THE RESPIRATORY SYSTEM

To better understand chronic obstructive pulmonary disease (COPD) and asthma, we should first explore the respiratory system and the breathing process in normal, healthy lungs.

The respiratory system's main job is to move oxygenated air into the body while removing waste. It also performs other roles that are important for breathing, such as[1]:

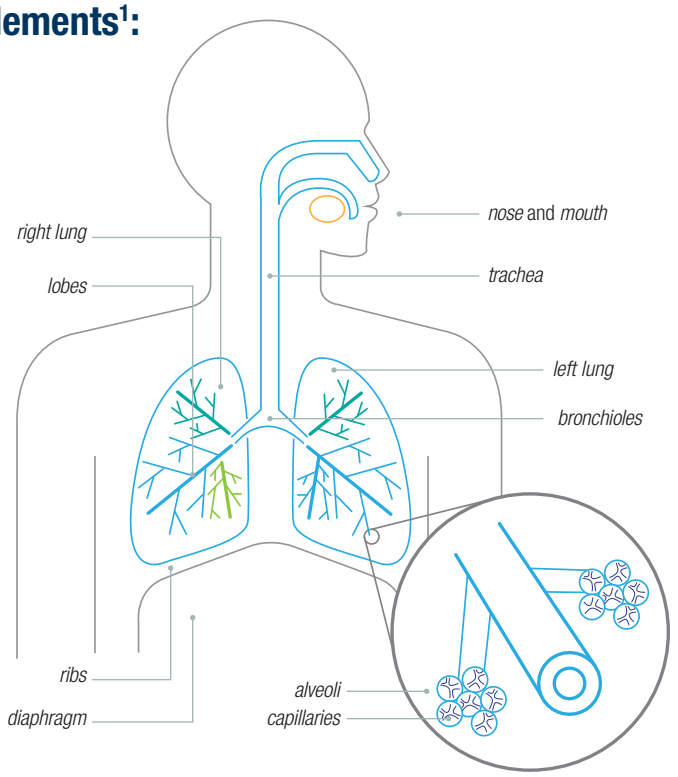
- Changing air to the right body temperature and moisturizing it to the correct humidity level
- Protecting the body from toxic substances by coughing, filtering, swallowing, or sneezing

Breathing by the Numbers[2]

Lungs help a person breathe **12 to 15 times** a minute when resting—that's over **6 million** breaths a year.[2]

The respiratory system consists of the following elements[1]:

- The *nose* and *mouth* allow air to enter the body. The hairs lining the nose help clean the air
- The *throat,* also called the *pharynx*, brings the air from the nose and mouth down to the *windpipe,* also called the *trachea.* The trachea connects the throat to the lungs via 2 main *bronchial tubes,* one for each lung
- These bronchial tubes branch further into *bronchioles.* At the end of the smallest branches are the *alveoli*, or air sacs—these are the destination of air that was breathed in
- *Capillaries* are tiny blood vessels in the walls of the alveoli. Blood passes through these capillaries, entering from the *pulmonary artery* and leaving by the *pulmonary vein.* While in the capillaries, blood releases carbon dioxide through the capillary wall into the alveoli and takes up oxygen from the air in the alveoli
- The *right lung* is divided into 3 *lobes* or sections. The *left lung* is divided into 2 lobes. Air moves in and out of the lungs through the branches of the bronchial tubes
- *Cilia* are very small hairlike projections that line the bronchial tubes. The cilia move like waves and carry mucus up and out of the lungs to the throat where it is either coughed up or swallowed. Mucus catches and holds the germs and dust that may have invaded the lungs. Coughing or sneezing gets rid of the foreign matter and mucus in the lungs and nasal passages
- The *diaphragm* is a strong wall of muscle that separates the chest cavity from the abdominal cavity. When it moves downwards, the diaphragm creates suction in the chest, drawing in air and expanding the lungs
- The *ribs* support and protect the chest cavity. They move slightly to help lungs expand and contract



