Pulmonary function measurements

Pulmonary function tests (PFTs) are non-invasive tests that show how well the lungs are working.

The tests measure lung volume, capacity, rates of flow, and gas exchange. This information can helpyour healthcare provider diagnose and decide the treatment of certain lung disorders.How the Test is performed.

Three basic types of measurements are made in the pulmonary clinic: ventilation, distribution anddiffusion.

- Ventilation deals with the measurement of the body as an air pump, determiningits ability to move volumes of air and the speed with which it moves the air.
- Distribution measurements provide an indication of where gas flows in the lungs and whether ornot disease has closed some sections to air flow.
- Diffusion measurements test the lung's ability to exchange gas with the circulatory system.

The most widely performed measurement is **ventilation**. This is performed using devices called spirometers that measure volume displacement and the amount of gas moved in a specific time. Usually this requires the patient to take a deep breath and then exhale as rapidly and completely as possible. Called the forced vital capacity, this gives an indication of how much air can be moved bythe lungs and how freely this air flows.

Distribution measurements quantify degrees of lung obstructions and also determine the residual volume, which is the amount of air that cannot be removed from the lungs by the patient's effort. The residual volume is measured indirectly, such as with the nitrogen washout procedure.

Diffusion measurements identify the rate at which gas is exchanged with the blood stream. This is difficult to do with oxygen since it requires a sample of pulmonary capillary blood, so it is usually done by measuring the diminishment of a small quantity of carbon monoxide mixed with the inhaledair.

Pulmonary function analysers provide the means for automated clinical procedures and analysis techniques for carrying out a complete evaluation of the lung function or the respiratory process. The respiratory activity ensures supply of oxygen to and removal of carbon dioxide from the tissues. These gases are carried in the blood—oxygen from the lungs to the tissues and carbon dioxide from the tissues to the lungs.

Air or tidal volume is about 0.5, only part of this volume takes part actually in oxygenating the blood, because no exchange of gases between air and blood takes place in the mouth, trachea and bronchi.The air filling these parts is called 'Dead Space' air.

The ultimate function of the lungs is to exchange gas with the environment,

measurement of thearterial blood gases would be sufficient to assess lung function. The ability of the pulmonary system to move air and exchange oxygen and carbon dioxide is affected by the various components of the air passages, the diaphragm, the rib cage and its associated muscles and by the characteristics of the lung tissue itself.

The pulmonary function can be assessed by means of two major classes of tests. These are:

(i) Evaluation of the mechanical aspects of pulmonary function, which affects the bulk gastransport into and out of the lungs.

(ii) Evaluation of gas exchange or diffusion at the alveoli.

Respiratory Volumes

Tidal Volume (TV): The volume of gas inspired or expired (exchanged with each breath)duringnormal quiet breathing, is known as tidal volume.

Minute Volume (MV): The volume of gas exchanged per minute during quiet breathing. It isequal tothe tidal volume multiplied by the breathing rate.

Alveolar Ventilation (AV): The volume of fresh air entering the alveoli with each breath Alveolar Ventilation = (Breathing rate) ¥ (Tidal volume – Dead space).

Inspiratory Reserve Volume (IRV): The volume of gas, which can be inspired from a normalend-tidalvolume.

$$IRV = VC – (TV + FRC)$$

Expiratory Reserve Volume (ERV): The volume of gas remaining after a normal expiration lessthevolume remaining after a forced expiration.

$$ERV = FRC – RV$$

Residual Volume (RV): The volume of gas remaining in the lungs after a forced expiration

Respiratory Capacities

Functional Residual Capacity (FRC): The volume of gas remaining in the lungs after normalexpiration.

Total Lung Capacity (TLC): The volume of gas in the lungs at the point of maximal inspiration.

$$TLC = VC + RV$$

Vital Capacity (VC): The greatest volume of gas that can be inspired by voluntary effort aftermaximum expiration, irrespective of time.

Inspiratory Capacity (IC): The maximum volume that can be inspired from the resting endexpiratory position.

Dead Space: Dead Space is the functional volume of the lung that does not participate in gasexchange.

