Chronic obstructive pulmonary disease (COPD) is a chronic lung disease with significant societal costs; its prevalence is probably underestimated. Acute exacerbations of COPD are usually triggered by respiratory irritants or infections that initiate an inflammatory cascade. Emergency department evaluation of potential acute exacerbations must include evaluation for other life-threatening causes of dyspnea such as cardiac ischemia, pneumonia, pulmonary embolism, and congestive heart failure. Emergency department management of COPD exacerbation includes oxygen, inhaled bronchodilators, antibiotics, corticosteroids, and in serious cases, noninvasive positive pressure ventilation or intubation.

KEY POINTS

- Chronic obstructive pulmonary disease (COPD) is a chronic lung disease with significant societal costs; its prevalence is probably underestimated.
- Acute exacerbations of COPD are usually triggered by respiratory irritants or infections that initiate an inflammatory cascade.
- Emergency department evaluation of potential acute exacerbations must include evaluation for other life-threatening causes of dyspnea such as cardiac ischemia, pneumonia, pulmonary embolism, and congestive heart failure.
- Emergency department management of COPD exacerbation includes oxygen, inhaled bronchodilators, antibiotics, corticosteroids, and in serious cases, noninvasive positive pressure ventilation or intubation.

PERSPECTIVE

Chronic obstructive pulmonary disease (COPD) is a heterogeneous disease that encompasses clinical entities such as emphysema and chronic bronchitis. Although a variety of guidelines have addressed the definition and diagnosis of COPD, a major issue is that most guidelines include a combination of clinical terms and anatomic pathology, which limits their utility for emergency physicians (EPs). The American Thoracic Society defines COPD as a disease state characterized by the presence of airflow obstruction as a result of chronic bronchitis or emphysema. Chronic bronchitis is defined 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. Emphysema is defined as abnormal permanent enlargement of the air spaces distal to the terminal bronchioles accompanied by destruction of their walls without obvious fibrosis. A potentially more useful definition for EPs comes from the Global Initiative for Chronic Obstructive Lung Disease (GOLD), which states that COPD is a disease state characterized by airflow limitation that is not fully reversible. The limitation in airflow is usually both progressive and associated with an inflammatory response of the lungs to noxious particles or gases, such as tobacco smoke in particular. This definition encompasses chronic bronchitis, emphysema, bronchiectasis, and to a lesser extent, asthma and acknowledges that most patients with COPD have a combination of these different diseases.

EPIDEMIOLOGY

Lack of agreement among definitions of COPD, combined with delayed diagnosis in many patients, makes estimates of prevalence difficult. In 2008, 13.1 million U.S. adults (aged 18 and older) were estimated to have COPD, but close to 24 million U.S. adults have evidence of impaired lung function, thus indicating underdiagnosis of COPD. COPD accounted for 1.5 million emergency department (ED) visits and 726,000 hospitalizations in 2000. In 2010, the cost to the nation for COPD was projected to be approximately $49.9 billion, including $29.5 billion in direct health care expenditures, $8.0 billion in indirect morbidity costs, and $12.4 billion in indirect mortality costs. COPD was the third leading cause of death in the United States in 2007 with 124,477 victims, more than half of whom were female. Of note, the prevalence of COPD in women has doubled in the past few decades but has remained stable in men.

In industrialized countries, 80% to 90% of the risk for COPD is from cigarette smoking. Tobacco smoke is the major risk factor for the development of COPD, but only 15% of smokers experience COPD. Other factors associated with the development of COPD, in addition to smoking, are occupational dust, chemical exposure, and air pollution.

PATHOPHYSIOLOGY

CHRONICALLY COMPENSATED CHRONIC OBSTRUCTIVE PULMONARY DISEASE

The lung reacts to irritants such as tobacco smoke by increasing the number of macrophages and neutrophils in the airways, lung interstitium, and alveoli. In susceptible individuals, these inflammatory cells release proteases that if left unchecked, eventually break down lung parenchyma and stimulate mucus secretion. Cells that normally secrete surfactant and protease inhibitors are replaced by mucus-secreting cells. At the alveolar and bronchiolar level there is loss of elastic recoil caused by tissue destruction, as well as collapse and narrowing of the...
smaller airways because of loss of surfactant-producing cells. At the bronchial level, irritants cause pooling of mucus and resultant colonization by bacteria.

ACUTE EXACERBATIONS

Acute exacerbations of COPD are usually triggered by an event, such as an infection or other respiratory irritant, that starts an inflammatory cascade. In more than 75% of patients with acute exacerbations an infectious agent is found. In addition, it is likely that up to 50% of acute exacerbations are bacterial in nature. Other important triggers for exacerbation are oxidative stress, lower temperatures, and medications. Beta-blockers, sedatives, and narcotics are the medications that most frequently contribute to exacerbations. Regardless of the specific trigger or triggers, inflammatory mediators cause bronchoconstriction and pulmonary vasoconstriction.

