CHAPTER

# 1

# Chronic Obstructive Pulmonary Disease: An Overview

## OUTLINE



## OBJECTIVES

1. Describe the prevalence of chronic obstructive pulmonary disease (COPD).
2. Discuss the inherent difficulties in the accurate depiction of the burden of COPD.
3. Enumerate the common risk factors for COPD.
4. Describe the relationship between forced expiratory volume ($FEV_1$) and the patient's health-related quality of life.
5. List the common comorbid conditions that are often associated with COPD.
6. Explain the importance of preventing a COPD exacerbation.
7. Describe pharmacological and nonpharmacological interventions for smoking cessation.
8. Identify the common vaccinations administered to patients with COPD.
9. List the benefits of pulmonary rehabilitation.
10. Explain the importance of integrating palliative and end-of-life interventions into the care of patients with COPD.
11. Illustrate the grouping of patients with COPD using GOLD (Global Initiative for Chronic Obstructive Lung Disease) criteria.
12. List the medications employed in the management of stable COPD and an exacerbation.

## KEY TERMS

**5 As**
**5 Rs**
**affective disorder**
**biomass**
**counseling**
**downward spiral**
**dyspnea**
**economic burden**
**$FEV_1$**
**GOLD**
**HRQoL**
**ICS**
**LABA**
**LAMA**
**MMRC**
**NRT**
**occupational exposure**
**palliative care**
**PDE4 inhibitor**
**prevalence**
**pulmonary rehabilitation**
**SABA**
**SAMA**
**smoking**
**smoking cessation**
**vaccinations**

## Introduction

Chronic obstructive pulmonary disease (COPD) continues to be a leading contributor to morbidity and mortality in the United States and across the globe. Much of the existing literature proclaims that COPD will be the third most common cause of death worldwide within the near future; some reports attest that it already is. COPD represents a major challenge to health care providers because it frequently occurs with serious comorbidity, such as cardiovascular disease and osteoporosis. It is also a unique disease in that it is perceived as a stigma by those patients who suffer from it as a result of smoking. Additionally, many patients with COPD are economically disadvantaged, so delivery of the appropriate health care to this patient population can be quite challenging. This chapter serves as an outline and provides a general description of the major characteristics of COPD and associated therapeutic management.

## Epidemiology

Because global estimates of the **prevalence** of COPD vary as a result of differences in methods of measurement, any comparison of data across study sources would be problematic. Several organizations, such as the Global Initiative for Chronic Obstructive Lung Disease (**GOLD**), are striving to construct standardized measurement methods so that an accurate picture of the global burden of COPD can be drawn.[1] Estimates from scientifically valid studies report that COPD prevalence ranges from 4% to 10% among adults across the globe.[2]

According to the Behavioral Risk Factor Surveillance System (BRFSS), estimates of the statewide prevalence of COPD across the United States ranged from 3.5% to 12.3% of the individual state populations in 2014.[3] **Figure 1-1** illustrates the state-by-state prevalence of COPD in the United States.

The **economic burden** of COPD in the United States is substantial. Ford et al. determined that the total cost burden of COPD within the United States in 2010 was $36 billion, including medical costs and total absenteeism costs. By 2020, according to the same authors, national costs are projected to total $49 billion, a 53% increase.[4]

An important point is that although COPD represents a huge health and economic burden and is the only disease that is increasing in prevalence while representing a major contributor to mortality, it is still relatively unknown to the public. GOLD was implemented by the National Heart, Lung, and Blood Institute (NHLBI) and the World Health Organization (WHO). Its goals include increasing awareness of COPD as a public health problem and standardizing management and prevention measures for the disease throughout the globe.[5] According to GOLD, COPD is a chronic

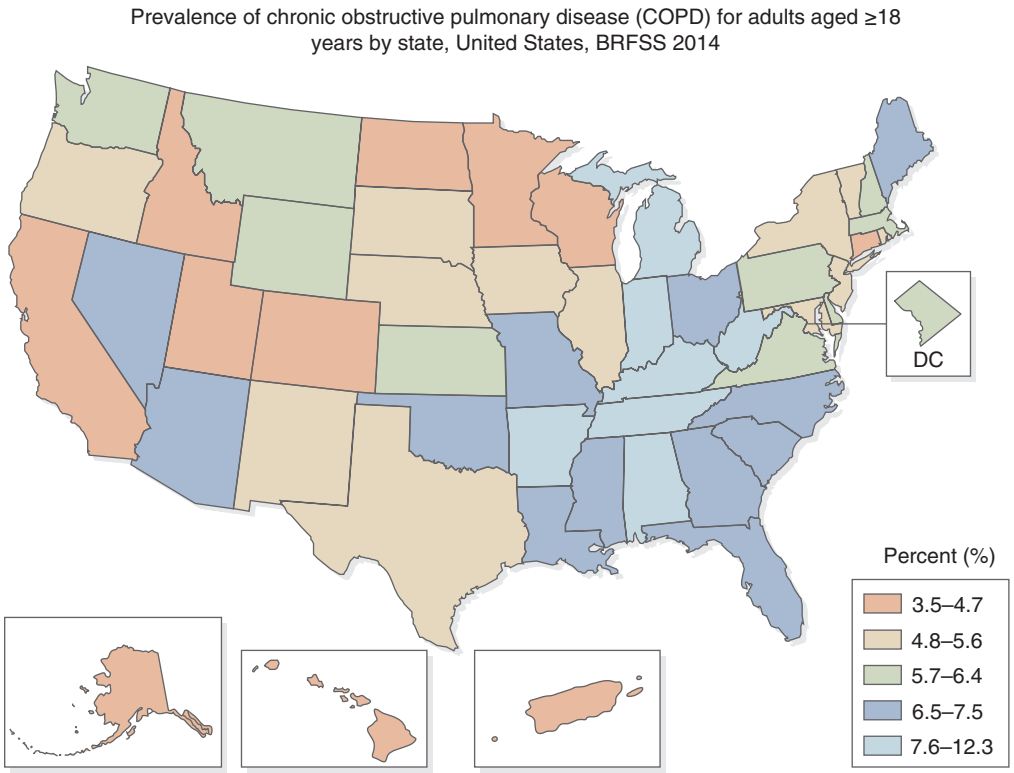


**FIGURE 1-1** Prevalence of chronic obstructive pulmonary disease (COPD) in the United States.

Modified from CDC. 2016. "Chronic Obstructive Pulmonary Disease (COPD). Data and Statistics." COPD Prevalence in the United States. Last updated August 15, 2016. Accessed April 5, 2018. https://www.cdc.gov/copd/data.html.

inflammatory disease that results in airflow limitation as well as airway changes and alveolar destruction. Emphysema and chronic bronchitis are included under the umbrella term of COPD.[6]

## Risk Factors

Multiple factors are responsible for COPD. The GOLD 2014 report stated that COPD is a result of these factors in combination with the individual's genetic makeup. For example, **smoking** is a major risk factor for COPD, but not all smokers have the genetic predisposition to develop COPD. It is reported that 20% of smokers contract the disease. Other factors that have been associated with COPD include advanced age and male gender, lower socioeconomic status, asthma/bronchial hyperreactivity, and infections.[6]

**Occupational exposures** have been demonstrated by epidemiological studies to be a risk factor for COPD. COPD sufferers have reported exposure to byproducts of combustion, as well as organic and inorganic dust and fumes.[7] Also contributory to COPD is the genetic deficiency of alpha$_1$-antitrypsin, which is a common yet frequently undiagnosed abnormality. According to Stoller and Aboussouan, this deficiency afflicts 1 in 2000 to 1 in 5000 people worldwide and can result in COPD and liver disease.[8]

