Chronic Obstructive Pulmonary Disease

Chapter 27

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Objectives
After studying this chapter, the learner should be able to:

1. Explain the pathophysiology of and interventions for chronic bronchitis, pulmonary emphysema, and asthma.
2. Discuss the clinical manifestations and care management of adults with cystic fibrosis.
3. Describe interventions for managing patients with respiratory failure.
4. Discuss the care of the patient with an endotracheal tube and mechanical ventilation.
5. Discuss the indications for and advantages of noninvasive methods of providing mechanical ventilation.
6. Explain the clinical considerations in weaning patients from mechanical ventilation.
7. Describe the unique needs of the patient undergoing a lung transplant.

Chronic Obstructive Pulmonary Disease

Chronic obstructive pulmonary disease (COPD) is not a disease entity but a complex of conditions that contribute to airflow limitation. COPD is a chronic, slowly progressive disorder characterized by stable phases increasingly interrupted by worsening of symptoms, termed acute exacerbations. In 1995 the American Thoracic Society defined COPD as a disease state characterized by airflow obstruction resulting from chronic bronchitis or emphysema (Figure 27-1). Asthma is discussed separately because of its unique characteristics of inflammation and degree of reversibility.

Etiology and Epidemiology.
Cigarette smoking is the primary causative factor of COPD in more than 90% of patients. Although the exact mechanism is unknown, cigarette smoking causes changes in the airways that limit airflow. However, only 15% to 20% of heavy smokers develop COPD. This points to...
known genetic abnormality that leads to COPD.4 AAT is a serum protein produced by the liver and normally found in the lungs. Its main role is to protect the lungs from a breakdown product of protein called neutrophil elastase. Severe AAT deficiency leads to premature emphysema. The majority of persons with AAT deficiency are misdiagnosed or undiagnosed. A high index of suspicion is needed when emphysema occurs in patients under age 60, even those with a significant smoking history.7 Environmental tobacco smoke, also called secondhand smoke or passive smoking, is the exposure of nonsmokers to cigarette smoke directly blocks the inhibitory capacity of AAT and promotes an excess of neutrophils through the attractant effects of alveolar macrophages.

Pathophysiology. The pathophysiologic hallmarks of COPD are destruction of the lung parenchyma (characteristic of emphysema) and inflammation of the central airways (characteristic of chronic bronchitis) (Figure 27-2). The functional consequence of these abnormalities is expiratory airflow limitation.

EMPHYSEMA. Emphysema is defined in terms of anatomic pathology as abnormal permanent enlargement of the air spaces distal to the terminal bronchioles, accompanied by destruction of their walls and without obvious fibrosis. However, recent data have shown that the destructive process is accompanied by an increase in the mass of collagen, suggesting alveolar wall fibrosis.43 Still, the defining element of emphysema is the destructive process. Depending on how the acinus is destroyed, emphysema is classified as centriacinar or panacinar. In centriacinar emphysema the destruction is restricted to respiratory bronchioles and central portions of the acini surrounded by areas of grossly normal lung parenchyma. In panacinar emphysema the whole acinus is uniformly involved; this type is less associated with smoking and more typically occurs in AAT-deficient persons.

As indicated above, evidence suggest that proteases released by polymorphonuclear leukocytes or alveolar macrophages are involved in destruction of the lung’s connective tissue. Connective tissue in the lungs is primarily composed of elastin, collagen, and proteoglycan, which can be damaged and destroyed by enzymes such as proteases and elastase. Protease-antiprotease imbalances in antiproteases can lead to enhanced lung parenchymal destruction. Alpha1-antitrypsin (AAT) deficiency is the only known genetic abnormality that leads to COPD.3 AAT is a serum protein produced by the liver and normally found in the lungs. Its main role is to protect the lungs from a breakdown product of white blood cells (WBCs) called neutrophil elastase. Severe AAT deficiency leads to premature emphysema. The majority of persons with AAT deficiency are misdiagnosed or undiagnosed. A high index of suspicion is needed when emphysema occurs in patients under age 60, even those with a significant smoking history.7 Environmental tobacco smoke, also called secondhand smoke or passive smoking, is the exposure of nonsmokers to cigarette smoke and is a risk factor for COPD. High levels of air pollution, occupational exposure to toxins, and infections are also considered causative factors for a small percentage of patients with COPD.

COPD is a major health problem, the fourth leading cause of death in the United States, and the only one in the top five that continues to rise.1,3 It is estimated that 11.2 million adults in the United States are diagnosed with COPD, but about 24 million Americans have evidence of impaired lung function, suggesting an underdiagnosis of COPD. According to estimates by the National Heart, Lung, and Blood Institute, in 2004 the annual cost to the nation for COPD was $37.2 billion. This included $20.9 billion in direct health care expenditures; $7.4 billion in indirect morbidity costs, and $8.9 billion in indirect mortality costs.2 Historically, COPD has had a greater prevalence and mortality rate among men compared with women. In 2002 studies revealed the incidence of COPD in women had surpassed the incidence in men (61,000 versus 59,000).2,3 Significantly more women have chronic bronchitis (6.2 million women versus 2.9 million men).3 The rates for emphysema remain higher for men, but the disparity has decreased.7

Figure 27-2 Pathogenesis of chronic bronchitis and emphysema. (Dashed arrows indicate role of alpha1-antitrypsin deficiency, if present.)
macrophages. The neutrophils release elastases, which are capable of destroying the elastin structure of the lung. An established familial tendency to AAT deficiency indicates that relatives of persons with this type of emphysema should be screened and provided with counseling.

An estimated 1% of persons with COPD have AAT deficiency, but a recent study showed 116 million carriers worldwide among all racial groups. The mean age for onset of dyspnea related to COPD is 40 to 45 years in persons with AAT deficiency. Their mean life expectancy is 50 to 65 years of age, with smokers dying about 10 years earlier than nonsmokers. Because AAT deficiency cannot be prevented, it is important that persons who have it do not smoke.

The clinical diagnosis of emphysema is inferred from the signs and symptoms of known pathophysiologic changes associated with the disease. Physiologic abnormalities characteristic of emphysema include:

- **Increased lung compliance:** Loss of elastic recoil resulting from destruction of elastin in lung parenchyma causes the lungs to become permanently overdistended (Figure 27-3). Thus, compared with normal lungs, emphysematous lungs have a larger increase in volume relative to the pressure change that occurs during inhalation.

- **Increased airway resistance:** Destruction of elastic lung tissue causes the small airways to either collapse or narrow, particularly during expiration (Figure 27-4). Thus air becomes trapped in the distal air spaces, contributing to the lungs’ overdistended state. The overdistended lungs press down against the diaphragm, diminishing its ventilatory effectiveness. Use of accessory muscles for breathing, which is a
compensatory attempt to force the trapped air out of the lungs, causes an increase in intrapleural pressure, which fur-
ther accentuates airway collapse.

- Altered oxygen–carbon dioxide exchange: Destruction of alveo-
lar and respiratory bronchiole walls decreases alveolocapillary
membrane surface area, which in turn may diminish diffu-
sion of oxygen and carbon dioxide. Persons with emphysema
are able to compensate for these destructive changes by
increasing their respiratory rate. Thus arterial blood gases
(ABGs) remain relatively normal, although mild hypoxemia
may be present. Late in the course of the disease, extensive
surface area loss and ventilation-perfusion (V/Q) inequalities
usually cause respiratory acidosis and hypoxemia. The first
sign of emphysema is an insidious onset of dyspnea, initially
on exertion. With further disease progression, they have diffi-
culty exhaling and constant dyspnea. There is minimal cough
and sputum production. Persons with emphysema usually
appear thin and manifest a “barrel chest” with an increased
anteroposterior (AP) diameter from hyperinflation. The char-
acteristic breathing pattern of the emphysematous individual
includes accessory muscle breathing, an increased respiratory
rate, and a prolonged expiratory phase resulting from airway
narrowing or collapse on expiration. These individuals spon-
taneously exhibit pursed-lip breathing, which facilitates
effective air exhalation (Figure 27-5).

Pulmonary function studies demonstrate an increased residual
volume (RV), functional residual capacity (FRC), and total lung
capacity (TLC). Diffusing capacity is significantly reduced
because of lung tissue destruction. Diminished respiratory airflow
is demonstrated by a decreased FEV1 (forced expiratory volume in
1 second) and maximum midexpiratory flow rate. The vital capac-
ity (VC) may be normal or only slightly reduced until late in the
disease progression; thus the FEV1/VC ratio is decreased.

ABGs are often near normal because of the individual’s ability
to compensate through an increased respiratory rate and tidal vol-
ume. Indeed, many people with emphysema overcompensate and
develop a mild respiratory alkalosis from hyperventilation. Because
resting hypoxemia is absent and ventilation is high, these individu-
als maintain a normal PaCO2 despite abnormal gas exchange. Late
in the course of the disease, the PaO2 is elevated, which promotes
the development of cor pulmonale and respiratory failure.53

Chronic Bronchitis. Chronic bronchitis is defined in clinical
terms as the presence of a chronic productive cough for 3 months
in each of 2 successive years in a patient in whom other causes of
chronic cough have been excluded.

The pathologic changes that typify chronic bronchitis are
hypertrophy of mucus-secreting glands and chronic inflammatory
changes in the small Airways. Mucous gland hypertrophy and
hyperplasia from chronic irritation cause excessive mucus produc-
tion. The excessive mucus and impaired ciliary movement associ-
ated with chronic bronchitis increase susceptibility to infection.
Bacteria, the most common of which are Streptococcus pneumoni-
 ae and Hemophilus influenzae, proliferate in the mucus secre-
tions in the lumen of the bronchi. As bacteria multiply, they exert a
neutrophilic chemotaxis, and pus cells migrate from between
bronchial epithelial cells to produce a mucopurulent exudate in
the lumen. The presence of granulation tissue and peribronchial
fibrosis results in stenosis and airway obstruction. Small Airways
may be completely obliterated, and others may become dilated.
This chain of events further traps secretions and promotes multi-
plication of bacteria. Some evidence exists that the pathologic
changes occur initially in small Airways and move to larger
bronchi. The disease may progress to ulceration and destruction
of the bronchial wall (Figure 27-6).

Persons with chronic bronchitis develop increased airway
resistance as a result of bronchial wall tissue changes, mucosal
edema, and excessive mucus production. Excess mucus in the air-
ways not only obstructs airflow but also often causes bron-
chospasm, which further increases airway resistance.

Figure 27-5 Pursed-lip breathing.
Oxygen–carbon dioxide exchange is altered. Airway obstruction results from all the pathophysiologic changes that increase airway resistance and cause V/Q mismatching at the alveolo-capillary membrane by decreasing the amount of oxygenated air that reaches the alveoli. In addition, the obstructed airways may lead to atelectasis (lung collapse), which further diminishes the surface area available for respiration. The result of these pathophysiologic alterations is hypercapnia, hypoxemia, and respiratory acidosis.

Right ventricular decompensation (cor pulmonale) may develop. The hypercapnia and hypoxemia typically associated with chronic bronchitis cause pulmonary vascular vasoconstriction. The increased pulmonary vascular resistance results in pulmonary vessel hypertension that in turn increases vascular pressure in the right ventricle of the heart. The earliest symptom of chronic bronchitis is a productive cough, especially on awakening. This symptom is often ignored by cigarette smokers, who become so accustomed to an early-morning cough that they take it for granted; some of them even refer to it as their “cigarette cough.” Early in the course of chronic bronchitis, the symptoms tend to be episodic. As the disease progresses, the patient’s symptoms are constantly present to some degree. The patient appears increasingly dyspneic, using accessory muscles to breathe. Chronic hypoxemia resulting in polycythemia causes the patient to appear cyanotic. Increased pulmonary vascular resistance caused by respiratory acidosis and hypoxemia increases pressure on the right side of the heart, ultimately resulting in right-sided heart failure (cor pulmonale). The person with late-stage chronic bronchitis and cor pulmonale appears stout or overweight from edema, and the skin appears dusky.

Patients with chronic bronchitis complicated by cor pulmonale often have chronic respiratory failure (gradual onset of PaO2 of less than 50 mm Hg and a PaCO2 of more than 50 mm Hg). They are also prone to acute respiratory failure as a complication of a respiratory infection superimposed on their already diseased lung.

Complications. Infection and respiratory failure are the major complications.

Clinical Manifestations. COPD progresses for about 30 years from inception to clinical manifestations. Decline in lung function develops insidiously and is almost always caused by decades of exposure to tobacco smoke. The normal decline in lung function as measured by FEV1 is 25 to 30 ml/yr beginning at about age 35. The rate of decline of FEV1 is steeper for smokers than for nonsmokers, and the heavier the smoking, the steeper the rate. Patients often do not complain of exertional dyspnea until their FEV1 is between 40% and 50% of its expected value. Patients with COPD have usually smoked at least 20 cigarettes per day for 20 or more years before symptoms develop. They commonly are seen in the fifth decade with productive cough or an acute chest illness. Dyspnea on effort usually does not occur until the sixth or seventh decade.

Persons with COPD often unconsciously reduce their activities of daily living (ADLs) to accommodate their respiratory symptoms. They usually do not seek medical help until their symptoms are severely exacerbated, often by a respiratory infection, or until their respiratory symptoms interfere significantly with ADLs, resulting in diminished quality of life.10

Physical examination early in the disease may reveal only slowed expiration and wheezing on forced expiration. As obstruction progresses, hypertension becomes evident and the AP diameter of the chest increases. The diaphragm becomes limited in its motion. Breath sounds are decreased, expiration prolonged, and heart sounds often distant. Course crackles may be heard at the lung bases. Wheezes can be elicited with forced expiration.

Collaborative Care Management

Diagnostic Tests. Underdiagnosis of COPD is common. It may be undiagnosed in up to 50% of individuals who have the disease.11

Pulmonary Function and Spirometry Tests. Pulmonary function and spirometry tests are used for diagnosis and to follow progression of disease. Spirometry testing can detect physiologic alterations that occur early in the disease. It measures airflow over time from fully inflated lungs. Although spirometry testing is sensitive in the identification of airflow obstruction, it does not identify the cause.29

FVC is the entire exhaled breath, FEV1 is the amount of air exhaled in the first second. Normally the FEV1/FVC ratio is 70%. In COPD both these measurements are reduced. Up to 30% of patients have an increase in FEV1 after inhalation of a bronchodilator. Lung volumes (TLC, FRC, RV) are usually within normal limits until later in the course of the disease, when the lung volumes may be increased. Usually no loss of diffusing capacity occurs.

The Third National Health and Nutrition Examination Survey (NHANES III) indicated a high prevalence of undiagnosed COPD. As a result, the survey recommended the use of office spirometry to screen at-risk patients before symptoms appear and early intervention to preserve pulmonary function. Clinicians have not yet fully embraced this recommendation for screening as a part of primary care; only about 25% of health care providers have a spirometer in their offices.15

Chest X-Ray Films. Chest x-ray films of patients with COPD typically demonstrate a low, flat diaphragm; increased AP diameter of the thorax; and overdistention of the lungs. Bullae may be present, and patients with chronic bronchitis may have increased bronchovascular markings.

Arterial Blood Gas Studies. In the early stage of COPD, ABG studies show mild or moderate hypoxemia without hypercapnia. In the later stages patients have more severe hypoxemia and hypercapnia, and values may worsen during exacerbations, exercise, and sleep.

Sputum and Hematology Studies. Sputum studies are done for Gram stain, culture, and sensitivity. The most frequent pathogens cultured are S. pneumoniae and H. influenzae. Neutrophils and bronchial epithelial cells usually are found in chronic bronchitis. On complete blood count, erythrocytosis is frequently seen as PaO2 levels fall below 55 mm Hg. AAT assay also may be done.
Medications. The judicious use of appropriate medications in a stepwise approach is the recommended treatment strategy, with the goals of improving airflow and providing significant symptomatic relief. Medications have yet to affect COPD mortality, so the focus is on improved morbidity outcomes.

Bronchodilators. COPD is not completely reversible, but most patients experience some improvement in dyspnea with the inhalation of bronchodilating and antiinflammatory medications.

Anticholinergic Agents. Multiple cholinergic receptors in the lung stimulate muscle contraction and mucus gland secretion. Acute anticholinergic medication use in patients with COPD produces equal or greater bronchodilation than beta-agonists. Long-term anticholinergic use provides sustainable effects. Anticholinergic agents are considered first-line therapy for COPD. Ipratropium (Atrovent) is currently the only anticholinergic available in the United States that is administered in a metered-dose inhaler (MDI). The usual dose is 2 puffs four times daily, but the dose may be increased to 3 or more puffs four times per day. Ipratropium is well tolerated. Some patients have a cough and dry mouth as side effects of anticholinergic agents.

Beta-Agonists. Inhaled beta₂-agonists are the second choice of therapy for COPD management. Beta-agonists produce bronchodilation and improve hyperinflation, dyspnea, exercise capacity, and quality of life in patients with COPD. In addition to short-acting beta-agonists (albuterol, metaproterenol, pirbuterol), a long-acting beta-agonist, salmeterol, is now available in the United States. Beta-agonists may be delivered by inhaled, oral, subcutaneous, or intravenous (IV) routes. The preferred route is by inhalation to minimize side effects. Table 27-1 lists the commonly prescribed adrenergic agents that work at beta sites in smooth muscles of the airways.

Methylxanthines. Methylxanthines such as theophylline and caffeine have been used to treat patients with respiratory problems for decades. Theophylline is known to increase respiratory muscle strength and prevent respiratory muscle fatigue. They are also mildly antiinflammatory and mitigate some lymphocyte responses. However, the role of theophylline in COPD management has been questioned, and use has fallen significantly. Theophylline has a narrow therapeutic range, interacts with numerous drugs, and is only a mild bronchodilator. Administering long-acting theophylline in the evening has been shown to reduce overnight decline in FEV₁ and morning respiratory symptoms. Current dosing recommendations include serum theophylline levels of 5 to 12 mg/L. Close monitoring for side effects and toxicity is required. Seizures and arrhythmias remain high-risk complications. The more common side effects include tremor and gastrointestinal (GI) distress.

Combination Therapy. Combinations of anticholinergics and beta-agonists are of added benefit in patients with stable COPD. Combination therapy may be achieved with the use of separate MDIs, a single MDI with two medications combined, or nebulizer delivery of medications. The addition of theophylline to this regimen appears to increase symptomatic relief.

Corticosteroids. The use of corticosteroids in COPD is controversial, although they are frequently prescribed for both acute and chronic regimens. During acute exacerbations corticosteroids can improve patient symptoms and reduce hospital stays. Steroids may also reduce the incidence of relapses after acute exacerbations in patients with a history of frequent exacerbations, and regular use of inhaled steroids may improve quality of life and decrease exacerbations in patients with severe disease. Thus some COPD patients benefit from chronic steroid use, but it may require 6 months of inhaled steroids to identify these patients. Therapy with inhaled corticosteroids is recommended by the National Heart, Lung, and Blood Institute; World Health Organization; and Global Initiative for Chronic Obstructive Lung Disease for (1) patients with symptomatic COPD who have a documented spirometric response to inhaled corticosteroids and (2) patients with moderate to severe COPD who have repeated exacerbations that require treatment with antibiotics or oral corticosteroids. Theophylline and beta-agonists are used, the dose should be maintained at the minimum level to achieve desired outcomes.

