at all steps of care for persistent asthma. Oral corticosteroids may be used to gain prompt control of asthma and are required for severe persistent asthma (see Tables 16–7 and 16–10).
Other medications used to gain long-term control include cromolyn sodium and nedocromil. These anti-inflammatory agents inhibit activation and release of mediators from mast cells, thus maintaining airway stability. Immunomodulators (omalizumab) is a monoclonal antibody given intramuscularly to prevent binding of IgE to the high-affinity receptors on basophils and mast cells (National Heart, Lung and Blood Institute, 2007). This is used as an adjunctive therapy for children 12 years and older who have demonstrated sensitivity to specific allergens and who require a step up in care to manage their persistent asthma. Leukotriene modifiers are used for children requiring step 2 care for mild persistent asthma. These products interfere with the pathway of leukotriene mediators that are released from mast cells, eosinophils, and basophils (National Heart, Lung and Blood Institute, 2007). Long-acting beta2 agonists such as salmeterol and formoterol are bronchodilators that open the airways by relaxing smooth muscle contraction and reducing bronchospasm, which thereby enhances mucociliary clearance and decreases vascular permeability. Methylxanthine is a sustained-release theophylline that has some mild anti-inflammatory effects and can be used as adjunctive therapy with inhaled corticosteroids for children older than 5 years. For a more detailed description of these medications and their recommended use, dose, adverse effects, and care concerns, please refer to the National Heart, Lung and Blood Institute (2007) asthma guidelines.

Medications are also used to provide quick relief for acute symptoms and exacerbations. These acute symptoms may be brought on by environmental exposures (as described earlier) or perhaps by exercise-induced bronchospasm that was not effectively managed by the medications previously described to step up or down care for long-term asthma control. Quick-relief medications include anticholinergics given via an MDI or nebulizer solution. These agents inhibit muscarinic cholinergic receptors and reduce the intrinsic vagal tone of the airways (National Heart, Lung and Blood Institute, 2007). Short-acting beta2 agonists (SABAs) such as albuterol, levalbuterol, and pirbuterol are rapid-acting bronchodilators that open the airways by relaxing smooth muscle contraction, enhancing mucociliary clearance, and reducing bronchospasm. Systemic corticosteroids may be used in addition to SABAs for moderate and severe exacerbations to speed recovery and to prevent recurrence of the exacerbation (National Heart, Lung and Blood Institute, 2007) (see the National Heart, Lung and Blood Institute [2007] asthma guidelines for further information on medications to treat acute symptoms of asthma).

Determine the medications the child is using and whether any complimentary and alternative medications or treatments (chiropractic medicine, acupuncture) are used.

**Alert!** There is insufficient evidence to support recommending the use of complimentary and alternative medications for treatment of allergy. Families who use herbal treatments for asthma should be cautioned about the interactions that some of the ingredients may have with their prescribed asthma medications.

Ask to view any records the child has been keeping of his or her symptoms and/or peak flow monitoring. Advise children with moderate or severe persistent asthma to keep daily peak flow monitoring records. These tools will aid the child and family to recognize adequate and inadequate asthma control. Watch the child using their peak flow meter and inhaler. Although the steps in this process seem easy, incorrect use of the inhaler means less medication is getting to the airways. Provide instruction materials and sample peak flow charts to the family (see the Point4 for Procedures: Use and Care of Peak Flow Meters and Spacers). Each healthcare encounter should include an assessment of asthma severity, measures to maintain control and the child’s responsiveness to the therapies initiated.

**Management and Treatment of Exacerbations**

**Question:** Based on the following information and Jose’s condition, what do you anticipate the nurse in the emergency department will do next?

An acute or subacute episode of asthma is identified as progressive and worsening shortness of breath, cough, wheezing, and/or chest tightness. These symptoms indicate decreases in expiratory airflow and require immediate intervention. Children whose asthma has been well controlled using inhaled corticosteroids are less likely to have an exacerbation; however, all children are at risk for exacerbations. Respiratory infections, exercise-induced bronchospasm, extreme changes in weather, exposure to a known (or unknown) allergen, and stress can precipitate a worsening of asthma symptoms. Severe exacerbations can be life threatening. Act quickly to assess the degree of severity and to determine the measures already taken to relieve the child’s symptoms. Use the child’s written asthma plan to help the family determine how to adjust the medications. School nurses should have copies of this written plan at the child’s school site. Remove or withdraw the child from allergens in the environment that may be contributing to the exacerbation. If the child does not have a written asthma plan, or if the child continues to deteriorate despite the increased use of inhaled corticosteroids and SABAs, then management in an urgent or emergency care or hospital setting is warranted.

When the child presents in the healthcare setting with an acute exacerbation, assess and carefully monitor alertness, heart rate, respiratory rate, breath sounds, pulse oximetry, and PEFR (if the child is able); and perform a full pulmonary assessment, including visual inspection of chest (accessory muscles), auscultation of breath sounds, and other respiratory assessments. Typically, supplemental oxygen is ordered to correct hypoxemia. Administer repetitive or continuous SABA treatments to reverse airflow obstruction rapidly. Oral systemic corticosteroids may be ordered to decrease airway inflammation if the child does not respond promptly to the SABA treatments. Usually, the child will prefer a high Fowler’s position or sitting up and leaning slightly forward. Continuously monitor the child in acute distress, including...
difficult to ascertain. Some retrospective studies of neo-
and universally distinct, the incidence of this disease is
dependent on supplemental oxygen; and have chest radio-
weeks; have symptoms of persistent respiratory distress; are
infants who required mechanical ventilation for at least 1
is generally made at approximately 1 month of age in
Although timing of diagnosis varies, the clinical diagnosis
clinical syndrome seen in infants who had been treated
infancy. BPD was first described as the radiographic and
BPD is a chronic lung disease of children that begins in
Chapter 16  The Child With Altered Respiratory Status 713
comprehensive reassessments of the child’s response to
therapy after the first hour. For acute exacerbation that
responds poorly to initial interventions, or when ongoing
observation and stabilization of the child is needed, hos-
pitalization may be indicated. If the child is becoming less
alert or drowsy, this may indicate impending respiratory
failure. Endotracheal intubation and assisted ventilation
must be considered if steady clinical deterioration occurs
despite continued intensive therapy.

ANSWER: Jose’s history, presentation of physical
symptoms, and oxygen saturation will affect the deci-
sion regarding whether Jose will receive inhaled SABA by
nebulizer or MDI, up to three doses during the first hour, and
oral corticosteroids if needed. If Jose is responding to the
nebulized medication and his respiratory distress is resolving,
inhaled SABA will be continued every 60 minutes. This treat-
ment will continue for 1 to 3 hours. If he continues in respira-
tory distress, despite his initial treatments, oxygen will be
administered. Hospitalization may be warranted for ongoing
administration of oxygen, nebulized SABAs, oral or intrave-
nous corticosteroids and intravenous therapy.