Asthma has been shown to be closely associated with COPD. In a longitudinal study, after adjusting for factors such as age and gender, patients with asthma who have active symptoms were found to be 12.5 times more likely to present a clinical picture closely resembling COPD.[9] Additionally, exposure to **biomass** smoke (solid fuel) and various indoor pollution agents as a result of heating and cooking in developing countries has been shown to contribute to COPD.[10]

## Clinical Considerations

The defining characteristic of COPD is airflow limitation, traditionally measured by the forced expiratory volume in 1 second (**FEV$_1$**). However, the disease is not uniform in its clinical presentation, and in fact is quite heterogeneous in its manifestations. Furthermore, a patient's health-related quality of life (**HRQoL**) does not correlate with a decline in FEV$_1$. Of interest, recent data from studies indicate that many patients afflicted with COPD succumb to cardiovascular complications rather than respiratory failure.[11]

Most patients who have COPD report a chronic productive cough, whereas others note only dyspnea on exertion. Some patients with COPD experience a rapidly progressive decline in lung function, whereas others exhibit a more gradual deterioration.[12]

Smoking has been found to influence the course of COPD. In a prospective study of the Framingham Offspring cohort, Kohansal and associates found that smokers had a faster rate of decline of lung function, although tobacco's effects on lung function are not uniform.[13]

Of note, a COPD exacerbation may cause a deterioration in lung function, thus increasing the likelihood of a patient experiencing yet another exacerbation. In a study conducted by Donaldson et al., it was shown for the first time that patients who have frequent exacerbations demonstrate a faster decline in lung function than those who have less frequent exacerbations.[14] Accordingly, it is imperative for the clinician to target therapy with the goal of decreasing the likelihood of an exacerbation.

It is now known that COPD is a systemic inflammatory disorder that can lead to the development of comorbid conditions, such as cardiovascular disease. **Figure 1-2** illustrates the central role of inflammation in diseases associated with COPD.

Frequent comorbid conditions associated with COPD include congestive heart failure, diabetes mellitus, and osteoporosis. Among patients experiencing COPD exacerbations, peripheral muscle dysfunction and difficulty in ambulating are common, along with a heightened state of anxiety and/or depression. In general, patients with COPD are at risk for both anxiety and depression, and the practitioner who hopes to promote self-efficacy in this patient population must recognize the deleterious effects that these affective disorders can have on cognition.

Many patients with chronic diseases take a myriad of medications. Fabbri et al. astutely observed that current clinical practice guidelines can contribute to this problem because they are designed for single-disease care and ignore accompanying comorbidity. This situation frequently results in polypharmacy.[15]

## Therapeutics

Options for the treatment of COPD range from the hallmark intervention of smoking cessation counseling to the preventive measure of vaccinations. Pharmacological treatments include a myriad of medications. Bronchodilators commonly employed include the beta$_2$-agonists, anticholinergics, and methylxanthines. Inhaled corticosteroids have been a mainstay in the management of COPD, while phosphodiesterase-4 inhibitors are relatively new additions. Augmentation therapy for alpha$_1$-antitrypsin deficiency is employed in managing the subset of patients with emphysema who have this genetic anomaly. The use of antibiotics and mucolytics for the treatment of COPD has been controversial due to little or no demonstrated benefit from the use of these drugs.

### Smoking Cessation

Smoking tobacco is an addiction that is due to the body's physical dependence on nicotine. A variety of interventions are available to help the smoker quit.

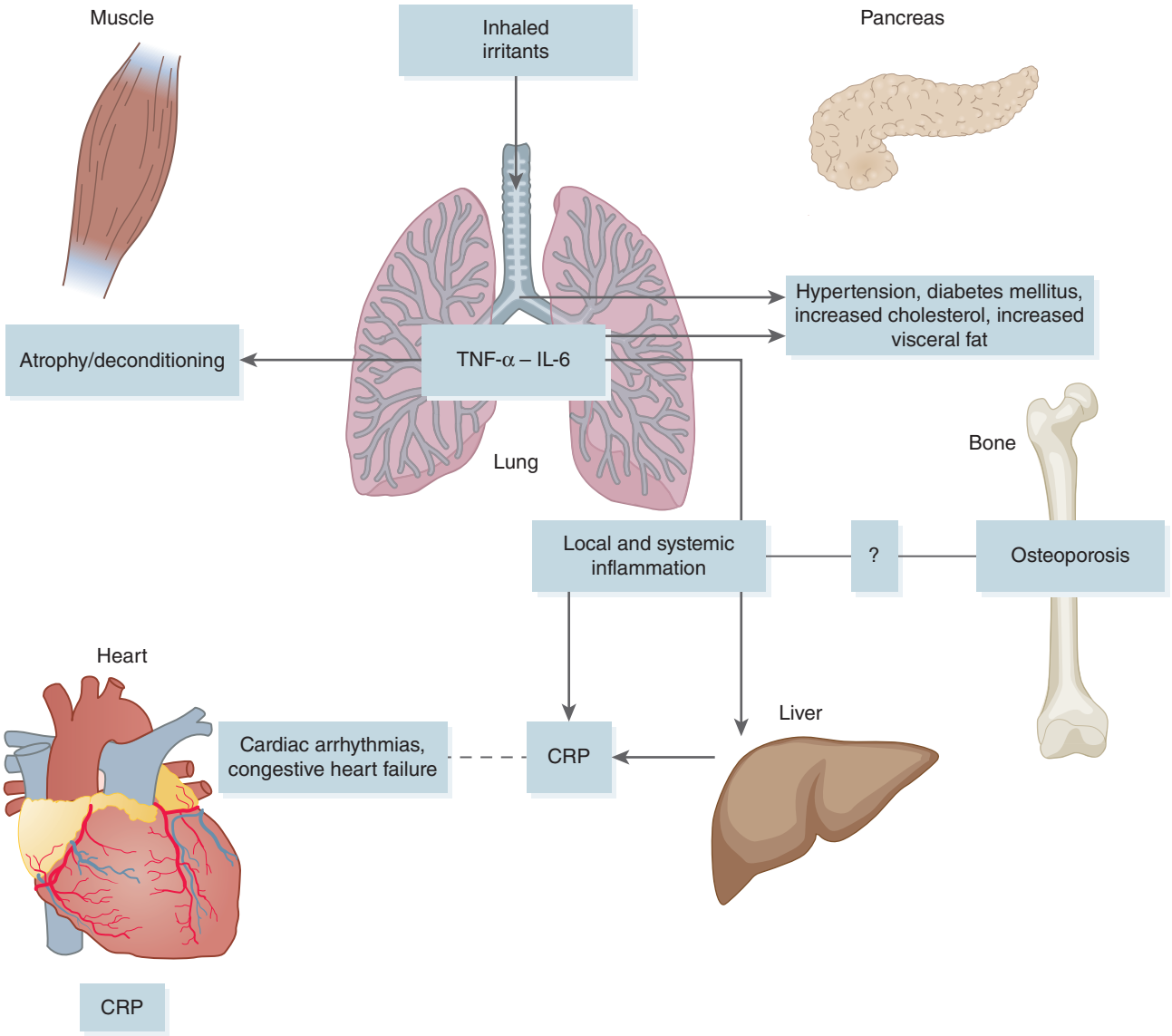


**FIGURE 1-2** Comorbid conditions associated with chronic obstructive pulmonary disease (COPD).

They include use of nicotine replacement therapy (**NRT**) products such as patches, lozenges, and gum. **Counseling** utilizing health behavior theory, such as the Transtheoretical Model (TTM) of behavior change and motivational interviewing, is also employed to help the patient overcome barriers to achieving a smoke-free lifestyle. These counseling interventions are discussed in a later chapter.