Breathing In and Out

When a person inhales, oxygen-rich air goes down the trachea into the bronchial tubes. These tubes branch out into thousands of smaller, thinner tubes called bronchioles when they reach the lungs. These tubes end in clusters of tiny, round air sacs called alveoli. When air reaches the alveoli, oxygen passes into the tiny blood vessels called capillaries that run through the alveoli's walls. At the same time, carbon dioxide gas moves out of the capillaries into the alveoli in a process called gas exchange. The air that contains the carbon dioxide then moves up and out of lungs.[3]

The air sacs and airways are elastic. When a person breathes oxygen-rich air in, each air sac fills up with air, like a balloon. When he or she breathes out, the air sacs deflate and the air containing carbon dioxide goes out.[3]

Lung capacity declines as a person ages.[1]

A balanced diet, exercise, smoking abstinence, and stress reduction may help lungs stay healthy.[1]

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COPD OVERVIEW

Chronic obstructive pulmonary disease, or COPD, is a common, preventable, and treatable disease that is characterized by persistent respiratory symptoms and airflow limitation that is due to airway and/or alveolar abnormalities. This is usually caused by significant exposure to noxious particles or gasses. COPD can be overwhelming to patients because breathing becomes increasingly labored over time.[1,2]

In COPD, less air flows in and out of the lungs for a variety of reasons. These include[2]:

- Airways and air sacs lose their elasticity
- Walls between some air sacs are destroyed
- Walls of the airways become thick and inflamed
- Airways make more mucus than usual, clogging themselves

The chronic airflow limitation that is characteristic of COPD is caused by a mixture of[2]:

- ***Parenchymal destruction (Emphysema)***, where the walls of the air sacs in the lungs are damaged and lose their elasticity. The walls of the air sacs can be destroyed leading to fewer and larger air sacs, reducing the amount of gas exchange in the lungs
- ***Small airways disease (obstructive bronchiolitis),*** where the lining inside the airways is irritated and inflamed. Excess mucus is formed making it hard to breathe

The Epidemiology of COPD

COPD is the third leading cause of death in the United States. Approximately 12 million Americans have been diagnosed with COPD, and an additional 12 million people are likely to have COPD without knowing it. Severe COPD can get in the way of doing even the most basic tasks, such as light housekeeping, taking a walk, bathing, and getting dressed.[3]

Risk Factors for COPD include[1]:

- Current or former cigarette, pipe, cigar, water pipe, or marijuana smokers
- Smoke from home cooking/heating fuels
- Occupational dusts, vapors, fumes, gases, or chemicals
- Genetic factors
- Diagnosed with asthma as a child

The Genetic Component of COPD

A small number of patients have a genetic predisposition to COPD; they lack a gene for a protein called alpha-1 antitrypsin (also known as alpha-1 antitrypsin deficiency). This deficiency is most common in Northern European populations.[6]

COPD is a serious disease, but with the proper treatment, its progress can be slowed.[7]

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DIAGNOSING COPD

COPD is not always easy to identify. At first, COPD may show no symptoms.† But as the disease progresses, symptoms appear and can become more severe.[1]

The most common symptoms are[1,2]:

- Shortness of breath (also called dyspnea) while doing everyday activities such as walking around the house, going up the stairs, or walking to the mailbox
- An ongoing cough or a cough that produces a lot of mucus (also called phlegm or sputum). This is often called "smoker's cough"
- Wheezing
- Chest tightness
- Fatigue

COPD commonly affects people who are 40 years of age or older and who are current or former smokers. Even secondhand smoke is a risk.[4,5]

Many symptoms do not appear until the disease has advanced; COPD can develop for years with no noticeable symptoms. Many people mistake their increased breathlessness and coughing for normal signs of aging.[3]