Another aspect of the pathophysiology of acute exacerbation is the potential for acute respiratory acidosis. When high levels of inspired oxygen are administered during management of a COPD exacerbation, the vasoconstriction that normally shunts blood away from inadequately ventilated areas is reversed, thereby leading to worsening ventilation-perfusion mismatch and acute rises in the arterial CO$_2$ concentration. Contrary to previous dogma, the hypoxic drive in this process has no significant role.

The overall clinical picture during acute exacerbations of COPD is caused by bronchospasm, inflammation, and mucus hypersecretion, which results in airway narrowing, worsening ventilation-perfusion mismatch, and hypoxemia. The work of breathing increases during an exacerbation as a result of greater airway resistance and hyperinflation. This increase creates a higher oxygen demand by the respiratory muscles, which further contributes to the physiologic stress on the patient. The limitation in expiratory airflow is not significantly increased during acute exacerbations, and the majority of the pathophysiologic manifestations result from ventilation-perfusion mismatch.

PRESENTING SIGNS AND SYMPTOMS

CLASSIC

The signs and symptoms in a chronically compensated patient depend largely on the stage of the patient’s disease. Very early in the course of the disease, patients often do not carry the diagnosis of COPD and have subtle findings, such as mild exertional dyspnea and a chronic cough that is frequently identified as a “smoker’s cough.”

Acute exacerbations produce signs and symptoms that represent the impact on multiple body systems. See Table 49.1 for the signs and symptoms of both chronically compensated COPD and acute exacerbations of COPD.

VARIATIONS

Because COPD encompasses a wide range of severity of disease, it has a variety of different manifestations. The biggest variations are to be found at the extremes of disease.

Early in the course of the disease, patients may simply have a persistent cough without notable dyspnea. It is important to identify such patients and secure follow-up care. Patients may also note a dry cough that is triggered by deep breaths and may or may not be associated with wheezing and dyspnea. This symptom suggests an episode of bronchitis that could be an exacerbation of underlying lung disease in at-risk patients.

Patients in the late stages of COPD pose a new set of challenges. Those with significant airway obstruction may not

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Table 49.1 Signs and Symptoms of Chronic Obstructive Pulmonary Disease (COPD)

<table>
<thead>
<tr>
<th>TYPE OF COPD</th>
<th>SYMPTOMS</th>
<th>SIGNS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chronically compensated COPD</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Earlier stages of disease</td>
<td>Mild to moderate exertional dyspnea</td>
<td>Mild tachypnea</td>
</tr>
<tr>
<td>(not likely to have a COPD diagnosis yet)</td>
<td>Chronic cough, frequently with small-volume hemoptysis</td>
<td>Wheezing with forced expiration</td>
</tr>
<tr>
<td>Later stages of disease</td>
<td>Increasing exertional dyspnea</td>
<td>Prolonged expiratory phase (pursed-lip breathing)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Increasing tachypnea</td>
</tr>
<tr>
<td></td>
<td></td>
<td>End-expiratory wheezing with normal breathing</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Use of accessory respiratory muscles</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Weight loss caused by both reduced caloric intake and increased caloric demands from work of breathing</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Plethora from secondary polycythemia</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Barrel chest (predominantly emphysematous disease)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Decreased breath sounds globally (predominantly emphysematous disease)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Coarse crackles or rhonchi from increased secretions (predominantly bronchitic disease)</td>
</tr>
<tr>
<td>Acute exacerbations</td>
<td>Dyspnea at rest</td>
<td>Tachypnea at rest</td>
</tr>
<tr>
<td></td>
<td>Exertional dyspnea that inhibits normal activities</td>
<td>Use of accessory respiratory muscles</td>
</tr>
<tr>
<td></td>
<td>Increase in coughing frequency and/or change in appearance of sputum</td>
<td>Diffuse expiratory wheezing at all times</td>
</tr>
<tr>
<td></td>
<td>Apprehension</td>
<td>Tachycardia</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cyanosis</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Altered mental status</td>
</tr>
</tbody>
</table>
generate enough air movement to wheeze and have a “silent chest.” Such patients need aggressive management to avoid progressive respiratory failure. Patients with a significantly enlarged chest from emphysematous changes may be difficult to auscultate. Finally, patients with severe hypoxemia or hypercapnia (or both) may have primarily symptoms of altered mentation.

