



the inspiratory capacity is progressively limited. This phenomenon contributes to symptoms of chest tightness and dyspnea during exercise and results in exercise limitation, especially in COPD.

There are two major consequences of the changes in lung volume in obstructive lung disease. First, breathing at higher lung volumes requires a higher change in pressure for the smaller change in lung volume, and this requirement increases the work of breathing. Second, larger lung volumes place the inspiratory muscles at a mechanical disadvantage. The diaphragms are flattened, decreasing its ability to change intrathoracic volume, and all the inspiratory muscle fibers are shortened, decreasing the tension they are able to exert to effect changes in lung volume. The combination of a higher work of breathing and mechanical disadvantages of the respiratory muscles caused by lung hyperinflation can lead to respiratory muscle fatigue and failure in the setting of an abrupt worsening of airway obstruction, as during an acute exacerbation of COPD or asthma.

In addition to the clinical history and physical examination, spirometry is a key step in the diagnostic work-up for a patient with suspected obstructive lung disease. Although spirometry is readily available and inexpensive, it is often underutilized, and as a consequence, obstructive lung diseases are underdiagnosed. Assessment of the clinical and spirometric response to a bronchodilator is a simple and helpful step in distinguishing asthma from COPD. Measurement of the diffusing capacity of the lungs for carbon monoxide (DLCO) can also be helpful in separating asthma, which is characterized by a normal or elevated diffusing capacity, from COPD, in which the diffusing capacity is often reduced by loss of surface area for gas exchange. More sophisticated testing, such as high-resolution chest computed tomography (HRCT), may be needed to help diagnose less common causes of obstructive lung disease (e.g., bronchiectasis).

The clinical features and laboratory findings associated with the various obstructive lung disorders are summarized in Table 16-1.

## CHRONIC OBSTRUCTIVE PULMONARY DISEASE

### Definition and Epidemiology

The Global Initiative for Chronic Obstructive Lung Disease (GOLD) currently defines COPD as a common preventable and treatable disease characterized by persistent airflow limitation that is usually progressive and associated with an enhanced chronic inflammatory response in the airways and lungs to noxious particles and gases. The presence of airflow limitation is established by spirometry: If the ratio of the forced expired volume in 1 second ( $FEV_1$ ) to the forced vital capacity (FVC) is less than 0.70 after administration of a bronchodilator, airway obstruction is indicated. Although in the past COPD was defined by the presence of either *emphysema* (a pathologic enlargement of the distal air spaces) or *chronic bronchitis* (a clinical syndrome characterized by the presence of cough and sputum production for at least 3 months in each of 2 consecutive years), the current definition is based on the presence of airflow limitation and not on the presence of these entities. Both emphysema and chronic bronchitis may occur with or without the simultaneous presence of expiratory airflow limitation, and therefore these entities overlap with but are not synonymous with COPD (see Fig. 16-1). The current definition of COPD highlights the presence of persistent, reproducible expiratory airflow limitation and emphasizes the progressive nature of COPD and the presence of abnormal inflammation in the lungs and airways.

COPD is a common disorder in populations across the world. The Burden of Obstructive Lung Disease study, in a sample of adults from 12 countries, found that 10.1% had at least moderate airway obstruction ( $FEV_1/FVC < 0.70$  and  $FEV_1 < 80\%$  predicted) after administration of a bronchodilator. Prevalence rates for COPD are correlated with increasing age, lower socioeconomic status, and smoking. Although COPD is more prevalent in men than in women, the prevalence of COPD in women has been increasing, and annual death rates for COPD have been steadily rising in both white and black women in the United

**TABLE 16-1** FEATURES OF OBSTRUCTIVE LUNG DISEASE

| DISORDER                              | CLINICAL FEATURES  | LABORATORY FINDINGS  |
|---------------------------------------|--|--|
| Chronic obstructive pulmonary disease | Chronic progressive dyspnea<br>Cough, sputum production<br>Periodic exacerbations  | $FEV_1/FVC < 0.70$ after bronchodilator use<br>Often reduced DLCO  |
| Asthma                                | Episodic dyspnea, cough, and/or wheezing<br>Nocturnal symptoms<br>May have environmental trigger(s)  | Variable airflow obstruction on spirometry<br>Typically significant improvement in $FEV_1$ with bronchodilator use<br>DLCO normal or elevated<br>Methacholine challenge shows airway hyperreactivity   |
| Bronchiectasis                        | Chronic cough and purulent sputum production<br>Hemoptysis   | Chest radiograph: "tram track" shadows<br>HRCT: dilated bronchi bigger than accompanying vessel, lack of tapering of bronchi, visible bronchi within 1-2 cm of lung border<br>Sputum culture may grow <i>Haemophilus influenzae</i> , <i>Pseudomonas aeruginosa</i> , or atypical mycobacteria<br>Laboratory evaluation may reveal specific etiology (e.g., decreased immunoglobulin levels in CVID) |
| Cystic fibrosis                       | Sinusitis, bronchiectasis, meconium ileus, malabsorption, infertility (in males, congenital absence of vas deferens)   | Increased sweat chloride concentration, mutation in CFTR chloride channel, elevated fecal fat, abnormal nasal mucosal potential difference   |
| Bronchiolar disorders                 | Progressive dyspnea<br>Possible history of connective tissue disease, inflammatory bowel disease, lung transplantation, or hematopoietic stem cell transplantation | Fixed airflow obstruction on spirometry<br>HRCT: mosaic attenuation pattern; centrilobular nodules; tree-in-bud opacities  |

CVID, Common variable immunodeficiency; DLCO, diffusing capacity for carbon monoxide;  $FEV_1$ , forced expiratory volume in 1 second; FVC, forced vital capacity; HRCT, high-resolution computed tomography.