Severe COPD

The severity of symptoms correlates with the extent of lung damage a patient has. If a patient continues to smoke, the damage will occur faster. Symptoms of severe COPD also include swelling in the ankles, feet, or legs; weight loss; and decreased lower-muscle endurance.[1]

Signs of severe COPD that require immediate medical attention include[1]:

- Difficulty catching a breath or talking
- Lips or fingernails turning blue or gray
- Lack of mental alertness
- Fast heartbeat
- Treatment prescribed for symptoms isn't working

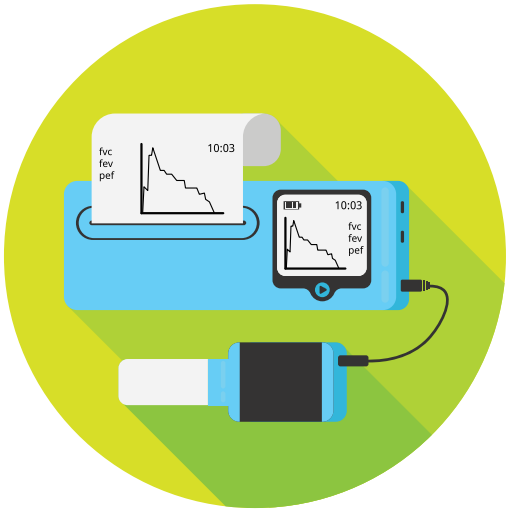
What is an exacerbation?

An exacerbation is a flare-up or worsening of COPD symptoms. It can occur from a lung infection, but in some instances, it is not known why some people have one. Symptoms of an exacerbation are similar to those found during an infection such as pneumonia. There is a change in the amount of sputum or color (from clear to deep yellow, green, or brown) and an increase in shortness of breath.[6]

Tests for COPD

A diagnosis of COPD is made through a combination of tests. A healthcare provider will take a medical history and ask if the patient is a current or former smoker, or if they have had any contact with lung irritants, such as secondhand smoke, air pollution, chemical fumes, or dust. He or she will also ask if the patient has had an ongoing cough and if they bring up mucus when they cough. Using a stethoscope, a healthcare provider will listen for wheezing or any other abnormal chest sounds.[7]

If a healthcare provider suspects COPD, he or she will usually perform a variety of lung function tests that measure how much air patients can inhale and exhale, how fast they can breathe out, and how well their lungs deliver oxygen to the bloodstream. The most common test is spirometry—a painless test in which patients take a deep breath in and then blow as hard as they can into a tube that's connected to a machine called a spirometer. This machine measures how much and how fast air is blown out.[7]



Other lung function tests include[8]:

- ***Lung volume test*** measures how much air the lungs can hold
- ***Lung diffusion capacity*** measures how well oxygen passes from the lungs into the bloodstream
- ***Pulse oximetry*** measures blood oxygen levels
- ***Arterial blood gas test:*** Oxygen and carbon dioxide levels are measured from a blood sample taken from an artery

