

# Understanding Lung Disease Tests





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is part of the COPD Foundation's  
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The COPD Foundation's mission is to prevent and cure Chronic Obstructive Pulmonary Disease and to improve the lives of all people affected by COPD.

# Understanding Lung Disease Tests

When you are sick, your doctor exams you, listens to you and asks you questions. This helps him or her make a **diagnosis** (*die-ag-know-sis*). (A diagnosis explains what is wrong with you.) Your doctor may also conduct tests on you. These also help in deciding what illness you have and why. People who have symptoms of lung disease (out-of-breath, coughing, tiredness, wheezing) may be given many different tests. These may include:

- **Pulmonary** (*puhl-mun-hairy*) **function tests:** tests that measure how well your lungs are working
- **Chest X-rays or CTs** (computed tomogram)
- **Lab tests:** **arterial** (*r-tear-ree-el*) blood gases and **pulse oximetry** (*ahk-sim-e-tree*)



## Pulmonary Function Tests

These tests measure how well the lungs are working. They also measure how well the lungs are moving oxygen to the blood. These breathing tests use special equipment. They are done by trained staff in a hospital or doctor's office. Most people with chronic obstructive pulmonary disease (COPD)\* have pulmonary function test results that are not normal. This means the airways in the lungs are blocked and air is trapped.

**\*COPD** is an umbrella term used to describe the progressive lung diseases including: emphysema (em-fa-see-ma), chronic bronchitis (kron-ick-brawn-kie-tis), refractory (re-frac-ta-ree) asthma (az-ma) and some forms of bronchiectasis (brawn-key-eck-tay-sis). If you have COPD you have trouble moving air in and out of your lungs because of damage to the airways and/or the air sacs.

Before the tests you will be told how to prepare for them. You may be told to:

- 1) Wear loose clothing.
- 2) Avoid large meals before the test.
- 3) Stop using some of your medicines before the test.

Pulmonary function tests include **spirometry** (spi-rom-e-tree), lung volume tests and **diffusing** (dee-few-zeen) **capacity** (kuh-pa-ci-tee) tests. Descriptions of these tests are provided here.

### Spirometry

**Spirometry** (spi-rom-e-tree) is the simplest lung function test. It is done by breathing into a tube, with a mouthpiece, that you hold in your mouth. You may be asked to breathe as hard as you can. You may be asked to do this three or four times.



#### Spirometry measures:

- How *much* air you can breathe in and out
- How *fast* you can breathe out that air

**REMEMBER:** With any test, if you do not understand what you are being asked to do, **ASK QUESTIONS**. And, if at any time you feel dizzy or faint, stop and tell the person giving you the test.

Here are the specific ways this test will measure your breathing:

- **Spirometry measures the amount of air you breathe out in one complete breath.** This is called the **Forced Vital Capacity (FVC)** measure. You will be asked to breathe in as fully as you can. Then you will blow out as hard and fast as you can until you cannot blow any more. (This measure is sometimes called the 6-second Force Expiratory Volume (FEV6). In these cases you will breathe out for just 6 seconds.) **Results:** Normal range is considered to be 80 to 120 percent (of the predicted normal value – see “Results EXAMPLE” sidebar). This test can be normal or near normal in some COPD patients.

- **Spirometry measures how much of the air you blew out was breathed out during the first second.** This is called the **Forced Expiratory Volume in the First Second (FEV1)** measure. **Results:** A reduced FEV1 measure means there is blockage to the flow of air out of your lungs. Your doctor will follow this number over time. The FEV1 measure is a good way to track if your COPD has become worse.

- **Spirometry measures the percentage of your total breath that was breathed out during the first second of the FVC test.** This is called **the Ratio**. It is your FVC (or FEV6) divided by your FEV1. This result is given as a percentage.

### A Spirometry Results EXAMPLE:

*A person with COPD may say, “I have only 30 percent lung function.” They are usually referring to their FEV1 value. Here’s what they mean. The predicted normal measure (for someone without lung disease) for FEV1 might be 3 liters. The COPD patient’s FEV1 is 1 liter. So their “percentage of predicted FEV1” is 33 percent. (The percentage is their result, 1, divided by the normal result, 3. This equals 33 or rounded to 30 percent.)*



**Results:** The average person can breathe out 60-90 percent of their breath during the first second. This decreases with age. For COPD patients, this percentage is lower than normal.

- **Spirometry measures how fast you breathe out air between 25 percent of your breath and 75 percent of your breath.** This is called the **Mid-Breath Forced Expiratory Flow (FEF<sub>25-70</sub>)**.