Community Care
The National Heart, Lung and Blood Institute (2007)
asthma guidelines represent the best evidence to date
regarding the assessment, monitoring, and management of
asthma. The primary emphasis of these standards of care
is to encourage early diagnosis and ongoing assessment by
the child’s medical home providers, and to provide teaching
and preventive measures that will ensure the child’s
overall health and well-being. Patient education should
occur at all points of care with the child and family. Sur-
veillance of environmental triggers must also occur in all
settings (home, school, daycare, and so forth) in which the
child is likely to spend time. Review the National Heart,
Lung and Blood Institute (2007) standards thoroughly and
utilize the information and products provided by this
agency and others to help children and their families effec-
tively manage the child’s chronic condition.

Bronchopulmonary Dysplasia (BPD)
BPD is a chronic lung disease of children that begins in
infancy. BPD was first described as the radiographic and
clinical syndrome seen in infants who had been treated
with mechanical ventilation and high levels of inspired ox-
gen, and who survived respiratory distress syndrome.
Although timing of diagnosis varies, the clinical diagnosis
is generally made at approximately 1 month of age in
infants who required mechanical ventilation for at least 1
week; have symptoms of persistent respiratory distress; are
dependent on supplemental oxygen; and have chest radio-
graphs that show hyperinflation, atelectasis, increased den-
Because the diagnostic criteria for BPD are not precise
and universally distinct, the incidence of this disease is
difficult to ascertain. Some retrospective studies of neo-


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Because the diagnostic criteria for BPD are not precise
and universally distinct, the incidence of this disease is
difficult to ascertain. Some retrospective studies of neo-
nates suggest that BPD occurs in 35% of premature
births, with the incidence being inversely related to birth
weight (Smith et al., 2005). This condition is seen pre-
dominantly in infants born prematurely (more than 10
weeks before their due date), infants less than 1,000 g at
birth, and in infants with multiple pulmonary disorders
who require ventilator support with high positive airway
pressures and oxygen during the first 2 weeks of life.
Early deaths from BPD are generally attributed to
untreatable respiratory failure, with later deaths being
associated with infection, pulmonary hypertension, and
cor pulmonale, or an acute severe cyanotic episode that
does not respond to rapid institution of CPR. The effects
of BPD may last several months to years. Although
infants with BPD have a prolonged and complicated neo-
natal course, the long-term pulmonary prognosis for sur-
vivors of BPD is relatively good.

Pathophysiology
The pathophysiology of BPD is complex and of multi-
tiologic and multisystem origins. It starts with an acute
insult to the neonate’s lungs, such as respiratory distress
syndrome, pneumonia, or meconium aspiration, that
requires positive pressure ventilation and high concentra-
tions of oxygen over an extended time. These therapies
result in tissue and cellular injury to the immature lung.
The epithelium of the conducting airways develops
lesions from injury thought to be related to hyperoxia and
positive pressure. Excessive pulmonary fluid, collection of
cellular debris in the alveoli, and recurrent bacterial and
viral infections are additional factors contributing to the
alveolar tissue damage. Infants with BPD often exhibit a
“state of chronic undernutrition” that affects the lung’s
ability to resist injury and repair damaged tissue (Ameri-
can Thoracic Society, 2003; Huysman et al., 2003).
The most important underlying pathologic process in
BPD is the profound alteration of lung compliance,
which is reduced as a result of a combination of factors.
These factors include fibrosis of the airways and marked
hyperplasia of the bronchial epithelium, which occur sec-
dary to alveolar damage; and increased fluid in the lung,
as a result of disruption of the alveolar–capillary
membrane. Damage to the alveolar supporting structures
results in overdistension and leads to air trapping, fibro-
sis, airway edema, and bronchoconstriction, increasing
airway resistance and decreasing compliance. Increased
airway resistance increases the work of breathing, result-

Pulmonary gas exchange is impaired by several factors.
Hypoxia occurs secondary to ventilation–perfusion mis-
mismatch in the areas of alveolar collapse. Increased pulmo-
nary vascular resistance causes intrapulmonic shunting,
thus also contributing to hypoxia. Hypercarbia is com-
mon and is also caused by ventilation–perfusion mis-
mismatch, as well as by hypoventilation.
Large airway pathology (i.e., in the trachea and bron-
chi) was not originally described as a component of BPD
but has since been recognized to be a frequent finding as
the disease progresses. Both tracheomalacia and bron-
chomalacia are commonly found in this population and
are postulated to be the cause of acute, severe cyanotic episodes in the older infant with BPD.

Growth failure in infants with BPD is almost universal and results from increased caloric needs, caused by the increased work of breathing, and high resting oxygen consumption. Growth failure and lung disease may also be complicated by gastroesophageal reflux with frequent emesis, poor oral feeding skills, and recurrent respiratory infections (Huysman et al., 2003).

Cor pulmonale (hypertrophy or failure of the right ventricle caused by disorders of the lungs, pulmonary vessels, or chest wall), pulmonary hypertension, systemic hypertension, and left ventricular hypertrophy are complications of BPD that result from the fibrosis and chronic hypoxia. The pulmonary vasculature of these infants develops increased reactivity to hypoxia, resulting in pulmonary hypertension and left ventricular hypertrophy with congestive heart failure.

The effect of therapies such as high-frequency oscillatory ventilation and surfactant replacement on the overall incidence of BPD remains to be fully demonstrated. High-frequency oscillatory ventilation delivers gas at extremely high frequencies (>200 “breaths”/minute) and considerably lower pressures than those used for standard mechanical ventilation, thus reducing barotrauma to the alveoli. Studies have shown that surfactant therapy reduces the severity of respiratory distress syndrome and decreases the amount of time on mechanical ventilation.

Assessment

The clinical manifestations of BPD are a direct reflection of the pathophysiology of this disorder. Tachypnea, dyspnea, and wheezing are intermittently or chronically present secondary to airway obstruction and increased airway resistance. Increased work of breathing, as evidenced by intercostal or substernal retractions and use of accessory muscles, is common in the infant with BPD. Infants who have been intubated for long periods may develop subglottic stenosis, which results in inspiratory stridor. Furthermore, hypoxemia and hypercapnia are chronic states that contribute to the problem. The child might turn cyanotic when crying or after a few moments without supplemental oxygen. Infants with moderate to severe BPD are frequently described as irritable and difficult to comfort. This behavior may result from hypoxia or underlying neurologic dysfunction. They may develop irregular sleep patterns as a result of frequent medical treatments, medications, and therapies. Inguinal hernias are often present, which may be a result of the continuous increase in abdominal pressure caused by high airway resistance and use of accessory respiratory muscles. These infants also have extraordinarily large insensible fluid losses because of tachypnea and excessive perspiration related to hypercarbia.