Mucolitics. Mucus hypersecretion is a risk factor for more rapid disease progression. It increases the likelihood for hospitalization and symptomatic limitations. Unfortunately, little evidence is available regarding mucolitics.

**Table 27-1 Beta₂-Agonists and Dosages for Metered-Dose Inhalers and Nebulized Solutions**

<table>
<thead>
<tr>
<th>Drug</th>
<th>MDI</th>
<th>Nebulization</th>
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<tbody>
<tr>
<td>Albuterol (Proventil, Ventolin)</td>
<td>2-3 puffs q4-6h, 0.09</td>
<td>0.3-0.5 ml 0.5% solution in 3 ml saline q4-6h</td>
</tr>
<tr>
<td>BDP (Tornalate)</td>
<td>2-3 puffs q6-8h, 0.37</td>
<td></td>
</tr>
<tr>
<td>Metaproterenol (Alupent, Metaprel)</td>
<td>2-3 puffs q4-6h, 0.65</td>
<td>0.3 ml 5% solution in 2.5 ml saline q4-6h</td>
</tr>
<tr>
<td>Pirbuterol (Maxair)</td>
<td>2-3 puffs q4-6h, 0.20</td>
<td></td>
</tr>
<tr>
<td>Salbutamol (Seretide)</td>
<td>2 puffs q12h, 0.50</td>
<td></td>
</tr>
<tr>
<td>Terbutaline (Brethaire)</td>
<td>2-3 puffs q4-6h, 0.20</td>
<td></td>
</tr>
</tbody>
</table>

MDI: Metered-dose inhaler; q, every; h, hour.
Currently available that mucokinetic agents reduce mucus production or enhance the elimination of mucus in patients with COPD.

**Antibiotics.** Chronic or prophylactic antibiotics are not routinely recommended for patients with COPD. Antibiotics can shorten the course of acute exacerbations that involve purulent sputum in association with increased sputum production or dyspnea. Lower-cost broad-spectrum antibiotics are preferred.

**Alpha1-Antitrypsin.** Regular replacement of AAT in patients with deficiency may prevent the protease-antiprotease imbalance that damages the lungs. Although definitive proof of long-term benefits of AAT replacement therapy is still lacking, a growing body of evidence suggests that patients who are AAT deficient and receive replacement therapy have a slower rate of lung destruction as measured by spirometry and a chest computed tomographic scan. It may also reduce mortality. IV infusion of AAT can be given on a weekly or biweekly basis but is most commonly administered monthly. Newer modes of delivery such as inhalation are under investigation.

**Antidepressant and Antianxiety Medications.** Depres- sion is frequently unrecognized in patients with COPD and may manifest as insomnia or anxiety. Multiple medications can successfully treat depressed patients with COPD; however, serotonin selective reuptake inhibitors (SSRIs) are the most commonly prescribed. Anxiety is also common in COPD patients, with panic attacks occurring in a significant number. SSRI medications, which provide effective therapy and relative patient safety, are the primary medications used to treat anxiety in patients with COPD. Buspirone is an example of an anxiolytic that does not have respiratory depressant effects. However, it has only mild antianxiety effects and may not be adequate.

**Treatments Smoking Cessation.** No intervention other than smoking cessation has been shown to slow the rate of decline in lung function in patients with COPD. Approximately 60% of individuals who smoke say they want to quit. Helping individuals quit smoking is an important nursing consideration. The Lung Health Study showed that early intervention in individuals with mild to moderate airflow obstruction can decrease age-related decline in FEV1. A consideration for nurses teaching smoking cessation is role modeling. Statistics continue to show that nurses and nursing students smoke at a higher rate than the general population.

Smoking cessation is a challenge at any age, but particularly for older patients who have been smoking for years. For each attempt to stop smoking, relapse rates approach 70% at 3 months and exceed 90% at 1 year. The older adult may have tried many interventions, made multiple attempts to quit, and have high expectations for failure. On the other hand, older adults are more likely to value advice from physicians and health care providers and therefore more seriously contemplate smoking cessation. Some intervention studies have shown positive results from regular, brief calls and letters of encouragement from health care professionals. Counseling alone has been shown to result in a less than 5% sustained quit rate. When using nicotine replacement strategies, older patients need to be monitored closely for signs of nicotine excess (nausea, tachycardia, dizziness). A lower dose may be needed.11

**Oxygen Therapy.** Administration of supplemental oxygen is the only therapy proven to alter the course of advanced stages of COPD. Hypoxemia in patients with COPD adversely affects function and leads to death. Oxygen therapy is required for patients with COPD who are unable to maintain a PaO2 greater than 55 mm Hg or oxygen saturation greater than 85% or more at rest and for those who cannot carry out ADLs (breathing, eating, dressing, toileting) without becoming short of breath. In these patients 1 to 2 L/min of oxygen is usually given via nasal prongs to relieve hypoxemia and decrease pulmonary hypertension, which in turn decreases the load on the right side of the heart. The goal of oxygen therapy is to provide oxygen to patients at rates sufficient to maintain oxygen saturations above 90% as close to 24 hours per day as possible.

Although supplemental oxygen improves alveolar, endurance, and walking distance, not enough evidence is available to support continuous long-term oxygen therapy for patients who do not qualify based on resting oxygenation levels. Dearth of oxygen assessment at rest and with activity is recommended for all patients with moderate to severe COPD. Patients with COPD with adequate resting daytime oxygen levels may have significant hypoxemia during activity or at night. Oxygen supplementation at these times can improve performance, quality of life, and sleep. It also may improve survival, especially if cor pulmonale or cardiac arrhythmias are present. Ambulatory oxygen is preferable to oxygen from stationary sources because it allows patients to exercise and improve cardiac output, thus improving tissue oxygenation.

A common misunderstanding expressed by patients requiring ongoing oxygen therapy is that they should use their oxygen only when they are symptomatic (i.e., short of breath) to avoid becoming habituated to the oxygen and thus requiring higher levels of oxygen. The nurse needs to clarify that habituation to oxygen will not occur. The nurse also stresses the importance of continual oxygen use to receive maximal benefits of the therapy.

Because many patients with COPD have chronic carbon dioxide retention, their stimulus to breathe is their low PaCO2 level. Patients must understand that high flow rates of oxygen (greater than 6 L/min) and high concentrations (greater than 40%) may elevate their PaCO2 to a level that removes the stimulus by which they breathe, resulting in respiratory failure. Long-term oxygen therapy has been shown to be of substantial benefit for patients with advanced COPD and chronic hypoxemia. Before discharge from the hospital, the nurse needs to determine ABC and oxygen saturation levels at rest, with exercise, and during sleep to evaluate the need for home use of oxygen. The Centers for Medicare and Medicaid Services (CMS), which fund Medicare, have established specific criteria for reimbursement of home oxygen and oxygen equipment under the durable medical equipment benefit.

CMS considers home oxygen therapy reasonable and necessary only for patients with significant hypoxemia who meet the criteria related to medical documentation, laboratory evidence, and specified health conditions. Required documentation includes a
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and fill during exhalation. In both systems the effective bolus of oxygen delivery system. Concentrators are fairly quiet, efficient, and low maintenance. The cost of electricity to operate these units are useful for travel. Ambulatory liquid oxygen systems that can be mounted on wheels and allow for some mobility but are difficult in some cases, acute respiratory failure. Oxygen-conserving devices reduce the cost of home oxygen therapy by reducing the frequency of renewing the supply of liquid or gaseous oxygen. Oxygen-conserving devices use a mechanical reservoir or an anatomic reservoir that fills with 100% oxygen during exhalation and empties the oxygen into the lungs early in inspiration. Mechanical reservoirs include a nasal reservoir cannula and a pendant reservoir cannula. Both empty on inspiration and fill during exhalation. In both systems the effective bolus of 100% oxygen is about 20 ml. The cannula is more visible, but the pendant is less conspicuous.

Another system for oxygen conservation is the pulsation of a bolus of oxygen during the first fourth to half of inspiration, when virtually all the oxygen delivered goes to the oxygen-exchanging areas of the lung with minimal distribution to anatomic dead space. These units have multiple manufacturers, and each functions differently. Most are battery powered. The quantity of oxygen in each pulse may occur with each breath or have a variable frequency based on the flow setting. Patient acceptance has been excellent. All oxygen-conserving devices provide 50% or more oxygen savings at rest, but the degree of conservation may vary substantially during exercise. 

Another mode of oxygen delivery that may be used with COPD patients is transtracheal oxygen (TTO) delivery. TTO involves insertion of a catheter percutaneously between the second and third tracheal interspaces; this is held in place by a necklace and transparent film dressing. Oxygen enters the trachea via this catheter, thus significantly reducing oxygen delivery to airway dead space. Patients have been reported to use 37% to 58% less oxygen during TTO delivery, compared with continuous-flow nasal oxygen. In all patients receiving TTO, it is standard practice to titrate the dose of oxygen to ensure adequate oxyhemoglobin saturation, both at rest and during exercise. Not all patients are candidates for TTO. The ideal candidate has a strong desire to remain active, is willing to follow the care protocol, is not experiencing frequent exacerbations, has a caregiver willing to assist with problem solving and details of care, and has access to good medical follow-up. Absolute contraindications to TTO include high-dose steroids and conditions that predispose the patient to delayed healing (e.g., diabetes, connective tissue disease, and severe obesity). Absolute contraindications include subglottic stenosis or vocal cord paralysis, herniation of the pleura into the insertion site, severe scoliosis, uncontrolled respiratory acidosis, and inability to practice self-care. Complications of TTO include catheter displacement, bacterial cellulitis, subcutaneous emphysema, hemoptysis, a severed catheter, and mucous balls that can result in acute respiratory distress and, in some cases, acute respiratory failure.

AEROSOL THERAPY. Aerosol therapy is one of the most effective ways to deliver bronchoactive medications with minimal side effects. Directions for teaching patients to use an inhaler with a spacer are described in the Patient/Family Teaching box.

VACCINATION. Pneumococcal and influenza vaccinations are recommended for all patients with COPD. Influenza vaccines usually become available by October, and the optimal time for vaccination is October through mid-November, before influenza become prevalent. Patients with COPD, their household contacts, and health professionals should be encouraged to get vaccinated. The nurse should teach the patient to:

• Exhale fully.
• Position nebulizer in mouth without sealing lips around it.
• Take a deep breath while releasing a puff of medication into spacer.
• Hold breath for 3 to 4 seconds at full inspiration.
• Exhale slowly through pursed lips.
• Take prescribed number of puffs—usually one or two.
• Take number of breaths necessary to receive the entire prescribed dose from the spacer.
• Rinse mouth after completing treatment.
• Wash inhaler and spacer with warm soapy water, rinse, and dry thoroughly after each use.

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• Wash inhaler and spacer with warm soapy water, rinse, and dry thoroughly after each use.
care workers who have contact with vulnerable patient populations are encouraged to receive vaccinations as soon as possible. Additional Therapy. Patients should be up and about as much as possible. Some use portable oxygen while walking or doing other tasks. To promote optimal daytime activity, nurses must assess adequacy of sleep and rest. Sleep disorders are pervasive in patients with COPD. Sleep is disturbed by symptoms, medications, gas exchange abnormalities, and sleep apnea. Pulmonary rehabilitation attempts to return patients to their highest possible functional capacity. The rehabilitative approach to the care of COPD patients has been shown to improve independence and quality of life, decrease hospital days, and improve exercise capacity (see Evidence-Based Practice box). Lung function is usually not improved.

Pulmonary health care teams consist of physicians, nurses, respiratory therapists, occupational therapists, physical therapists, dietitians, social workers, and psychologists or psychiatrists. The complex multidisciplinary rehabilitation team is ideal, but the nurse in a small community hospital or community health agency can provide effective rehabilitation activities for the person with COPD. Hospice is also considered for its palliative care. Since COPD is a progressive and ultimately fatal disease, palliative care should be the focus when physical or psychologic suffering becomes central. The provision of palliative care is not limited by the site of care (home, hospital, acute care, intensive care). The National Hospice Organization suggests that the following criteria be used for admission to a hospice program for patients with noncancerous conditions: disabling dyspnea at rest with progressive pulmonary disease, cor pulmonale, hypoxemia at rest (PaO2 less than 55 mm Hg or oxygen saturation less than 88%) or hypercapnia (PaCO2 greater than 50 mm Hg), or unintentional progressive loss of 10% of body weight in 6 months, or resting tachycardia (more than 55 mm Hg or oxygen saturation less than 88%) or hypercapnia have COPD require a multidisciplinary approach. Management programs should be designed to prevent premature morbidity and mortality from COPD, educate patients and families, minimize airflow limitation and retard its progression, correct secondary physiologic problems, and optimize functional capabilities. A comprehensive management program benefits all patients, even those with severe disease.

Surgical Management Lung Transplantation. COPD is the most frequent indication for lung transplantation. The survival rate after transplantation for emphysema is the highest of any patient population with lung disease. Generally, it is considered an option for patients under age 65 with an FEV1 below 30% of the predicted rate; without evidence of pulmonary hypertension; and with consideration given to the patient's functional status and quality of life, assessed after pulmonary rehabilitation. Long-term survival is generally better if emphysematous recipients undergo bilateral lung transplantation, rather than single lung. Single lung transplantation is generally performed when only one lung is available. Infection is the most significant complication. Lung transplantation is discussed more thoroughly later in the chapter.

Lung Volume Reduction Surgery. Lung volume reduction surgery (LVRS) is a surgical procedure for patients with severe emphysema. The hyperinflated portion of the lung or lungs is removed so that the patient's chest wall and diaphragm can return to normal positions, thereby easing breathing. Most often it is used as a bridge to transplantation that improves respiratory function for patients during the prolonged waiting time for donor organs. Patient eligibility criteria for LVRS include:
- Severe limitation of pulmonary function, with FEV1 less than 30% of that predicted, FVC less than 60%, and TLC greater than 8 L
- Impaired ADLs
- Maximal flattening of diaphragm documented on chest x-ray examination
- No effective response to medical management
- Completion of 6 to 12 weeks of pulmonary rehabilitation
- Successful smoking cessation for at least 6 months

LVRS involves either mediastinoscopy or video-assisted thoracoscopic surgery. Regardless of the approach, the goal is to reduce lung volume by approximately 25%. The procedure involves deflating one lung by clamping one side of the bifurcated double-lumen endotracheal tube. Normal lung tissue turns gray, but the hyperinflated section of the lung remains pink from trapped air. The surgeon excises the hyperinflated area, then fills the patient's chest cavity with saline to inspect for air leaks. If none are detected, the surgeon repeats the procedure on the opposite lung. After surgery one or two chest tubes are placed and connected to a water-seal drainage system. No suction is used unless an air leak develops. Postoperative emphasis is on monitoring ABGs, early ambulation; and management of pain, usually with an epidural catheter. LVRS can improve both objective and subjective measures of lung performance in carefully selected COPD patients, with demonstrated positive effects of up to 5 years. The National Emphysema Treatment Trial showed most benefit for patients who had predominantly upper lobe emphysema and low exercise capacity. Most studies demonstrate improvement in pulmonary dysfunction.
function, decreased dyspnea, and enhanced exercise capacity. As of 2003, the CMS agreed to cover the costs of LVRS for patients who were not at high risk of death from the procedure, whose disease affected the upper lobes exclusively, and who had a combination of diffuse disease and low exercise capacity.3 Further work in bronchoscopic lung volume reduction may offer expanded options for nonsurgical candidates in the future.3

**Diet.** Improving nutrition is an important goal.40 (See discussion under Nursing Interventions.)

**Health Promotion and Prevention.** Ideally, all types of COPD would be prevented if people quit smoking and respiratory irritants were removed from the environment. Although this is not likely to happen soon, continued efforts should be made to educate people about respiratory irritants and dangers. Public education must focus on the pulmonary health risks associated with inhaled irritants, regardless of their source. Increased public awareness of the vital role that clean air plays in pulmonary health is essential for the success of any legislative actions promoting air quality standards. Individuals must also understand the importance of personal responsibility to decrease their own health risk through smoking cessation. *Healthy People 2010* has set goals for reducing cases of chronic respiratory disease (see *Healthy People 2010* box).34 Persons with a family history of emphysema should be screened for AAT deficiency. It is imperative that persons with this enzyme deficiency take active measures to prevent progressive lung damage from smoking, air pollution, and infection. Those at high risk for emphysema may require vocational counseling if their current work environment has inhaled irritants. These individuals should also be counseled to receive the influenza vaccine yearly and the pneumococcal vaccine every 3 to 5 years.

**Nursing Management of the Patient with Chronic Obstructive Pulmonary Disease**

**Assessment.**

**Health History.** Assess for:
- History, character, onset, and duration of symptoms
- Dyspnea, including its effects on ADLs and whether it is associated with any specific illness or event
- Sputum production (amount, color, consistency)
- Cough
- Pain in right upper quadrant (hepatomegaly)
- Smoking history
- Family history of COPD, respiratory illnesses
- Disease history, especially influenza, pneumonia
- History of respiratory tract infections, chronic sinusitis
- Past or present exposure to environmental irritants at home or at work
- Self-care modalities used to treat symptoms
- Current pattern of activity and rest, willingness to exercise
- Nutritional status—caffeine and alcohol use, history of eating disorders, weight history, food allergies, body mass index
- Medications taken and their effectiveness in relieving symptoms

**Physical Examination.** Assess for:
- General appearance (Appearance and hygiene may be indicators of symptom interference with ADLs. Patient may appear underweight, overweight, or bloated, and skin color may be dusky or pale.)
- Increased AP diameter of chest ("barrel chest")
- Dependent edema and jugular venous distention
- Enlarged or tender liver
- Elevated temperature, tachycardia, tachypnea
- Use of accessory muscles of breathing, forward-leaning (tripod) posture, pursed-lip breathing, central cyanosis, clubbed fingers
- Sputum production: amount, color, consistency, time of day, change from baseline
- Signs of an altered sensorium (restlessness or lethargy), which may be the first indicator of hypoxia
- Auscultation of breath sounds, which may be distant as a result of increased AP diameter and decreased airflow; commonly reveal crackles (rales), especially in dependent lung fields; rhonchi (gurgles); and wheezes, especially on forced expiration
- Relevant laboratory findings, including an elevated hemoglobin, hematocrit, and WBC count; alterations in ABGs; decreased FEV1, decreased VC, normal diffusing capacity, and normal to increased lung volumes (TLC, FRC, RV)

**Nursing Diagnoses, Outcomes, and Interventions**

**Nursing Diagnosis: Impaired Gas Exchange**

**Outcomes.** Common examples of expected outcomes for the patient with a diagnosis of impaired gas exchange are:

- Demonstrate improved ventilation and oxygenation.
- Exhibit arterial blood PaO2, PaCO2, and pH levels at patient’s baseline.
- Explain how and when to use oxygen therapy.