Your doctor will compare your spirometry results with what is normal for a person of your age, size and sex. This is called comparing to “normal values.” Your doctor may also have you do the spirometry test before and after you are given an inhaled medicine. This medicine is called a **bronchodilator** (*brawn-coe-die-lay-ter*). It helps open up the lungs’ airways.

After the spirometry test, your doctor will decide how serious your COPD is. Your doctor can do this by using the FEV1 measure you had, after you inhaled the medicine. The doctor will use a percentage of predicted FEV1 to give your COPD a “grade.” The grade will be mild, moderate, severe or very severe. These grades help your doctor decide the best treatment for you. See the chart below for more details on these grades or stages.

<b>Stage or Grade of COPD*</b>	<b>FEV1 Percent Predicted</b>
Mild	80 percent or more (but with a low FEV1/FVC ratio)
Moderate	50 to 80 percent
Severe	30 to 50 percent
Very Severe	Less than 30 percent

*\*The above grades match the Global Initiative for Chronic Obstructive Lung Disease (GOLD) definitions. Other groups may define the stages of COPD differently.*

## Peak Flow Testing

The peak flow is a very simple test. You blow out as fast as you can into a tube. The peak flow test is used a lot in asthma. There is evidence it may have a role with COPD. Peak flow testing cannot make a diagnosis of COPD. But an abnormal peak flow suggests that something is not right. Further testing, such as spirometry, can better define the problem. It is simpler and less expensive than spirometry.

## Lung Volumes

There are other tests that measure how well you are able to breathe.

**Total Lung Capacity (TLC)** is the amount of air your lungs can hold when you start breathing in. **Residual Volume** is the amount of air left in your lungs after you breathe out all the air you can.

These two lung volume tests are important. They can be measured in several ways:

- **Nitrogen Washout:** You breathe in pure oxygen. The air you breathe out is collected. It is studied to find out how much nitrogen is in it.
- **Helium Dilution:** You breathe a mixture of helium and oxygen.
- **Body Box:** You sit in a clear plastic or glass box. You breathe small panting breaths. This test is very accurate.

## Diffusing Capacity

The third type of lung function test your doctor may order for you is the **diffusing capacity (dee-few-zeen) (kuh-pa-ci-tee) test (DCLO)**. This test measures how well oxygen is moving from your lungs into your blood. This test also involves breathing into a tube while seated.



*Example of a body box*

When your lungs move oxygen to the blood, this is called **diffusion** (*dee-few-zjun*). How well your lungs do this is your lungs' *diffusing capacity*. There are three major factors involved in this:

- 1) How much lung tissue, filled with air, is in contact with blood?
- 2) How thick are the air sac walls? (Oxygen is moved into the blood in the lungs' air sacs. These are called **alveoli** (*al-vee-oh-lee*)).
- 3) How many red blood cells are there? (Red blood cells carry the oxygen from the lungs through the body.)

**Results:** The results of this test can tell your doctor if there is damage to the air sacs in your lungs and if so, how much. If you have COPD and get a low DLCO measure, some or all of your lung blockage is caused by **emphysema** (*em-fa-see-ma*). Emphysema occurs when the air sacs in the lungs are destroyed.

## Chest X-rays and CT Scans

A chest X-ray is done by having you sit or stand with your chest pressed to an X-ray machine. You are asked to take a deep breath and hold it. The X-ray machine takes a type of picture of your chest. Sometimes a side view of your chest is also taken. Unfortunately a chest X-ray is not a good test for examining lung disease or COPD.

A much better test is a computed tomogram or CT of the lungs. These tests are high-tech X-rays.

**Results:** CT scans are good for diagnosing emphysema and bronchiectasis, two types of COPD. A **high resolution** (*rez-oh-lew-shun*) CT scan can find emphysema in people whose lung function is normal. CT scans can also find other problems that may not be seen on a normal chest X-ray.

## Lab Tests

An **arterial** (*r-teer-re-el*) **blood gases** test may be ordered by our doctor. This test will show how well your lungs are getting oxygen into your blood and carbon dioxide out of your blood. (You breathe in oxygen. It is passed into your blood in the tiny air sacs in the lungs. Carbon dioxide is passed out of the blood and into the lungs. Carbon dioxide is the waste that is created when your tissues and muscles are active. You breathe out carbon dioxide.) For this test, blood is taken out of your arm, usually near your wrist. The blood is taken from an artery. Arteries are large blood vessels that carry blood filled with oxygen from the lungs through the body.

Several measurements are taken from this blood sample. They are:



- **Your blood's acid/base or "pH"**

**balance:** Body fluids are mostly water. But they also contain acids and bases. Your body tries to keep a balanced pH. A pH *below* 7.35 means you have too much acid in your body. This is called **acidosis** (*aa-see-doe-sis*). A pH *above* 7.45 means you have too much base. This is called **alkalosis** (*al-kah-loe-sis*).