The incidence of neurologic abnormalities and developmental delay in infants with bronchopulmonary dysplasia varies, but these problems are known to occur in children with BPD. Infants who are born prematurely likely experience some degree of developmental delay with or without neurologic insult. Even if there is no evident damage to the neurologic system during hospitalization in the neonatal intensive care unit, children with BPD may show signs of problems when they are school age. These problems can range from vision and hearing loss to speech delays, learning disabilities, and poor attention span. Developmental delays result from long-term ventilatory support, poor nutritional status, inadequate sensory stimulation, neurologic sequelae, and decreased energy and respiratory reserves.

Nursing assessment requires close observation and awareness of BPD signs and symptoms. Take a thorough history, including the child’s baseline symptoms (retractions, respiratory effort), requirements (oxygen needs), and nutritional intake. Next, complete a physical examination focusing on respiratory, cardiac, nutritional, and developmental status. An interdisciplinary team may assist in a comprehensive evaluation. Report any abnormal findings to the team and implement appropriate interventions and referrals.

Interdisciplinary Interventions

Just as the pathophysiology of BPD is multifactorial, its treatment is multifaceted. Medical management of BPD centers on preventing and minimizing hypoxia and hypercarbia, treating bronchoconstriction and airway hyperreactivity and inflammation, treating pulmonary edema, and promoting repair of chronic lung injury.

These desired ends are achieved in varying degrees by medical therapies such as supplemental oxygen, diuretics, bronchodilators, anti-inflammatory agents, and various modes of assisted mechanical ventilation. Pulmonary hypertension responds at least in part to oxygen, a potent pulmonary vasodilator. Low-flow supplemental oxygen is administered, at times on a long-term basis, in an attempt to prevent chronic hypoxia and subsequent complications. Tracheostomy is considered for those who require assisted ventilation for more than 3 months as a neonate or who have chronic hypercarbia and increased work of breathing.

Management of Hypoxia

The primary and most important aspect of therapy in infants with BPD is managing hypoxia. Maintaining adequate tissue oxygenation is imperative to prevent severe morbidity and potential death. Supplemental oxygen therapy is prescribed to promote growth and neurodevelopment, and to prevent or control pulmonary hypertension. Administering and monitoring oxygen therapy is a major nursing responsibility in the care of an infant with BPD. Pulse oximetry or transcutaneous oxygen monitors are used to continuously or intermittently display oxygen saturation. Oxygen saturation levels (SaO2) of 92% to 95%, depending on severity of illness, are necessary to facilitate an improved rate of weight gain and to control pulmonary hypertension. The nurse must respond to the infant’s changing oxygen needs, titrating oxygen flow to keep saturations within the prescribed parameters. Feedings, periods of increased activity, and periods of sleep are occasions when desaturations are most likely.

Tailor the mode of oxygen delivery to the specific needs of the infant. Most infants with mild to moderate BPD can tolerate a nasal oxygen cannula. Children with tracheostomies may use a tracheostomy mist collar (Fig. 16–18). Humidification is necessary for liter flow equal to or greater than 1 L/minute to prevent airway irritation.
and mucous plugging. Watch infants for increased oxygen demand, especially during acute illnesses, fever, stress, and periods of increased activity. Reassessment should include child’s color, presence and degree of respiratory distress (report any retractions, nasal flaring, or use of accessory respiratory muscles), breath sounds, vital signs, and level of consciousness.

Other nursing interventions for the infant with BPD include administering multiple oral and inhaled pharmacologic agents, monitoring their effectiveness, and identifying possible adverse effects (Table 16–11).

Respiratory Care

Because excessive airway secretions present difficult problems for the infant or child with BPD, diligent airway clearance is needed to prevent mucous plugging and airway obstruction. Cough is often ineffective in these children because of generalized debilitation and tracheomalacia. Nasopharyngeal or tracheal suctioning is needed frequently to maintain patent airways, especially during illnesses or respiratory tract infections. Chest physiotherapy may also help improve secretion clearance and lessen atelectasis. Always collaborate with respiratory therapists and parents to schedule chest physiotherapy to occur 30 minutes before feedings and before rest periods if possible. Suctioning should immediately follow chest physiotherapy and be done at other times as needed.

Positioning and comforting interventions are of extreme importance in caring for the infant with BPD. Ill or premature infants who are chronically “air hungry” are extremely irritable and may be difficult to console. With the collaboration of physical and occupational therapists, develop individualized plans for the handling and activity level of these infants that accommodate their developmental level and ability to tolerate stimulation. Frequent and prolonged rest periods are necessary because of increased energy demand and sleep deprivation. Watch for signs of overstimulation in the neurologically immature child such as cyanosis, avoidance of eye contact, vomiting, diaphoresis, and falling asleep.

Table 16–11

<table>
<thead>
<tr>
<th>Type of Medication</th>
<th>Action</th>
<th>Possible Side Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Bronchodilators</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aminophylline</td>
<td>Bronchodilators open the airways of the lungs. They work by relaxing the muscles around the airways. These medicines can be used alone or in groups.</td>
<td>Increased heart rate</td>
</tr>
<tr>
<td>Terbutaline</td>
<td></td>
<td>Shakiness or tremors</td>
</tr>
<tr>
<td>Albuterol (inhaled)</td>
<td></td>
<td>Hyperactivity</td>
</tr>
<tr>
<td><strong>Diuretics</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Furosemide (Lasix)</td>
<td>Diuretics cause an increased amount of water and salt to be excreted in the urine. They also decrease the amount of fluid in the lungs.</td>
<td>Imbalances in potassium (hypokalemia/hyperkalemia) and calcium (hypocalcemia)</td>
</tr>
<tr>
<td>Spironolactone (Aldactone)</td>
<td></td>
<td>Muscle cramps and irregular heart rhythm are signs that serum electrolytes must be closely monitored</td>
</tr>
<tr>
<td>Chlorothiazide (Diuril)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Anti-inflammatory Drugs (Corticosteroids)</strong></td>
<td>Anti-inflammatory drugs are used in children whose wheezing is not controlled with bronchodilators. These medicines do not reverse or stop existing wheezing. They are used on a long-term basis to prevent wheezing and respiratory distress. They work well only if taken continuously.</td>
<td>Short-term use causes little or no side effects. Longer term effects include impaired growth and decreased ability to fight infections.</td>
</tr>
</tbody>
</table>