**Nursing Interventions.** The nurse monitors ABGs for indications of hypoxemia, respiratory acidosis, and respiratory alkalosis. Hypoxemia and hypercapnia often occur simultaneously, and
the signs and symptoms are similar. These include headache, irritability, confusion, increasing somnolence, asterixis (flapping tremors of extremities), cardiac dysrhythmias, and tachycardia. Morning headache is a frequent sign of hypercapnia. If hypercapnia is developing, tachypnea, vertigo, tingling of the extremities, muscular weakness, and spasm are often present. The presence of signs and symptoms associated with altered levels of PaO2 and PaCO2 depends more on the rate of change than on the degree. Rapidly changing signs usually indicate a rapid worsening of the patient's condition, whereas patients with longstanding hypoxemia and hypercapnia may be relatively asymptomatic because they have physiologically accommodated to increased PaCO2 and decreased PaO2.

The nurse is in a key role to assess the need for supplemental oxygen, to assess the response to therapy and acceptance of therapy, to assess the response to therapy and acceptance of therapy, and to ensure that the patient meets Medicare criteria for home oxygen therapy. It is important for the nurse to educate the patient and family on the following points:

- Oxygen is to be delivered at the prescribed flow rate. Adjustments need to be discussed with the health care provider.
- Oxygen dries the nose membranes. Applying a water-soluble lubricant (K-Y Jel) to the inside of the nose may reduce drying and cracking. Petroleum jelly (Vaseline) should not be used because it may be inhaled.
- If humidification is used, the amount of water in the humidifier bottle must be checked every 6 to 8 hours and refilled as needed with sterile or distilled water.
- A new supply of oxygen must be ordered when the oxygen source reads one-fourth full.
- Safety precautions must always be observed. Oxygen is not flammable itself, but it supports combustion. No one should smoke in the room where oxygen is being used; patients using oxygen should stay away from gas stoves, gas space heaters, or kerosene heaters or lamps; the container should always be kept upright to prevent leakage; and an all-purpose fire extinguisher should be readily available in the home.
- The health care provider should be notified if breathing is more difficult or if restlessness, anxiety, tiredness, drowsiness, difficulty waking up, persistent headache, slurred speech, confusion, or cyanosis of the fingernails or lips occurs.

**RELATED NIC INTERVENTIONS.** Airway Management, Oxygen Therapy, Respiratory Monitoring

**Nursing Diagnosis: Ineffective Airway Clearance**

*Outcomes.* Common examples of expected outcomes for the patient with the diagnosis of ineffective airway clearance are:

- Patient will:
  - Demonstrate adequate airway clearance.
  - Use effective methods of coughing.
  - Use bronchoalveolar medications, including MDIs, dry powder inhalers (DPIs), nebulizers, and humidifiers appropriately.

**Nursing Interventions.** Clearing of the airways is of utmost importance in meeting tissue demands for increased oxygen during periods of rest and increased activity. The nurse should teach the patient effective coughing maneuvers of sitting upright and using the huff coughing technique.

To thin secretions, a fluid intake of 3 to 4 L has traditionally been encouraged unless contraindicated. However, evidence suggests that this quantity of fluids may not be needed to keep secretions mobile. Although expectorants are sometimes prescribed, some experts believe they do more harm than good. Water is still considered the best expectorant, and the nurse should encourage adequate hydration without fluid overload.

Pulmonary physiotherapy techniques may be helpful to some patients with COPD, but many are not able to tolerate this intervention because of hypoxemia, age, debilitation, and other factors. The Global Initiative for Chronic Obstructive Lung Disease recommends manual or mechanical chest percussion and postural drainage in patients producing more than 25 ml of sputum each day as well, as in those with lobar atelectasis.25 (These techniques are discussed under Cystic Fibrosis.)

**RELATED NIC INTERVENTIONS.** Airway Management, Cough Enhancement, Respiratory Monitoring

**Nursing Diagnosis: Ineffective Breathing Pattern**

*Outcomes.* Common examples of expected outcomes for the patient with a diagnosis of ineffective breathing pattern are:

- Patient will:
  - Demonstrate effective breathing pattern.
  - Have inspiratory/expiratory ratio 5:10 seconds.
  - Use forward-leaning postures, controlled breathing techniques (pursed-lip breathing), and diaphragmatic breathing (abdominal muscle breathing).
  - Exhale with exertion.
  - Demonstrate respiratory rate within near-normal limits, with moderate tidal volume.

**Nursing Interventions.** The nurse encourages the patient to use controlled breathing techniques, including pursed-lip breathing, the forward-leaning position, and abdominal breathing, to control dyspnea and anxiety. The goal is a reduced respiratory rate and enhanced expiratory tidal volume, thus decreasing air trapping. Pursed-lip breathing (see Figure 27-5) decreases dyspnea when it is used with activities that produce tachypnea, which leads to progressive air trapping. Pursed-lip breathing decreases the respiratory rate, increases tidal volume, decreases PaCO2, and increases PaO2 and SaO2. Some patients use pursed-lip breathing intra-ritively, and others need to be taught. To teach it, the nurse asks the patient to (1) inhale through the nose for several seconds with the mouth closed and (2) exhale slowly (taking twice as long as inhalation) through pursed lips held in a narrow slit. One method of teaching this technique is by using a child’s soap bubble wand and blowing one big soap bubble. This approach combines an enjoyable activity with a measurable means of visualizing a pursed-lip exhalation, provides immediate patient feedback, and promotes relaxation of the patient’s upper body and decreased use of accessory breathing.

The nurse teaches the forward-leaning (tripod) position for accessory breathing. A forward-leaning position of 30 to 40 degrees with the head tilted at a 16- to 18-degree angle effectively improves exhalation (Figure 27-7). As mentioned previously, patients with
emphysema have increased TLC and RV with the diaphragm in a fixed, flattened position. Therefore the diaphragm cannot assist in exhalation as it does normally. Leaning forward allows removal of more air from the lungs on exhalation. The patient can achieve the forward-leaning position while sitting or standing. The patient sits on the edge of the bed or chair and leans forward on two or three pillows placed on a table or overbed stand, or sits in a chair with the legs spread apart shoulder width (or wider, if the patient is obese) with the elbows on the knees and the arms and hands relaxed, or stands with the back and hips against the wall with the feet spread apart and about 12 inches (30 cm) from the wall. The patient then relaxes and leans forward. In these positions the patient cannot use the accessory muscles of respiration, and the upward action of the diaphragm is improved.

Abdominal breathing improves the breathing efficiency of persons with COPD because it assists in elevating the diaphragm. Abdominal breathing can be done in the sitting or lying position. The patient sits on the side of the bed or in a chair and holds a small pillow or a book against the abdomen. The patient exhales slowly while leaning forward and pressing the pillow or book against the abdomen. In the lying position, the patient places a hand on the abdomen and then "puffs out" the abdomen while inhaling and raises the hand as high as possible. The patient then exhales slowly through pursed lips while pulling in on the abdominal muscles. Manual pressure on the upper abdomen during expiration facilitates this maneuver (see Chapter 26). In addition to abdominal breathing, exercises to strengthen the abdominal muscles help patients use them more effectively in emptying their lungs. This controlled breathing pattern is used while performing various ADLs, from sitting, standing, walking, and climbing stairs to more complex activities. As this pattern becomes natural, the patient uses it automatically during periods of increased shortness of breath.

Environment plays a significant role in ease of breathing. Humidity of 30% to 50% is ideal and can be achieved with a humidifier. An air conditioner may reduce dyspnea by controlling the temperature and preventing entrance of pollutants from outside air. The cost of an air conditioner is a medically deductible expense for persons with COPD. Movement of cool air with a fan has also been shown to reduce dyspnea, perhaps from the stimulation of receptors on the face or decreased temperature of facial skin. Wearing a scarf over the nose and mouth in cold weather helps warm the air and prevent bronchospasm. Masks for this purpose are also available. Smoking cessation is essential, as is minimal exposure to air pollution and the avoidance of environmental tobacco smoke.

**RELATED NIC INTERVENTIONS.** Airway Management, Oxygen Therapy, Respiratory Management

**Nursing Diagnosis: Activity Intolerance**

**OUTCOMES.** Common examples of expected outcomes for the patient with a diagnosis of activity intolerance are:

- Patient will
  - Maintain or work toward an optimal activity level.
  - Pace activities.
  - Plan for simplification of activities.
  - Participate in planned muscle-conditioning program.
  - Demonstrate how to carry out the exercise program to be followed at home, including specific exercises to be completed; frequency of each exercise; and criteria for monitoring physical response to exercises, such as heart rate increase or perceived fatigue.

**NURSING INTERVENTIONS.** To minimize the discomfort of dyspnea, individuals with COPD often avoid physical exertion. The result is gradual deconditioning and dyspnea at ever-lower levels of exertion. Fatigue and muscle wasting also result from deconditioning. Exercise training (aerobic exercise training, strength
training, and inspiratory muscle training) improves aerobic capacity, endurance, strength, and functional performance in day-to-day life, and it reduces breathlessness and fatigue during exertion.33 Patients should undertake both general exercises and specific muscle training.33

For general exercise conditioning, graded led exercises performed by stationary cycling, stair climbing, and walking are safe and well tolerated. Oxygen during exercise is recommended for patients who have significant exercise desaturation and show improved exercise tolerance while using oxygen.

Leg-raising exercises, with each leg being raised alternately as the patient exhales, is one way to strengthen abdominal muscles. Another way is for the patient to raise the head and shoulders from the bed while he or she exhales. With practice and encouragement, the patient can do the exercises 10 times each morning and evening after clearing the lungs of secretions as completely as possible.

The term muscle reconditioning refers to a variety of muscle-toning exercises. For patients who are able to be out of bed, walking, using a treadmill, or riding a stationary bicycle is helpful. The exercise period starts slowly, with 10 minutes twice daily three times a week, increasing to 20 minutes twice daily three times a week. The patient needs to be assessed for his or her ability to carry out such an exercise program, and a staff member should be present during the exercise period.

Patients need to be encouraged not to rush (i.e., to allow ample time for activities). Supplemental oxygen may be needed before and during activities. Activities such as walking should be gradually increased. The nurse should provide positive feedback on progress and encourage new endeavors when the patient is ready. The nurse assists patients in balancing work, rest, and recreation to regulate energy expenditure.

New research suggests that the nurse should take a sleep history.39 Physiologic changes during sleep can exacerbate COPD symptoms and disrupt sleep. Changes in sleep patterns may be early indicators of illness progression and changes in health status. Sleep affects breathing, even in healthy adults, by increasing airway resistance and decreasing ventilation, particularly during rapid-eye-movement sleep. Changes in airway caliber resulting from mild nocturnal bronchoconstriction and relaxation of upper respiratory muscles are common causes of increased airway resistance during sleep. Minute ventilation falls by about 0.5 to 1.5 L/min. In persons with COPD, this increase in airway resistance and decline in minute ventilation during sleep can lead to hypoxemia and hypercapnia during sleep.40 Hypoxemia is a common cause of arousal and sleep disruption as a result of the increased respiratory effort that occurs when the body corrects for increases in airway resistance or decreases in minute ventilation. Bronchodilators and coughing can prolong period of wakefulness.

Recurrent episodes of hypoxemia are seen in COPD patients during sleep. Effects of nocturnal hypoxemia include cardiac dysrhythmias, pulmonary hypertension, heart failure, and poly- cythemia. Hypoxemia during sleep may also adversely affect daytime cognition and function. Nurses need to routinely assess sleep and breathing patterns. For patients with COPD, therapies to promote rest should avoid benzodiazepines, since they can depress respiration. Triazolone is perhaps the most frequently prescribed hypnotic, since it reduces arousals and increases overall sleep quality. Melatonin has improved both duration and quality of sleep.41

RELATED NIC INTERVENTIONS. Energy Management, Exercise Promotion: Strength Training, Exercise Therapy: Ambulation, Sleep Enhancement

Nursing Diagnosis: Imbalanced Nutrition: Less Than Body Requirements

OUTCOMES. Common examples of expected outcomes for the patient with a diagnosis of imbalanced nutrition are:

Patient will:

• Explain dietary changes required after discharge.
• Maintain optimal weight for height, age, and gender.
• Describe food and fluid requirements and daily plan for achieving them.
• State specific foods to avoid.
• Discuss plan for frequent, small feedings that are easily chewable, increased time for eating, and use of supplements at oxygen as indicated.

NURSING INTERVENTIONS. Malnutrition plays a role in the deterioration of physical performance, the development of clinical complications, and overall prognosis. Loss of appetite affects many people with COPD, and evidence shows that hypoxia may be contributory. Hypoxia has an anorexic effect and is a key catabolic stimulus. In malnourished COPD patients hypoxia-induced cytokine release leads to anorexia and muscle wasting.42 Other contributing factors are the feeling of satiety that occurs with small amounts of food because the flattened diaphragm compresses abdominal contents; dyspnea, which interferes with eating; and gastric irritation associated with the use of bronchodilators and steroids. Diminished total weight is correlated with a dramatic decrease in size and strength of respiratory muscle (especially the diaphragm). Physical reconditioning and endurance training combined with a balanced diet are essential to maintaining or improving energy metabolism and nutritional status.

To help the patient with COPD maintain adequate nutrition, the nurse explores the patient's and family's usual dietary habits and counsels the patient to select foods that provide a high-protein, high-calorie diet. It is important to counsel the patient to select foods that derive their calories from high fat rather than high carbohydrate levels. Persons with advanced chronic bronchi- tis or emphysema are unable to exhale the excess carbon dioxide that is a natural end product of carbohydrate metabolism. There- fore calories obtained from high-carbohydrate foods may elevate PaCO2 levels in persons with COPD. The nurse also advises the patient to take supplemental vitamins and prepackaged food supplements such as milk shakes or snack bars between meals because they are an excellent source of protein and calories. The patient is taught that smaller, more frequent meals are often tolerated better than three larger meals. Larger meals require more energy to digest and limit the downward movement of the diaphragm during inspiration. Patients are encouraged to select foods that are easy to chew and swallow to further conserve energy.40
Protection causes of AECOPD. Pulmonary response to the infectious bacteria, viruses, and atypical pathogens have been implicated as a respiratory infection that produces acute exacerbations (AECOPD). Bac-

**Nursing Diagnosis: Risk for Infection**

**OUTCOMES.** Common examples of expected outcomes for the patient with a diagnosis of risk for infection are:

- Patient will:
  - Remain free from infection.
  - Be afebrile.
  - Exhibit sputum at baseline in color, amount, and consistency.
  - Inform health care provider if signs of infection occur.

**Nursing Interventions.** The most common complication of COPD, and the cause of most hospital readmissions, is respiratory infection that produces acute exacerbations (AECOPD). Bacteria, viruses, and atypical pathogens have been implicated as causes of AECOPD.74 Pulmonary response to the infectious process includes increased respiratory rate, mucosal irritation, and increased mucus production. Because of these localized responses, patients may have bronchospasm and a change in their pattern of sputum production. If the infection remains untreated, the result is overall increased work of breathing with eventual respiratory failure. Patient teaching is an important component of infection prevention (see the Patient/Family Teaching box).

The nurse should also evaluate the patient's knowledge of the care, cleansing, and use of inhalant and nebulizer equipment. Contaminated MDIs, DPIs, and nebulizer equipment are common sources of infection.

**Nursing Diagnosis: Ineffective Coping (Individual and Family)**

**OUTCOMES.** Common examples of expected outcomes for the patient with a diagnosis of ineffective coping are:

- Patient will:
  - Identify own coping mechanisms, both effective and ineffective.
  - Identify stressors, threats to role.

**PATIENT/FAMILY TEACHING**

The Patient With Chronic Obstructive Pulmonary Disease

To decrease the risk of respiratory infections, the nurse should teach the patient to:

- Avoid large crowds, especially during known influenza seasons.
- Avoid contact with people who have an upper respiratory tract infection.
- Obtain influenza and pneumonia immunizations.
- Contact the health care provider if the following common signs and symptoms occur: change in sputum color, amount, and consistency; more frequent or productive cough; elevated temperature; change in behavior (e.g., more argumentative than usual), which indicates an increase in PaCO2; increased fatigue; increased restlessness; weight gain; or peripheral edema.

- Use effective coping mechanisms (discussion with family, health care providers).
- Set realistic personal goals.
- Participate in ADLs and therapeutic regimens.
- State names and telephone numbers of appropriate community support services, such as home health provider, Visiting Nurses Association, home medical equipment supplier.

**Nursing Interventions.** Persons who are short of breath are usually anxious and frightened. The nurse encourages the patient to talk about anxiety and fears with family members and health care professionals. The nurse should foster a realistic assessment of abilities and limitations, with a focus on those activities the patient is still able to do. Positive body responses should be stressed without negating the seriousness of the health issues involved. Vocational rehabilitation may be an option for some patients. Enrollment in pulmonary rehabilitation programs can also mitigate the sense of isolation and encourage ongoing involvement. The nurse encourages the patient to try new coping behaviors and gradually master them. Referral to professional counseling should be initiated if indicated.

Acute exacerbations in COPD are particularly stressful and affect quality of life. Patients may experience fear because of excessive breathlessness, which can trigger anxiety, depression, or panic. COPD patients are reported to perceive an acute exacerbation as a possible life threat. Nurses are in a unique position to determine needs for psychologic support that may enhance quality of life.75 They should provide patients phone numbers for support services such as the home health nurse, medical equipment supplier, etc., and encourage them to call when needed.

COPD also affects the well-being of the family and caregivers. Spouses of COPD patients are more likely to report depressive symptoms compared with spouses of individuals without COPD. Nurses and other health care providers should be aware of the strain that COPD places on caregivers' mental health and consider methods of screening for depressive symptoms.76-77

**RELATED NIC Interventions.** Coping Enhancement, Emotional Support, Support System Enhancement

**EVALUATION**

To evaluate the effectiveness of nursing interventions, compare patient behaviors with those stated in the expected patient outcomes.


**Gerontologic Considerations**

Many patients with COPD are older and may require additional time and support in learning how to take their medications, perform breathing exercises, and use oxygen properly. A multidisciplinary team, including social services, nutritional services, and physical therapy, may be necessary to assess the patient and assist
the nurse with teaching. The patient's significant others need to be involved in each teaching activity so that they can assist the patient as necessary.42

In addition to the nursing care for COPD described in previous paragraphs, see the Nursing Care Plan.

**Asthma**

Asthma is a chronic inflammatory disorder of the airways that is characterized by an exaggerated bronchoconstrictor response (narrowing of the air passages) to a wide variety of stimuli. Airway hyperresponsiveness leads to clinical symptoms of wheezing and dyspnea after exposure to allergens, environmental irritants, viral infections, cold air, or exercise.

**Etiology and Epidemiology.** Asthma results from complex interactions among inflammatory cells, mediators, and other cells and tissues that reside in airways. An initial trigger may be the release of inflammatory mediators from bronchial mast cells, macrophages, T lymphocytes, and epithelial cells. These substances direct the migration and activation of other inflammatory cells to the airway, where they cause injury, abnormalities in autonomic neural control of airway tone, mucus hypersecretion, cell to the airway, where they cause injury, abnormalities in autonomic neural control of airway tone, mucus hypersecretion, cell migration, and increased airway smooth muscle responsiveness. Box 27-1 lists common asthma triggers.