## Nicotine Replacement Therapy

NRT products include patches, gum, lozenges or tablets, nasal spray, and inhalers. A study conducted in 2008 revealed that each of these products was more effective than placebo in helping the smoker to quit the habit.[16] Smokers routinely err in only using these products when they are experiencing an acute urge to smoke. These products are more effective when used according to the instructions on their labeling.[17] **Box 1-1** contains examples of pharmacotherapy products that assist smoking cessation.

Combining NRT products has proved to be beneficial and has resulted in higher quit rates. It has been suggested that NRT combinations may be more effective for smokers who are most likely to relapse.[18]

## Counseling Strategies

The following tables are indispensable guides and illustrate the steps to follow when counseling a patient on smoking. **Table 1-1** describes the five steps, known as the **5 As**, for smokers ready to quit: ask, advise, assess, assist, and arrange. **Table 1-2** discusses the five steps, known as the **5 Rs**, for smokers not yet ready to quit: relevance, risk, rewards, roadblocks, and repetition.

### BOX 1-1 Pharmacologic Interventions to Assist Smoking Cessation

**Nicotine Replacement Therapy**

*Gum*: Increases cessation rates about 1.5 to 2 times control at 6 months

*24-hour patch*: Increases cessation rates about 1.5 to 2 times control at 6 months

*Nasal sprays*: Increase cessation rates about 1.5 to 2 times control at 6 months

*Inhaler*: Increases cessation rates about 1.5 to 2 times control at 6 months

*Lozenges*: Increase cessation rates about 1.5 to 2 times control at 6 months

**Bupropion**

*Oral sustained-release formulation*: Increases cessation rates about 2 times control at 1 year

**Varenicline**

*Oral tablet*: Increases cessation rates over 3.5 times control and almost 2 times those for bupropion at 12 weeks

Hess, D. 2016. *Respiratory Care: Principles and Practice*, 3rd ed. Burlington, MA: Jones & Bartlett Learning.

As a first step in counseling patients on **smoking cessation**, the patient must be questioned about tobacco use. The Stages of Change behavior model can be useful in gauging the readiness of the patient to quit. This model is discussed further in a later chapter.

Research has shown that self-help literature is not as helpful as counseling. Clinicians should be clear and unequivocal in their interactions with these patients and reinforce the negative effects of smoking. Active assistance in quitting should be provided, with follow-up support to ensure that relapses do not occur.[19] A combination of counseling and selective NRT products can increase the efficacy of smoking cessation interventions.[20] In addition to these practice-based measures, every state now has a telephone tobacco quit line, and the use of this resource has been found to be an effective support for smoking cessation intervention at the population level.[21]

## Vaccinations

Two types of **vaccinations** are commonly administered to patients with COPD: pneumococcal and influenza. According to a review published in 2012, influenza vaccination diminishes the likelihood of flu-related respiratory infections among patients afflicted with COPD. The same report stated that although the pneumococcal vaccine does not influence the rate of

**TABLE 1-1**
**The Five Steps of a Tobacco Cessation Program for Patients Willing to Quit: The 5 As**

| Strategy | Action | Strategies for Implementation |
|---|---|---|
| 1. Ask | Implement an officewide system that ensures that, for every patient at every clinic visit, tobacco use is queried and documented. | Expand the vital signs to include tobacco use, or use an alternative universal identification system. |
| 2. Advise | In a clear, strong, and personalized manner, urge every tobacco user to quit. | Advice should be:<br>*Clear:* "It is important that you quit smoking (or using chewing tobacco) now, and I can help you." "Cutting down while you are ill is not enough." "Occasional or light smoking is still dangerous."<br>*Strong:* "As your clinician, I need you to know that quitting smoking is the most important thing you can do to protect your health now and in the future. The clinic staff and I will help you."<br>*Personalized:* Tie tobacco use to current symptoms and health concerns, and/or its social and economic costs, and/or the impact of tobacco use on children and others in the household. "Continuing to smoke makes your asthma worse, and quitting may dramatically improve your health." "Quitting smoking may reduce the number of ear infections your child has." |
| 3. Assess | Assess every tobacco user's willingness to make an attempt to quit at this time. | Assess patient's willingness to quit: "Are you willing to give quitting a try?"<br>If the patient is willing to try to quit at this time, provide assistance.<br>If the patient will participate in an intensive treatment, deliver such a treatment or link/refer to an intensive intervention.<br>If the patient is a member of a special population (e.g., adolescent, pregnant smoker, racial/ethnic minority), consider providing additional information relevant to that group.<br>If the patient clearly states that he or she is unwilling to make a quit attempt at this time, provide an intervention shown to increase future quit attempts. |

(*Continues*)

**TABLE 1-1**
**The Five Steps of a Tobacco Cessation Program for Patients Willing to Quit: The 5 As (*Continued*)**

| Strategy | Action | Strategies for Implementation |
|---|---|---|
| 4. Assist | Help the patient with a quit plan.<br>Recommend the use of approved medication, except when contraindicated or with specific populations for which there is insufficient evidence of effectiveness (e.g., pregnant women, smokeless tobacco users, light smokers, adolescents).<br>Provide practical counseling (problem-solving/skills training).<br>Provide intratreatment social support.<br>Provide supplementary materials, including information on quit lines. | A patient's preparations for quitting:<br>Set a quit date. Ideally, the quit date should be within 2 weeks.<br>Tell family, friends, and coworkers about quitting, and request understanding and support.<br>Anticipate challenges (e.g., nicotine withdrawal symptoms) to the upcoming quit attempt, particularly during the critical first few weeks.<br>Remove tobacco products from your environment. Prior to quitting, avoid smoking in places where you spend a lot of time (e.g., work, home, car). Make your home smoke-free.<br>Recommend the use of medications found to be effective in this guideline. Explain how these medications increase quitting success and reduce withdrawal symptoms. The first-line medications include bupropion SR, nicotine gum, nicotine inhaler, nicotine lozenge, nicotine nasal spray, nicotine patch, and varenicline; second-line medications include clonidine and nortriptyline. There is insufficient evidence to recommend medications for certain populations (e.g., pregnant women, smokeless tobacco users, light smokers, adolescents).<br>*Abstinence.* Striving for total abstinence is essential. Not even a single puff after the quit date.<br>*Past quit experience.* Identify what helped and what hurt in previous quit attempts. Build on past success.<br>*Anticipate triggers or challenges in the upcoming attempt.* Discuss challenges/triggers and how the patient will successfully overcome them (e.g., avoid triggers, alter routines).<br>*Alcohol.* Because alcohol is associated with relapse, the patient should consider limiting/abstaining from alcohol while quitting. (Note that reducing alcohol intake could precipitate withdrawal in alcohol-dependent persons.)<br>*Other smokers in the household.* Quitting is more difficult when there is another smoker in the household. Patients should encourage housemates to quit with them or to not smoke in their presence.<br>Provide a supportive clinical environment while encouraging the patient in his or her quit attempt. "My office staff and I are available to assist you." "I'm recommending treatment that can provide ongoing support."<br>*Sources:* Federal agencies, nonprofit agencies, national quit line network (1-800-QUIT-NOW), or local/state/tribal health departments or quit lines.<br>*Type:* Culturally, racially, educationally, and age-appropriate for the patient.<br>*Location:* Readily available at every clinician's workstation. |
| 5. Arrange | Arrange for follow-up contacts, either in person or via telephone. | *Timing:* Follow-up contact should begin soon after the quit date, preferably during the first week. A second follow-up contact is recommended within the first month. Schedule further follow-up contacts as indicated.<br>*Actions during follow-up contact:* For all patients, identify problems already encountered and anticipate challenges in the immediate future. Assess medication use and problems. Remind patients of quit line support (1-800-QUIT-NOW). Address tobacco use at next clinical visit (treat tobacco use as a chronic disease).<br>For patients who are abstinent, congratulate them on their success.<br>If tobacco use has occurred, review circumstances and elicit recommitment to total abstinence. Consider use of or link to more intensive treatment. |