- **The level of carbon dioxide in the blood:** This is done by measuring the pressure the carbon dioxide applies in the blood sample. This is called the "partial pressure of carbon dioxide from arterial blood" or PaCO<sub>2</sub>.

- **The level of oxygen in the blood:** This is done by measuring the pressure the oxygen applies in the blood sample. This is called the "partial pressure of oxygen from arterial blood" or PaO<sub>2</sub>.

- **The percentage of hemoglobin in your red blood cells that are carrying oxygen: Hemoglobin** (*he-mow-glow-bin*) is a protein in the red blood cells. These proteins carry oxygen all through your body. This percentage is called "arterial oxygen saturation" or SaO<sub>2</sub>.

A **pulse oximetry** (*ahk-sim-e-tree*) test is another way of measuring the amount of oxygen in the blood. But this test is done without taking a blood sample. The amount of oxygen is only *estimated*. A pulse oximeter is used for this simple test. This small device is clipped to your finger or an ear lobe. It gives fast results.

Hemoglobin that carries oxygen is a different color from hemoglobin *not* carrying oxygen. Blood carrying oxygen is bright red. The oximeter shines a special light through the skin. It measures how much of the light is absorbed by the hemoglobin. This is used to get the percentage of hemoglobin carrying oxygen, or the amount of oxygen in the blood.

Pulse oximetry is very good for measuring oxygen levels while walking, exercising or sleeping. It can help with deciding if there is a need for oxygen therapy. (See the *Slim Skinny Reference Guide*®: *Oxygen Therapy*). This simple test is not as accurate as the

### **Blood Cell Parts Measured in a CBC:**

**Red blood cells:** These contain hemoglobin which carries oxygen. Long periods of low oxygen will cause the number of these cells to increase.

**Hemoglobin:** This is the protein in red blood cells that carries the oxygen. The count of this can increase during periods of low oxygen (as with red blood cells).

**Platelets:** This is a part of the blood that helps form clots.

**White blood cells:** also called leukocytes. They are part of our immune system. They help our bodies fight infection. They move to the area where an infection has started.

**Hematocrit** (*he-maa-toe-crit*): This is the percentage of blood that are red blood cells. There can be a difference between the red blood count and the hematocrit. This can mean the red blood cell size is not normal. (The cells may be too small when the body does not have enough iron. The cells can be too large when the body does not have enough vitamin B<sub>12</sub>.)

arterial blood gases tests. So, for patients with severe COPD, the arterial blood gases test is used more.

Other common lab tests your doctor may order are a complete blood count (CBC), and a basic chemistry profile. (See the CBC sidebar.)

## Alpha-1-Antitrypsin Tests

A disease called **Alpha-1-Antitrypsin** (*al-fa-one-an-tee-trip-sin*) **Deficiency** (*dee-fi-shin-see*) is known to cause COPD. People with Alpha-1 have a much lower than normal level of the blood protein called alpha-1-antitrypsin. This protein protects the lungs from irritation caused by breathing in toxins. Alpha-1 is a **genetic** (*ja-net-ick*) disorder. This means it is passed from parents to their children. You can find out if you have Alpha-1 through a simple blood test. Everyone with COPD should be tested for Alpha-1. This is very important because there is a specific treatment for Alpha-1. It can slow the progress of COPD. (For more information on Alpha-1-Antitrypsin Deficiency, visit the Alpha-1 Foundation's website at [www.alpha-1foundation.org](http://www.alpha-1foundation.org) or AlphaNet at [www.alphanet.org](http://www.alphanet.org))

## Cardiopulmonary Exercise Testing

(*car-dee-oh-puhl-mun-nairy*)

This is an exercise test your doctor may order to help define how limited you are. It is done on an exercise bike or a treadmill. It differs from the "usual" cardiac stress tests. It gives information not only on how your heart works during exercise but also how your lungs work. It also gives information about how your muscles work and how your heart, lungs and muscles work together. It can



help decide how much of your breathing problem is related to your heart, your lungs, or your muscles. Often the test can help your doctor to set up an exercise program specifically for your needs.

## 6 Minute Walk

This is a walking test. It measures how far you can walk in 6 minutes. It allows your doctor to determine your activity level and how much oxygen you may need.

## And finally...

The most common lung disease tests have been explained here. However, it is not possible to explain every detail of every test. This information should be used only as a guide. If you have questions or concerns about your specific test results, **ASK YOUR DOCTOR.**









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