In sensitive individuals the inflammatory response causes recurrent episodes of wheezing, breathlessness, chest tightness, and cough, particularly at night and in the early morning. Early-phase reactions appear seconds after exposure and last about 1 hour. About half of all patients with asthma also experience a delayed, or late-phase, reaction. The symptoms are the same, but these reactions begin 4 to 8 hours after exposure and can last for hours or days. These episodes are usually associated with widespread but variable airflow obstruction that is often reversible either spontaneously or with treatment. Asthma begins most frequently in childhood and adolescence, but it can develop at any time in life.

**Box 27-1 Common Factors Triggering Asthma Attack**

- Environmental factors
  - Change in temperature, especially cold air
  - Change in humidity: dry air
  - Atmospheric pollutants: cigarette and industrial smoke, ozone, sulfur dioxide, formaldehyde
- Strong odors: perfume
- Allergens: feathers, animal dander, dust mites, molds, allergens, foods treated with sulfites (beer, wine, fruit juices, snack foods, salads, potatoes, shellfish, fresh and dried fruits)
- Exercise
- Stress or emotional upset
- Medications: aspirin and nonsteroidal antiinflammatory drugs, beta-blockers (including eyedrops), cholinergic drugs (to promote bladder contraction and in eyedrops for glaucoma)
- Enzymes, including those in laundry detergents
- Chemicals: toluene and others used in solvents, paints, rubber, and plastics

Increases in the prevalence of asthma and in its mortality and morbidity rates have been seen in the past 2 decades. Asthma affects 17.3 million people in the United States with costs in excess of $6 billion. Asthma accounts for approximately 500,000 hospital admissions annually, with an average length of stay of 5 days, and 2 million emergency visits. People with asthma experience 79% more sick days than controls. Both hospitalizations for the treatment of asthma and deaths from it have increased. Most of the morbidity and all of the mortality involve acute exacerbations of asthma, and treatment of these events accounts for the majority of expenditures in money and health care resources. The reasons for the increase in morbidity and mortality are not well understood but may include lack of access to primary care, overuse and incorrect use of medications, or the inability to recognize the severity of symptoms.

**Pathophysiology.** Airflow limitation in asthma is recurrent and caused by a variety of changes in the airway (Figure 27-8). These changes include bronchoconstriction, edema, chronic mucus plug formation, and airway remodeling. Bronchoconstriction in the early asthmatic response is thought to be due to airway smooth muscle contraction, whereas bronchoconstriction in the late asthmatic response is due to airway inflammation.

**Acute Bronchoconstriction.** Allergen-induced acute bronchoconstriction results from an immunoglobulin E–dependent release of mediators from mast cells. These mediators include histamine, tryptase, leukotrienes, and prostaglandins that directly contract airway smooth muscle. Aspirin and other nonsteroidal antiinflammatory drugs can also cause acute airflow obstruction in some patients, and this also involves mediator release from airway cells. Other stimuli, including exercise, cold air, and irritants, can cause acute airflow obstruction, but these mechanisms are less well defined.

**Airway Edema.** Airway wall edema, even without smooth muscle constriction or bronchoconstriction, limits airflow in asthma. Increased microvascular permeability and leakage caused by
A 68-year-old man was admitted to the hospital for severe shortness of breath and inability to care for himself at home. He was diagnosed with chronic obstructive pulmonary disease (COPD) about 9 years ago, most likely related to his 40-year history of cigarette smoking. He is widowed, lives alone, and ordinarily manages his care and disease without difficulty. The patient states that the cold, rainy weather has made his breathing much worse over the past couple of days. He complains of being severely fatigued and short of breath.

Physical examination reveals a thin appearing man who is diaphoretic, leaning forward in a sitting position, and in obvious respiratory distress. Vital signs are temperature, 100.8°F orally; heart rate, 104 beats/min; respiratory rate, 36 breaths/min and labored; and blood pressure, 146/92 mm Hg. He has wheezing and crackles throughout all lung fields. Humidified oxygen is initiated at 2 L/min via mask, 5% dextrose in water (D5W) is started at 75 ml/hr, and 125 mg of methylprednisolone (Solu-Medrol) is administered intravenously. The respiratory care department is notified to provide the patient with an immediate breathing treatment as the nurse initiates an aminophylline drip.

### Nursing Care Plan

#### Patient With Chronic Obstructive Pulmonary Disease

**Data:** A 68-year-old man was admitted to the hospital for severe shortness of breath and inability to care for himself at home. He was diagnosed with chronic obstructive pulmonary disease (COPD) about 9 years ago, most likely related to his 40-year history of cigarette smoking. He is widowed, lives alone, and ordinarily manages his care and disease without difficulty. The patient states that the cold, rainy weather has made his breathing much worse over the past couple of days. He complains of being severely fatigued and short of breath.

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**Nursing Diagnosis**

**Impaired gas exchange related to chronic obstructive lung disease**

**Goals and Outcomes**
- Patient will regain and maintain gas exchange within baseline.
- Patient will be free from changes in mental status.

**Related NOC Outcomes**

- Respiratory Status: Airway Patency
- Respiratory Status: Gas Exchange

**Related NIC Interventions**

- Cough Enhancement
- Oxygen Therapy
- Respiratory Monitoring

**Nursing Activities and Rationales**

- Monitor respiration and assess breath sounds hourly and more often as needed. To establish baseline for future comparisons to determine whether treatment is effective or different interventions are required to prevent further respiratory distress.
- Monitor arterial blood gases (ABGs), oxygen saturation, and mentation. To detect early signs of hypoxemia, respiratory acidosis, and respiratory alkalosis so corrective interventions may be implemented. Hypoxemia and hypercapnia often occur simultaneously, and the signs and symptoms are similar. Decreasing PaO2, coupled with increasing PaCO2, is a sign of respiratory failure and may be manifest by changes in mentation.
- Administer pulmonary toilet (turning, chest physiotherapy) every 2 hours and as needed. To maintain patent airway and prevent complications.
- Assess peripheral pulses and warmth and color of extremities. To detect changes that indicate inadequate oxygenation and to determine effectiveness of ventilation.
- Encourage slow, pursed-lip breathing. Pursed-lip breathing decreases the respiratory rate, increases tidal volume, decreases PaCO2, and increases PaO2, all of which help reduce dyspnea.
- Encourage abdominal breathing and abdominal muscle exercises. To improve breathing efficiency by elevating the diaphragm. Exercises strengthen the abdominal muscles and help patients empty their lungs more effectively.
- Administer humidified oxygen therapy as prescribed. Low-flow oxygen is generally prescribed because COPD patients chronically retain carbon dioxide and depend on their hypoxic drive to stimulate respirations. Apnea can occur if the oxygen delivery is too high.

**Risk for infection related to inability to clear trapped secretions secondary to chronic lung disease**

**Goals and Outcomes**
- Patient will remain free from infections.

**Related NOC Outcomes**

- Immune Status
- Risk Control

**Related NIC Interventions**

- Infection Protection
- Surveillance

**Nursing Activities and Rationales**

- Assess white blood cell (WBC) count. Patients with COPD are at high risk for lung infection because of trapping of secretions, which serve as media for bacterial growth. An elevated WBC count is associated with systemic infection and may indicate the presence of pneumonia.
- Monitor for signs of systemic infection (chills, fever, diaphoresis). Indicates the presence of actual or developing infection.
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- Maintain hydration. To thin secretions, prevent stasis, and facilitate clearance.
- Monitor for signs of systemic infection (chills, fever, diaphoresis). Indicates the presence of actual or developing infection.
- Encourage patient to obtain influenza vaccine annually and the pneumococcal pneumonia vaccine as indicated by the Centers for Disease Control and Prevention. Patients with COPD are at high risk for respiratory complications secondary to influenza or bacterial pneumonia. Vaccines reduce the risk for and duration of these illnesses.
**Nursing Diagnosis**

**Activity Intolerance** related to dyspnea secondary to COPD

**Goals and Outcomes**
- Patient will report decreased fatigue.
- Patient will achieve heart rate, respirations, and blood pressure at baseline within 3 minutes after increased activity.

**Related NOC Outcomes**
- Activity Tolerance
- Endurance
- Energy Conservation

**Related NIC Interventions**
- Energy Management
- Progressive Muscle Relaxation
- Teaching: Prescribed Activity/Exercise

**Nursing Activities and Rationales**
- Assess and monitor patient's response to activity (vital signs, dyspnea, signs of exertion). To determine patient's response to self-care or other activities. Activity tolerance depends on the ability to physiologically adapt to changes in demand.
- Assist the patient in sequencing activities to provide for rest periods. Rest decreases myocardial oxygen consumption, allowing intervals of low energy demand. Decreased oxygen consumption allows more oxygen to be available for ventilation.
- Provide an environment conducive to rest. Environmental stimulation inhibits the patient's ability to enter a state of relaxation and subsequent rest.
- Assist with activities of daily living as needed. Patients are unable to perform self-care during periods of severe dyspnea. Activity increases metabolic demand and decreases available oxygen for breathing.

**Nursing Diagnosis**

**Risk for imbalanced nutrition: less than body requirements** related to increased energy expenditure from difficulty breathing

**Goals and Outcomes**
- Patient will remain within 5 pounds of preillness (or ideal) body weight.
- Patient will gain weight as condition stabilizes and breathing effort decreases.

**NOC Suggested Outcomes**
- Nutritional Status
- Nutritional Status: Food & Fluid Intake
- Nutritional Status: Nutrient Intake

**NIC Suggested Interventions**
- Nutrition Management
- Nutrition Therapy
- Nutritional Monitoring

**Nursing Activities and Rationales**
- Provide small, frequent meals and nutritional supplements. Difficult breathing increases the metabolic demands on the body. Nutritional status must be maintained to meet the caloric needs of patients expending excessive calories on breathing and prevent weight loss, especially in patients who are below their ideal weight.
- Monitor intake and output. Decreased urinary output or concentrated urine is an indication of inadequate fluid replacement.
- Weigh daily. To determine whether nutritional needs are being met and to evaluate the effectiveness of nutritional interventions.
- Administer albumin and plasma expanders as prescribed. Protein and volume expanders increase colloidal osmotic pressure, thus maintaining fluid within the intravascular compartment.
- Monitor serum albumin levels. Serum albumin levels reflect the adequacy of protein intake. Decreased levels are associated with peripheral edema caused by loss of osmotic pull from within the vascular space.

**Nursing Diagnosis**

**Risk for Ineffective Therapeutic Regimen Management** related to chronic disability secondary to COPD

**Goals and Outcomes**
- Patient will verbalize understanding of therapeutic regimen.
- Patient will report ability to adhere to therapeutic regimen.

**Related NOC Outcomes**
- Adherence Behavior
- Compliance Behavior
- Knowledge: Treatment Regimen

**Related NIC Interventions**
- Behavior Modification
- Referral
- Self-Modification Assistance

**Nursing Activities and Rationales**
- Assess patient's understanding of the disease process. To identify specific learning needs so teaching can be individualized. Patients with longstanding COPD may be familiar with how to control their disease, which will change the type and amount of teaching.
- Provide verbal and written instructions as needed. Teaching reinforces the need to comply with recommended management. Written material provides additional resources for home reference.
- Teach the importance of maintaining prescribed medication dosages and schedules. To maintain blood levels to control symptoms while also preventing underdosing or overdosing.
- Stress the importance of compliance with follow-up care recommendations. Follow-up care is essential for patients with COPD so complications can be identified early and corrective measures implemented.

**Evaluation**
Evaluation is based on comparing the patient's outcomes with desired goals and outcomes.
released mediators contribute to mucosal thickening and airway swelling. As a consequence, the airway becomes more rigid and interferes with airflow. In sudden-onset asthma, neutrophils predominate; eosinophils predominate in the slow-onset form of the disease.46

**CHRONIC MUCOUS PLUG FORMATION.** In severe, intractable asthma, airflow limitation is often persistent. This change may arise as a consequence of mucus secretion and the formation of mucous plugs.

**AIRWAY REMODELING.** In some patients with asthma, airflow limitation may be only partially reversible because of structural changes in the airway that accompany longstanding and severe airway inflammation. A histologic feature of asthma may be an alteration in the amount and composition of the extracellular matrix in the airway wall. The importance of airway remodeling and persistent airflow limitation suggest a rationale for early intervention with antiinflammatory therapy.

To prevent airway remodeling and to help standardize asthma management with the hope of improving outcomes, the National Asthma Education and Prevention Program (NAEPP) developed Guidelines for the Diagnosis and Management of Asthma. Under these guidelines asthma is classified into four categories:

1. **Mild intermittent**: Symptoms occur less than twice a week.
2. **Mild persistent**: Symptoms occur more than twice a week but less than daily.
3. **Moderate persistent**: Daily symptoms occur, including exacerbations more than twice a week.
4. **Severe persistent**: Symptoms occur continually, along with frequent exacerbations, limiting the patient’s physical activity.

For each category a stepwise approach to symptom management has been outlined by the NAEPP for physicians to use in treating patients with asthma.46,47 (Table 27-2).

**COMPLICATIONS.** Complications of asthma include status asthmaticus and respiratory failure (see the Respiratory Failure section later in the chapter). Persons who are severely affected by asthma and who have attacks that cannot be controlled with the usual medications have status asthmaticus. In status asthmaticus the symptoms of an acute attack continue despite measures to relieve them. Air trapping in the distal air spaces ultimately leads to respiratory muscle exhaustion and severe V/Q abnormalities with resultant respiratory failure and hypoxemia. Repeated attacks of status asthmaticus may cause irreversible emphysema, resulting in a permanent decrease in total breathing capacity.

Patients with status asthmaticus often demonstrate such severe respiratory distress that they are unable to talk. They may be moving minimal amounts of air into and out of the lungs; thus audible wheezing and adventitious lung sounds may not be present. During this phase of the attack, the patient appears cyanotic and may demonstrate both pulsus paradoxus and sensorium changes. This is a medical emergency, and the patient requires immediate therapy. Most patients arrive in the emergency department, where treatment is begun. Patients remain in the emergency department until their condition is stabilized. Most patients are then admitted to the hospital for ongoing therapy and observation.

**COLLABORATIVE CARE MANAGEMENT.** The major focus in asthma treatment is education for an active partnership with the patient. It begins at the time of asthma diagnosis and is integrated into all aspects of care. Patients learn to treat inflammation and day-to-day symptoms themselves through a program of provider-guided comanagement or partnership that stresses collaboration. This self-management program is developed according to the needs of each patient, with sensitivity to cultural beliefs and practices. Desired outcomes include effective symptom management, improved quality of life, and the ability to engage in usual activities.

**DIAGNOSTIC TESTS.** Tests for asthma are described in Table 27-3.

**MEDICATIONS.** The objectives of medical management of asthma are to promote normal functioning and prevent recurrent symptoms, severe attacks, and side effects from medication. The chief aim of various medications is to afford the patient immediately, progressive, ongoing bronchial relaxation. Table 27-4 lists the drugs used to treat patients with asthma.

**TREATMENTS.** Patients, families, and health care professionals need an objective measure of airflow obstruction to guide them in managing asthma attacks promptly. Numerous clinical and experimental studies show that many patients with asthma cannot accurately evaluate the severity of airflow obstruction. Many patients manage their asthma with the aid of peak flow meters. Peak expiratory flow rate (PEFR) is the greatest airflow velocity that can be produced during a forced expiration that starts from fully inflated lungs. Peak flow monitoring is used to audit daily response to treatment, detect a buildup in airflow obstruction, assess the severity of an attack, evaluate response to therapy, and aid decisions about hospitalization. PEFR monitoring devices cost from $15 to $40 and are portable and easy to use. The normal range for peak flow is 500 to 700 L/min for men and 380 to 500 L/min for women. Peak flow rates vary with age, sex, race, height, smoking history, respiratory muscle strength, and effort. The NAEPP recommends that the peak flow value be at least 75% of the predicted value.47

Patients with moderate or severe persistent asthma are encouraged to measure PEFR daily and to keep a diary of their readings and symptoms. A system based on a traffic light has been developed: the green zone is equal to 80% or better, the yellow zone is 50% to 79%, and the red zone is less than 50%. Patients are taught that the yellow zone requires increasing bronchodilator use as needed and, if there is no improvement, adding either an anti-inflammatory drug or beginning oral corticosteroids. The red zone indicates a need to contact the patient’s health care provider.

Patients with status asthmaticus require emergent treatment. Humidified oxygen is given to achieve full saturation. Inhaled short-acting beta-agonists are given in large and frequent doses. Subcutaneous epinephrine may help patients who do not respond after several hours of inhaled beta-agonists. Treatment with bronchodilators is continuous until the desired clinical effect is achieved or until toxic side effects limit continued use. Noninvasive positive-pressure ventilation (NIV) is preferable to intubation and mechanical ventilation. If mechanical ventilation is required, MDIs and nebulizers may be used to deliver bronchodilators. MDIs require the use of a spacing device on the inspi-
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rsatory limb of the ventilator to optimize drug delivery. A minimum of 4 puffs and up to 10 to 20 puffs may be given. Patient-ventilator synchrony is essential, and an inspiratory pause may be useful. Nebulizers may increase barotrauma because they require added gas flow (8 L/min) when used with mechanical ventilation. This can be minimized by decreasing the minute ventilation, placing the nebulizer close to the ventilator, raising the tidal volume above 500 ml, and decreasing the inspiratory flow to 40 L/min.36

Corticosteroids are administered as soon as possible. The minimum dose is 40 mg of methylprednisolone every 6 hours. Evidence is accumulating that people with asthma are being managed with higher than needed doses of corticosteroids. Theophylline does not add to bronchodilation but may be helpful for its long-term control (Table 27-2).

<table>
<thead>
<tr>
<th>TABLE 27-2: STEPWISE APPROACH TO ASTHMA MANAGEMENT</th>
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<tbody>
<tr>
<td><strong>Long-Term Control</strong></td>
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<tr>
<td><strong>STEP 1</strong></td>
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<td><strong>STEP 2</strong></td>
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<td><strong>STEP 4</strong></td>
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<table>
<thead>
<tr>
<th>TABLE 27-3: DIAGNOSTIC TESTS FOR ASTHMA</th>
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<tbody>
<tr>
<td><strong>Test</strong></td>
</tr>
<tr>
<td>Pulmonary function/spirometry tests, which include forced expiratory volume in 1 sec (FEV₁) and peak expiratory flow (PEF)</td>
</tr>
<tr>
<td>Arterial blood gases</td>
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<tr>
<td>Induced sputum specimen examinations</td>
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<tr>
<td>Allergy testing</td>
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<tr>
<td>Exhaled breath testing</td>
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</tbody>
</table>

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The use of long-acting beta 2-adrenoceptor agonists (LABAs) is a relatively new development in therapy and is indicated for persons with persistent asthma who experience breakthrough symptoms despite using inhaled corticosteroids. LABAs are currently not recommended as sole therapy for asthma, since they do not inhibit allergen-induced increases in sputum eosinophils.

