Pulmonary Function Testing

by Christopher Green, M.D.

Pulmonary function testing, or lung function testing, is a method of determining how well your lungs and airways are working. The most common pulmonary function test (PFT) is called spirometry. This is the test that most of you are familiar with. To do this test you take in as deep a breath as possible, and blow out all of the air as fast and as hard as you can. Several blows are needed to assure that your best performance has been measured. At the University of Wisconsin CF Center, spirometry is carried out on a routine basis and at nearly every visit. We do this test because it gives us a series of numbers which allows us to compare each patient's lung function with their lung function in the past. Following spirometry closely allows us to intervene early when lung function is falling and to fine tune your therapy. If you carry out lung function testing several times during a day or once a day for several days in a row there will be changes of a few percent in the various numbers measured. These small changes have little clinical meaning. Larger changes may indicate a need for adjustments in your therapy.

Spirometry may be carried out while you are sitting in a chair or while you are standing. In adults, the testing is usually carried out with the patient sitting. In children either approach is satisfactory. You may request to stand or to sit for your testing, but you should be consistent in this request. You should either be tested sitting each time or standing each time.

There are many other pulmonary function tests available through our laboratory. The term pulmonary function test, or PFT, is a general term. Just as there are many blood tests (hemoglobin level, blood electrolytes, tobramycin levels, and many others) there are many pulmonary function tests. Each test gives us different information. The first test discussed, spirometry, is by far the most common test carried out at our CF Center and CF centers around the world.

The most common abnormality seen in patients with cystic fibrosis is called obstructive lung disease. Because of infection/inflammation in the airways, mucus, and perhaps a degree of muscle constriction in the airways, the air flow when one is asked to forcefully exhale is lower than normal. Graphically, this is expressed as a flow volume curve. Flow is on the y-axis and volume is on the x-axis. In the graph pictured here, the flow volume curve is normal. The flow rapidly rises to a peak, and then the descending limb of the flow volume curve is straight.
The flow volume curve here illustrates obstructive lung disease. The descending limb of the flow volume curve is scooped out or concave with respect to the x-axis. This concave appearance of the flow volume curve represents decreased air flow.

The second common pulmonary function test is called lung volumes. At our center this test is usually carried out in the body plethysmograph or body box. This is the booth you have seen in the pulmonary function laboratory. You sit in the booth with the door closed and pant into the mouthpiece. Using measurements obtained from the body plethysmograph, we can calculate the total amount of air in your lungs after you have taken a full breath and the remaining amount of air in your lungs when you have blown out all the way. The total amount of air in your lungs after a full inspiration is called total lung capacity (TLC). The amount of air in your lungs after you have fully exhaled is called residual volume (RV). The ratio of these two numbers (RV/TLC) is a sensitive measure of mild lung disease.

Having normal lung function as measured by spirometry and lung volumes does not imply that your lungs are completely normal. Research has shown that patients with cystic fibrosis have evidence of lung inflammation or lung infection in the first few months of life. Spirometry and lung volumes do not necessarily pick up these very early changes. These changes have been picked up using a procedure called bronchoscopy. Bronchoscopy is a more invasive test and is not a test that is carried out routinely at any cystic fibrosis center.

We have two tests available which are occasionally used to collect further information on how your lungs function. The first test is called forced oscillation measurement of respiratory system resistance. Some of you may remember research Dr. Green carried out in the mid eighties using forced oscillation. The forced oscillation test available now uses new equipment. This test is attractive because it requires only normal breathing with your mouth on a mouthpiece. It may provide some insights into early changes in CF lung disease.

A second test which some of you may perform is called the single breath oxygen test. In this test you take a breath of pure oxygen and then blow out slowly into the testing equipment. The equipment measures the amount of nitrogen in the air that you breath out. Measurements from this test also provide insights into early lung disease in patients with cystic fibrosis.

Finally, infant pulmonary function testing is being used more and more in the United States and around the world. For this test infants are sedated with chloral hydrate. Measurements are made of air flowing in and out of the lungs both with normal breathing and with the squeeze or hug technique. In the hug technique, a cuff around the chest and tummy blows up quickly and helps the baby to blow out quickly.
Some of you may be asked to carry out spirometry before and after breathing in a bronchodilator. Changes which may occur after breathing in a bronchodilator allow your doctor to adjust your therapy properly. Many other pulmonary function tests are available, but are used less frequently. If you have questions about PFTs, please ask your physician or another member of the Cystic Fibrosis Center staff.

A Glossary of Spirometry Terminology

FVC - forced vital capacity: the total amount of air that can be blown out after inhaling as deeply as possible and then blowing out as hard and forcefully and long as possible. (unit is in liters)

FEV₁ - forced expiratory volume in one second: the amount of air that is blown out in the first second of the forced vital capacity maneuver. (unit is in liters)

FEFₘₐₓ - forced expiratory flow, maximum (also known as PEF, peak expiratory flow or PEFR, peak expiratory flow rate): the fastest flow that can be forcefully blown out. (unit is in liters/second, although home peak flow meters measure this in liters/minute)

FEF₂₅₋₇₅ - forced expiratory flow between 25% and 75% of the vital capacity (also known as MMEF, maximum mid-expiratory flow): the fastest flow that can be forcefully blown out within the middle half of the forced vital capacity maneuver. (unit is in liters/second)