**DIFFERENTIAL DIAGNOSIS**

The differential diagnosis of acute dyspnea is quite large. Because many of these conditions are life-threatening, it is critical to differentiate between them so that appropriate treatment can be initiated.

The EP must resist the temptation to automatically diagnose COPD as the sole cause of dyspnea in a patient with a history of COPD. Patients with COPD frequently have serious comorbid conditions that may be unrecognized and play a role in their ED visit. It is also important for the EP to continue to keep an open mind to the possibility of alternative diagnoses, particularly if the patient is not showing the expected response to standard treatment of COPD.

**ASTHMA**

Asthma and COPD coexist in some patients, and both diseases involve the presence of airway obstruction, with some key differences. In the ED setting the key point is that the initial stabilizing actions for severe manifestations of either disease do not vary greatly.

**CONGESTIVE HEART FAILURE**

Congestive heart failure (CHF) can pose a significant diagnostic challenge for EPs because it can be manifested similar to other causes of acute dyspnea and also coexists with other chronic causes of dyspnea such as COPD. Patients with a history of both conditions and acute dyspnea may have exacerbations of one or even both conditions at the same time.

Historical elements are minimally helpful in discriminating among patients. Although studies indicate that the presence of orthopnea (likelihood ratio [LR] = 2.0) and dyspnea with exertion (LR = 1.3) is more commonly associated with CHF, both symptoms are common in either disease.14

Physical examination can be of some assistance in clarifying the differentiation between CHF and COPD. The presence of jugular venous distention is helpful in pointing toward CHF, and the EP must resist the temptation to automatically diagnose COPD as the sole cause of dyspnea. To check hepatogenous reflux, the EP puts the head of the bed at 45 degrees and presses on the upper part of the patient's abdomen for 10 seconds. The result is positive if the venous pulsations rise at least 3 cm over baseline. Wheezing can be present with both CHF and COPD and therefore does not have high diagnostic certainty.

The chest radiograph is most useful in patients with evidence of significant interstitial edema. Absence of this finding and therefore does not have high diagnostic certainty.

**PULMONARY EMBOLISM**

The diagnosis of pulmonary embolism (PE) must be considered in any dyspneic patient, particularly when risk factors for venous thromboembolism are present. There is evidence that 25% of patients with a severe COPD exacerbation of unknown origin actually have PE.21,22 Key risk factors include older age, recent surgery or trauma, previous venous thromboembolism, hereditary thrombophilia such as factor V Leiden, malignancy, smoking, and use of estrogen-containing hormone replacement therapy. The classic manifestation of PE—pleuritic chest pain, dyspnea, tachycardia, and hypoxia—is not frequently encountered in the ED, but at least one of these elements is almost always present. Some historical clues to possible PE are a sudden onset of symptoms and syncope or near syncope in combination with the risk factors listed previously.

Physical examination offers no clues to the diagnosis of PE in 28% to 58% of patients.23 The diagnosis is based on a combination of the initial clinical impression of a patient's risk level and the results of additional testing such as pulmonary imaging. Patients with significant underlying asthma or COPD are frequently not good candidates for ventilation-perfusion (VQ) scans because preexisting ventilation and perfusion abnormalities will reduce the utility of the test by increasing the likelihood of an intermediate-probability result. D-dimer testing may be of some assistance in patients with a sufficiently low pretest probability, as determined by various clinical decision rules in the literature. The EP must be aware of the many disease processes that cause false-positive results and make the utility of d-dimer assay questionable in many acutely ill patients. It is of highest utility in a population that is at low risk for PE and has a lower severity of symptoms, and it is unlikely to include patients with an exacerbation of COPD.

**ACUTE CORONARY SYNDROME**

Dyspnea can be the main complaint in patients with acute coronary syndromes. Among elderly patients with a diagnosis of acute coronary syndrome in the Global Registry of Acute Coronary Events (GRACE), dyspnea was the dominant symptom in 49.3%.24 An electrocardiogram should be obtained in all patients seen in the ED with significant dyspnea. Patients with underlying coronary artery disease may have elevations in cardiac biomarkers simply from cardiac myonecrosis secondary to hypoxia. Clinical judgment will guide further cardiac evaluation.