**Health Promotion and Prevention.** In asthma, perhaps more than in any other disease, an effective partnership between the patient and the health care professional is essential. Knowing about the patient’s attitudes toward health and his or her lifestyle, such as type of work, leisure activities, social supports, learning style, and interest in self-care management, is an essential element in developing an effective management plan. The identification of asthma triggers requires involvement of both the patient and the health care professional. Avoidance of triggers can be an important component in preventing exacerbations. The Healthy People 2010 document sets goals to reduce the problems and incidence of asthma (see Healthy People 2010 box).

### Table 27-4 Common Medications for Asthma

<table>
<thead>
<tr>
<th>Drug</th>
<th>Action</th>
<th>Nursing Intervention</th>
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<tbody>
<tr>
<td><strong>Maintenance Medications</strong></td>
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<tr>
<td><strong>Nonsteroidal Antiinflammatory Drugs</strong></td>
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<tr>
<td>Cromolyn (Intal)</td>
<td>Decrease airway inflammation and irritation</td>
<td>Teach patient: (1) use medication routinely, not more often than prescribed; (2) if a dose is missed, take as soon as possible and then continue other doses at regular intervals; (3) do not take a double dose; (4) do not discontinue taking without consulting physician or exacerbation of symptoms may occur; (5) do not discontinue concurrent glucocorticoid or bronchodilator therapy without consulting health care professional. Explain use of inhaler (Spinhaler or Halermatic devices) or how to use intranasally, depending on product.</td>
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<tr>
<td>Nedocromil (Tilade)</td>
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<tr>
<td><strong>Corticosteroids</strong></td>
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<tr>
<td>Beclomethasone (Vanceril, Beclovent, Reinusone, Vancenase AQ)</td>
<td>Antiinflammatory</td>
<td>Teach patient: if using inhalation corticosteroids and bronchodilator, use bronchodilator first, wait 5 min before administering corticosteroid, unless otherwise directed by health care professional. Explain that inhaled corticosteroids should not be used to treat acute asthma episode. Systemic corticosteroids may be needed for acute attacks. Explain how to use regular peak flow monitoring to determine respiratory status and how to use inhaler or other device correctly. Explain need to avoid smoking, known allergens, and other respiratory irritants, and to notify physician if sore throat or sore mouth occurs.</td>
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<td>Budesonide (Pulmicort)</td>
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<td>Flunisolide (AeroBid)</td>
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<tr>
<td>Fluticasone (Flovent)</td>
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<tr>
<td><strong>Leukotriene Inhibitors/Receptor Antagonists</strong></td>
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<tr>
<td>Zafirlukast (Accolate)</td>
<td>Antiinflammatory</td>
<td>Teach patient: (1) take medication on empty stomach as directed, at evenly spaced times; (2) if dose is missed, take as soon as possible but do not double dose; (3) do not discontinue therapy without consulting physician; (4) do not discontinue or reduce other asthma medications unless instructed to do so. Explain the medication is not for acute asthma attacks but for maintenance. Explain side effects such as generalized flulike syndrome, fever, muscle aches and pain, weight loss, and worsening respiratory symptoms, and to report these to physician.</td>
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<tr>
<td>Zileuton (Zyflo)</td>
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<tr>
<td>Montelukast sodium (Singulair)</td>
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<tr>
<td><strong>Theophylline</strong></td>
<td>Long-acting bronchodilator</td>
<td>Monitor vital signs and ABGs. Teach patient: (1) take medication exactly as prescribed; (2) take missed doses as soon as possible but do not double dose; (3) drink plenty of fluids (2000 ml/day minimum) to decrease viscosity of airway secretions; (4) try to avoid</td>
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</table>
Nursing Management of the Patient with Asthma

ASSESSMENT

Health History. Assess for:
- History of asthma onset and duration
- Precipitating factors
- Any recent changes in medication regimen
- Medications used to relieve asthma symptoms
- Other medications
- Self-care methods used to relieve symptoms

Physical Examination. Assess for:
- General appearance
- Mental status; signs of altered sensorium or apprehension, which may indicate hypoxemia
- Tachycardia, pulse paradoxus (diminished pulse with inspiration, confirmed by a 6 to 8 mm Hg drop in systolic blood pressure during inspiration); tachypnea; or other abnormality
- Dyspnea, use of accessory muscles for breathing, forward-leaning (tripod) posture, prolonged expiration, and cyanosis; palpation for decreased lateral expansion of the chest and decreased fremitus; percussion for hyperresonance and decreased diaphragmatic excursion; auscultation of breath sounds (may be absent or faint as the patient approaches exhaustion from the increased work of breathing; inspiratory and expiratory wheezing and rhonchi common)
- Relevant laboratory findings, including ABGs (during a short-term or moderate asthma attack, indicate respiratory alkalosis with mild hypoxemia; during a prolonged or severe attack, demonstrate respiratory acidosis with severe hypoxemia); PFTs (document a decreased FEV1 and VC); and sputum examinations (show eosinophilia)
Nursing Diagnosis: Ineffective Airway Clearance

OUTCOMES. Common examples of expected outcomes for the patient with a diagnosis of ineffective airway clearance are:

Patient will:
- Demonstrate effective airway clearance.
- Cough effectively.
- Have breath sounds that are clear or at baseline.

NURSING INTERVENTIONS. During an asthma attack, secretions tend to become viscous and can plug airways, causing increased airway obstruction. Mobilizing secretions often prevents the need for intubation and artificial ventilation. To promote mobilization, the nurse should ensure adequate systemic fluid intake. Overhydration is not necessary, since research findings suggest it may not increase secretion clearance above levels obtained by normal hydration. It is also important to provide extra humidity, teach effective cough maneuvers, provide adequate nutrition for energy, and medicate with short-acting rescue medications.

RELATED NIC INTERVENTIONS. Airway Management, Asthma Management, Respiratory Management

Nursing Diagnosis: Ineffective Breathing Pattern

OUTCOMES. Common examples of expected outcomes for the patient with a diagnosis of ineffective breathing pattern are:

Patient will:
- Have arterial blood pH and PaCO₂ at baseline levels.
- Demonstrate improved ventilation.
- Have arterial blood pH and PaCO₂ at baseline levels.
- Have respiratory rate within normal limits.

NURSING INTERVENTIONS. The nursing role in improving breathing patterns and gas exchange is to help the patient assume a position of comfort, administer medication as ordered, and monitor for both therapeutic and adverse effects of medications. The nurse must also assess for possible medication overuse (see Table 27-4). The nurse encourages the patient to exercise and monitors the need for an inhaled β₂-agonist 15 to 30 minutes before exercise.

RELATED NIC INTERVENTIONS. Airway Management, Asthma Management, Vital Signs Monitoring

Nursing Diagnosis: Impaired Gas Exchange

OUTCOMES. Common examples of expected outcomes for the patient with a diagnosis of impaired gas exchange are:

Patient will:
- Maintain PaO₂ at optimal level for the patient.
- Have inspiratory/expiratory ratio of 5:10 seconds.
- Demonstrate effective breathing pattern.

NURSING INTERVENTIONS. The nurse monitors blood gas results carefully. If respiratory alkalosis is present, the nurse encourages the patient to breathe more slowly. If respiratory acidosis and hypoxemia are present, oxygen is administered as prescribed. If oxygen and other therapeutic measures do not relieve the attack, intubation and ventilatory assistance may be required.

RELATED NIC INTERVENTIONS. Airway Management, Oxygen Therapy, Respiratory Management

Nursing Diagnosis: Anxiety

OUTCOMES. Common examples of expected outcomes for the patient with a diagnosis of anxiety (mild, moderate, or severe) are:

Patient will:
- Demonstrate activities to control anxiety response to symptoms.
- Use progressive muscle relaxation.
- Use medications appropriately.

NURSING INTERVENTIONS. The nurse should never leave the patient alone during an asthma attack. The nurse guides the patient in the use of relaxation techniques and respiratory maneuvers and encourages use of relaxation and other techniques to reduce anxiety (see Patient/Family Teaching box).

RELATED NIC INTERVENTIONS. Anxiety Reduction, Simple Relaxation Therapy

Nursing Diagnosis: Ineffective Therapeutic Regimen Management

OUTCOMES. Common examples of expected outcomes for the patient with a diagnosis of ineffective therapeutic regimen management are:

Patient will:
- Describe the "stepped plan" and partnership approach to asthma management.
- Identify asthma triggers (e.g., allergens, infections, stress).
- Describe strategies for avoiding asthma triggers.
- State the importance of keeping a diary of symptoms and medications (time and dose).
- Explain home medication program.
- State name, dose, action, and side effects of each medication.
- Describe conditions under which medications might be increased (e.g., infection, start or increase antibiotics, etc.).

Related NIC INTERVENTIONS. Airway Management, Asthma Management, Oxygen Therapy, Respiratory Management

PATIENT/FAMILY TEACHING

Progressive Relaxation Exercises

The nurse should teach the patient to:
- Contract each muscle to a count of 10 and then relax it.
- Do exercises in quiet room while sitting or lying in a comfortable position.
- Do exercises to relaxing music, if desired.
- Have another person serve as a “coach” by giving the command to contract a specific muscle, count to 10, and relax the muscle.
- Exercises that are helpful to some persons with chronic obstructive pulmonary disease include:
  - Raise shoulders, shrug them, and relax for 5 seconds; then relax them completely.
  - Make a fist of both hands, squeeze them tightly for 5 seconds, and then relax them completely.

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- Exercises that are helpful to some persons with chronic obstructive pulmonary disease include:
  - Raise shoulders, shrug them, and relax for 5 seconds; then relax them completely.
  - Make a fist of both hands, squeeze them tightly for 5 seconds, and then relax them completely.
NURSING INTERVENTIONS. The nurse assesses the patient’s knowledge of asthma and teaches the information needed for the patient to become an effective partner in managing the disease (see Patient/Family Teaching box).

RELATED NIC INTERVENTIONS. Emotional Support, Patient Counseling, Teaching: Disease Process

EVALUATION. To evaluate the effectiveness of nursing interventions, compare patient behaviors with those stated in the expected patient outcomes.

PATIENT/FAMILY TEACHING. The Patient With Asthma

Nursing interventions for the patient with asthma include teaching the patient:

- Signs and symptoms of an attack: tightness in chest, restlessness or vague feeling of uneasiness, dyspnea, increased wheezing, productive cough
- Importance of keeping a symptom diary to record timing of attacks, symptom patterns, possible precipitating factors, time and dose of self-administered medications, and their effectiveness
- Self-treatment of signs and symptoms:
  - Importance of taking bronchoactive medications as ordered
  - Conditions under which medication might be increased (e.g., change in peak flow readings, infection, increased stress, or worsening of symptoms)
  - Need to call someone in the event of an attack so as not to be alone
- Importance of remaining calm, breathing slowly, and using relaxation techniques at the first sign of an attack
- Need to call a physician or go to the nearest emergency facility if symptoms do not dissipate
- Use of equipment such as a metered dose inhaler, inhaler with a spacer, and peak flow meter if one is prescribed (The patient should demonstrate use of the inhaler with each visit to the health care provider to reinforce correct technique.)
- Importance of smoking cessation and avoidance of environmental tobacco smoke
- Need to avoid large crowds during flu season
- Importance of obtaining influenza and pneumococcal vaccines

Cystic Fibrosis

Cystic fibrosis (CF) is a multisystem disorder characterized by chronic airway obstruction and infection and by exocrine pancreatic insufficiency, with its effects on GI function, nutrition, growth, and maturation.

Etiology and Epidemiology. CF continues to be the most common fatal genetic disease among Caucasians. Numerous mutations of a single gene are responsible for CF. The gene encodes a membrane protein known as the CF transmembrane regulator (CFTR), and mutations of CFTR protein result in reduced secretion of chloride from epithelial cells. It is an autosomal recessive disease. When both parents are carriers (heterozygotes), there is a one-in-four chance with each pregnancy that the child will have CF (Figure 27-9).

In Caucasian populations 2% to 5% are carriers of a CF gene mutation. Approximately 25,000 individuals with CF live in the

RELATED NOC OUTCOMES. Anxiety Self-Control, Knowledge: Treatment Regimen, Respiratory Status: Airway Patency, Respiratory Status: Gas Exchange, Respiratory Status: Ventilation, Symptom Control, Vital Signs

GERONTOLOGIC CONSIDERATIONS

Although the goals of treatment of asthma are the same for persons of all ages, they may be more difficult to achieve in older adults. The Cardiovascular Health Study is one of the largest population-based examinations of heart and lung disease in older persons in the United States. This study explored the associations of asthma in older adults with quality of life, morbidity, and use of asthma medications. Results of the study indicated that asthma in older persons is associated with a lower quality of life. Participants who had asthma were much more likely to rate their general health as fair or poor and report their activity as less than the previous year. Results also indicated that asthma is underdiagnosed in older adults and is often associated with allergic triggers. Inhaled corticosteroids are underused. This study provides considerable impetus for health care providers to prioritize the diagnosis and treatment of asthma in the older population.

Nursing interventions for the patient with asthma include teaching the patient:

- Signs and symptoms of an attack: tightness in chest, restlessness or vague feeling of uneasiness, dyspnea, increased wheezing, productive cough
- Importance of keeping a symptom diary to record timing of attacks, symptom patterns, possible precipitating factors, time and dose of self-administered medications, and their effectiveness
- Self-treatment of signs and symptoms:
- Conditions under which medication might be increased (e.g., change in peak flow readings, infection, increased stress, or worsening of symptoms)
- Need to call someone in the event of an attack so as not to be alone
- Importance of remaining calm, breathing slowly, and using relaxation techniques at the first sign of an attack
- Need to call a physician or go to the nearest emergency facility if symptoms do not dissipate
- Use of equipment such as a metered dose inhaler, inhaler with a spacer, and peak flow meter if one is prescribed (The patient should demonstrate use of the inhaler with each visit to the health care provider to reinforce correct technique.)
- Importance of smoking cessation and avoidance of environmental tobacco smoke
- Need to avoid large crowds during flu season
- Importance of obtaining influenza and pneumococcal vaccines
United States. The number of adults with CF continues to increase steadily because of increased life expectancy and diagnostic advances. Two groups make up this adult CF population: (1) those diagnosed when infants or children and (2) those diagnosed as adolescents or adults. Statistics indicate that approximately 20% of the adult CF population is diagnosed after age 15.11

Reaching adulthood is now a realistic expectation for infants and children with CF. The average life expectancy in 1998 was 32.3 years.12 The major contributing factors to this increased life expectancy include advancements in antibiotic therapies, new treatments, more aggressive management, and the availability of a network of about 115 comprehensive CF referral centers sponsored by the Cystic Fibrosis Foundation.

Pathophysiology. CF is an exocrine gland disease involving various systems (pulmonary, pancreatic/hepatic, GI, reproductive). Obstruction of the exocrine gland ducts or passageways occurs in nearly all adult patients with CF. Exocrine gland secretions are known to have decreased water content, altered electrolyte concentration, and abnormal organic constituents (especially mucous glycoproteins); however, the specific biochemical or physiologic defect that leads to obstruction is not known.

Pulmonary Involvement. Disease of the conducting airways in CF is acquired after birth. Either hypersecretion or failure to clear secretions at an early age accounts for mucus accumulation in bronchial regions. Failure to clear secretions from the airway probably initiates infection because mucous plaques and plugs serve as media for growth of bacteria.36 Chronic airway infection probably initiates infection because mucous plaques and plugs serve as media for growth of bacteria.36 Chronic airway infection is rarely eradicated. As lung disease progresses, bronchiolitis and bronchiectasis are evident, submucosal glands hypertrophy, and goblet cells increase. Bronchiectasis is a consequence of persistent obstruction-infection cycles. Bronchiectatic cysts occupy as much as 50% of the late-stage CF lung. Pseudomonas aeruginosa and Staphylococcus aureus are the organisms most frequently causing infection.37 The earliest manifestation of lung involvement is generally cough, at first intermittent and then daily. It is often worse at night and on arising in the morning. Cough becomes productive, then paroxysmal, and is associated with gagging and emesis. Sputum is usually tenacious, purulent, and green. Recurrent pulmonary infections erode blood vessels such as the bronchial arteries, which branch from the aorta and the lung at high pressures. Pulmonary infections erode blood vessels such as the bronchial arteries, which branch from the aorta and the lung at high pressures. Shortness of breath and dyspnea on exertion, wheezing, and weight loss; occur with respiratory complications and usually indicate need for vigorous therapy.

Gastrointestinal and Pancreatic Involvement. Intestinal obstruction occurs in 20% of adult patients with CF. Generally, pancreatic insufficiency predisposes them to intestinal obstruction. Cramps and abdominal pain in adults with CF should arouse suspicion of intestinal obstruction. Pancreatic insufficiency is reported in 80% to 90% of adults with CF. The pathologic lesions in the pancreas decrease pancreatic enzyme production and lead to malabsorption of fat.

Other Involvement. In older children and young adults CF may be manifested by heat exhaustion after exercise or exposure to hot weather, or by dehydration after fever. In some young adults the only clinical manifestation of CF may be infertility. The varied signs and symptoms of CF are summarized in the Clinical Manifestations box.

Complications. Complications of CF include pneumomediastinum, pneumothorax, airway problems, GI problems, and respiratory failure. Patients with CF eventually succumb to progressive respiratory and cardiac failure. Because these patients have a fatal disease, they usually have do-not-resuscitate (DNR) orders and are not intubated or placed on mechanical ventilation. The patient and family have to be involved in the DNR decision, and nurses play an important role in supporting them in their decision.

Pneumothorax. A pneumothorax occurs secondary to rupture of a subpleural bleb. The incidence is 1% per year but increases with age. It occurs more frequently in the right side of the chest. It should be suspected any time a patient with CF experiences the acute onset of shortness of breath, chest pain, or hemoptysis. When a pneumothorax occurs, the surgeon makes a stab wound between the ribs and inserts a chest tube connected to a closed drainage system. After the lung is reexpanded, pleural sclerosis using doxycycline or talc may be induced. This procedure causes the visceral pleura to adhere to parietal pleura, obliterating the pleural space. If an air leak is persistent or pleural sclerosis fails, the surgeon may perform a partial pleurectomy, removing the portion of the pleura overlying the cysts that ruptured.