Figure 16–18. Humidified oxygen is provided to the child using a mist delivery device.
Nutritional Support

Because growth failure is common in the infant with BPD, providing nutritional support is a crucial, although difficult, aspect of caring for these children. Management of feedings in infants and young children with BPD has direct implications for long-term outcome, because an adequate caloric intake is necessary for growth of healthy lung tissue and resolution of the disease. Yet, these infants suffer from a myriad of conditions that impair their ability to feed: gastroesophageal reflux, often with aspiration; emesis; chronic fatigue; behavioral oral aversion; and swallowing dysfunction caused by poor oral–motor development. For the healthy infant, feeding is generally viewed as a pleasant and positive experience; however, for the child with BPD, it is often perceived as a battle. It can seem that the more that nurses and parents are concerned and anxious about nutrition and place pressure on the infant or child to eat, the less the child eats. Feeding with the infant or child with BPD can be a frustrating and challenging experience, and coordinated interdisciplinary effort is the key to successfully approaching these problems.

Begin with a nutritional assessment that includes documentation of anthropometric (precise measurement of the body includes weight, height, and head circumference) and biochemical data, dietary intake, and clinical status. Strategies in nutritional support then focus on optimizing the caloric intake to meet individual needs. Concentrating forings all are appropriate for mild to moderate growth failure.

Infants with severe growth failure, or for whom the previously listed strategies are unsuccessful, should be considered for surgical placement of a gastrostomy tube or percutaneous endoscopic gastrostomy tube. This procedure may or may not be performed in conjunction with a Nissen fundoplication, depending on the severity of gastroesophageal reflux. Because parents sometimes view the need for a gastrostomy tube as a sign of their failure to feed their infant orally, the entire healthcare team must provide support and stress the benefits of this mode of therapy. Calorie-dense formulas can be administered with minimal risk of aspiration, in a continuous infusion if necessary, to promote optimal growth. Feeding specialists and caregivers can provide therapy to develop and refine suck and swallow coordination skills concurrently, so that as the infant’s growth, strength, and ability to orally feed improve; tube feedings can be slowly weaned and the frequency and amount of oral feedings can be increased (Nursing Interventions 16–2). This strategy temporarily relaxes the intense focus on eating and can transform parental anxiety into energy devoted to interventions such as positive oral stimulation and nonnutritive sucking during tube feedings.

Family Education and Support

Other nursing and social service interventions should focus on providing education and support. Teach parents about all aspects of BPD, especially topics related to home care. If the child is to receive oxygen, arrangements must be made for administering the oxygen (Community Care 16–4). Medication administration, feeding and nutrition, developmental interventions, chest physiotherapy, and suctioning are among the most important topics of education for the parents and family of a child with BPD. Family members are taught CPR. Teach them the

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**NURSING INTERVENTIONS 16–2**

How to Improve Feeding Capabilities in an Infant With BPD

- Have baby in a calm, alert state before beginning to feed.
- Position the baby in the caregiver’s lap with the baby’s neck in a neutral position, hips and knees at 90 degrees of flexion, both upper extremities with elbows flexed at 90 degrees, and swaddled across the chest. Note: If the baby becomes excessively hot or sweaty with swaddling of the entire body, then fold a thin pillowcase or light towel in a long rectangle and swaddle only around the arms and partial trunk to prevent excessive scapular retraction, arching, and flailing of the upper extremities.
- Carefully monitor physiologic parameters, especially respiratory rate. Feedings may need to be limited or postponed if the infant remains tachypneic.
- Choose a nipple that allows moderate resistance to flow without excessive energy expenditure. Standard-shaped nipples are preferred.
- Present the nipple slowly and calmly, with minimal intraoral stimulation.
- Emphasize normal total body posture during feeding. Head and neck posture can alter oral–motor patterns during sucking. Ideally, marked neck extension should be reduced to aid oral–motor control. The goal of improving head and neck positioning may need to be approached slowly, to minimize stress to the infant.
- Allow baby to set the nippling pace, with rests as needed.
- Stop nippling if baby begins to sweat or cries inconsolably for 1 minute or longer; if respiratory rate or heart rate increases excessively, as determined by the physician; or if feeding takes longer than 20 minutes.
symptoms that indicate the child’s respiratory condition is worsening and when to seek medical attention.

**Community Care**

The emotional effect on parents and family of having a child with BPD is profound. The development of a chronic condition with life-threatening implications in a premature infant, followed by complex home care, is a situation so laden with stress and anxiety that it is often described by families as an “emotional roller coaster” from which they have no opportunity to escape. The family must deal with grief and sorrow over the loss of the expected healthy child, financial demands, and social isolation.

Social isolation is a common psychosocial issue for these families. Caring for a frequently hospitalized infant with a chronic illness can absorb virtually all the parents’ time and energy. They must balance time with the ill child against time with their other children and for themselves. Family sacrifices often have to be made. Parents and older siblings may be required to adjust work, school, and recreational schedules. Social interactions are often drastically reduced because of lack of time, energy, transportation, and financial resources. In addition, clear-cut social guidelines for approaching families with chronically ill children are limited. At a time when support is most important, individuals in the family’s social network may feel awkward and tend to withdraw. Assessing social support and interactions is crucial when planning care for a family with a child who has BPD.

Parent support groups facilitated by nursing or social service professionals are often successful in addressing parental anxiety and promoting positive coping. Sibling reactions and coping, financial stress, profound chronic fatigue, and uncertainty about their child’s physical and intellectual future all are topics many parents find comforting to discuss with others who have had similar experiences and concerns. Some families, too, are referred by
social services for private counseling to address and facilitate stress management.

**Cystic Fibrosis (CF)**

Once considered a fatal childhood disease, CF is a chronic, multisystem condition. Ongoing advances in understanding the pathophysiology of CF, particularly its genetic and molecular mechanisms, has greatly improved diagnosis and treatment, and thus improved survival rates, life expectancy, and quality of life for children and adolescents with CF. The median age of survival for individuals with CF has increased to 37 years in 2004, up from 32 years in 2003 (Cystic Fibrosis Foundation, 2007). Intensive research has also resulted in better screening tests to detect carriers through genetic testing.