Modified from Fiore, M.C., C.R. Jaen, T.B. Baker, et al. 2008. Treating Tobacco Use and Dependence: 2008 Update. Clinical Practice Guideline. Rockville, MD: U.S. Department of Health and Human Services, 58.

community-acquired pneumococcal pneumonia, it does offer significant protection to patients with COPD.[22]

Two types of pneumococcal vaccines are available: PCV13 (pneumococcal conjugate vaccine), and PPSV23 (pneumococcal polysaccharide vaccine). PCV13 protects against 13 pneumococcal strains; PCV23 protects against 23 strains. The Centers for Disease Control and Prevention (CDC) states that adults 65 and older should receive both types of vaccine, but not at the same time. The flu vaccine can be administered concurrently with the pneumonia vaccine.[23]

According to the CDC, a flu vaccine should be given every year to patients 6 months of age and older. Of the two types of injectable vaccines, the trivalent vaccine protects against three flu viruses, the quadrivalent against four.[24]

**TABLE 1-2**
**The Five Steps of a Tobacco Cessation Program for Patients Unwilling to Quit: The 5 Rs**

| Step | Explanation |
|---|---|
| 1. Relevance | Encourage the patient to indicate why quitting is personally relevant, being as specific as possible. Motivational information has the greatest impact if it is relevant to a patient's disease status or risk, family or social situation (e.g., having children in the home), health concerns, age, gender, and other important patient characteristics (e.g., prior quitting experience, personal barriers to cessation). |
| 2. Risk | The clinician should ask the patient to identify potential negative consequences of tobacco use. The clinician may suggest and highlight those that seem most relevant to the patient. The clinician should emphasize that smoking low-tar/low-nicotine cigarettes or use of other forms of tobacco (e.g., smokeless tobacco, cigars, pipes) will not eliminate these risks. Examples of risks are as follows.<br>*Acute risks:* Shortness of breath, exacerbation of asthma, increased risk of respiratory infections, harm to pregnancy, impotence, infertility.<br>*Long-term risks:* Heart attacks and strokes, lung and other cancers (e.g., larynx, oral cavity, pharynx, esophagus, pancreas, stomach, kidney, bladder, cervix, acute myelocytic leukemia), chronic obstructive pulmonary diseases (e.g., chronic bronchitis, emphysema), osteoporosis, long-term disability, and need for extended care.<br>*Environmental risks:* Increased risk of lung cancer and heart disease in spouses; increased risk for low birth weight, sudden infant death syndrome (SIDS), asthma, middle ear disease, and respiratory infections in children of smokers. |
| 3. Rewards | The clinician should ask the patient to identify potential benefits of stopping tobacco use. The clinician may suggest and highlight those that seem most relevant to the patient. Examples of rewards follow.<br>Improved health<br>Food will taste better<br>Improved sense of smell<br>Saving money<br>Feeling better about oneself<br>Home, car, clothing, and breath will smell better<br>Setting a good example for children and decreasing the likelihood that they will smoke<br>Having healthier babies and children<br>Feeling better physically<br>Performing better in physical activities<br>Improved appearance, including reduced wrinkling/aging of skin and whiter teeth |
| 4. Roadblocks | The clinician should ask the patient to identify barriers or impediments to quitting and provide treatment (e.g., problem-solving counseling, medication) that could address barriers. Typical barriers might include the following.<br>Withdrawal symptoms<br>Fear of failure<br>Weight gain<br>Lack of support<br>Depression<br>Enjoyment of tobacco<br>Being around other tobacco users<br>Limited knowledge of effective treatment options |
| 5. Repetition | The motivational intervention should be repeated every time an unmotivated patient visits the clinic setting. Tobacco users who have failed in previous quit attempts should be told that most people make repeated quit attempts before they are successful. |

Modified from Fiore, M. C., C. R. Jaen, T. B. Baker, et al. 2008. Treating Tobacco Use and Dependence: 2008 Update. Clinical Practice Guideline. Rockville, MD: U.S. Department of Health and Human Services, 58–60.

## Pulmonary Rehabilitation

For patients with COPD, a high rate of utilization of health services is typical, as is expected from the nature of their illness. Additionally, COPD represents a significant impediment to the patient's ability to perform daily activities. The many positive effects of **pulmonary rehabilitation** for these patients include the reduction of both dyspnea symptoms and the consumption of health care resources.[25]

A typical pulmonary rehabilitation program consists of exercise training, education, and psychosocial support. In order to qualify for the program, a patient should meet certain criteria for each component. First, patients should be motivated before they are deemed eligible for rehabilitation. Additionally, they should be stable and display symptoms of COPD, such as shortness of breath on exertion. There must also be a complete assessment of the patient's current physical condition, including exercise

tolerance.[26] Positive outcomes of pulmonary rehabilitation include an increase in activity and improved physical conditioning, thus resulting in a decline in the **downward spiral** of the patient's daily activities (**Figure 1-3**).

A vital component of a pulmonary rehabilitation program is the assessment and treatment of **affective disorders** that influence the patient's ability to adhere to the regimen. It is common knowledge that many patients with COPD also have anxiety and/or depression. Pulmonary rehabilitation programs include stress reduction techniques and ways to address the panic that accompanies an acute episode of dyspnea.[27]

Patients with COPD frequently have negative or inaccurate perceptions of **dyspnea**. They often believe that their lung function is more compromised than it actually is when they are dyspneic. Emotions also play a large role in the sensation of dyspnea. Negative emotions lead to an inaccurate perception of dyspnea. Studies have revealed that inaccurate or negative perceptions of dyspnea result in poor outcomes among patients with COPD.[28] The phenomenon of dyspnea is further explored in a later chapter.

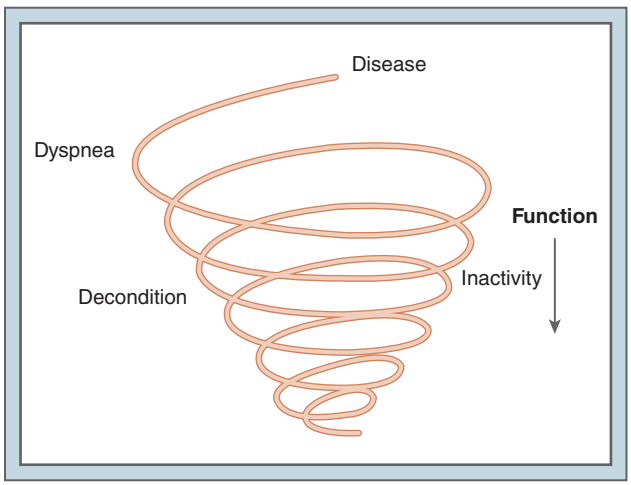


**FIGURE 1-3** Downward spiral of functional activity.
Hess, D. 2016. *Respiratory Care: Principles and Practice*, 3rd ed. Burlington, MA: Jones & Bartlett Learning.