Hemoptysis. Hemoptysis occurs when a blood vessel is eroded as a result of chronic airway inflammation. It is more common in older CF patients and correlates with the presence of bronchiectasis. Patients with large-volume hemoptysis may describe a bubbling or gurgling sensation in one area of the chest. The patient may expectorate as much as 300 to 500 ml of blood in 24 hours. The patient is very anxious and should not be left alone. During episodes of hemoptysis the nurse elevates the head of the bed 45 to 90 degrees and turns the patient’s head to the left side to facilitate expectoration of blood. The nurse provides tis-

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**Clinical Manifestations**

**Cystic Fibrosis**

<table>
<thead>
<tr>
<th>Pulmonary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chronic productive cough, recurrent bronchitis or pneumonia</td>
</tr>
<tr>
<td>Crackles and ronchi, decreased pulmonary compliance, digital clubbing</td>
</tr>
<tr>
<td>Shortness of breath and dyspnea on exertion, wheezing, and weight loss; occur with respiratory complications and usually indicate need for vigorous therapy</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Gastrointestinal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequent, bulky, greasy stools</td>
</tr>
<tr>
<td>Weight loss</td>
</tr>
<tr>
<td>Cramps and abdominal pain; should arouse suspicion of obstruction</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Glucose Intolerance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polyuria, polydipsia, polyphagia</td>
</tr>
<tr>
<td>Absence of ketonuria even with above signs</td>
</tr>
</tbody>
</table>
Chapter 27 695

Chronic Obstructive Pulmonary Disease

Airway Problems. Allergic bronchopulmonary aspergillosis is an allergic immune reaction to Aspergillus organisms that is characterized by airway inflammation and edema. This complication occurs in 1% to 10% of patients with CF. It should be considered when new lung infiltrates appear on chest radiographs or when increased cough, respiratory distress, wheezing, and the expectoration of rust-colored plugs of sputum occur. Treatment is with corticosteroids and oral antifungal agents for several months.

Gastrointestinal Problems. GI problems are common, and treatment includes vitamin and pancreatic enzyme supplements. Supplemental fat-soluble vitamins aid digestion and improve weight. Most patients take multivitamins and vitamin E. Pancreatic enzyme supplement doses are individualized and titrated by patients to limit fatty stools to less than three per day. Approximately 90% of patients with CF require mealtime pancreatic enzyme supplements. The number and dose are prescribed on the basis of weight gain, the presence or absence of abdominal cramping, and the number of stools. When a patient can take nothing by mouth (NPO), minimal doses of pancreatic enzyme supplements are necessary. If adequate intake cannot be maintained orally, IV feedings or gastrostomy may be necessary.

Respiratory Failure. Respiratory failure leads to death in more than 90% of CF patients. Hypoxemia develops during exertion or sleep and progresses over years. Hypercapnia reflects severe airway obstruction. The principal mechanism underlying hypoxemia is a V/Q mismatch causing hypoxemia.

Collaborative Care Management. Management of CF often involves extensive and complicated treatment regimens that require many hours daily.

Diagnostic Tests. The diagnosis of CF is confirmed by the presence of at least two of the following:

- A positive sweat test with a chloride level greater than 60 mEq/L.
- Chronic sinusitis.
- Chronic chest x-ray abnormalities: hyperinflation of the lung; mucoid impaction of bronchi, which is seen as branching, fingerlike shadows; or atelectasis of the right upper lobe.
- Pancreatic exocrine insufficiency.
- Obstructive azoospermia in men.

- Laboratory evidence of CFTR dysfunction.
- Positive family history of CF.

Medications. Lung infection is the major source of morbidity and mortality. By age 18, 80% of CF patients are chronically infected with P. aeruginosa, 40% with S. aureus, and 50% with Burkholderia cepacia. Antibiotic therapy is a mainstay designed not to eradicate the bacteria from the airways but to reduce the number of bacteria and control progression of disease. Best results have been shown with early and vigorous use of antibiotics. Dosages need to be higher than in non-CF-related chest infections, and the choice is based on sputum culture and sensitivity. Combination therapy with two or three antibiotics for 10 to 14 days is recommended to prevent bacterial resistance. Shorter courses of antibiotic therapy are associated with exacerbation of symptoms. In both moderate and severe exacerbations, aerosolized (inhaled) antibiotics are used in conjunction with intravenous antibiotics. Organisms with multiple resistance profiles such as B. cepacia have emerged in the CF population. This reinforces the need for close monitoring of antibiotic susceptibility and strict adherence to isolation policies for infection control.

Dornase alfa (Pulmozyme) is a recombinant form of the naturally occurring human enzyme deoxyribonuclease I (DNase I), which is responsible for the breakdown of extracellular deoxyribonucleic acid (DNA). In patients with CF the viscosity of airway secretions is abnormally high because of an increased number of neutrophils and DNA in cellular breakdown products. Inhalation of dornase alfa may provide a modest improvement in lung function and decreased pulmonary exacerbation in patients with mild to moderate lung disease. The dosage is 2.5 mg aerosolized daily.

Bronchodilator use is controversial despite the fact that it is prescribed for more than 80% of CF patients. Most CF patients have some bronchodilation after aerosolized albuterol. This may serve to enhance secretion clearance. Some experts are concerned, however, that bronchodilators may be detrimental to cough clearance of secretions by decreasing airway tone, causing dynamic collapse of airways.

Treatments. Treatment goals include the control of infection, promotion of mucus clearance, and improved nutrition. The patient is encouraged to be as active and independent as possible.

Patients are often referred to pulmonary physiotherapy, respiratory therapy, social services, and genetic counseling. It is important to promote compliance with therapy. Approaches that promote a positive self-concept and foster the patient’s ability to control the medical management have been successful. Care that promotes continuity and fosters trust is essential to achieving expected patient outcomes.

As persons with CF move into adulthood, their medical care should transition from a pediatric to adult focus, and they need support in taking control of their health issues. One concern that often interferes with this transition to independence is the difficulty in acquiring adequate health insurance. Health care professionals can be key in identifying useful resources.

Pulmonary Physiotherapy (Chest Physiotherapy). Cough clears mucus from large airways, and chest vibration

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moves secretions from small airways to large ones. Daily pulmonary physiotherapy is one of the most important preventive and therapeutic aspects of care in patients with CF. Pulmonary physiotherapy activities (segmental postural drainage, percussion, and vibration) may be performed by a physical therapist, nurse, or family member, or by the patient using new modalities. Pulmonary physiotherapy is physically demanding and time consuming but essential to care. The frequency and duration of treatment are individualized.

Segmental postural drainage with percussion and vibration combines the force of gravity with the natural ciliary activity of the small bronchial airways to move secretions upward toward the main bronchi and the trachea. From this point the patient can cough secretions up, or can be suctioned. All segments are usually drained by placing patients in various postural drainage positions (Table 27-5). Treatment may also be directed at draining specific areas of the lung. For example, if the right middle lobe of the lung is affected, drainage is accomplished best by way of the right middle bronchus. The patient lies supine with the body turned at approximately a 45-degree angle. The angle can be maintained by pillow supports placed under the right side from the shoulders to approximately a 45-degree angle. The angle can be maintained by pillow supports placed under the right side from the shoulders to the hips. The foot of the bed is raised about 30 cm (12 inches). Most patients can maintain this position fairly comfortably for half an hour. If the lower posterior area of the lung is affected, the foot of the bed can be raised 45 to 50 cm (18 to 20 inches) with the patient assuming a prone position for drainage. While the patient is in each position, the health care provider performs percussion with a cupped hand over the area being drained. This maneuver helps loosen secretions and stimulates coughing (Figure 27-10). After percussing the area for approximately 1 minute, the caregiver instructs the patient to breathe deeply. Vibration (pressure applied with a vibrating movement of the hand on the chest) is performed during the expiratory phase of the deep breath. This helps the patient exhale more fully. The procedure is repeated as necessary. When the patient cannot tolerate a head-down position, a modified position is used.

Positions that provide gravity drainage of the lungs can be achieved in several ways, depending on the person's age and general condition, as well as the lobe or lobes of the lungs where secretions have accumulated. Electric hospital beds can be tilted into a head-down position with little difficulty. If an electric bed is not available (e.g., in the home), blocks can be placed under the casters at the foot of the bed, or a hydraulic lift can be used.

Newer techniques such as positive expiratory pressure, a FLUTTER valve device, the Vest System and autogenic drainage, or active cycle breathing are alternatives to traditional and time-intensive chest physiotherapy. FLUTTER, a mucus-clearance device, is a small, handheld device in the shape of a pipe. Within the FLUTTER is a high-density stainless steel ball resting in a plastic cone. As the patient exhales, the ball rolls out of place and back many times, resulting in variance of endobronchial pressure and expiratory airflow. The oscillations loosen mucus from the airways. The oscillations also decrease collapsibility of the airways. The Vest System is a portable, high-frequency chest compression system. It is an inflatable, tailored, fitted vest jacket

![Table 27-5 Positions for Segmental Postural Drainage, Percussion, and Vibration](image-url)

<table>
<thead>
<tr>
<th>Area of Lung</th>
<th>Position of Patient</th>
<th>Area to Be Percussed or Vibrated</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Upper Lobe</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Apical bronchus</td>
<td>Semi-Fowler's position, leaning to right, then left, then forward</td>
<td>Over area of shoulder blades with fingers extending over clavicles</td>
</tr>
<tr>
<td>Posterior bronchus</td>
<td>Upright at 45-degree angle, rolled forward against pillow at 45 degrees on left and then right side</td>
<td>Over shoulder blade on each side</td>
</tr>
<tr>
<td>Anterior bronchus</td>
<td>Supine with pillow under knees</td>
<td>Over anterior chest just below clavicles</td>
</tr>
<tr>
<td>Lateral and medial bronchus</td>
<td>Trendelenburg's position at 30-degree angle or with foot of bed raised 35–40 cm (14–16 inches), turned slightly to left</td>
<td>Anterior and lateral right chest from axillary fold to midanterior chest</td>
</tr>
<tr>
<td><strong>Middle Lobe</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Superior and inferior bronchus</td>
<td>Trendelenburg's position at 30-degree angle or with foot of bed raised 35–40 cm (14–16 inches), turned slightly to right</td>
<td>Left axillary fold to midanterior chest</td>
</tr>
<tr>
<td>Apical bronchus</td>
<td>Prone with pillow under hips</td>
<td>Lower third of posterior rib cage on both sides</td>
</tr>
<tr>
<td>Medial bronchus</td>
<td>Trendelenburg's position at 45-degree angle or with foot of bed raised 45–50 cm (18–20 inches) on right side</td>
<td>Lower third of left posterior rib cage</td>
</tr>
<tr>
<td>Lateral bronchus</td>
<td>Trendelenburg's position at 45-degree angle or with foot of bed raised 45–50 cm (18–20 inches) on left side</td>
<td>Lower third of right posterior rib cage</td>
</tr>
<tr>
<td>Posterior bronchus</td>
<td>Prone Trendelenburg's position at 45-degree angle with pillow under hips</td>
<td>Lower third of posterior rib cage on both sides</td>
</tr>
</tbody>
</table>
attached to a large pump that generates high-frequency oscillations. The resulting pressures cause the vest to inflate and deflate against the chest wall. In this passive technique, the vibrations cause transient increased airflow, resulting in improved mucus mobilization. Postural drainage and percussion should be planned to achieve maximal benefit. Some patients spend up to 8 hours per day involved with this treatment. The frequency of treatments depends on each person’s needs, but care should be taken to avoid exhaustion, which results in shallow ventilation and negates the positive effects of the treatment. Because the patient may feel nauseated by the odor and taste of sputum, the procedure should be timed for at least 1 hour before meals. A short rest period after percussion while still in the postural drainage position often improves the effectiveness of treatment. Chest percussion is contraindicated in patients with pulmonary emboli, hemorrhage, exacerbation of bronchospams, or severe pain and also over areas of resectable carcinoma.

LUNG TRANSPLANTATION. Lung transplantation has become accepted therapy for respiratory failure secondary to CF. Patients should be referred when their prognosis is about equal to the waiting time for donor lungs, currently about 2 years. The best indica-

tor currently is an FEV1 of less than 30% of predicted, although women and younger children may need a transplant before reaching this level. The transplanted lungs remain free of CF but are subject to secondary infection and acute or chronic rejection. Survival rates for lung transplant patients with CF is 73% at 1 year and 48% at 5 years.

DIET. The diet may be as tolerated, but may need to be altered because of GI problems.

HEALTH PROMOTION AND PREVENTION. Because CF is a genetically inherited disease, identification of carriers who may pass on the defect and disease to offspring remains the most important preventive strategy. Early identification of carriers combined with genetic counseling minimizes the chance of offspring inheriting this lethal genetic disease. Family histories of possible incidences of CF should be followed up by genetic testing. Patient teaching is an important component of patient care (see Patient/Family Teaching box).

Nursing Management of the Patient with Cystic Fibrosis

ASSESSMENT

Health History. Assess for:

• Description of symptoms such as shortness of breath, dyspnea on exertion, fatigue, and wheezing.

• Patient’s understanding of CF pathophysiology and treatment regimens, including postural drainage and percussion; antibiotics; aerosol therapy with dornase alfa, bronchodilators, and antibiotics; and nutritional supplements such as pancreatic enzymes and vitamins.

• Color, consistency, and frequency of stools.

• Color, smell, and frequency of urination.

PATIENT/FAMILY TEACHING

The Patient With Cystic Fibrosis

Because the adult patient with cystic fibrosis patient has had the disease for several years, teaching is more in the form of review and reinforcement. Information to review includes:

• Daily nutrition requirements, vitamins, and the need to check weight daily.

• Daily pulmonary exercises and treatments, including postural drainage and percussion, as well as use of bronchoactive medication before postural drainage.

• Usual dose, expected effects, and side effects of medications.

• Clinical symptoms that indicate that the health care provider should be notified, such as signs of an acute respiratory tract infection (fever, increased fatigue, shortness of breath, increased production of sputum, or change in color of sputum); hemoptysis; and sudden, sharp chest pain.

• Patient’s knowledge and understanding of fertility, genetic testing, and contraceptive methods.

• Patient’s and family’s knowledge of community and social resources for assistance with health care reimbursement programs, disability insurance, and support groups.
UNIT 6 Respiratory Problems

**Nursing Diagnosis: Risk for Infection**

**Outcomes.** Common examples of expected outcomes for the patient with a diagnosis of risk for infection are:

- Patient will:
  - Exhibit no signs of infection.
  - Demonstrate decreased mucus in the airway.
  - Maintain an environment free of pathogenic bacteria.
  - Discuss ways of reducing risk of infection.
  - Verbalize knowledge of when to take influenza and pneumococcal vaccines.

**Nursing Interventions.** Because the adult with CF is extremely vulnerable to infection, the environment should be kept as free of pathogens as possible. The patient should wash his or her own hands frequently, especially after coughing, and the nurse should provide frequent mouth care, especially after postural drainage. The nurse encourages visitors to wash their hands before touching the patient and minimizes exposure to persons with upper respiratory tract infections.

The nurse monitors the patient's temperature regularly, along with the color, volume, and consistency of sputum. Sputum specimens must be collected correctly and sent for culture and sensitivity as indicated. Care must be taken to administer antibiotics on time to ensure that an adequate blood level is maintained.

**Related NIC Interventions.** Infection Prevention

**Nursing Diagnosis: Ineffective Airway Clearance**

**Outcomes.** Common examples of expected outcomes for the patient with a diagnosis of ineffective airway clearance are:

- Patient will:
  - Demonstrate improved airway clearance.
  - Demonstrate decreased mucus production.
  - Have clear breath sounds.
  - Report decreased fatigue and shortness of breath.

**Nursing Interventions.** The nurse assists the patient with coughing, postural drainage, and percussion every 2 to 4 hours, depending on the severity of the infection. The newer FLUTTER valves and Vest System devices help promote independence with these needed interventions. The nurse auscultates breath sounds before and after each treatment to determine its effectiveness. The patient is encouraged to increase fluid intake to 3 to 4 L/day unless contraindicated, and the room is kept cool, with the temperature below 70° F (21.1° C).

**Related NIC Interventions.** Airway Management, Cough Enhancement, Respiratory Monitoring

**Nursing Diagnosis: Imbalanced Nutrition: Less Than Body Requirements**

**Outcomes.** Common examples of expected outcomes for the patient with a diagnosis of imbalanced nutrition are:

- Patient will:
  - Demonstrate improved nutrition.
  - Maintain weight within 20% of ideal weight.
  - Maintain normal blood glucose level.
  - Eat small, frequent meals.

**Nursing Interventions.** Because the patient with CF often has difficulty maintaining nutrition, the nurse may need to be creative. The nurse performs baseline and periodic assessments of nutrition, including food history, recording of daily intake and output, and recording of daily weight. Blood glucose levels are monitored so that insulin can be given as prescribed according to blood glucose findings. The nurse works with the dietitian and the patient to provide small, frequent meals that are appealing to the patient. The nurse administers pancreatic enzymes and vitamins as ordered.

**Related NIC Interventions.** Nutrition Management, Nutrition Therapy
Chronic Obstructive Pulmonary Disease  Chapter 27

Nursing Diagnosis: Anticipatory Grieving

Outcomes. Common examples of expected outcomes for the patient with a diagnosis of anticipatory grieving are:

- Manifest enhanced coping skills.
- Verbalize actual and potential losses.
- Identify own strengths and personal goals.
- Identify support person to assist with coping and achievement of goals.

Nursing Interventions. The nurse can play a major role in helping the patient work through the grieving process by identifying the stage of grieving, allowing time for the patient to verbalize feelings, hopes, and fears; and supporting expressions of hope, while avoiding false reassurance. The nurse supports both patient and family through grief work and recommends CF support groups as indicated. The nurse may also refer the patient for genetic counseling, career counseling, or social services. The nurse intervenes for pathologic symptoms of grief, such as anxiety, sleeplessness, and hallucinations.

Related NIC Outcomes. Family Support, Grief Work Facilitation

Evaluation

To evaluate the effectiveness of nursing interventions, compare patient behaviors with those stated in the expected patient outcomes.


Gerontologic Considerations

Only a few CF patients live into the sixth or seventh decade of life. However, 50% of patients can now expect to survive beyond age 50, so in a few years many more CF patients may be living at ages 55 and older. The Cystic Fibrosis Foundation is helpful to patients and families in terms of supplying names of health care resources and providing support to family caregivers.

Are You Ready?

In planning care for the adult patient with cystic fibrosis, the nurse incorporates which of the following interventions?

1. Maintain room temperature above 75° F
2. Enforce fluid intake to 3-4 L/day
3. Administer cough suppressants
4. Decrease protein in diet

Respiratory Failure

Etiology and Epidemiology. Respiratory failure is impairment of the lung’s ability to maintain adequate oxygen and carbon dioxide homeostasis. Analysis of ABGs and pulse oximetry are required for diagnosis. Respiratory failure is classified as acute (ARF), chronic (CRF), or acute-on-chronic (AOCF). ARF is any rapid change in respiration resulting in hypoxemia, hypercarbia, or both. It occurs over hours to days, and the term acute respiratory failure connotes a sense of urgency. CRF develops over months to years, allowing compensatory mechanisms to improve oxygen transport and buffer respiratory acidemia. AOCF is ARF superimposed on CRF, as in a patient with COPD who experiences an acute exacerbation.