CF is a highly complex disease and requires a holistic approach to care by a trained, interdisciplinary team, including physicians, advance practice nurses, nurses, dietitians, social workers, psychologists, and respiratory care therapists. Coordination and communication with the child, family, and other healthcare providers are essential. Specialist care in a dedicated CF center has been associated with improved survival and quality of life in children. As with any chronic condition, the primary objectives of CF care for children should focus on (1) ensuring optimal care, including treatments, routine monitoring, and general pediatric preventive care; (2) facilitating access to pertinent healthcare resources and support; (3) assisting the family in coordinating care among specialists and primary care providers, and in accessing medications, dietary supplements, and durable medical equipment; and (4) supporting quality of life and independence.

Although CF is rare overall, it is more common among white northern Europeans. The overall prevalence of CF in the U.S. population is estimated to be 1 in 3,700 live births (Green et al., 2005). Based on reports from the Centers for Disease Control (2004), the prevalence is 1 in 2,500 to 3,500 births among non-Hispanic whites, 1 in 4,000 to 10,000 births among Hispanics, and 1 in 15,000 to 20,000 births among non-Hispanic blacks.

**Pathophysiology**

CF is an autosomal recessive genetic condition. In such conditions, the risk of disease transmission is 25% if both parents carry the gene, and the chance that the child will be a carrier of the disease is 50% (see Fig. 3–3). Prenatal screening is common in women from populations that have an elevated prevalence of CF, or in women with known or suspected family histories. Prenatal testing is also done when obstructed fetal bowel is detected by ultrasound, because CF is associated with meconium ileus.

The gene responsible for CF is located on chromosome 7. CF results from mutations in the cystic fibrosis transmembrane regulator (CFTR), a protein that regulates chloride and sodium transport in secretory epithelial cells of the body’s exocrine glands. The alteration in the CFTR protein results in abnormal ion concentration across the apical membranes of these cells. They do not release chloride, resulting in an improper salt balance. This imbalance causes the mucus secretions of the pulmonary, gastrointestinal, and reproductive systems to become thick and sticky, and to block ducts in those organs. The sweat glands are also affected by blocked or abnormal transport and produce sweat with elevated sodium and chloride concentrations (Fig. 16–19).

The most CF common mutation, DF508, occurs in more than 90% of individuals with CF in the United States (Rowe, Miller, & Sorscher, 2005). More than 1,000 other gene mutations of CFTR genes have been described. A small number of these mutations occur with reasonable frequency, but most are rare. Thus, the clinical manifestations (the phenotypic expressions) of CF vary widely. For example, 99% of those who are homozygous for the DF508 allele have pancreatic insufficiency, whereas only 36% of people with CF with other mutations are pancreatic insufficient (Rowe, Miller, & Sorscher, 2005).

Clinical consequences of CF are progressive pulmonary damage (e.g., airway obstruction, inflammation, infection, scarring), pancreatic dysfunction, liver disease that may lead to cirrhosis, gut motility problems, and elevated sweat electrolyte levels. Approximately 80% to 85% of children with CF are pancreatic insufficient, resulting in malabsorption of important nutrients, fats, and proteins. Approximately 98% of males are sterile, because of blockage of the vas deferens by thick secretions, or from abnormal development (atresia of the vas deferens) that prevents passage of sperm. Females can become pregnant, but the thick cervical mucus acts as a natural barrier to sperm. Although the true biologic fertility in CF remains unknown, females with normal lung function appear to experience relatively few problems with pregnancy; those with decreased lung function and chronic infection tend to have poorer pregnancy outcomes (Edenborough, 2001).

The thickened, sticky mucus of a child with CF is ineffective in removing bacteria from the body, and in fact constitutes an ideal medium for bacterial growth. Thus, the child with CF is especially prone to pulmonary infection. Bacterial lung infections are responsible for most morbidity and mortality among children with CF, and these infections are often caused by multiple pathogens. The most common cultured bacteria are *Pseudomonas aeruginosa*, *S. aureus*, *Burkholderia cepacia*, and *H. influenzae*. Children with CF often remain colonized with organisms such as *P. aeruginosa*, which is never eradicated from the lungs.

**Alert!** *Pseudomonas (Burkholderia) cepacia* cause extremely virulent infections and have been associated with rapid deterioration of pulmonary function. *B. cepacia* has been associated with death in approximately 2% of children with mild or moderate forms of CF. To prevent spreading, children with *B. cepacia* should not have contact with CF patients.

Children with CF often experience acute pulmonary exacerbations, many of which are caused by respiratory viruses. Infections such as RSV may result in severe pulmonary complications, particularly in infants. Exacerbations cause fatigue, decreased appetite, weight loss, increased sputum production, increased cough, hemoptysis, decreased spirometry values, and poor response to outpatient therapeutic measures such as oral antibiotics and increased pulmonary treatments at home. Treating
pulmonary exacerbations requires careful monitoring, aggressive therapies, and often hospitalization.

Adolescents’ cognitive development is normal, but secondary sexual development may be delayed, causing teens to look younger than their peers. During the adolescent years, infertility must not be assumed for either gender; teens should receive appropriate referrals for informed family planning and life decisions.

**Assessment**

CF is often diagnosed early in life, although children with less severe CF may not be diagnosed until later childhood. The clinical presentation of CF can be extremely varied, although the most common symptoms are very salty tasting skin; persistent cough; excessive appetite but poor weight gain; and foul-smelling, greasy, bulky stools. As people live longer with CF, other symptoms and complications may manifest themselves (Chart 16–2).

Before diagnosis, newborns often present with meconium ileus and bowel obstruction, and perforation requiring surgical intervention. Young infants may be irritable and present with failure to thrive despite good appetite. Children with CF may appear physically small for their age in both linear growth and weight.

When assessing a child known to have CF, include an intensive history (by system) of current and past symptoms, changes in activity tolerance, exercise, sleep and
**CHART 16–2  COMPLICATIONS OF CYSTIC FIBROSIS**