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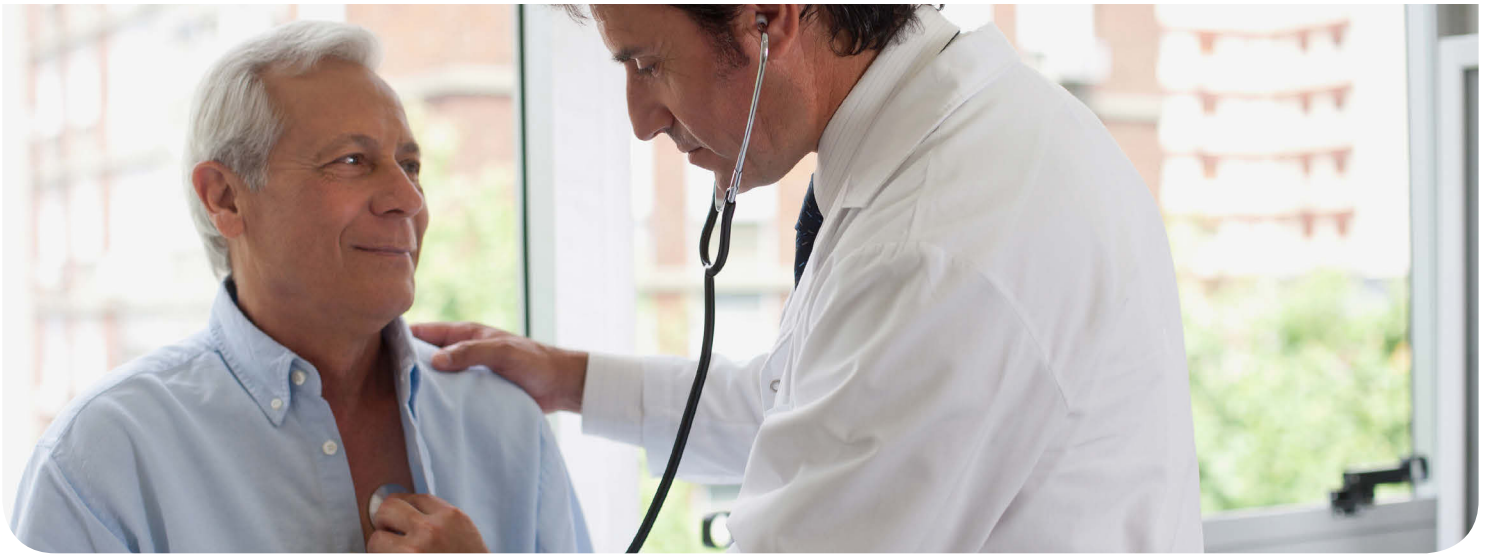

TREATING COPD

There is no cure for COPD, but there are medications used to reduce symptoms, reduce the frequency and severity of exacerbations, and improve exercise tolerance and health status.[1]

The different classes of COPD medication include:

Bronchodilator Medications

These medicines increase FEV_1. They act by altering airway muscle tone and tend to improve exercise performance. Bronchodilators are most often given on a regular basis to prevent or reduce symptoms.[1]

There are 2 different classes of bronchodilators:

- ***Beta$_2$-agonists*** relax the airway muscle. They can either be short-acting beta$_2$-agonists (SABAs), lasting about 4 to 6 hours and used only when needed for quick relief, and long-acting beta agonists (LABAs), which last 12 hours or more[1]
- ***Anticholinergics*** are drugs that stop the airways from tightening and clear mucus away from the lungs. The combination of airway relaxation and mucus clearing with anticholinergics allows patients to cough out mucus more easily, providing needed relief[2]

Inhaled Corticosteroids (ICS)

These anti-inflammatory medicines reduce swelling and mucus production in the airways, making it easier for the patient to breathe. They may be combined with a long-acting beta agonist to improve lung function, health status, and number of exacerbations.[1]

Combination Medicines

Some medicines combine 2 different types of medicines in the same inhaler. Common examples of drug combinations are a SABA and a short-acting anticholinergic, a LABA and an inhaled corticosteroid, or a long-acting beta$_2$-agonist and a long-acting anticholinergic. Some of these combination medicines may increase the degree of bronchodilation with a lower risk of side effects compared to increasing the dose of a single bronchodilator.[1]

Oral Corticosteroids

These medications are used during a COPD exacerbation. They are used for the very short time to improve lung function and decrease recovery time.[1]

Antibiotics

Patients sometimes have flare-ups caused by bacterial or viral infections. Antibiotics treat bacterial infections and prevent them from getting worse. Antibiotics may also reduce the risk of exacerbations in patients prone to exacerbations.[1,2]