**PNEUMOTHORAX**

COPD is a risk factor for spontaneous pneumothorax, and the primary diagnostic tool is the chest radiograph. The EP should also look for clinical clues, such as asymmetric chest wall excursion and asymmetry in breath sounds or, in more severe cases, tracheal deviation and hemodynamic instability.
PNEUMONIA
Pneumonia commonly coexists with a COPD exacerbation. Clues such as the presence of fever and asymmetric rales on chest auscultation are helpful, but the chest radiograph remains the most useful tool for this diagnosis. The EP should be wary of the accuracy of temperatures taken orally in patients with tachypnea. 25

DIAGNOSTIC TESTING

HISTORY
The history should focus on determining the severity of disease to predict critical outcomes, such as the need for admission and mechanical ventilation. Key historical elements include fever, changes in sputum production, hemoptysis, exercise tolerance, orthopnea, current medications, and compliance with medications. The EP should remember to consider key elements of the differential diagnosis while taking the history and should remain alert for alternative causes of the patient’s dyspnea. The presence of symptoms such as chest pain and leg swelling and clarification of how acute in onset the symptoms were will help include or exclude other life-threatening diseases. Important historical questions to ask patients with possible COPD for the purpose of risk stratification are listed in Box 49.1.

PHYSICAL EXAMINATION
On entering the room, the EP should observe the patient’s overall level of distress and body position. Patients with significantly increased work of breathing or in the tripod position should undergo immediate and aggressive intervention.

The patient’s respiratory rate should then be assessed; very high or very low respiratory rates are ominous. Next, the EP should observe movement of the chest wall. Is it symmetric? Is there evidence of abdominal breathing, or are retractions present? On auscultation, are wheezes, rales, or rhonchi apparent, and where are they located? The EP should be wary of a “silent chest,” which implies poor air movement. Wheezing can occur as a result of CHF, and asymmetric auscultation findings suggest other diagnoses, such as pneumothorax and pneumonia.

The remainder of the physical examination should focus on findings that suggest alternative diagnoses. The EP should seek signs of CHF, such as gallop rhythms, jugular venous distention, and symmetric lower extremity edema. Asymmetric lower extremity edema and calf tenderness would suggest deep vein thrombosis.

IMAGING AND LABORATORY TESTING

Chest Radiographs
Chest radiographs should be obtained in all patients with anything but a very mild acute exacerbation of COPD. Evidence has shown that clinical criteria are unreliable in accurately predicting the need for radiography. 26 The chest radiograph provides valuable information about alternative diagnoses, such as pneumonia, CHF, pneumothorax, and aortic dissection. 3

Pulse Oximetry
Pulse oximetry provides a simple and noninvasive method of monitoring hypoxemia in patients with exacerbations of COPD. Pulse oximeters provide accurate estimates of PaO2 (arterial partial pressure of oxygen), as long as the SaO2 (arterial oxygen saturation) value is greater than approximately 90%; with an SaO2 value below this level, the hemoglobin-oxygen dissociation curve becomes quite steep and the correlation is far less reliable. Evidence indicates that an SaO2 value of 92% correlates with a PaO2 value of greater than 60 mm Hg. 27

Arterial Blood Gas Analysis
Arterial blood gas (ABG) measurements are not routinely required for COPD exacerbations, although they can be helpful in patients with altered mental status, severe distress, or acidosis. ABG analysis can be helpful for estimating the severity of exacerbations or predicting the future need for mechanical ventilation or bilevel positive airway pressure (BiPAP). 28 Patients with simultaneous hypoxemia and hypercapnia are at greatest risk for the development of respiratory failure. It is important to remember that the decision to initiate mechanical ventilation should be based on clinical grounds and not be delayed to obtain ABG results. ABG values can provide clues to questions about issues such as patient fatigue but can never replace the decision-making ability of an experienced EP.

Venous blood gas values may be used to screen for hypercapnia. Although correlation between arterial and venous pH is good, agreement for PCO2 (partial pressure of carbon
dioxide) is only fair. Data indicate that venous Pco₂ is 5.8 mm Hg higher than arterial Pco₂, but the confidence interval was wide and the correlation was not consistent. This same study indicated that when a cutoff of 45 mm Hg is used, venous blood gas measurements are 100% sensitive and 57% specific in detecting hypercapnia.²⁹

**Spirometry**

Unlike the case with asthma, spirometry is not of significant utility in assessing acute exacerbations of COPD. Spirometry in patients with COPD is most useful in the primary care setting to monitor disease progression over time. Its use in diagnosing or assessing acute exacerbation is not recommended by either the American College of Physicians or the American College of Chest Physicians. Forced expiratory volume in 1 second (FEV₁) is only weakly correlated with Pco₂ and pH and has no correlation with arterial Po₂ in acute exacerbations.³⁰ Although many ED studies use spirometry to track clinical changes in patients with COPD, it is important to realize that doing so may provide an incomplete picture of patient status.