<table>
<thead>
<tr>
<th>Complications</th>
<th>Causes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pulmonary</strong></td>
<td></td>
</tr>
<tr>
<td>Minor hemoptysis</td>
<td>Common after 10 years of age. Blood streaking is from mucosal irritation in the airway.</td>
</tr>
<tr>
<td>Major hemoptysis</td>
<td>Occurs more frequently with age; in less than 10% of adults. Bleeding caused from high systemic pressure of bronchial circulation when infection erodes a blood vessel.</td>
</tr>
<tr>
<td>Pneumothorax</td>
<td>Incidence increases with age (approximately 16% to 20% of patients older than 16 years experience this complication). Rupture of subpleural blebs through visceral pleura. High rate of recurrence.</td>
</tr>
<tr>
<td>Nasal polyps</td>
<td>Occurs in 10% to 25% of CF patients. Most common in older children and adolescents; etiology is unknown.</td>
</tr>
<tr>
<td>Chronic sinusitis</td>
<td>Occurs in more than 90% of CF patients. Etiology is thought to be from abnormal occlusion of the ducts that prevents mucus drainage; maxillary and ethmoid sinuses are most commonly involved.</td>
</tr>
<tr>
<td>Cor pulmonale</td>
<td>Occurs in advanced disease. Right ventricular hypertrophy, chronic hypoxemia and pulmonary hypertension, and right-sided heart failure are noted.</td>
</tr>
<tr>
<td>Pulmonary hypertrophic osteoarthropathy</td>
<td>Occurs in approximately 4% of older patients; etiology is unclear.</td>
</tr>
<tr>
<td><strong>Gastrointestinal</strong></td>
<td></td>
</tr>
<tr>
<td>CF diabetes</td>
<td>Occurs in 8% to 15% of patients, with onset during adolescence. Etiology is unknown. It is postulated that insulin deficiency is secondary to fibrosis of the pancreas, which destroys the islet’s architecture; usually nonketotic.</td>
</tr>
<tr>
<td>Distal intestinal obstruction syndrome equivalent (formally called meconium ileus equivalent)</td>
<td>Incidence is 10% to 20% of adult CF patients. Usually occurs during adolescence or later. May be partial or complete obstruction; etiology is multifaceted. Intestinal mucoproteins may be more viscous. Enteroglucagon release results from increased undigested fats that slow transit time. A fecal mass forms at the ileocecal region and extends distally.</td>
</tr>
<tr>
<td>Cholelithiasis</td>
<td>Occurs in up to 12% of patients and is rarely symptomatic prior to the teenage years. Stones are usually cholesterol. Etiology results from alterations in bile lipid composition.*</td>
</tr>
<tr>
<td>Liver disease</td>
<td>Occurs in about 4% of patients, peaking in adolescence and decreasing after 20 years of age.</td>
</tr>
<tr>
<td>Multilobar cirrhosis</td>
<td>Results from thickened secretions in bile ductules, causing plugging, ductular proliferation, inflammation, and cirrhosis.</td>
</tr>
<tr>
<td>Gastroesophageal reflux</td>
<td>Occurrence of symptoms varies. There is a transient, inappropriate relaxation of the lower esophageal sphincter. Contributing factors include positioning, cough, and increased intra-abdominal pressures versus thoracic pressure gradient.</td>
</tr>
<tr>
<td>Pancreatitis</td>
<td>Acute pancreatitis occurs in approximately 10% of patients. It can occur with pancreatic sufficiency. It is an inflammatory response. The exact causative mechanism is unclear.</td>
</tr>
<tr>
<td>Fibrosing colonopathy</td>
<td>Occurs in a small percentage of patients. Risk factors include age younger than 12 years. There is a strong association with oral pancreatic high-dose enzyme intake for more than 6 months.</td>
</tr>
</tbody>
</table>

Sources: Brennan et al. (2006) and Kerem et al. (2005).
Interdisciplinary Interventions

The care and treatment of CF is often complex and thus requires a multidisciplinary approach. Specialized CF centers that meet specific criteria and are accredited by the Cystic Fibrosis Foundation deliver quality care and maintain strict standards of practice. Although most CF centers are directed by pediatric pulmonologists, other pediatric specialists such as gastroenterologists, infectious diseases specialists, geneticists, and endocrinologists also are involved. Additional team members include nurses, advance practice nurses (pediatric nurse practitioner or clinical nurse specialist), registered dietitian, respiratory care practitioner, medical social worker, physical therapist, child life specialist, and genetic counselor. As the life expectancy for CF increases, and more patients survive into adulthood, pediatric healthcare teams must foster a “wellness” focus and incorporate planning for adult CF care. Planning for a productive life is the norm.

The family is central to chronic disease management teams. The child should be an active member in the CF care team. Working together, the child, parents, family, and the interdisciplinary team develop individualized management plans to treat the complex needs of the child and family (see the Point for Care Paths: An Interdisciplinary Plan of Care for the Child With Cystic Fibrosis). Although each member of the CF care team has specialized knowledge and a clearly defined role, overlap in role functions may occur, depending on the needs of the individual family. The goal of the team is to “normalize” the lives of the family, maintain existing pulmonary function, and prevent further pulmonary damage so the child can benefit as new treatment options become available.

Because of the chronic pulmonary infections, activities and lifestyles for children with CF may be altered. For example, *P. aeruginosa* is extremely communicable among the CF population, so room isolation, limited social interactions with others with CF, and infection control measures are required during hospitalization and community events for children colonized or infected with this organism. For example the Cystic Fibrosis Foundation has a policy that prohibits the participation of anyone with *B. cepacia* from participating at CF Foundation-sponsored events. Because of the highly communicable nature of *B. cepacia*, the CF Foundation believes this policy enables people with CF who are not infected with *B. cepacia* to more safely participate in its events (Cystic Fibrosis Foundation, 2008).
Medical Management

Medical management of CF is multifaceted. Successful chronic disease management requires complete assessments and routine monitoring of treatments. A comprehensive annual review, generally conducted at CF centers by the multidisciplinary team, should include assessments such as a full clinical examination and respiratory, nutritional, and psychosocial assessments, as well as a critical review of current therapies and treatments. Clinical diagnostic tests during the annual review may include complete blood count including iron status, blood chemistries, microbial cultures, bone density examinations (to evaluate for osteoporosis secondary to poor nutritional intake), and auditory assessments. In addition to the annual reviews, documenting overall health maintenance (immunizations, annual flu vaccine, and adherence history) is important.

For some children with early symptoms of pulmonary exacerbations, treatment may be managed in the home setting with oral antibiotics, aggressive pulmonary therapy, and close follow-up. Hospitalization is required for children who have declining pulmonary status, infection, or both. Such stays are often called “tune-ups.” During the “tune-up” period, aggressive pulmonary and nutritional therapies are instituted, along with intravenous antibiotics and an exercise program, and response to these therapies is evaluated. Frequency of aerosol treatments and airway clearance therapies is increased. A daily program to increase or prevent loss of endurance during hospitalization is part of the plan of care. The gastrointestinal therapies include nutritional assessment and evaluation of blood chemistries for nutritional deficits, including measurement of hematocrit, hemoglobin, albumin, prealbumin, and vitamins A and E levels (see Nutritional Support).

Today, with a shift toward ambulatory services, many individuals with CF initiate their “tune-ups” in the hospital and complete them at home. During the hospital phase, antibiotics are administered as appropriate, based on findings from sputum cultures. The shift to home care depends on factors such as severity of illness, venous access, ability and resources of the family, and payer source.