Respiratory failure may also be classified according to the underlying pathophysiology as hypoxemic respiratory failure or hypoxemic-hypercapnic respiratory failure. Patients often demonstrate characteristics of both during the course of the illness. Hypoxemic respiratory failure is characterized by a low PaO2 (less than 55 mm Hg) and a normal or low PaCO2. The result of V/Q mismatch is best demonstrated by acute respiratory distress syndrome (ARDS). Hypoxemic-hypercapnic respiratory failure is characterized by a low PaO2 (less than 55 mm Hg) and an elevated PaCO2 (greater than 50 mm Hg). An elevated PaCO2 normally increases ventilatory drive, so this form of respiratory failure indicates the patient is not able to sense the elevated PaCO2 (COPD) or the lungs and chest are not able to respond (parenchymal or muscular inefficiency).

Many disorders can lead to or are associated with respiratory failure (Box 27-2).

Pathophysiology. The respiratory system is made up of two basic parts: the gas exchange organ (the lungs) and the pump (the respiratory muscles and the respiratory control mechanisms). Any alteration in the function of the gas exchange unit or the pump can result in respiratory insufficiency or failure. Regardless of the underlying condition, the resultant events or processes that occur in respiratory failure are the same. With inadequate ventilation, the arterial oxygen falls and tissue cells become hypoxic. Carbon dioxide accumulates, leading to a fall in pH and respiratory acidosis.

Diseases Associated With Respiratory Failure

<table>
<thead>
<tr>
<th>Pulmonary Disorders</th>
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<tbody>
<tr>
<td>Severe infection</td>
</tr>
<tr>
<td>Pulmonary edema</td>
</tr>
<tr>
<td>Pulmonary embolism</td>
</tr>
<tr>
<td>Chronic obstructive pulmonary disease</td>
</tr>
<tr>
<td>Cystic fibrosis</td>
</tr>
<tr>
<td>Acute respiratory distress syndrome</td>
</tr>
<tr>
<td>Cancer</td>
</tr>
<tr>
<td>Chot trauma (flail chest)</td>
</tr>
<tr>
<td>Severe anaphylaxis</td>
</tr>
<tr>
<td>Airway compromise secondary to trauma, infection, or surgery</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Nonpulmonary Disorders</th>
</tr>
</thead>
<tbody>
<tr>
<td>Central nervous system disturbance secondary to drug overdose, anesthesia, head injury</td>
</tr>
<tr>
<td>Neuromuscular disorders (e.g., Guillain-Barré syndrome, myasthenia gravis, multiple sclerosis, polymyelitis, muscular dystrophy, spinal cord injury)</td>
</tr>
<tr>
<td>Postoperative reduction in ventilation after thoracic and abdominal surgery</td>
</tr>
<tr>
<td>Prolonged mechanical ventilation</td>
</tr>
</tbody>
</table>
ARF is defined by predetermined physiologic criteria. These criteria are sudden onset of:

- PaO2 of 50 mm Hg or less (measured on room air)
- PaCO2 of 50 mm Hg or more
- pH of 7.35 or less

Hypercapnia and hypoxemia are present in CRF. In CRF the pH usually stays within the range of 7.35 to 7.40 because of compensation. Patients with CRF develop AOCF as a result of a secondary insult to their compromised pulmonary system, usually in the form of a respiratory infection. The individual can no longer compensate for the altered lung function, and a dramatic decrease in pH (below 7.35), accompanied by severe hypoxemia, occurs. Because carbon dioxide retention (hypercapnia) preexists in patients with AOCF, the PaCO2 is less relevant than pH and PaO2 in determining respiratory status. In fact, these patients often display few clinical signs or symptoms, even though they may have major blood gas derangements.

Underlying blood gas alterations are the basis for the clinical signs and symptoms associated with respiratory failure (see Clinical Manifestations box). The signs and symptoms of hypoxemia, hypercapnia, and respiratory acidosis are presented together because the blood gas derangements causing them usually occur simultaneously. It is important for the nurse to recognize that the signs and symptoms associated with hypoxemia and hypercapnia depend more on the rate of change in value than on absolute value. The patient with COPD may show few signs until severe ARF occurs.

Complications. Complications of respiratory failure and mechanical ventilation include impaired gas exchange from a plugged tube, kinked tube, or cuff herniation; fluid volume excess; electrolyte imbalance; stress ulcer and GI bleeding; infection; increased intracranial pressure secondary to altered cerebral perfusion; tissue hypoxia; and cardiopulmonary arrest.

One-year survival after respiratory failure is 28% to 72%. The prognosis is best for those with kyphoscoliosis or neuromuscular disease and worst for those with pneumococcal and pulmonary fibrosis. Men with COPD who require mechanical ventilation may have a survival rate of about 50% at 1 year.45
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ventilator or a continuous positive airway pressure (CPAP) or bilevel positive airway pressure (BiPAP) ventilation device.

A tight-fitting mask allows ventilatory assistance and provides for brief periods off the ventilator, during which the patient can speak, inhale nebulized medications, expectorate, and swallow liquids. NIV methods may be used for up to 1 week. They have been effective in relieving symptoms, decreasing respiratory rate, increasing tidal volume, improving gas exchange, decreasing the length of the hospital stay, and decreasing in-house mortality. Complications are few compared with other methods of ventilatory support and include skin breakdown and aspiration; also, some patients cannot tolerate the mask.

With NIV the positive pressure is applied during the patient’s inspiration via IPPV or PSV or throughout the respiratory cycle at a constant pressure (CPAP). The NPPV may also be set to different levels during inspiration and expiration through the use of BiPAP. These positive-pressure modes reduce the work of breathing, decrease respiratory muscle fatigue, and increase minute ventilation. NIV requires an alert, cooperative, hemodynamically stable patient. Relative contraindications include copious secretions, aspiration risk, and impaired mental status. This approach to ventilatory support requires careful attention to a properly fitting mask and time from the clinicians to stay with the patient to explain the device, titrate pressures, troubleshoot problems, and provide support and close, ongoing assessment.

**Intubation.** If the patient with respiratory failure is not a candidate for NIV or if NIV is not maintaining adequate ventilation, intubation is required for mechanical ventilation.

**Ventilator Modes.** Ventilator modes determine whether the machine controls the breaths and, if so, how many, or whether, to some degree, the patient controls the breaths with assistance from the machine. The most common modes are assist/control (A/C), synchronized intermittent mandatory ventilation (SIMV), and CPAP (Table 27-6).

In the A/C mode the ventilator senses each time the patient begins to inspire and delivers a breath. If the patient is unable to trigger the machine, the ventilator delivers the preset number of breaths at the set tidal volume. The A/C mode, also called continuous mechanical ventilation, gives the patient complete ventilatory support. This mode is the most frequently used in respiratory failure to ensure respiratory muscle rest. Tidal volumes of 5 to 7 ml/kg are used with respiratory rates of 20 to 24 breaths/min.

**Table 27-6 Ventilator Modes**

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assist/control (A/C)</td>
<td>Each breath ventilator assisted. If patient unable to trigger machine, ventilator continues to deliver preset number of breaths at set tidal volume.</td>
</tr>
<tr>
<td>Bilevel positive airway pressure (BiPAP)</td>
<td>Positive pressure applied to spontaneous breathing, allowing independent settings for inspiratory positive pressure and expiratory positive pressure.</td>
</tr>
<tr>
<td>Continuous positive pressure (CPAP)</td>
<td>Positive pressure applied during inspiration and maintained throughout entire respiratory cycle. Decreases airway intrapulmonary shunting.</td>
</tr>
<tr>
<td>Controlled mandatory ventilation (CMV)</td>
<td>Delivers preset volume at fixed rate regardless of patient’s effort to breathe.</td>
</tr>
<tr>
<td>Intermittent mandatory ventilation (IMV)</td>
<td>Delivers preset number of breaths. Patient may take unassisted breaths.</td>
</tr>
<tr>
<td>Positive end-expiratory pressure (PEEP)</td>
<td>Applies positive pressure at end of expiration. Decreases intrapulmonic shunting.</td>
</tr>
<tr>
<td>Pressure support ventilation (PSV)</td>
<td>Selected amount of positive pressure applied to airway during patient’s spontaneous respiratory efforts. Amount of pressure gradually reduced until patient receives no assistance.</td>
</tr>
<tr>
<td>Synchronized intermittent mandatory ventilation (SIMV)</td>
<td>Intermittent ventilator breaths synchronized with patient’s spontaneous breaths. Reduces competition between patient and ventilator.</td>
</tr>
<tr>
<td>High-frequency ventilator</td>
<td>Special positive-pressure ventilator used in some patients.</td>
</tr>
<tr>
<td>High-frequency positive-pressure ventilation (HFPPV)</td>
<td>Extremely short inspiratory times with total volume equivalent to dead space. Rate 60-100 cycles/min.</td>
</tr>
<tr>
<td>High-frequency jet ventilation (HFJV)</td>
<td>Small volumes less than anatomic dead space pulsed through jet injector catheter at 100-600 cycles/min.</td>
</tr>
<tr>
<td>High-frequency oscillation ventilation (HFO)</td>
<td>Small volume of gas continuously vibrated in airways at rates up to 4000 cycles/min.</td>
</tr>
</tbody>
</table>

Adapted from Stillwell S: Mosby’s critical care nursing reference, ed 3, St Louis, 2002, Mosby.
SIMV allows the patient to take additional breaths over the set rate of the ventilator. The volume of extra breaths is determined by the patient's ability and effort to breathe spontaneously. In SIMV the number of ventilator breaths can be gradually reduced until the patient is breathing on his or her own.

In the CPAP mode the machine delivers a set airway pressure throughout inspiration and exhalation, and the patient determines respiratory rate, tidal volume, inspiratory flow, and inspiratory time. Additional pressure can be added to assist the inspiratory muscles.

Different kinds of ventilators are available to deliver these modes (Table 27-7, Figures 27-11 and 27-12). In adults there are two basic types: pressure-cycled and volume-cycled ventilators. Volume-cycled ventilators, the ones used most frequently, deliver a constant volume of air with each breath. The volume is preset and delivered to the patient at whatever pressure is necessary to attain that volume. A volume-cycled machine should have a pressure cutoff valve that allows a pressure limit to be set. If the pressure required to deliver the set volume exceeds the pressure limit, the machine will turn off before the entire volume is delivered.

The pressure limit on a volume-cycled machine usually has an audible alarm. The nurse can set the limit slightly above the pressure required to ventilate the patient (approximately 5 cm H₂O). The alarm will then go off if the patient coughs, accumulates secretions, or starts to resist the machine. Box 27-3 describes the functionality of the volume-cycled ventilator.

Pressure-cycled ventilators deliver a volume of gas to the airway using positive pressure during inspiration. The positive pressure is delivered until the preselected pressure has been reached; the machine then cycles off. Exhalation occurs passively. The disadvantage of pressure-cycled ventilators is that a varying tidal volume may be delivered as a result of changes in airway resistance or compliance.

Suctioning the Patient. When the patient on a ventilator needs suctioning, a closed system is preferred. In closed-system endotracheal suctioning, the nurse inserts an adaptor at the endotracheal tube–ventilatory circuitry interface (Figure 27-13). This allows patients to be suctioned without disconnecting them from the ventilator. The benefits of this form of suctioning are (1) continuation of the oxygen supply, (2) the stability of PEEP, and (3) a reduced incidence of ventilator-assisted pneumonia. Refer to the Guidelines for Safe Practice box for the steps in closed-system suctioning.

General Care of the Patient on a Ventilator. When care is planned for the patient on a mechanical ventilator, knowing the patient's ability to breathe spontaneously in the event of accidental disconnection from the ventilator is imperative. In most facilities respiratory therapists regularly monitor ventilator function and settings, but the nurse is also responsible for maintaining the ventilator settings. Usually a checklist is used to verify the settings on an hourly basis.

The nurse assesses the patient regularly and any time a ventilator alarm sounds. The cause of an alarm sounding can be a dysfunction anywhere from the person's lungs to the machine. Troubleshooting is carried out in a systematic manner, starting with the patient and moving toward the machine (Box 27-4). If the alarm continues to sound and the cause cannot be determined or the patient is in respiratory distress, the nurse disconnects the patient from the machine and manually ventilates with an Ambu bag (or anesthesia bag) with oxygenated air until the problem can be resolved.

Patients who have a prolonged course of mechanical ventilation need to be evaluated for tracheostomy. If a course of mechanical

### Table 27-7 Types of Mechanical Ventilators

<table>
<thead>
<tr>
<th>Types</th>
<th>Basic Function Mode</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive-pressure ventilator (requires intubation)</td>
<td>Types of positive-pressure ventilators are based on how inspiratory phase is ended.</td>
<td></td>
</tr>
<tr>
<td>Pressure-cycled ventilator (requires intubation)</td>
<td>Inspiration ends at a preset pressure limit; time and volume are variable.</td>
<td></td>
</tr>
<tr>
<td>Time-cycled ventilator (requires intubation)</td>
<td>PRESET pressure for given time interval; volume and pressure are variable.</td>
<td></td>
</tr>
<tr>
<td>Volume-cycled ventilator (requires intubation)</td>
<td>PRESET volume of air is delivered. Time and pressure are variable. However, volume-cycled ventilators often have pressure- and time-cycled capacities.</td>
<td></td>
</tr>
<tr>
<td>Negative-pressure ventilator (intubation not required)</td>
<td>Thorax, at least, is encapsulated. When ventilator expands, it creates negative pressure by pulling thorax outward. Air rushes into airways because of pressure gradient created.</td>
<td></td>
</tr>
<tr>
<td>High-frequency ventilation (requires intubation)</td>
<td>Several variants are available. All use high respiratory rates to deliver small tidal volumes at low pressures.</td>
<td></td>
</tr>
</tbody>
</table>
ventilation is projected to go beyond 2 weeks, a tracheostomy is usually placed for patient comfort and communication and to avoid the complications associated with prolonged endotracheal tube placement.

Weaning From the Ventilator. Prolonged mechanical ventilation is dangerous and expensive. The incidence of pneumonia increases with each day on mechanical ventilation. Most patients can be extubated once the precipitating cause of ARF resolves and the patients are medically stable. The decision to wean a person from the ventilator is based on clinical evidence of improved physical status. Weaning is most successful when the health care team plans it in partnership with the patient. Weaning protocols are used in a number of settings and are overseen by highly skilled clinicians.

Some nurse experts divide the weaning process into three phases: preweaning, weaning, and extubation. During the preweaning stage, the nurse ensures the patient has normal electrolytes, including phosphate, calcium, and magnesium. Malnutrition is avoided, but the patient should not be overfed. Overfeeding with carbohydrates and extra calories may result in increased carbon dioxide production and increased ventilatory demand. The recommended 24-hour caloric intake is 1500 to 2500, which should ensure adequate calories for energy expenditure. Protein intake is important, and 1 to 1.5 mg/kg has been suggested. Tube feedings containing these requirements are given to prepare the patient for weaning.

**Box 27-3 Adjustable Functions With Volume-Cycled Ventilators**

- Tidal volume: volume of air in a normal breath
- FIO₂: oxygenation concentration delivered through the ventilator
- Alarm systems: vary from machine to machine; basic alarms usually present
  - High-pressure alarm: increased resistance somewhere in system from lungs to machine
  - Low-pressure alarm: system not reaching minimal pressure required for ventilation
  - Low-volume alarm: volume of ventilation does not equal the amount set
- Control modes: degree of ventilation that is controlled by the ventilator; can vary from complete ventilator control to almost total patient control

**Figure 27-12 Mechanical ventilator.**

**Figures 27-12, 27-13.**

**Closed-System Suctioning**

- Wash hands for 10 seconds, as recommended by the Centers for Disease Control and Prevention, and put on gloves.
- Select a catheter that is half the diameter of the artificial airway. The catheter has a suction valve at one end, has a patient connector at the other end, and is enclosed in a plastic sheath.
- Attach suction valve to suction source. Select suction pressure between 80 and 120 mm Hg. Set maximum pressure by pinching suction tubing closed.
- Attach patient connector to ventilator tubing and the endotracheal tube (ET). Use the ventilator to hyperoxygenate and hyperinflate the patient’s lungs before suctioning.
- Open access valve and advance catheter through the connector into the ET and trachea.
- Using the suction valve, apply suction for not more than 10 seconds as the catheter is withdrawn. Repeat as necessary.
- Provide 100% oxygen and have patient take deep breaths while suctioning.
- Withdraw catheter and close access valve.
- Clean suction tip by attaching a normal saline unit–dose vial or syringe containing normal saline to irrigation port. Squirt the saline on the catheter tip and apply suction until the catheter is clean and saline is sucked out of the catheter.
- Remove gloves and wash hands for 10 seconds.
Weaning is initiated when the patient meets certain physiologic criteria:

- Acceptable ABGs
- Tidal volume greater than 10 ml/kg
- VC greater than 15 ml/kg
- Fraction of inspired oxygen (FiO2) less than 0.5
- Maximum inspiratory pressure greater than 220 cm H2O (usually 230 to 240 cm H2O preferred)
- Normal hematocrit (Most patients on long-term ventilator support have hematocrits below 30%). They are usually not transfused until their hematocrit falls to about 25%. There is general agreement that weaning is most successful when the patient’s hematocrit is 30% or higher.

Nursing interventions during the weaning process are listed in Box 27-5. The weaning process is individualized to meet the patient’s needs. The three most common methods of weaning are T-piece weaning, SIMV weaning, and PSV weaning. For T-piece weaning, the nurse places the patient in an upright position, disconnects the ventilator, and connects a T-piece to the endotracheal tube cuff. Patients with a prolonged course may be transferred to a transitional ventilator unit for specialization beyond 2 weeks usually have a tracheostomy done to make them more comfortable, facilitate communication, and avoid complications from the endotracheal tube. Patients with a prolonged course may be transferred to a transitional ventilator unit for specialization but less intensive care.

**Box 27-5 Nursing Interventions During Weaning Process**

- Before initiating weaning, prepare the patient.
- Teach effective breathing techniques.
- Inform the patient that weaning may require several attempts, each for a longer period, before the ventilator can be disconnected.
- Obtain baseline vital signs, tidal volume, and vital capacity.
- Stay with the patient during the initial weaning process.
- Coach the patient as needed to breathe more slowly and deeply, with emphasis on increasing the time of exhalation.
- Suction as needed.
- Monitor for the clinical signs of hypoxemia and hypercarbia (increased respiratory rate, tachycardia, dysrhythmias, increased blood pressure, agitation, diaphoresis, or increased somnolence).
- Reconnect the ventilator if the patient cannot breathe on his or her own.

Box 27-4 Patient and Ventilator Assessment

**Patient Assessment**

**Inspection**

Does the person appear to be in respiratory distress? Is the person’s chest moving with machine-cycled inspiration? Is the chest moving bilaterally?

**Assessment of Machine**

Are all ventilator settings and readouts correct? Are breath sounds coordinated with ventilator inspiration?

**Assessment of Tubing to Machine**

Is there an air leak around the endotracheal cuff? Is there excess condensation in the tubing? (Always remove water from the tubing system. Do not empty back into the humidifier reservoir.)

**Assessment of Machine**

Are all ventilator settings and readouts correct?