Phosphodiesterase-4 (PDE4) Inhibitors

The principal action of PDE4 inhibitors is to reduce inflammation by inhibiting the breakdown of cAMP (cyclic adenosine monophosphate) in the immune cells. The breakdown of cAMP has been associated with COPD. PDE4 inhibitors may reduce moderate and severe exacerbations in patients already being treated with corticosteroids who have chronic bronchitis, severe or very severe COPD, or a history of exacerbations.[1,3]

Mucolytic Agents

These drugs help thin mucus in the airways. For patients not receiving an ICS, regular treatment with mucolytics may reduce exacerbations and modestly improve health status.[1,4]

The choice of medication within each of the above medication classes should be individualized to each patient. It should be based on the patients' current symptoms and future exacerbation risk. The expected clinical response should be balanced with side effects. The management strategies are not limited to pharmacologic treatments and should also include appropriate non-pharmacologic intervention.[1]

Other treatment options for severe COPD include:

Oxygen Therapy

For patients with very severe COPD who have low levels of oxygen in their blood, extra oxygen may be given via a mask or nasal cannula. The extra oxygen may help you to do more activities with fewer symptom, sleep better, or live longer.[5]

Surgery

Surgery is a last resort for people with severe COPD symptoms that have not improved with medications. Surgical procedures for severe COPD include[5]:

- *Bullectomy.* When the walls of the air sacs are destroyed, larger air spaces called *bullae* form. They can become so large that they need to be removed
- *Lung volume reduction surgery (LVRS).* Damaged tissue is removed from the lungs
- *Lung transplant.* A damaged lung is removed and replaced with a healthy lung from a deceased donor

References: 1. Global Initiative for Chronic Obstructive Lung Disease. Global strategy for the diagnosis, management, and prevention of chronic obstructive pulmonary disease (2017 report). http://goldcopd.org/. Accessed November 15, 2017. **2.** American Lung Association. Managing your COPD medications. http://www.lung.org/lung-health-and-diseases/lung-disease-lookup/copd/diagnosing-and-treating/managing-your-copd-medications.html. Accessed November 21, 2017. **3.** Rabe KJ. Update on roflumilast, a phosphodiesterase 4 inhibitor for the treatment of chronic obstructive pulmonary disease. *Br J Pharmacol.* 2011;163:53–67. **4.** American Thoracic Society. Medicines used to treat COPD. https://www.thoracic.org/patients/patient-resources/resources/copd-medicines.pdf. Accessed November 21, 2017. **5.** National Heart, Lung, and Blood Institute. Treatment. https://www.nhlbi.nih.gov/health/health-topics/topics/copd/treatment. Accessed November 21, 2017.

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MEDICATION ADMINISTRATION FOR COPD, ASTHMA, AND SEVERE ASTHMA

Delivery systems for COPD, asthma, and severe asthma medication take many different forms. There are multiple types of inhalation devices, in addition to drugs that are delivered orally or by injection.[1,2]

Below are examples of the different types of inhalation delivery systems:

Pressurized Metered-Dose Inhalers (pMDIs)[3]

A pMDI delivers a measured amount of medication into a patient's lungs with each spray or puff. pMDIs use a chemical propellant to produce the puff and deliver the medicine to the lungs. Many pMDIs have a dose counter to let patients know how many puffs are left.

Pros:

Small and convenient to carry; doesn't require a deep, fast, inhaled breath; humidity doesn't affect medication[2]

Cons:

Medication may stick to the back of the throat or tongue; requires shaking and priming[2]

pMDIs With a Spacer[3]

A spacer can be used with a pMDI and may help to coordinate inhalation with the actuation. The inhaled medication is sprayed into the spacer, which holds the puff from the pMDI for a few seconds so that a patient doesn't have to both breathe in and spray the pMDI at the same time.

Pros:

Helps deliver more medication into the lungs; may reduce the risk of corticosteroid side effects such as hoarseness or thrush[2]

Cons:

Spacers make pMDIs less portable[3]

Dry Powder Inhalers (DPIs)[4]

A DPI delivers medications in a dry powder form. DPIs are breath activated. The medication is only released when a patient takes a deep, fast breath in through the inhaler.