The daily medications required to maintain the baseline health include a long list of pharmaceutical agents (Table 16–12). Long-term use of oral antibiotics for chronic bacterial suppression has raised concern that antimicrobial-resistant infections will develop among children and youth with CF (Kerem et al., 2005). Susceptibility testing may be required for some pathogens to determine the effectiveness of unusual antibiotics.

Monitoring all therapies (with laboratory tests, pulmonary function tests, bone density studies, and radiographic studies) and coordinating the team consults are both part of the medical management of CF. Identifying new symptoms that may indicate complications is an ongoing process. Managing CF by intervening promptly when new symptoms occur contributes to improved outcomes.

Nutritional Support

Key components of the nutritional assessment in CF care are to determine baseline nutritional requirements and need for pancreatic enzyme replacement or vitamin therapy and to monitor for changing nutritional needs if comorbidities (e.g., diabetes) develop. Nutritional assessments are conducted at each encounter and hospitalization. Plot physical growth (e.g., height, body mass index) on the growth chart to monitor progress and response to therapeutic interventions. The dietitian assesses physical growth, conducts a nutritional assessment at each admission, identifies dietary requirements and goals, and initiates an overall plan to meet the child’s high-caloric nutritional needs. Serum laboratory results such as albumin, prealbumin, glucose, electrolytes, and complete blood count are assessed. Levels of vitamins A and E are assessed annually, and skinfold measurements are obtained as indicated. Guidelines for administering pancreatic enzymes are provided in Nursing Interventions 16–3. Effectiveness of replacement enzymes is monitored through fecal fat studies.

<table>
<thead>
<tr>
<th><strong>TABLE 16–12</strong></th>
<th><strong>Pharmaceutical Agents Used in the Care of the Child With Cystic Fibrosis</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Category</strong></td>
<td><strong>Purpose</strong></td>
</tr>
<tr>
<td>Aerosols Bronchodilators</td>
<td>Open up airways</td>
</tr>
<tr>
<td>Inhaled antibiotics</td>
<td>Antimicrobial, for lung treatment</td>
</tr>
<tr>
<td>Mucolytic enzyme</td>
<td>Thins mucus</td>
</tr>
<tr>
<td>Pancreatic enzymes</td>
<td>Increase food/nutrient absorption</td>
</tr>
<tr>
<td>Vitamins/minerals (A, D, E, K)</td>
<td>Fat-soluble vitamin supplement in water-miscible form; supplement overall diet</td>
</tr>
<tr>
<td>H₂ block.</td>
<td>Alters gastrointestinal acidic environment; gastroesophageal reflux therapy</td>
</tr>
<tr>
<td>Prokinetic agents</td>
<td>Enhances gastrointestinal motility; gastroesophageal reflux therapy</td>
</tr>
<tr>
<td>Oral and intravenous antibiotics</td>
<td>Antimicrobial for <em>S. aureus</em></td>
</tr>
<tr>
<td></td>
<td>Antimicrobial for <em>H. influenzae</em></td>
</tr>
<tr>
<td></td>
<td>Antimicrobial for <em>P. aeruginosa</em></td>
</tr>
</tbody>
</table>
Infants are usually given an elemental formula to optimize absorption. Elemental formulas are composed of simple and easily absorbed forms of carbohydrates (glucose polymers or monosaccharides), proteins (amino acids or casein hydrolysates), and fat as medium-chain triglycerides. Elemental formulas are relatively expensive, and costs may vary across individual pharmacies. Special state-funded programs may provide assistance. Infants may thrive adequately on breast milk or standard infant formula without gastrointestinal complications, as long as enzymes are adjusted appropriately. The older child is managed with a high-calorie, high-protein diet, including snacks and nutritional oral supplements to boost calories and nutrition. Pancreatic enzymes are administered at each feeding, meal, and snack to optimize nutrient absorption.

If weight gain and progress toward nutritional goals are not demonstrated, alternate feeding routes are considered. Gastrostomy tubes, (such as percutaneous endoscopic gastrostomy tubes), low-profile ("button") gastrostomies, or jejunostomy tubes (J-tubes) are possible options (see Chapter 18). Nocturnal drip feedings through the gastrostomy tube are recommended to supplement oral intake.

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needs and stresses. Many social workers facilitate support groups and provide parent-to-parent networking.

**Physical Therapy**

The physical therapist evaluates the muscles used for breathing and posture and assesses the child’s ability to carry out daily activities. The physical therapist also prescribes individualized exercise programs and monitors endurance. The roles of the physical therapist and respiratory care practitioner may overlap in certain regions of the country. The child with CF is assessed on a regular basis and is provided a home exercise program.

**Child Life Services**

The child life specialist’s focus of practice is on therapeutic play along with recreational and diversional activities. This professional helps the child cope with hospitalization, medical visits, and procedures through play, and can contribute to motivational and behavioral programs to encourage children to do their treatments, drink their nutritional supplements, cooperate with therapy, and take medicines. Some child life departments may offer school programs or assist with arrangements for home-bound teachers.

Education regarding self-care and ways to integrate CF care into daily schedules is necessary to help the family foster independence and age-appropriate skills of daily living. All too often, the healthcare team may be so focused on the disease process that lags occur in educating families to integrate developmentally appropriate strategies as a part of the child’s care. Each developmental stage merits review with the family and the patient, when age appropriate, to facilitate strategies that will allow this specialized care to be provided daily (Developmental Considerations 16–1). Parents must understand concepts such as offering the toddler a choice of juice to take with medicines; thus, there is no unacceptable choice and the toddler maintains the “control” for mastery of that stage.

Parents, caregivers, and patients must also be kept informed regarding changes in condition and updates on expanding and newer therapies. They must be educated when new therapies are introduced for maintenance care, such as oxygen, enteral home nutrition programs, home intravenous antibiotic administration, home maintenance of venous access devices, administration of aerosolized antibiotics, or the use of newly prescribed medications.

**Community Care**

CF presents challenges, obstacles, and opportunities that can shape the child’s future. For parents, childrearing roles and responsibilities can be complicated by the increased demands and restrictions imposed by CF (e.g., constant need for daily treatments), numerous contacts with healthcare services, altered plans for family outings and vacations, fatigue, depression, and, possibly, financial constraints.

Children living with CF must incorporate a variety of treatments into their daily life, and these treatment demands and restrictions can often result in psychological stress and burdens for children and their families. Psychological functioning of the child and family depends on multiple factors, such as family income, family structure, parental education levels, social support, and coping styles. Thus, nurses caring for these children and families must carefully assess for developmental and psychosocial risks.