It has been stated that the usual pulmonary rehabilitation program does not lead to long-term results 1 year after completion of the program.[29] An excellent clinical review by Spruit et al. suggested that the following factors, among others, should be areas of study in future research concerning pulmonary rehabilitation and its effects on patients with COPD: the altering effects of physical activity, the factors that influence physical activity, strategies of self-management that affect physical activity, and the influence of both pharmacological and nonpharmacological therapeutics on the level of physical activity.[30]

## Palliative and End-of-Life Care

COPD is a chronic disease that can lead to significant suffering and poor HRQoL, yet many patients with COPD do not receive adequate support and relief through palliative and/or end-of-life care regimens. According to Curtis, there are reasons for this: communication between the patient and physician seldom addresses these topics and the physician may be inadequately equipped to effectively discuss them. Additionally, the difficulty in accurately predicting the end-of-life phase of COPD renders the discussion of palliative or end-of-life care particularly challenging.[31] WHO defines **palliative care** as the effective assessment and treatment of the holistic needs of the patient that thus increases the HRQoL of the individual and the family.[32] Palliative care can be delivered at any time during the treatment of the disease. Hospice care can be conceptualized as palliative care that is delivered at the end of life (**Figure 1-4**).

## Pharmacological Therapy

As previously noted, GOLD was formulated to standardize the care and management of patients with COPD. GOLD has developed a grouping system so that

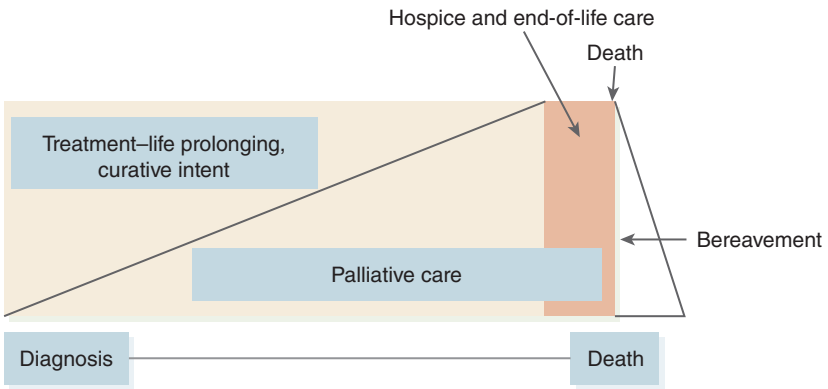


**FIGURE 1-4** The role of palliative care in patient treatment.
Data from Parikh, R. B., R. A. Kirch, T. J. Smith, and J. S. Temel. 2013. "Early Specialty Palliative Care—Translating Data in Oncology into Practice." *The New England Journal of Medicine*, 369(24): 2347–2351.

pharmacological treatment can be adjusted according to the severity of COPD. It is now recognized that a patient's HRQoL does not necessarily correlate with the degree of flow impairment as quantified by the $FEV_1$. Consequently, GOLD has recommended a combined assessment that encompasses not only spirometry, including the measurement of $FEV_1$ and FVC (forced vital capacity), but symptoms and exacerbation risks as well. The spirometry criterion for COPD is a postbronchodilator $FEV_1$/FVC ratio[35] of $< 0.7$. **Table 1-3** illustrates the staging of COPD as determined by the $FEV_1$.

Patient symptomology can be assessed from either the Modified Medical Research Council (**MMRC**) or the COPD Assessment Test (CAT).[34] The MMRC uses a simple grading scale to assess dyspnea (**Box 1-2**).

The grouping of patients with COPD is determined by spirometry, symptoms as measured by the MMRC or the CAT, and the patient's exacerbation history. **Table 1-4** illustrates the four **groups** of patients with COPD as formulated by GOLD criteria.

We will now discuss the various classes of respiratory drugs that are administered for COPD.

## $Beta_2$ Agonists

$Beta_2$-agonists are subdivided into short-acting and long-acting medications. The short-acting $beta_2$-agonists (**SABA** medications) include fenoterol, levalbuterol, and albuterol. The duration of activity of these medications is typically 4–6 hours.[36]

The long-acting $beta_2$-agonists (**LABA** medications) include arformoterol, formoterol, indacaterol,

**TABLE 1-3**
**Spirometric Classification of COPD Severity Based on Postbronchodilator $FEV_1$**

| Stage/Severity | $FEV_1$ Values |
|---|---|
| Stage I: Mild | $FEV_1/FVC < 0.70$<br>$FEV_1 \geq 80\%$ predicted value |
| Stage II: Moderate | $FEV_1/FVC < 0.70$<br>$50\% \leq FEV_1 < 80\%$ predicted value |
| Stage III: Severe | $FEV_1/FVC < 0.70$<br>$30\% \leq FEV_1 < 50\%$ predicted value |
| Stage IV: Very severe | $FEV_1/FVC < 0.70$<br>$FEV_1 < 30\%$ predicted *or* $FEV_1 < 50\%$ predicted value plus chronic respiratory failure |

$FEV_1$, forced expiratory volume in 1 second; FVC, forced vital capacity. Respiratory failure is defined as a $Pa_{O_2}$ less than 60 mm Hg with or without a $Pa_{CO_2}$ greater than 50 mm Hg while breathing air at sea level.

Hess, D. 2016. *Respiratory Care: Principles and Practice*, 3rd ed. Burlington, MA: Jones & Bartlett Learning.

### BOX 1-2 Modified Medical Research Council (MMRC) Dyspnea Scale

Grade 0: I am short of breath with vigorous activity.

Grade 1: I am breathless when walking fast on flat ground or when walking up a slight incline.

Grade 2: Because of my shortness of breath I walk slower on flat ground than people of my own age, and I must stop to catch my breath when walking at my usual speed.

Grade 3: I must stop to catch my breath after walking about 100 yards or after a few minutes walking on flat ground.

Grade 4: I am too short of breath to go outside, and I get short of breath when getting dressed.