Pros:

Small and convenient to carry; doesn't require the coordination of breathing with medication release; may use single dose capsules of medication so it is easy to tell how many doses are left[2]

Cons:

Requires a deep, fast, inhaled breath which some patients may not be able to do (especially the elderly); some medication can get stuck to the back of the throat or tongue; high humidity can cause medication to clump[2]

Breath-Actuated Inhalers (BAIs)[5]

BAIs automatically release a spray of medication when a patient inhales.

Pros:

Does not require coordination of inhalation and actuation[5]

Cons:

Slightly larger than a pMDI[5]

Nebulizer[6]

A nebulizer delivers medicine in a fine, steady mist. The nebulizer machine connects to a tube that, in turn, connects to a medicine cup and mouthpiece or mask.

Pros:

May be used at any age, no specific inhalation technique is needed; may disperse drugs not available in an inhaler[7]

Cons:

More expensive than inhalers alone; treatment time may be long; possibility of bacterial contamination from unsterile chambers or tubing; drug is wasted when mist comes out from the sides of the mask[7]

Peak Flow Monitor[8]

This is a portable, inexpensive, hand-held device that is used to measure how quickly a patient is able to push air out of the lungs. Patients can use the monitor at home and record the results. Why use a peak flow monitor? The results can help healthcare providers see if a patient's medication needs to be adjusted. A peak flow monitor can also determine whether a patient's asthma is worsening.

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SMOKING, COPD, AND ASTHMA

It could be difficult for your patients to hear the words, “Don’t smoke.” It’s been pounded into their brains for years. But, despite all the warnings, people still smoke. And smoking has a direct link to COPD. In fact, it’s the main risk factor for the disease. It’s also the most common trigger to set off an asthma attack.[1,2]

The younger a patient was when they started smoking, the more vulnerable they are now to respiratory disease. Smoking as a child and as a teenager can slow down the lungs’ growth and development—increasing the risk of getting COPD as an adult. Tobacco smoke is unhealthy for everyone, especially for people with asthma.[1,2]

Secondhand smoke from cigarettes, cigars, or pipes can make your patients’ COPD or asthma worse. So it’s important for the places where your patients live, work, and visit are smoke-free.[3]

21%
of people with asthma are smokers and patients with asthma should not smoke. Another important reason for your patients to quit.[2]

The COPD-Smoking Link

- Nearly 8 out of 10 deaths are a result of smoking[4]
- The severity of COPD symptoms depends on the extent of the damage to the lungs. If patients continue smoking, the damage will get worse[1]
- In 2011, 15 million American adults were diagnosed with COPD[1]

Tools For Quitting Smoking

Smoking is an addiction, both mentally and physically. Fortunately, there are several tools that can help make stopping smoking a reality. Most people will need a combination of them: medicine, a methodology to change personal habits, and emotional support.[5]

Here are some of the ways to help your patients quit:

- ***Nicotine-replacement therapy (NRT).***[6] The nicotine in cigarettes leads to physical dependence and can cause unpleasant withdrawal symptoms, making it more difficult to quit. NRT gives patients nicotine but not the other harmful chemicals found in tobacco. This helps to relieve physical withdrawal symptoms so patients can concentrate on the emotional aspects of quitting. Studies show that using NRT can almost double the chances of success in quitting. The best time to use NRT is when a patient first quits.

  There are some smokers who should not use NRT. People who continue to smoke, pregnant women, and teens should stay away from NRT. All patients should speak to their healthcare provider before starting NRT or any other quit-smoking methodology.