Pulmonary function tests are performed for the assessment of the lung's ability to act as a mechanical pump for air and the ability of the air to flow with minimum impedance through the conductingairways. These tests are classified into two groups: single-breath tests and multiple-breath tests.

There are three types of tests under the single-breath category are:

- Tests that measure expired volume only.
- Tests that measure expired volume in a unit time.
- Tests that measure expired volume/time

In the class of multiple-breath test measurements is the Maximal Voluntary Ventilation (MVV)whichis defined as the maximum amount of air that can be moved in a given time period

Normal Results

Normal values are based on your age, height, ethnicity, and sex. A value is usually consideredabnormal if it is approximately less than 80% of your predicted value.

Different measurements that may be found on your report after pulmonary function tests include:

- Diffusion capacity to carbon monoxide(DLCO)
- Expiratory reserve volume (ERV)
- Forced vital capacity (FVC)
- Forced expiratory volume in 1 second(FEV1)
- Forced expiratory flow 25% to 75%(FEF25-75)
- Functional residual capacity (FRC)
- Maximum voluntary ventilation (MVV)
- Residual volume (RV)
- Peak expiratory flow (PEF)
- Slow vital capacity (SVC)
- Total lung capacity (TLC)

What Abnormal Results Mean

Abnormal results usually mean that you may have chest or lung disease.
Some lung diseases (such as emphysema, asthma, chronic bronchitis, and infections) can make thelungs contain too much air and take longer to empty. Other lung diseases make the lungs scarred and smaller so that they contain too little air and are poorat transferring oxygen into the blood. Examples of these types of illnesses include:

- Extreme overweight

- Pulmonary fibrosis (scarring or thickening of the lung tissue)
- Sarcoidosis and scleroderma

Muscular weakness can also cause abnormal test results, even if the lungs are normal, that is, similar tothe diseases that cause smaller lungs.

Risks

There is a small risk of collapsed lung (pneumothorax) in people with a certain type of lung disease. The test should not be given to a person who has experienced a recent heart attack, has certain othertypes of heart disease, or has had a recent collapsed lung.

Spirometer

Spirometry is a standard test doctors use to measure how well your lungs are functioning. The testworks by measuring airflow into and out of your lungs.

To take a spirometry test, you sit and breathe into a small machine called a spirometer. This medicaldevice records the amount of air you breathe in and out and the speed of your breath.

Spirometry tests are used to diagnose these conditions:

- COPD
- asthma
- restrictive lung disease (such as interstitial pulmonary fibrosis)
- other disorders affecting lung function

They also allow your doctor to monitor chronic lung conditions to check that your current treatment is improving your breathing.

Spirometry is often done as part of a group of tests known as pulmonary function tests. It can help distinguish between diseases with similar symptoms and determine whether the condition is obstructive (in which exhalation is impaired) and/or restrictive (in which inhalation is impaired).

Spirometry is rarely used alone to diagnose a lung condition. It is typically combined with other findings, such as a physical exam, medical history review, and imaging tests, to reach a diagnosis.

Spirometry is also useful for evaluating disease progression (namely, whether it is getting better, worse, or staying the same). This can help determine if a treatment is working or needs to be modified. Spirometry may also be used before lung cancer surgery to predict how well a patient will tolerate the operation and manage once a portion or lobe of a lung is removed.

Spirometry side effects

Few complications can occur during or after a spirometry test. You may feel a bit dizzy or have some shortness of breath immediately after performing the test. In very rare cases, the test may trigger severe breathing problems.

The test requires some exertion, so it isn't recommended if you recently had a heart condition or have other heart problems.

Interpreting Results

Since the results of your test are immediately available, your doctor will likely be able to review themwith you at your appointment.

Spirometry provides two important measurements of lung function:

- Forced vital capacity (FVC), a measure of how much air you can blow out of your lungs with acomplete breath
- Forced expiratory volume (FEV1), the amount of air you can blow out of your lungs in one second When the doctor is satisfied that the test results are valid, the information will be used to determine iflung function is normal or abnormal. Only the greatest FEV1 and FVC values will be used for this. Allothers will be ignored.

Abnormal results indicate one of three possible breathing patterns:

- Obstructive
- Restrictive

- A combination of both