**TABLE 1-4**
**Combined Assessment of COPD Using GOLD Criteria**

| | |
|---|---|
| **Group A:**<br>Low risk,<br>low symptom burden | $FEV_1/FVC < 0.70$<br>Low symptom burden (MMRC of 0–1 OR CAT score $< 10$) *AND*<br>$FEV_1$ of 50% or greater (old GOLD 1–2) *AND* low exacerbation rate (0–1/year) |
| **Group B:**<br>Low risk,<br>higher symptom burden | $FEV_1/FVC < 0.70$<br>Higher symptom burden (MMRC of $\geq 2$ *OR* CAT of $\geq 10$) *AND*<br>$FEV_1$ of 50% or greater (old GOLD 1–2) *AND* low exacerbation rate (0–1/year) |
| **Group C:**<br>High risk,<br>low symptom burden | $FEV_1/FVC < 0.70$<br>Low symptom burden (MMRC of 0–1 *OR* CAT score $< 10$) *AND*<br>$FEV_1 < 50\%$ (old GOLD 3–4) *AND/OR* high exacerbation rate ($\geq 2$/year) |
| **Group D:**<br>High risk,<br>higher symptom burden | $FEV_1/FVC < 0.70$<br>Higher symptom burden (MMRC of 2 or more *OR* CAT of $\geq 10$) *AND*<br>$FEV_1 < 50\%$ (old GOLD 3–4) *AND/OR* high exacerbation rate ($\geq 2$/year) |

Hess, D. 2016. *Respiratory Care: Principles and Practice*, 3rd ed. Burlington, MA: Jones & Bartlett Learning.

olodaterol, and salmeterol. The duration of activity of these medications is typically 6–24 hours.[36]

### Anticholinergics

Anticholinergics also are subdivided into short-acting and long-acting medications. The short-acting anticholinergics are also known as short-acting muscarinic agents (**SAMAs**). The most common SAMA prescribed is ipratropium bromide, which was introduced in 1974 and has a duration of activity of approximately 6 hours. Oxitropium bromide was introduced in the early 1990s. Although it was reported to have a longer duration of activity than ipratropium bromide, studies revealed that this was not so. Both of these medications are minimally absorbed, so the frequency of side effects is reduced.[37]

The long-acting anticholinergics, also known as long-acting muscarinic agents (**LAMAs**), include aclidinium bromide, glycopyrronium bromide, tiotropium, and umeclidinium.[36] Of note, a review of the use of tiotropium for stable COPD revealed that this drug significantly reduced hospitalizations for COPD exacerbations.[38]

### LABA/LAMA Combinations

The available LABA/LAMA combinations include fenoterol/aclidinium, formoterol/glycopyrronium, indacaterol/glycopyrronium, vilanterol/umeclidinium, and olodaterol/tiotropium.[36] Studies have concluded that use of these combination medications leads to better outcomes in the care of patients with COPD.[39]

### SABA/SAMA Combinations

SABA/SAMA drug combinations include fenoterol/ipratropium and salbutamol/ipratropium.[40(p. 15)] A study documented by Petty indicated that the combination of albuterol (salbutamol) and ipratropium was more effective than either medication alone when administered to patients with COPD.[41]

### Methylxanthines

Methylxanthines include theophylline and aminophylline. Aminophylline is a compound of theophylline. Currently, theophylline is recommended for patients with COPD who do not respond optimally to bronchodilators and those with decreased self-efficacy in the use of inhalers.[34(p. 813)]

### LABA/Corticosteroid Combinations

Combinations of LABA and inhaled corticosteroids (**ICS**) include formoterol/beclomethasone, formoterol/budesonide, formoterol/mometasone, salmeterol/fluticasone, and vilanterol/fluticasone furoate.[36] A UK study conducted by Kiri et al. found that the risk of hospital readmission and death within a 12-month period after discharge is reduced with the use of LABA/ICS in patients with moderate to severe COPD.[42]

### Phosphodiesterase-4 (PDE4) Inhibitors

The **PDE4 inhibitor** most commonly prescribed for COPD is roflumilast. This drug is effective in reducing exacerbations in patients who have chronic bronchitis, a history of exacerbations, and significant airflow limitation.[34(p.813)]

## Management of Stable COPD

The following information is derived from the GOLD 2017 report.[40] Recommendations for pharmacotherapy are in accordance with GOLD patient grouping.

### Group A: Few Symptoms, Low Exacerbation Risk

A bronchodilator is recommended. Over time, and depending on evaluation of efficacy, an alternative bronchodilator can be selected to replace the initial drug.

### Group B: Significant Symptoms, Low Exacerbation Risk

A LABA or LAMA can be administered. Depending on the resilience of symptoms, these drugs can be combined to increase efficacy.

### Group C: Few Symptoms, High Exacerbation Risk

A LAMA is initially recommended but can be combined with a LABA, or a LABA can be combined with an ICS if there are persistent exacerbations.

### Group D: Many Symptoms, High Exacerbation Risk

Recommended therapy is a LAMA/LABA combination, which can be replaced by either a LAMA or a LABA/ICS combination. If there are further exacerbations or if symptoms only minimally diminish, a LAMA/LABA/ICS combination can be employed. If exacerbations still persist, and the patient has chronic bronchitis with an $FEV_1 < 50\%$ of predicted value, roflumilast should be added, and possibly a macrolide antibiotic.[40(p.27)]

## Management of an Exacerbation

According to a task force led by Wedzicha et al., treatment recommendations for a COPD exacerbation include noninvasive ventilation (NIV), oral corticosteroids for inpatients, antibiotic therapy, judicious application of home-based therapy, and the initiation of outpatient pulmonary rehabilitation 3 weeks after hospital discharge.[43] Additionally, $beta_2$-agonists should be added and/or increased to their maximum dose.[34(p.820)] Alternatively, a

meta-analysis has indicated that beta-agonists are inferior to anticholinergics, and it is suggested that anticholinergics should replace beta-agonists as the preferred bronchodilator.[44]

According to GOLD, antibiotics should be administered only to patients with increased shortness of breath, increased volume of sputum, or purulent sputum, or who are receiving mechanical ventilation.[45]

Respiratory support should be provided as needed and includes oxygen therapy, NIV, and invasive mechanical ventilation. Of particular importance is the use of NIV, which has been shown to reduce the following: the need for intubation, the incidence of complications, and mortality rate. NIV may also reduce the length of stay for the patient.[46]

## Key Points

- COPD is now reported to be the third most common cause of death worldwide.
- GOLD has done much to standardize the diagnosis and therapy of COPD.
- A patient's HRQoL does not directly correlate with the degree of pulmonary function impairment.
- COPD is now recognized as a systemic disorder.
- Dyspnea is a complex phenomenon that has physiological, sensory, and affective components.
- The hallmark intervention for COPD is smoking cessation. Pharmacological and nonpharmacological therapeutic modalities, such as NRT and counseling, have been found to be effective.
- Pulmonary rehabilitation is a valuable component in the care of the patient with COPD. It can increase the patient's HRQoL as well as disrupt the downward spiral of deterioration in the patient's ability to perform daily activities.
- Palliative and end-of-life care are underutilized in the care of the patient with COPD.
- GOLD has constructed a grouping model that standardizes the pharmacological management of COPD.
- NIV has become an important component in the management of COPD exacerbation and can reduce the need for intubation, the mortality rate, and the length of hospital stay.

## Case Study

A 42-year-old man has been an inpatient for 7 days. He was admitted for a presumed COPD exacerbation. This is the patient's first hospital admission. He is a 46-pack-per-year smoker but has never been diagnosed with COPD. He is now stable and is ready for discharge. As a COPD navigator, you have already instructed the patient extensively on tobacco cessation. Additionally, the patient has received flu and pneumonia vaccinations. You will be calling the patient after his discharge to ensure that he follows his discharge instructions and treatment regimen. You are attempting to anticipate the patient's medication and equipment needs.

Oxygen therapy for home use must meet specific criteria in order for insurance to cover the expense. Two of the criteria that must be met are for the patient to have at room air a resting $Spo_2 \leq 88\%$ or a resting $Pao_2 \leq 55$ mm Hg. His resting $Spo_2$ on room air is 94%. Bedside spirometry has revealed a postbronchodilator $FEV_1/FVC$ ratio of $< 0.65$ and an $FEV_1$ less than 70% of predicted value, indicating that he has moderate COPD. The consulting pulmonologist has designated him as GOLD group B.