  NRT comes in several forms: gum, patches, sprays, inhalers, and lozenges. The delivery system should be based on the patient's habits and preferences

- ***Prescription drugs.***[7] There are a few prescriptions that have been found to help smokers quit. Some can be used in conjunction with NRT. Others must be started weeks before the day a patient decides to quit. As always, patients must discuss with their healthcare provider whether or not a prescription drug is right for them

- ***Emotional support.***[8] Physical withdrawal is only half the equation for smoking cessation. The mental cravings can be even more challenging for patients. Fortunately, there is support for the emotional side of quitting smoking, with counselors who can help with everything from listening to sharing tips and insights:

  – Telephone-based help with trained counselors, available day and night

  – Quit-smoking programs and support groups, such as Nicotine Anonymous® and groups sponsored by the American Cancer Society, the American Lung Association, or your local hospital

  – One-on-one counseling with a trained professional

  – Network of family and friends to lend a helping hand when a craving hits

  – Workplace, hospital or wellness centers may offer support programs

Try, Try Again

Encourage patients to continue trying to quit smoking if they relapse. Most people go back to smoking within the first month of quitting because of withdrawal symptoms. It can take up to 10 times to finally be free of smoking.[6]

Other Ways to Quit Smoking

The following methods have helped some people quit smoking, but they have not been studied extensively[9]:

- Cold turkey
- Gradual withdrawal
- Electronic cigarettes
- Hypnosis
- Acupuncture
- Magnet therapy
- Herbs and supplements
- Mind-body practices such as yoga and meditation

Two to five years after quitting smoking, the risk of stroke is the same as a non-smoker![10]

Quitting smoking isn't easy. But it's not impossible. Millions of people have quit, and your patients can too.

References: 1. National Heart, Lung, and Blood Institute (NHLBI). Morbidity & Mortality: 2012 Chart Book on Cardiovascular, Lung and Blood Diseases. https://www.nhlbi.nih.gov/files/docs/research/2012_ChartBook_508.pdf. Accessed January 9, 2018. **2.** Centers for Disease Control and Prevention. Asthma and secondhand smoke. https://www.cdc.gov/tobacco/campaign/tips/diseases/secondhand-smoke-asthma.html. Accessed November 21, 2017. **3.** COPD Foundation. Quitting smoking. http://www.copdfoundation.org/What-is-COPD/Living-with-COPD/Quitting-Smoking.aspx. Accessed November 21, 2017. **4.** Centers for Disease Control and Prevention. Smoking and Respiratory Diseases. https://www.cdc.gov/tobacco/data_statistics/sgr/50th-anniversary/pdfs/fs_smoking_respiratory_508.pdf. Accessed January 18, 2018. **5.** American Cancer Society. How to quit smoking or smokeless tobacco. https://www.cancer.org/healthy/stay-away-from-tobacco/guide-quitting-smoking.html. Accessed November 21, 2017. **6.** American Cancer Society. Nicotine replacement therapy for quitting tobacco. http://www.cancer.org/healthy/stayawayfromtobacco/guidetoquittingsmoking/nicotine-replacement-therapy. Accessed November 21, 2017. **7.** American Cancer Society. Prescription drugs to help you quit tobacco. https://www.cancer.org/healthy/stay-away-from-tobacco/guide-quitting-smoking/prescription-drugs-to-help-you-quit-smoking.html. Accessed November 21, 2017. **8.** American Cancer Society. Benefits of quitting smoking over time. https://www.cancer.org/healthy/stay-away-from-tobacco/benefits-of-quitting-smoking-over-time.html. January 11, 2018. **9.** American Cancer Society. Other ways to quit smoking. http://www.cancer.org/healthy/stayawayfromtobacco/guidetoquittingsmoking/other-ways-to-quit-smoking. Accessed November 21, 2017. **10.** American Cancer Society. Benefits of quitting smoking over time. https://www.cancer.org/healthy/stay-away-from-tobacco/benefits-of-quitting-smoking-over-time.html. Accessed November 21, 2017.