**Additional Laboratory Testing**

No data support or refute the use of routine laboratory testing such as a complete blood count or serum chemistry panels in patients with exacerbations of COPD. The need will be dictated mainly by the potential alternative diagnoses, such as CHF or pneumonia. A serum chemistry panel is helpful if an ABG measurement has been ordered. ABG analysis provides a more reliable bicarbonate measurement for clarifying the acuity of respiratory acidosis and in addition assists in diagnosing other acid-base disorders that may be present. A serum chemistry panel should also be ordered in patients complaining of vomiting or weakness and in patients who are taking diuretics or have a history of renal failure. Because of the frequently significant comorbid conditions present in patients with COPD who are sick enough to require admission, laboratory tests for cardiac biomarkers and BNP are often indicated. Other indications for testing are discussed in the section on differential diagnosis.

### INTERVENTIONS, PROCEDURES, AND TREATMENT

ED goals for treating acute exacerbations of COPD are as follows:

- Rule out other life-threatening causes of dyspnea.
- Ensure adequate oxygenation and ventilation.
- Manage reversible airway obstruction.
- Treat any infectious component of the exacerbation.
- Determine appropriate patient disposition.
- Provide a discharge plan of care that will minimize the risk for recurrences.

A concise summary of the ED management of acute exacerbations of COPD can be found in **Table 49.2**, and key indicators of severe disease are described in the Red Flags box. The rest of this section supplies additional detail on the different components of management.

### RED FLAGS

<table>
<thead>
<tr>
<th>Condition</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Worse than the patient’s typical exacerbation of chronic obstructive pulmonary disease</td>
<td></td>
</tr>
<tr>
<td>Significant hypoxia (i.e., $\text{SaO}_2 &lt; 92%$) with a typical home $\text{O}_2$ flow rate</td>
<td></td>
</tr>
<tr>
<td>Drowsiness or confusion—probable secondary to hypoxia or hypercapnia</td>
<td></td>
</tr>
<tr>
<td>Silent chest—indicative of poor air movement and potential impending respiratory failure</td>
<td></td>
</tr>
</tbody>
</table>

### OXYGEN

Appropriate use of supplemental oxygen is a key component of management of COPD exacerbations. Oxygen has a number of benefits during exacerbations, including relief of pulmonary vasoconstriction, decrease in right heart workload, and reduction of myocardial ischemia. The effects on the heart allow an increase in oxygen delivery to tissues above and beyond simple rises in hemoglobin oxygen saturation.

The challenge is to maintain appropriate oxygenation while not provoking acute CO₂ retention. For most patients, targetting an oxygen saturation value of just over 92% (a reasonable surrogate for a Po₂ value of 60 mm Hg) provides a good balance between these two issues.³³ Whether this saturation value is maintained with oxygen administered via nasal cannula or a Venturi-type mask is not important as long as the saturation values are closely monitored to avoid delivering too little or too much oxygen.

There is good evidence in the prehospital setting that carefully titrated oxygen delivery results in reduced mortality, hypercapnia, and respiratory acidosis in patients experiencing an acute exacerbation of COPD.³¹

### INHALED MEDICATIONS

After oxygen, inhaled β₂-agonists and anticholinergics are the primary treatment modality for COPD exacerbations because there is usually a small reversible component of the airflow obstruction.

The prototypic β₂-agonist for COPD is albuterol, delivered either by nebulizer or by metered dose inhaler (MDI) with a spacer. Side effects include tremor, palpitations, tachycardia, headache, mild hypokalemia, nausea, and vomiting. Evidence has shown that the two delivery methods are probably comparable but that severely dyspneic patients may tolerate nebulized medications better.³² Albuterol can be given continuously via nebulizer or intermittently. The American Thoracic Society guidelines advise that β₂-agonists may be used every 30 to 60 minutes but that more frequent use or continuous administration is well tolerated and may have some benefit. However, the literature on continuous administration of β₂-agonists in the treatment of COPD is limited. Decreasing the treatment interval from 60 to 20 minutes has not been shown to improve FEV₁, but patients with a lower starting FEV₁ value appear to have more benefit with shorter treatment intervals.³³ It is important to realize the limitations of the FEV₁ value in assessing acute exacerbations; the EP should instead rely on the overall clinical picture to guide treatment. Evidence suggests that 2.5 to 5 mg per dose is adequate for the management of COPD exacerbation.³⁴
Ipratropium bromide, a quaternary anticholinergic compound, is delivered either by nebulizer or by MDI with a spacer. Side effects include tremor and dry mouth. Both ipratropium bromide and albuterol have comparable clinical effects, and when used together, these two agents improve clinical outcomes and shorten ED length of stay.

Long-acting inhaled anticholinergics, such as tiotropium, have no place in the acute management of COPD. This agent has demonstrated better efficacy than ipratropium taken four times daily for the chronic management of COPD.