The general approach for children with CF is to “normalize” their daily living activities (e.g., home, school, recreational) within the child’s specific limitations. Typical childhood events such as a common cold can create substantial problems for the child with CF. Thus, parents need to use strict respiratory infection prevention strategies such as handwashing, isolating the child from people with respiratory or other infections, and isolating the child from others with CF. Provide anticipatory guidance for parents and children as they seek to maintain normalcy in their daily home lives.

For the parents of an infant or child newly diagnosed with CF, the process of adjustment may be compared with the grief process. Parents often have difficulty regaining stability for 6 months to 1 year after diagnosis. Patients and their families may generally function adequately, but need additional support during times of crisis. Some examples are the first hospitalization after diagnosis, the death of another child at the CF center, the transition to adult care, addition of new home therapies such as oxygen or intravenous antibiotics, or the first day of school.

Work closely with school personnel to develop an educational plan that will promote learning and to reduce CF-associated risks. Encourage parents to provide school personnel with information (available through local CF centers) about CF and about their child’s specific needs. Parent–teacher conferences at the beginning of each school year are an effective way to provide information and establish communication to reduce the sense of difference the child may feel at school. Encourage school attendance, so that the child can socialize and diversify his or her strengths to prepare for future goals. Social isolation because of sporadic school attendance can lead to other psychosocial issues, such as depression.

During adolescence, planning for the future and choosing a career are central tasks. Children must choose careers that will fulfill their ability to work despite changing conditions. Career and vocational counselors can assist in this planning process. Transitional care during the adolescent years, necessary to guarantee lifetime continuity of care, requires close cooperation between the patient’s pediatric and adult CF centers. Transition to adult care usually occurs around age 16 to 18 years, but the timing should be determined by the adolescent’s social maturity and health status.

The CF team members work in concert with each other, the families, and the children to support a common goal. Because of the complexities and variations of CF, many of the team’s functions overlap or may be carried out differently across different centers. Supporting a family through the decision-making process of the end-of-life stage is generally a process shared by all team members, but may be the primary responsibility of the clinical social worker. It is also critical for the CF team members to acknowledge the support systems of the family and to consult other professionals, such as pastoral care services or psychologists.

See the Point4 for a summary of Key Concepts.
## Developmental Considerations 16–1

### Self-Care Strategies for the Child With Cystic Fibrosis

<table>
<thead>
<tr>
<th>Developmental Stage</th>
<th>Strategies</th>
</tr>
</thead>
</table>
| Infancy             | Discuss normal developmental behaviors with parents.  
                    | Respond to crying promptly (0–3 months).  
                    | Respond to cues as indicated (>3 months).  
                    | Establish regular routines.  
                    | Incorporate special care into routines.  
                    | Provide reinforcement about PD&P and comfort related to “sensorimotor stimulation.”  
                    | Monitor all developmental progress.  
                    | Provide recommendations for home schedule/time management.  
                    | Provide healthcare teaching:  
                    | • Disease management  
                    | • Discuss normal acquisition of developmental skills, especially for first-time, new parent |
| Early childhood     | Discuss normal developmental behaviors with parents.  
                    | Institute measures to promote age-appropriate behaviors.  
                    | Assess and monitor feeding behaviors.  
                    | Support choices for beginning of “daycare”/out-of-home care.  
                    | Provide information regarding age-appropriate behavioral management.  
                    | Provide information for self-care skills:  
                    | • Incorporate distraction techniques for resistant behaviors.  
                    | • Use games to gain cooperation.  
                    | Allow child simple choices that are all acceptable.  
                    | Encourage sharing of care between primary caregivers at home.  
                    | Assist with integrating therapy schedules into family rituals.  
                    | Teach coughing secretions “up” and in tissue.  
                    | Provide information to identify basic symptoms that indicate need for healthcare team/doctor visit.  
                    | Support exercise as part of ADLs:  
                    | • Provide opportunities for therapeutic play.  
                    | • Offer medications in a medicine cup.  
                    | • Allow child to help gather supplies.  
                    | • Encourage “blowing” activities, such as bubbles, horns, pinwheels.  
                    | Provide information on disease management.  
                    | Provide information for self-care skills:  
                    | • Assistance with pill swallowing.  
                    | • Begin PEP therapy (≥4 years). |
| Middle childhood    | Institute measures to promote age-appropriate behaviors.  
                    | Assess understanding of  
                    | • Meditations  
                    | • Nutrition/snacks  
                    | • Respiratory treatments  
                    | Provide information for self-care skills:  
                    | • Assist with pill swallowing.  
                    | • Allow choices with food/snack selection.  
                    | Give responsibilities for simple tasks regarding therapies:  
                    | • Set up nebulizer.  
                    | • Prepare medications.  
                    | • Clean nebulizer. |

(Continued)
### Developmental Stage Strategies

#### Adolescence

- Remind child to initiate ACT time.
- Have child answer health team’s questions.
- Include child in decision making.
- Incorporate exercise as part of ADLs: group or solo sports.
- Encourage use of wind instruments (horns).
- Coach during PEP/ACT therapy by caregiver.
- Discuss school performance/attendance and ways to ensure self-care at school.
- Provide information on disease management.
- Institute measures to promote age-appropriate behaviors.
- Discuss/assess/monitor normal developmental concerns/issues.
- Provide information to facilitate increased self-care skills:
  - Self-administer medications, aerosol treatments, snack/meals, ACT.
  - Take inventory of medications.
  - Arrange for refills for medications.
  - Schedule clinic appointments.
  - Set up nocturnal/daily oxygen and check flow rate.
- Assess and monitor:
  - Understanding of disease process
  - Medication
  - Problem-solving skills
  - Current self-care behaviors
- Provide information on disease management.
- Encourage and facilitate with individual and caregiver:
  - Monitoring of self-care by caregiver from afar
  - Decision for when parental presence is desired at clinic
  - Involvement in decision making
  - Negotiation of schedule with special events
- Support exercise as part of ADLs:
  - Aerobic and anaerobic
  - Upper body strengthening
  - Stretching
  - Energy conservation techniques
- Provide information on education and career planning.
- Facilitate discussion of peer relationships/dating.
- Discuss transitioning plans and process.
- Initiate referrals to support choices:
  - Genetic counseling
  - Sexuality issues
- Provide information on insurance and healthcare systems.

ACT, airway clearance techniques; ADLs, activities of daily living; PD&P, postural drainage and percussion; PEP, positive expiratory pressure.

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### References


See the Point3 for additional organizations.