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COPD LIFESTYLE ADAPTATIONS

As your patients' COPD worsens and becomes severe may be, their lifestyles will change. Maybe they won't be able to walk as far as they used to without taking a break. Maybe they will begin to wheeze or cough especially when doing any physical activity. If their disease is severe enough they may develop a wheeze or cough while trying to have a conversation. A patient with severe disease may be too tired to eat.[1,2] An inability to breathe translates into an inability to do the things we take for granted every day: walking, doing chores, working, and sleeping. These restrictions may make your patients depressed, scared, or angry.

As a healthcare professional, it's good to know that there are things you can do to help manage your patients' symptoms. In most cases, a few simple lifestyle adaptions can help your patients with COPD improve their everyday life.

Everyday Solutions

The most important thing for your patients with COPD to do is quit smoking. It's also a good idea for them to avoid secondhand smoke and environments with dust, fumes, or other toxic substances that could irritate their lungs when they inhale.[2]

Patients with COPD, especially those with severe disease may have trouble eating because of their shortness of breath. They might not get the calories and nutrients they need—which can not only make their symptoms worse but also make them more susceptible to infections. Discuss your patients' eating habits with them to help them come up with an eating plan that meets their nutritional needs. Smaller, more frequent meals may help. So might resting before eating and taking vitamins or nutritional supplements.[2]

The flu can cause serious problems for patients with COPD. This population is also more susceptible to pneumonia. Flu shots and pneumococcal vaccines may help reduce their risk.[2]

Pulmonary Rehabilitation

The goal of pulmonary rehabilitation is to help improve the well-being of patients with COPD. A team designs a program for each individual. Rehabilitation may include an exercise program, disease management training, and nutritional and psychological counseling to help patients stay active and carry out their daily activities.[2]

A bonus of pulmonary rehabilitation is peer-to-peer support. Patients will meet other people who have COPD and have the same experiences, questions, and feelings as they do.[3]

Common Sense Tips

Here are some suggestions for patients who may have trouble breathing[4]:

- Take frequent rest stops when walking
- Avoid stairs when possible
- Wear loose clothes that won't constrict breathing
- Keep windows closed if the weather is windy, to avoid debris blowing in
- Use air filters inside
- Keep the house–including shelves, picture frames, rugs, and curtains–clean and dust-free
- Wear scarves over their noses and mouths when it's cold outside, to keep their breath warm

And, most importantly, emphasize the need to call their healthcare provider if symptoms worsen!

When Loved Ones Can No Longer Take Care of Themselves

Unfortunately, COPD symptoms may, in time, get worse. It may get more and more difficult for patients to breathe or get around. Simple everyday tasks may become too much of a chore. Loved ones will have to take on a bigger and bigger role. They might need to set up bedrooms on the first level of a home. They might need to do the shopping and the laundry, the cooking and the cleaning. As the disease worsens, patients might also need help in getting dressed or eating. Family members might need to enlist the help of friends, home aides, or visiting nurses.

What Is an Advance Directive?

An advance directive is a plan patients make to ensure that their wishes and preferences regarding treatment are in place for when the time comes that they are unable to speak for themselves or make their own decisions. It is not comfortable for patients to think they might need an advance directive, but the document provides relief for family members that they "did the right thing." It also offers you and the other members of the healthcare team clarity on whether patients want life-sustaining measures if there is little likelihood of recovery.[5]

When all treatment options have been explored, palliative care or hospice might be necessary. While both palliative care and hospice are dedicated to providing relief from pain, offering a support system to help families cope with a patient's illness and their own bereavement, and enhancing quality of life, palliative care can begin while a patient is still receiving treatment for COPD, while hospice does not start until treatment has been exhausted and a patient has only 6 months or less to live.[6,7]

It is not an easy task to begin a conversation about the possibility of COPD symptoms getting to the point where patients can no longer care for themselves, but it is a necessary one. Being prepared can make life more comfortable for your patients, as well as being a gift to loved ones who may need to share the burden.

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