CORTICOSTEROIDS

Administration of corticosteroids in the ED, followed by an outpatient course of treatment, improves oxygenation and airflow and decreases the rate of treatment failures. The current literature supports a longer course of treatment than is traditionally done for asthma. Tapering the dosage over a period of 7 to 14 days most likely sufficiently balances the risks associated with corticosteroid use with the advantage of decreased treatment failures. No evidence has shown that a corticosteroid course longer than 14 days confer added benefits. Despite common practice, no strong clinical evidence has indicated that courses shorter than 14 days require a tapering dose.

Administration of corticosteroids in the ED has not been shown to affect the rate of hospitalization. This finding is probably due to the approximate 6-hour delay before the onset of action of corticosteroids. Nevertheless, it is important to administer these medications in the ED as soon as possible and before transferring the patient to an inpatient unit because

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Table 49.2 Basic Approach to Acute Exacerbations of Chronic Obstructive Pulmonary Disease

<table>
<thead>
<tr>
<th>INTERVENTION</th>
<th>COMMENTS AND CAUTIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initiate O₂ to maintain saturation &gt;90%</td>
<td>Observe closely for CO₂ retention</td>
</tr>
<tr>
<td>Initiate continuous cardiac monitoring and pulse oximetry</td>
<td></td>
</tr>
<tr>
<td>Albuterol, 2.5-5 mg via nebulizer</td>
<td>Can give continuously (10-15 mg/hr) or q20-60min</td>
</tr>
<tr>
<td></td>
<td>Alternatively, give 4-10 puffs via MDI with spacer</td>
</tr>
<tr>
<td>Ipratropium, 0.5 mg via nebulizer</td>
<td>Little data on frequency of administration—typically given once during emergency department visit</td>
</tr>
<tr>
<td></td>
<td>Can mix with albuterol nebulizer</td>
</tr>
<tr>
<td></td>
<td>Alternatively, give 4-6 puffs via MDI with spacer</td>
</tr>
<tr>
<td>Prednisone, 60 mg orally, or methylprednisolone (Solu-Medrol), 125 mg intravenously</td>
<td>Oral and intravenous routes probably equivalent in patients who are well enough to tolerate oral administration; however, little data on this issue</td>
</tr>
<tr>
<td>Administer antibiotics</td>
<td>Many options—common choices include macrolides such as azithromycin (plus ceftriaxone if being admitted) or quinolones such as moxifloxacin</td>
</tr>
<tr>
<td></td>
<td>Local resistance patterns and patient’s previous antibiotic use are important considerations</td>
</tr>
<tr>
<td>Consider NIPPV in seriously ill patients who do not yet need intubation</td>
<td>NIPPV is most effective in reducing need for intubation if initiated early</td>
</tr>
<tr>
<td>Chest radiograph</td>
<td>Seek out alternative diagnoses</td>
</tr>
<tr>
<td></td>
<td>Perform as soon as possible in course because can be done without disrupting lifesaving care</td>
</tr>
<tr>
<td>Electrocardiography</td>
<td>Most useful for patients with chest pain, arrhythmias, severe exacerbations</td>
</tr>
<tr>
<td></td>
<td>Strongly consider for all patients</td>
</tr>
<tr>
<td>Directed laboratory testing</td>
<td>ABG analysis if severe disease, altered mental status, significant hypoxia, suspected acidosis</td>
</tr>
<tr>
<td></td>
<td>Theophylline level as appropriate</td>
</tr>
<tr>
<td></td>
<td>Electrolytes if renal failure, vomiting, weakness</td>
</tr>
<tr>
<td></td>
<td>BNP if differential diagnosis unclear</td>
</tr>
<tr>
<td></td>
<td>D-dimer as appropriate</td>
</tr>
<tr>
<td>Further diagnostic imaging</td>
<td>Pulmonary embolism protocol; CT if differential diagnosis in doubt</td>
</tr>
<tr>
<td>Determination of disposition</td>
<td>If good response to therapy with mild exacerbation, consider discharge home</td>
</tr>
<tr>
<td></td>
<td>For patients with moderate exacerbations, consider admission to observation unit if available</td>
</tr>
<tr>
<td></td>
<td>Patients with severe illness and/or multiple significant comorbid conditions will probably need hospital admission—use likelihood of need for ventilatory support to guide decision for ICU versus floor</td>
</tr>
<tr>
<td></td>
<td>Patients requiring NIPPV should be admitted to a closely monitored setting, which in most hospitals means at least a stepdown-level bed</td>
</tr>
</tbody>
</table>

ABG, Arterial blood gas; BNP, brain natriuretic protein; CT, computed tomography; ICU, intensive care unit; MDI, metered dose inhaler; NIPPV, noninvasive positive pressure ventilation.
doing so will probably decrease the overall length of stay in the hospital.