Noninvasive ventilation modes are being used more often in weaning protocols. Patients who are able to breathe comfortably after weaning and have satisfactory ABGs are extubated. Some patients may receive supplemental oxygen by face mask for 24 hours. The nurse observes the patient closely for signs of respiratory distress and increased efforts to breathe (e.g., respirations less than 8 breaths/min or more than 30 breaths/min, increase in respiratory rate of 10 breaths/min or more from starting rate; increase or decrease in heart rate by 20 beats/min; increase or decrease in blood pressure by 20 mm Hg; decrease in PaO2 or increase in PaCO2 or pH less than 7.35). If a patient develops dysfunctional ventilatory weaning response, nursing interventions include: alternate ABGs; decrease in blood pressure by 20 mm Hg; decrease in PaO2 and increase in PaCO2 or pH less than 7.35). If a patient develops dysfunctional ventilatory weaning response, nursing interventions include: alternate ABGs; decrease in blood pressure by 20 mm Hg; decrease in PaO2 and increase in PaCO2 or pH less than 7.35). If a patient develops dysfunctional ventilatory weaning response, nursing interventions include: alternate ABGs; decrease in blood pressure by 20 mm Hg; decrease in PaO2 and increase in PaCO2 or pH less than 7.35).

Because of the number of patients who require long-term ventilatory support and thus may be difficult to wean, the North American Nursing Diagnosis Association has approved two nursing diagnoses: Dysfunctional Ventilatory Weaning Response (mild, moderate, or severe) and Impaired Spontaneous Ventilation (major or minor). With either diagnosis, related factors are noted. For Dysfunctional Ventilatory Weaning Response, the related factors are pathophysiologic, such as muscle weakness; situational, such as fear of separation from the ventilator; and treatment errors, such as rushing the weaning process. Related factors for Impaired Spontaneous Ventilation include physiologic, such as respiratory muscle fatigue; and psychosocial, such as depression.
Care of the patient who cannot be weaned. Patients who require prolonged mechanical ventilation may be cared for in a specialized respiratory unit of a hospital or long-term care facility or at home. Chronic ventilator units have a larger nurse/patient ratio than critical care units. Thus the patient’s acute care needs must be resolved before transfer. These units usually continue weaning efforts, often using a slower, more individualized approach. Few patients find it possible to go home on a ventilator, because of the lack of suitable space and a significant other who can assume responsibility for the ventilator 24 hours a day, 7 days a week. If the patient and significant others decide that the patient will be discharged home, careful planning is required to ensure that the home can accommodate the patient and the necessary equipment. The home assessment is best made by a nurse from the health care agency that will be monitoring home care.

Patients and families also may choose to be taken off the ventilator. Once the patient indicates that this is his or her choice, the care team meets to discuss how the patient’s wishes can best be accommodated. To ease the patient’s anxiety, sedation, usually a morphine infusion, is started before the ventilator is disconnected. A comfort measures–only approach to care is then adopted. Hospice involvement is encouraged.

Diet. Diet is as tolerated. However, the patient may be NPO, depending on the acuity and severity of the respiratory failure.

Health Promotion and Prevention. Prevention of respiratory failure focuses on early identification of persons at high risk for developing ARF. In the inpatient setting every person with an increased risk of developing respiratory failure should have a preventive care plan, including:

- Keeping the airway clear by instituting regular deep breathing and coughing maneuvers and using nasotracheal suctioning if necessary
- Maintaining an optimal activity level
- Using sedatives or analgesics judiciously
- Assessing regularly for signs and symptoms indicating deterioration of respiratory status

Nursing Management

Assessment

Health History. Assess for:

- History of past or present associated disorders, recent change in respiratory status, change in sputum (color, viscosity, odor), increased dyspnea, change in mental status, complaints of chest tightness or pain
- Current medications and any recent changes in medication regimen
- Self-care modalities used
- A family member or friend who may be able to provide objective information about changes in the patient

Physical Examination. Assess for:

- Abnormalities of general appearance, such as wasting appearance, breathing difficulty, postural changes

Nursing Procedures

Nursing Diagnosis: Impaired Gas Exchange

Outcomes. Common examples of expected outcomes for the patient with a diagnosis of impaired gas exchange are:

- Patient will:
  - Demonstrate improved ventilation and oxygenation.
  - Have PaO2, PaCO2, and pH within acceptable baseline limits.
  - Demonstrate mental status at prerespiratory failure level.
  - Exhibit respiratory rate within or near normal levels, with moderate tidal volume.
  - Have no dyspnea or preacute illness level of dyspnea.

Nursing Interventions. Severe hypoxemia is incompatible with life. Thus it is imperative for the nurse to initiate oxygen therapy rapidly if severe hypoxemia is present. The effectiveness of oxygen therapy is evaluated with ABG measurements and pulse oximetry. Supplemental oxygen should be provided to maintain a PaO2 of 60 to 90 mm Hg. Persons without underlying pulmonary disease can receive oxygen by either high-flow or low-flow systems. However, hazards are associated with prolonged exposure to high concentrations of oxygen. Oxygen toxicity is the term used to describe the damage to lung tissue that results from prolonged exposure to high oxygen concentrations. Although the exact effects of oxygen in any one individual may depend on the person’s underlying pathologic condition, exposure to greater than 60% oxygen for more than 36 hours or exposure to 90% oxygen for more than 6 hours may result in atelectasis and alveolar collapse. Breathing very high concentrations of oxygen (80% to 100%) for prolonged periods (24 hours or more) is often associated with the development of ARDS. Thus a firm principle is to use the lowest amount of oxygen necessary to achieve an acceptable PaO2.

Special precautions must be taken when administering oxygen to patients with COPD who are carbon dioxide retainers to avoid further elevation of their PaCO2 levels, resulting in carbon dioxide narcosis or coma. These patients must receive supplemental oxygen via a controlled oxygen therapy system. The preferred mode is a nasal cannula or Venturi mask. A nasal cannula has the advantage of allowing the patient to talk, eat, and drink. However, the actual concentration of oxygen delivered to the lungs by cannula depends on the patient’s ventilatory pattern. The Venturi...
mask (Figure 27-14) provides oxygen at controlled ranges of 24% to 40% but may be poorly tolerated. Regardless of the oxygen delivery system used, the patient’s response to oxygen therapy can be accurately assessed only by ABG measurements or pulse oximetry. The goal is to achieve a $\text{PaO}_2$ of 60 mm Hg, which allows an arterial saturation of 90% or greater.

Adequate oxygenation is essential for life. Therefore if adequate oxygenation cannot be maintained without a concurrent rise in $\text{PaCO}_2$ (hypercapnia), oxygen therapy must be provided by alternative delivery modes. (See previous section on Mechanical Ventilation.) Although carbon dioxide narcosis might be precipitated if a chronically hypoxic person receives high concentrations of oxygen, treatment of the hypoxemia is the first priority in the patient’s care.

Nursing interventions for patients with ARF must be implemented in a firm but empathetic manner. The patient may be agitated or nearly exhausted from hypoxemia, hypercapnia, and the increased work of breathing. It is imperative that the patient be gently guided in respiratory maneuvers to improve breathing. The nurse must be alert for signs and symptoms indicating that the patient’s condition has changed from acutely ill but adequately ventilating to critically ill with insufficient ventilation to maintain body functions. Nursing interventions include:

- Frequent assessment of respiratory status, vital signs, level of consciousness, tolerance of ventilatory support, ventilator settings
- Facilitation of use of controlled breathing techniques
- Review of pertinent laboratory data, especially electrolytes, hematocrit
- Judicious administration of analgesia, especially opiates

RELATED NIC INTERVENTIONS. Airway Management, Oxygen Therapy, Ventilation Assistance, Vital Signs Monitoring

Nursing Diagnosis: Ineffective Airway Clearance

OUTCOMES. Common examples of expected outcomes for the patient with a diagnosis of ineffective airway clearance are:

- Patient will:
  - Demonstrate effective airway clearance.
  - Use effective coughing maneuvers.
  - Have breath sounds clear or at baseline level.
  - Use nebulizers, MDIs, and humidifiers appropriately.

NURSING INTERVENTIONS. Airways clogged with excess mucus are one of the most reversible precipitating components of ARF. Causes of mucus plugging are many, and positive-pressure ventilation itself may contribute to increased mucus production. Monitoring is basic to effective intervention; and patients’ breath sounds need to be auscultated at least every 1 to 2 hours in the acute phase of respiratory failure.

The nurse helps patients cough effectively using the huff technique; changes the patient’s position every 2 hours; elevates the patient’s head and chest; guides the patient in performing frequent deep breathing exercises or using the sigh mechanism on the ventilator; encourages the patient to be out of bed as tolerated; and promotes sufficient fluid intake to mobilize secretions (3 to 4 L, unless contraindicated, has traditionally been encouraged, but some evidence suggests that this quantity may not be needed). In addition, humidification of the airway is maintained to further liquefy secretions, and nasotracheal suctioning is done if the patient is unable to cough effectively.

RELATED NIC INTERVENTIONS. Airway Management, Mechanical Ventilation, Respiratory Monitoring

Nursing Diagnosis: Decreased Cardiac Output

OUTCOMES. Common examples of expected outcomes for the patient with a diagnosis of decreased cardiac output are:

- Patient will:
  - Maintain adequate cardiac output.
  - Have blood pressure within acceptable limits.
  - Demonstrate heart rate and rhythm within acceptable limits.
  - Have palpable and equal peripheral pulses.
  - Maintain urinary output of greater than 30 ml/hr.

NURSING INTERVENTIONS. Decreased cardiac output may be a complication of ARF or may be a precipitating factor related to underlying cor pulmonale. Diminished cardiac output causes tissue hypoxia, which creates a metabolic acidosis in addition to the respiratory acidosis caused by the respiratory failure. Thus the nurse must assess vital signs and hemodynamic parameters (arterial, central venous, pulmonary, and left atrial pressures) at least every hour during ARF. In addition, the nurse must monitor the patient for signs of inadequate tissue perfusion (urinary output of less than 30 ml/hr, cool extremities with decreased peripheral pulses) and for cardiac arrhythmias.

RELATED NIC INTERVENTIONS. Cardiac Care, Circulatory Care: Mechanical Assist Device, Oxygen Therapy, Vital Signs Monitoring

Figure 27-14 Venturi mask.
Nursing Diagnosis: Imbalanced Nutrition: Less Than Body Requirements

OUTCOMES. Common examples of expected outcomes for the patient with a diagnosis of imbalanced nutrition: less than body requirements are:

- Patient will:
  - Maintain nutritional intake adequate to balance metabolic needs.
  - Maintain weight at preacute illness weight or make progress toward an established goal weight.

NURSING INTERVENTIONS. Individuals with ARF are at increased risk for nutritional deficits because of the increased work of breathing. The overall focus of nutritional interventions is to prevent or correct malnutrition. Nutritional intake affects ventilatory drive, respiratory muscle function, and the amount of oxygen consumed and carbon dioxide produced from metabolic processes. Nutritional status can have a major impact on the individual’s ability to be successfully weaned from the ventilator. The nurse focuses on providing appropriate nutrition to meet the patient’s specific metabolic needs while on the ventilator and during and after weaning from it. Nutritional support by either enteral supplementation or parenteral hyperalimentation may be necessary. Whenever feasible, the enteral route should be used because it poses fewer risks and is more economical. It is advisable to supply at least 50% of total calories in the form of lipids to minimize high levels of carbon dioxide production.

RELATED NIC INTERVENTIONS. Nutrition Management, Nutrition Therapy

EVALUATION. To evaluate the effectiveness of nursing interventions, compare patient behaviors with those stated in the expected patient outcomes.


GERONTOLOGIC CONSIDERATIONS. Care for older adults with respiratory failure is similar to that for older adults with COPD. Some evidence does exist that those older than 70 years are especially susceptible to long-term ventilator dependence. Elderly patients with COPD and subsequent respiratory failure have poor outcomes, which are more a product of the disease process than age.

Lung Transplantation

Etiology and Epidemiology. Successful transplantation of the lungs became a reality in the 1980s. The first lung transplant was performed in the United States in 1983 on a patient with pulmonary fibrosis. (A heart-lung transplant was performed in 1981.) Lung transplants may involve a single lung, two lungs, or a lobe of a lung. Many of the patients who need lung transplants have a history of primary pulmonary hypertension. Other diseases that cause problems severe enough to require a lung transplant include emphysema, CF, sarcoidosis, and pulmonary fibrosis. It is a last-resort treatment for lung failure.

The procedure is usually limited to patients less than 60 years old who are not active smokers and who suffer from advanced lung disease. Single lung transplantation is used for restrictive lung disease, since the decreased compliance and increased pulmonary resistance of the recipient’s remaining lung result in preferential ventilation and perfusion of the transplanted lung. Double lung transplants are typically used in persons with emphysema or CF. Most lobe transplants are for CF patients.

Complications. This is an extreme measure for preserving life in a patient who has damaged and diseased lungs. The survival rate ranges as high as 80% at 1 year after transplant and 60% at 4 years after transplant, but this is not without some long-term problems for the patient. The major one is the ongoing immunosuppression process from antirejection drugs. Complications include lymphoproliferative disorders, pulmonary edema, infections, phrenic nerve injury, atrial fibrillation, and deep venous thrombosis.

Posttransplant lymphoproliferative disorders (PTLD) are a heterogeneous group of diseases that occur often after lung transplant. Lung transplant recipients are at a higher risk for PTLD than other solid organ transplant recipients. The intensive posttransplant immunosuppressive regimens coupled with a greater degree of pulmonary transplant lymphoid tissues likely contribute. PTLD can occur anytime after transplantation, with highest incidence in the first year. Manifestations vary from asymptomatic pulmonary nodules to marked constitutional symptoms, including fever, lethargy, and weight loss. A biopsy of lung tissue is required for diagnosis. PTLS is often confined to the transplanted lung, but in single lung transplant patients it is occasionally seen in both the transplanted and the native lung.

Risk factors for PTLD include pediatric age, age over 55 years, cytomegalovirus infection, specific immunosuppressive regimens, and Epstein-Barr virus reactivation. Treatment in patients with less aggressive disease begins with a decrease in immunosuppression. This therapy may, in fact, be curative in early lesions. Other treatment options include antivirals (acyclovir, ganciclovir), but this approach has been minimally effective. Chemotherapy may be used in disseminated disease, but patients have difficulty tolerating this treatment and the side effects. Radiotherapy with surgical resection for PTLS may have a role in specific situations. The use of anti-B-cell monoclonal antibodies has shown promise.

Infection is a risk for any transplant recipient but is of particular concern for lung transplant recipients. Obliterative bronchiolitis causes severe deterioration of lung function in as many as 50% of lung transplant recipients after the first year. It is mostly irreversible, and the only viable treatment option is retransplantation. The cause of this condition has not been determined. Possibilities include chronic rejection, viral infection, cyclosporine toxicity, long-term denervation of the lung, the lack of lymphatics, and the loss of bronchial blood supply. Patients experience a cough and progressive dyspnea. Obliterative bronchiolitis is diagnosed with fiberoptic bronchoscopy and transbronchial lung biopsy.

Collaborative Care Management. Single lung transplants are performed through an anterolateral thoracotomy (Figure 27-15).
Some patients, especially those with primary pulmonary hypertension, require cardiopulmonary bypass. The double lung transplant procedure has been modified to a bilateral single lung transplant procedure with individual bronchial anastomoses (Figure 27-16). Cardiopulmonary bypass is required in the double lung procedure. When heart-lung procedures are performed with the use of cardiopulmonary bypass, the recipient’s heart is first removed and the phrenic nerves isolated. Enough left atrium is removed to allow the donor’s right lung to fit into the right pleural space. The lungs are then removed individually and the donor’s heart-lung bloc is placed into the recipient’s chest. Tracheal anastomosis completes the surgical process.

Figure 27-16 Anastomotic sites in heart-lung transplant: 1, Aorta; 2, right atria; 3, trachea.

The patient is cared for in an intensive care setting after surgery. The most important aspects of care are promoting adequate airway clearance and gas exchange and preventing major complications associated with lung transplant. Poor gas exchange is a common complication and may be caused by reperfusion edema of the lung, impaired cough, infection, or rejection. Appropriate immunosuppressive therapy is initiated, and the patient is monitored closely for signs of rejection.

It is common for the patient undergoing lung transplantation to experience two or three episodes of acute rejection during the first 6 weeks after transplantation (see Clinical Manifestations box).14 As with other solid organ transplants, treatment of rejection involves enhancement of immunosuppression, but corticosteroids are not used for the first 7 to 14 days after the lung transplant procedure, since they jeopardize healing of the tracheal and bronchial anastomoses. Once healing has occurred, immunosuppressive therapy using drugs such as cyclosporine begins, but these drugs also reduce the body’s ability to fight infections. Research is being conducted to enhance the delivery of the drugs to improve their effectiveness in the rejection process (see Future Watch box).

Aggressive respiratory care is critical. It is difficult for the patient to clear the airway because the transplanted lung (or lungs) is denervated below the level of the trachea and mucociliary clearance is decreased. Care includes frequent position changes and deep breathing, along with postural drainage and coughing. Supplemental oxygen is necessary. Patients with lung transplants are prone to cardiovascular complications from hypervolemia or hypovolemia, myocardial irritability, or decreased contractility. Hemodynamic status is carefully managed to maintain adequate cardiac output without fluid overload that can lead to pulmonary edema and elevated pulmonary vascular resistance.

**Clinical Manifestations**

*Lung Transplant Rejection*

- Fever
- Dyspnea
- Nonproductive cough
- Malaise
- Decreased oxygen saturations
- Abnormal pulmonary function tests
Future Watch

An Inhaled Antirejection Drug?
A transplanted lung is highly susceptible to rejection, more so than any other transplanted organ. Patients who have had a lung transplant are being tested with an experimental version of inhaled cyclosporine that may significantly increase their chances of survival. It is delivered directly to the lungs and helps prevent immune cells from attacking the transplanted organ. In a recent study over 2 to 5 years, patients using the inhaled antirejection medication were four times more likely to survive than those taking a placebo. Also, patients using the inhaled cyclosporine had a significantly lower rate of rejection. Researchers will seek U.S. Food and Drug Administration approval for the new therapy.


Patients are at risk for dysrhythmias because of the use of cardiopulmonary bypass.35 The use of anticoagulants with cardiopulmonary bypass or excessive replacement of blood products puts patients at risk for excessive bleeding from coagulopathy. Careful monitoring of coagulation and QOL measures, and promotion of adequate sleep.

Preparation for discharge involves teaching the importance of adherence to the regimen and regular follow-up monitoring. Postrecovery patients are cautioned about daily activities and exercise. Although they might experience an increased ability to participate in exercises, research has found limitations to exercise for up to 2 years.39 Quality of life before and after transplantation is still controversial. Although the surgery is often a last hope for survival procedure, its impact on the patient’s quality of life is still being evaluated37 (see Research box).

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A patient has just been admitted to your unit with a history of chronic obstructive pulmonary disease (COPD). Consider the trend of increasing the life expectancy for patients with COPD. What ethical issues arise from this trend? What is the nurse’s responsibility when discussing these issues? A patient with asthma is on your unit. This patient has had many episodes of status asthmaticus in the past. What preparations should you make in case she has another episode while hospitalized? What nursing assessments are important?

References