**Questions:**

1. **Assuming that the ordering physician abides by GOLD recommendations, what respiratory medications do you think will be prescribed?**
2. **What equipment needs should be communicated to the discharge planner?**

## Testing Your Knowledge

Choose one answer from each of the following questions:

1. Tiotropium is a medication from which drug classification?
   a. Methylxanthine
   b. Corticosteroid
   c. LAMA
   d. SABA
2. What is the hallmark intervention for COPD?
   a. Oxygen
   b. Vaccinations
   c. $Beta_2$-agonist
   d. Smoking cessation
3. Chronic disease management clinical practice guidelines should *not* include which component?
   a. Guidelines for postdischarge care
   b. Single-disease care plan
   c. Medication management
   d. Criteria for rehabilitation
4. Which possible component of a smoking cessation plan would be least helpful?
   a. Self-help literature
   b. Stages of Change model

c. Combination of NRT and counseling
d. Counseling

5. Which of the following statements about COPD is false?
   a. It is frequently associated with comorbid conditions.
   b. HRQoL always correlates with $FEV_1$.
   c. The most common risk factor is smoking.
   d. COPD is a systemic disorder.

## References


1. Halbert, R. J., J. L. Natoli, A. Gano, E. Badamgaray, A. S. Buist, and D. M. Mannino. 2006. "Global Burden of COPD: Systematic Review and Meta-Analysis." *European Respiratory Journal* 28: 523–532. http://dx.doi.org/10.1183/09031936.06.00124605.
2. Halbert, R. J., S. Isonaka, D. George, and A. Iqbal. 2003. "Interpreting COPD Prevalence Estimates. What Is the True Burden of Disease?" *Chest* 123(5): 1684–1692. http://dx.doi.org/10.1378/chest.123.5.1684.
3. Centers for Disease Control and Prevention. 2018. "Chronic Obstructive Pulmonary Disease (COPD). Data and Statistics. COPD Prevalence in the United States." Accessed April 5, 2018. https://www.cdc.gov/copd/data.html.
4. Ford, E. S., L. B. Murphy, O. Khaviou, and W. H. Giles. 2015. "Total and State-Specific Medical and Absenteeism Costs of COPD Among Adults Aged 18 Years in the United States for 2010 and Projections Through 2020." *Chest* 147(1): 31–45. http://dx.doi.org/10.1378/chest.14-0972.
5. Hurd, S. S. 2000. "International Efforts Directed at Attacking the Problem of COPD." *Chest* 117: 336S–338S. http://dx.doi.org/10.1378/chest.117.5_suppl_2.336S
6. Global Initiative for Chronic Obstructive Lung Disease. 2014. "Definition and Overview. Factors That Influence Disease Development and Progression." Global Strategy for the Diagnosis, Management, and Prevention of Chronic Obstructive Pulmonary Disease. http://www.goldcopd.org/uploads/users/file/GOLD_AtAGlance_2014.pdf.
7. Trupin, L., G. Earnest, J. San Pedro, J. R. Balmes, M. D. Eisner, E. Yelin, . . . P. D. Blanc. 2003. "The Occupational Burden of Chronic Obstructive Lung Disease." *European Respiratory Journal* 22: 462–469. http://dx.doi.org/10.1183/09031936.03.00094203.
8. Stoller, J. K., and L. S. Aboussouan. 2012. "A Review of $\alpha_1$-Antitrypsin Deficiency." *American Journal Respiratory Critical Care Medicine* 185: 246–259. http://dx.doi.org/10.1164/rccm.201108-1428CI.
9. Silva, G. E., D. L. Sherrill, S. Guerra, and R. A. Barbee. 2004. "Asthma as a Risk Factor for COPD in a Longitudinal Study." *Chest* 126(1): 59–65. http://dx.doi.org/10.1378/chest.126.1.59.
10. Kurmi, O. P., S. Semple, P. Simkhada, W. Cairns, S. Smith, and J. G. Ayres. 2010. "COPD and Chronic Bronchitis Risk of Indoor Air Pollution from Solid Fuel: A Systematic Review and Meta-analysis." *Thorax* 65: 221–228. Accessed April 6, 2018. http://thorax.bmj.com/. http://dx.doi.org/10.1136/thx.2009.124644.
11. Mannino, D. M., G. Watt, D. Hole, C. Gillis, C. Hart, A. McConnachie, . . . J. Vestbo. 2006. "The Natural History of Chronic Obstructive Lung Disease." *European Respiratory Journal* 27: 627–643. http://dx.doi.org/10.1183/09031936.06.00024605.
12. Viegi, G., F. Pistelli, D. L. Sherrill, S. Maio, S. Baldacci, and L. Carrozzi. 2007. "Definition, Epidemiology, and Natural History of COPD." *European Respiratory Journal* 30: 993–1013. http://dx.doi.org/1183/09031936.00082507.
13. Kohansal, R., P. Martinez-Camblor, A. Agusti, A. S. Buist, D. M. Mannino, and J. B. Soriano. 2009. "The Natural History of Chronic Airflow Limitation Revisited. An Analysis of the Framingham Offspring Cohort." *American Journal Respiratory Critical Care Medicine* 180: 3–10. http://dx.doi.org/10.1164/rccm.200901-0047OC.
14. Donaldson, G. C., T. A. R. Seemungal, A. Bhowmik, and J. A. Wedzicha. 2002. "Relationship Between Exacerbation Frequency and Lung Function Decline in Chronic Obstructive Lung Disease." *Thorax* 57: 847–852. http://dx.doi.org/10.1136/thorax.57.10.847
15. Fabbri, L. M., F. Luppi, B. Beghe, and K. F. Rabe. 2008. "Complex Chronic Comorbidities of COPD." *European Respiratory Journal* 31: 204–212. http://dx.doi.org/10.1183/09031936.00114307.
16. Stead, L. F., R. Perera, C. Bullen, D. Mant, and T. Lancaster. 2008. "Nicotine Replacement Therapy for Smoking Cessation." *Cochrane Database of Systematic Reviews* (1): CD000146. http://dx.doi.org/10.1002/14651858.CD000146.pub3.
17. Henningfield, J. E., R. V. Fant, A. R. Buchalter, and M. L. Stitzer. 2005. "Pharmacotherapy for Nicotine Dependence." *CA: A Cancer Journal for Clinicians* 55: 281–299. http://dx.doi.org/10.3322/canjclin.55.5.281
18. Ebbert, J. O., J. T. Hays, and R. D. Hurt. 2010. "Combination Pharmacotherapy for Stopping Smoking: What Advantages Does It Offer?" *Drugs* 70(6): 643–650. http://dx.doi.org/10.2165/11536100-000000000-00000.
19. Anderson, J. E., D. E. Jorenby, W. J. Scott, and C. Fiore. 2002. "Treating Tobacco Use and Dependence. An Evidence-Based Clinical Practice Guideline for Tobacco Cessation." *Chest* 121: 932–941. http://dx.doi.org/10.1378/chest.121.3.932
20. Stead, L. F., and T. Lancaster. 2012. "Combined Pharmacotherapy and Behavioral Interventions for Smoking Cessation (Review)." *Cochrane Database of Systematic Reviews* (10): CD008286. http://dx.doi.org/10.1002/14651858.CD008286.
21. Keller, P. A., A. Feltracco, L. A. Bailey, Z. Li, J. Niederdeppe, T. B. Baker, and M. C. Fiore. 2010. "Changes in Tobacco Quitlines in the United States, 2005-2006." *Preventing Chronic Disease* 7(2): A36. Accessed April 12, 2018. http://www.cdc.gov/pcd/issues/2010/mar/09_0095.htm.
22. Sehatzadeh, S. 2012. "Influenza and Pneumococcal Vaccinations for Patients with Chronic Obstructive Pulmonary Disease (COPD): An Evidence-Based Analysis." *Ontario Health Technology Assessment Series* 12(3): 1–64. Accessed April 13, 2018. http://www.hqontario.ca/en/mas/tech/pdfs/2012/rev_COPD_Vaccinations_March.pdf.
23. Centers for Disease Control and Prevention. 2017. "Adults: Protect Yourself with Pneumococcal Vaccines." Accessed April 13, 2018. https://www.cdc.gov/features/adult-pneumoccal/index.html.
24. Centers for Disease Control and Prevention. 2017. "Key Facts About Seasonal Flu Vaccine." Accessed April 14, 2018. https://cdc.gov/flu/protect/keyfacts.htm.
25. Ries, A. L., G. S. Bauldoff, B. W. Carlin, R. Casaburi, C. F. Emery, D. A. Mahler, . . . C. Herrerias. 2007. "Joint ACCP/AACVPR Evidence-Based Clinical Practice Guidelines." *Chest* 131: 4s–42s. http://dx.doi.org/10.1378/chest.06-2418.
26. MacIntyre, N. R., and R. H. Crouch. 2016. "Pulmonary Rehabilitation." In *Respiratory Care Principles and Practice*, 3rd ed., edited by D. R. Hess, N. R. MacIntyre, W. F. Galvin, and S. C. Mishoe, 594–605. Burlington, MA: Jones & Bartlett Learning.
27. Mahler, D. A. 1998. "Pulmonary Rehabilitation." *Chest* 113: 263S–268S. http://dx.doi.org/10.1378/chest.113.4_Supplement.263S
28. von Leupoldt, A., and B. Dahme. 2007. "Psychological Aspects in the Perception of Dyspnea in Obstructive Lung Disease." *Respiratory Medicine* 101: 411–422. http://dx.doi.org/10.1016/j.rmed.2006.06.011.
29. Egan, C., B. M. Deering, C. Blake, B. M. Fullen, N. M. McCormack, M. A. Spruit, and R. W. Costello. 2012. "Short Term and Long-Term Effects of Pulmonary Rehabilitation on Physical Activity in COPD." *Respiratory Medicine* 106: 1671–1679. http://dx.doi.org/10.1016/j.rmed.2012.08.016.
30. Spruit, M. A., E. M. Pitta, E. McAuley, R. L. ZuWallack, and L. Nici. 2015. "Pulmonary Rehabilitation and Physical Activity in