In patients who can tolerate oral intake, there is probably no advantage to intravenous administration of corticosteroids, but data specifically addressing this clinical question are limited.

ANTIBIOTICS

The use of antibiotics for acute exacerbations of COPD is recommended in all current guidelines despite some conflicting evidence regarding their efficacy. Two large systematic reviews showed an overall benefit to antibiotic use, with greater efficacy in more severe exacerbations. Antibiotics shorten the duration of the exacerbation and accelerate recovery of peak expiratory flow rates.

The choice of antibiotic has been studied with particular concern about recent increases in β-lactamase–producing strains of bacteria. There is evidence that newer extended-spectrum quinolones achieve better clinical outcomes at lower overall cost than does nonquinolone therapy in patients at high risk for treatment failure (severe underlying lung disease, more than four exacerbations per year, COPD duration > 10 years, elderly, and significant comorbid illnesses). There is also evidence that newer antibiotics, such as macrolides, quinolones, and amoxicillin-clavulante, are associated with lower hospitalization and clinical failure rates while costing less overall than older antibiotics such as cephalosporins and trimethoprim-sulfamethoxazole. When selecting an antibiotic, factors such as previous antibiotic treatment in the past 3 months, severity of illness, and community resistance patterns must be taken into account.

The ideal duration of antibiotic treatment is not clear. Data suggest that 5 days of antibiotic treatment is probably sufficient, but studies on the optimal duration of treatment with extended-spectrum macrolides and quinolones are lacking.

METHYLXANTHINES

Despite a number of guidelines that still recommend their use, methylxanthines such as aminophylline are of no significant benefit to patients with acute exacerbations of COPD and should not be used. It is useful, however, to measure methylxanthine drug levels in patients who are already taking them on an outpatient basis.

NONINVASIVE POSITIVE PRESSURE VENTILATION

Noninvasive positive pressure ventilation (NIPPV) involves the application of positive pressure ventilation via face mask and is associated with significantly fewer complications than the case with endotracheal intubation and mechanical ventilation. NIPPV can be applied in one of two modes, continuous positive airway pressure (CPAP) or BiPAP. Both modes can have oxygen bleb into the system.

CPAP delivers a continuous level of positive pressure throughout the respiratory cycle and is analogous to positive end-expiratory pressure (PEEP) in mechanical ventilation. CPAP improves respiratory mechanics by increasing mean airway pressure, improving functional residual capacity, and opening underventilated and collapsed alveoli. The overall effect is to enhance gas exchange and oxygenation. CPAP is usually initiated at a low level and titrated upward to a typical maximum of 15 cm H2O to allow adequate oxygenation with as low an FIO2 (fraction of inspired oxygen) value as possible.

BiPAP provides different levels of positive airway pressure for inspiration (IPAP) and expiration (EPAP). This is analogous to pressure support and PEEP in mechanical ventilation. BiPAP provides the same benefits of continuously applied positive pressure as CPAP does but also theoretically reduces the work of breathing by providing a pressure boost for inspiration. BiPAP can be time-triggered to a certain number of breaths per minute or flow-cycled to allow the patient to trigger the device. IPAP is generally started at approximately 8 cm H2O and titrated upward to a typical maximum of 20 cm H2O. EPAP is generally started at approximately 4 cm H2O and titrated upward to a typical maximum of 15 H2O. The settings should be balanced to allow physiologic tidal volumes (5 to 7 mL/kg) and maximal oxygenation with a minimum FIO2 while still maintaining patient comfort.

To be successful candidates for NIPPV, patients must be alert, breathing spontaneously, and able to cooperate with instructions (Box 49.2). This modality can be used with extreme care in patients with mild decreases in level of consciousness. A good rule of thumb is that patients who cannot constantly keep their head up independently will not probably succeed with NIPPV. Adequate staffing levels, continuous monitoring of the heart rate and pulse oximetry, and intermittent blood pressure measurements are essential for safe and successful use of NIPPV. NIPPV is most likely to be successful when a partnership exists among the patient, nursing staff, respiratory therapist, and physician that involves effective communication in all directions before and during the initiation of treatment. It is also most likely to be successful if initiated early in the patient's stay in the ED.

As with mechanical ventilation, the EP must be alert for hemodynamic changes and desaturations that may indicate loss of mask seal, intrinsic PEEP (also called auto-PEEP), pneumothorax, and patient intolerance. Gastric distention with resultant restriction of diaphragmatic excursion or vomiting is another potential complication of NIPPV.

Contraindications to NIPPV are altered mental status, impaired airway protection mechanisms, apnea, cardiovascular instability, and pneumothorax. In addition, any craniofacial abnormality (e.g., previous surgery, trauma) that impairs the ability to obtain a reliable mask seal would preclude NIPPV.

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**BOX 49.2 Indications for Use of Noninvasive Positive Pressure Ventilation (NIPPV)**

NIPPV should be considered in patients with the following clinical features as long as the contraindications previously discussed are not present:

- Difficulty maintaining oxygen saturation greater than 90% with a nonrebreather mask
- Moderate to severe dyspnea
- Respiratory rate greater than 25 breaths/min
- Moderate respiratory acidosis (pH of 7.30 to 7.35)
- Sufficient alertness to hold one’s own head upright and follow commands
In patients with COPD, NIPPV has been shown to significantly decrease both the need for intubation and overall patient mortality and to generate significant improvements in pH, PCO₂, and respiratory rate. The delivery method (CPAP versus BiPAP) has not been shown to make a significant difference in outcomes.

ENDOTRACHEAL INTUBATION AND MECHANICAL VENTILATION

The decision to intubate a patient with COPD is based largely on clinical judgment and experience. Some patients obviously need intubation (respiratory arrest, decline with NIPPV), but in other patients the need is far less apparent. As mentioned previously, ABG values can assist in the decision to intubate, but the ultimate decision must always be based on clinical assessment. Intubation decisions should not be delayed in critically ill patients to wait for ABG results. General guidelines are available to assist in this decision-making process, but they are just tools that will not make the final decision, and some of the guidelines are vague; they are listed in Box 49.3.

Once the EP has determined that a patient with COPD requires intubation, a few special considerations should be borne in mind. In general, the largest tube that can fit safely between the vocal cords should be used (8 to 8.5 in men, 7.5 to 8 in women) to decrease overall airway resistance. The EP must also carefully consider the expected difficulty of intubation before administering paralytic agents. Effective bag-valve-mask ventilation can be difficult in patients with COPD because of higher airway resistance and lung hyperinflation. Other potential comorbid conditions such as obesity can also make intubation difficult. Patients with COPD are commonly difficult to preoxygenate adequately, a feature that significantly reduces the time available for direct laryngoscopy. Even in a patient who is known to require intubation, NIPPV combined with supplemental oxygen can be helpful in maximizing the effectiveness of preoxygenation. Consider an “awake” look with a combination of topical anesthesia of the airway and light sedation before using full rapid-sequence intubation, particularly in patients in whom intubation may be difficult. Ketamine in initial doses of 0.5 to 1 mg/kg intravenously has some properties that make it an attractive option in this situation because it preserves the airway protection reflexes and also has bronchodilating properties. Additional doses can be given as necessary. Ketamine can stimulate the sympathetic nervous system, so it should be used with caution in patients with significant coronary artery disease. Other options include benzodiazepines and propofol, but these agents often cause respiratory depression at sedative doses. A full discussion of these issues is outside the scope of this chapter.

Management of hypotensive episodes in patients recently intubated for COPD is the same as that for other intubated patients, but some causes are more common in COPD. Note that patients with NIPPV can exhibit similar issues. See Table 49.3 for additional information.

Disposition and Follow-Up

The decision to admit or discharge a patient with exacerbation of COPD is multifactorial and involves issues that may not be clinical. The response to ED management is the most useful indicator of disposition. EPs must consider whether the patient will be able to receive the maintenance care necessary at home; that is, outpatient management will almost certainly fail in a patient with an oxygen requirement who was not already receiving oxygen. Clinicians must also estimate the probable clinical course: is this patient showing a clear trend toward improvement, or is the course in doubt? The availability of rapid and reliable follow-up care can allow safe discharge of potentially sicker patients. Unfortunately, the absence of such care is more frequently encountered in the ED environment; patients whose social issues, such as limited access to care, put them at high risk for a return ED visit should be admitted.

Finally, it is important to emphasize to patients with COPD that they should promptly seek medical attention for...
worsening respiratory symptoms. Patients who wait longer than 24 hours before seeking medical attention are more than twice as likely to require admission regardless of what home care was administered.  

Patients at higher risk for relapse need more careful discharge planning that includes reliable follow-up (Box 49.4).

**BOX 49.4 Risk Factors for Relapse Within 2 Weeks of an Emergency Department (ED) Visit**

Evidence has shown that the following factors place patients at higher risk for relapse within 2 weeks after an ED visit:
- Number of ED or clinic visits in the past year (>5 visits)
- Amount of limitation in activity before arrival
- Initial respiratory rate higher than 16 breaths/min
- Patients who were taking oral corticosteroids before arriving at the ED

**SUGGESTED READINGS**


**REFERENCES**

References can be found on Expert Consult @ www.expertconsult.com.
REFERENCES