Patients with Chronic Obstructive Lung Disease." *American Journal of Respiratory Critical Care Medicine* 192(8): 924–933. http://dx.doi.org/10.1164/rccm.201505-0929CI.

31. Curtis, J. R. 2008. "Palliative and End-of-Life Care for Patients with Severe COPD." *European Respiratory Journal* 32: 796–803. http://dx.doi.org/10.1183/09031936.00126107.
32. World Health Organization. 2019. "WHO Definition of Palliative Care." Accessed April 17, 2018. http://www.who.int/cancer/palliative/definition/en.
33. Reifsnyder, J., and T. P. Yeo. 2011. "Continuity of Care." In *Population Health. Creating a Culture of Wellness,* edited by D. B. Nash, J. Reifsnyder, R. J. Fabius, and V. P. Pracilio, 63–88. Sudbury, MA: Jones & Bartlett Learning.
34. Kohli, P. 2016. "Chronic Obstructive Pulmonary Disease." In *Respiratory Care Principles and Practice*, 3rd ed., edited by D. R. Hess, N. R. MacIntyre, W. F. Galvin, and S. C. Mishoe, 801–830. Burlington, MA: Jones & Bartlett Learning.
35. Global Initiative for Chronic Obstructive Lung Disease. 2014. "Diagnosis and Assessment." Global Strategy for the Diagnosis, Management, and Prevention of Chronic Obstructive Pulmonary Disease.
36. Global Initiative for Chronic Obstructive Lung Disease. 2018. "Evidence Supporting Prevention and Maintenance Therapy." Global Strategy for the Diagnosis, Management, and Prevention of Chronic Obstructive Pulmonary Disease. Accessed April 19, 2018. http://goldcopd.org/wp-content/uploads/2017/11/GOLD-2018-v6.0-FINAL-revised-20-Nov_WMS.pdf.
37. Scullion, J. E. 2007. "The Development of Anticholinergics in the Management of COPD." *International Journal of Chronic Obstructive Pulmonary Disease* 2(1): 33–40. http://dx.doi.org/10.2147/copd.2007.2.1.33
38. Barr. R. G., J. Bourbeau, C. A. Camargo, and F. S. F. Ram. 2006. "Tiotropium for Stable Chronic Obstructive Pulmonary Disease: A Meta-Analysis." *Thorax* 61: 854–862. http://dx.doi.org/10.1136/thx.2006.063271.
39. Petite, S. E. 2017. "Role of Long-Acting Muscarinic Antagonist/Long-Acting $\beta_2$-Agonist Therapy in Chronic Obstructive Pulmonary Disease." *Annals of Pharmcotherapy* 51(8): 1–10. http://dx.doi.org/10.1177/1060028017705149
40. Global Initiative for Chronic Obstructive Lung Disease. 2017. "Pocket Guide to COPD Diagnosis, Management, and Prevention. A Guide for Health Care Professionals." https://www.goldcopd.org
41. Petty, T. L. 1995. "The Combination of Ipratropium and Albuterol Is More Effective Than Either Agent Alone." *Chest* 107(5): 183S–186S. http://dx.doi.org/10.1378/chest.107.5_supplement.183s.
42. Kiri, V. A., G. Bettoncelli, R. Testi, and G. Viegi. 2005. "Inhaled Corticosteroids Are More Effective in COPD Patients When Used with LABA Than with SABA." *Respiratory Medicine* 99: 1115–1124. http://dx.doi.org/10.1016/j.rmed.2005.02.018.
43. Wedzicha, J. A., M. Miravitlles, J. R. Hurst, P. M. Calverley, R. K. Albert, A. Anzueto, . . . J. A. Krishnan. 2017. "Management of COPD Exacerbations: A European Respiratory Society/American Thoracic Society Guideline." *European Respiratory Journal* 49: 1–16.
44. Salpeter, S. R. 2007. "Bronchodilators in COPD: Impact of β-Agonists and Anticholinergics on Severe Exacerbations and Mortality." *International Journal of Chronic Obstructive Pulmonary Disease* 2(1): 11–18. http://dx.doi.org/10.2147/copd.2007.2.1.11.
45. Global Initiative for Chronic Obstructive Lung Disease. 2014. "Management of Exacerbations." Global Strategy for the Diagnosis, Management, and Prevention of Chronic Obstructive Lung Disease. https://www.goldcopd.org.
46. Brochard, L., J. Mancebo, M. Wysocki, F. Lofaso, G. Conti, A. Rauss, . . . F. Lemaire. 1995. "Noninvasive Ventilation for Acute Exacerbations of Chronic Obstructive Lung Disease." *New England Journal of Medicine* 333: 817–822.