6- Lung Volumes and Pulmonary Function Tests

Pulmonary function tests (PFTs) are noninvasive diagnostic tests that provide measurable feedback about the function of the lungs. By assessing lung volumes, capacities, rates of flow, and gas exchange, PFTs provide information that, when evaluated by doctor, can help in diagnosis of certain lung disorders.

Some medical conditions may interfere with ventilation. These conditions may lead to chronic lung disease. Conditions that interfere with normal ventilation are categorized as obstructive or restrictive. An obstructive condition occurs when air has difficulty flowing out of the lungs due to resistance, causing a decreased flow of air. A restrictive condition occurs when the lungs or chest muscles are unable to expand adequately, creating a disruption in air flow.

Why the Test is Performed

Pulmonary function tests are done to:

- Diagnose certain types of lung disease (such as asthma, bronchitis, and emphysema)
- Find the cause of shortness of breath
- Measure whether exposure to chemicals at work affects lung function
- Check lung function before someone has surgery
- Assess the effect of medication measure progress in disease treatment.

Lung volumes:-

There are four different volumes, they are:

1- The tidal volume (TV):- It is the volume of air inspired or expired with each normal breath. It is about 500 ml. in the normal young adult subject.

2-The inspiratory reserve volume (IRV):- It is extra lung volume that can be inspired over the normal tidal volume. It is about 3000 ml.

3- The expiratory reserve volume (ERV):- It is the amount of air that can still be expired by forceful expiration after the end of a normal tidal expiration. It is about 1100 ml.

4- The residual volume (RV):- It is the volume of air still remaining in the lung after the most forceful expiration. It is about 1200 ml. this volume cannot be measured by spirometer.

Lung capacities:-

There are four different capacities. The lung capacity includes two or more lung volumes. They are:

1- The inspiratory capacity (IC):- Maximal volume of air inhaled after a normal expiration. It equals the TV plus the IRV (about 3500 ml).

2- The functional residual capacity (FRC):- The volume of gas that remains in the lung at the end of a passive expiration. It equals the ERV plus RV (2300 ml).

3- The vital capacity (VC):- The total volume of air that can be forcibly expired after maximal inspiration. It equals the IRV plus the TV plus the ERV (4600 ml).

4- The total lung capacity (TLC):- It is equal to the vital capacity plus the residual volume (5800 ml). It is the maximum volume to which the lung can be expanded with greatest possible inspiratory effort.

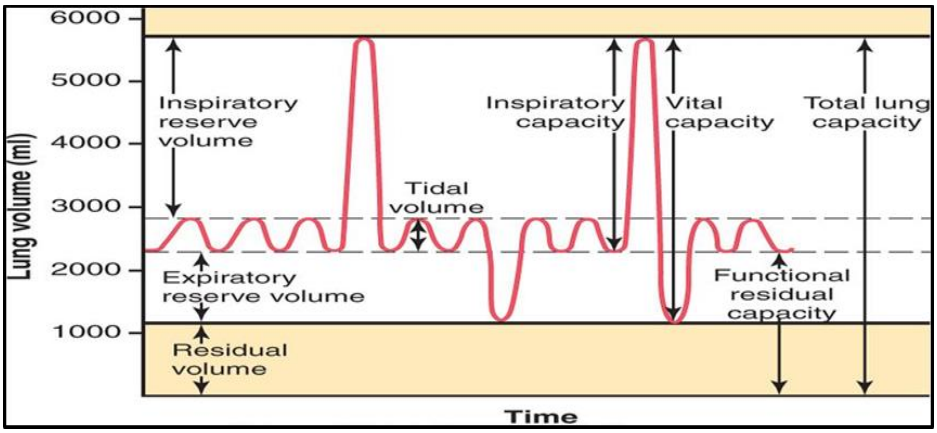


Figure 6-1: Lung volumes and capacities

Pulmonary function tests encompasses a wide variety of objective tests to assess lung function which provide objective and standardized measurements for assessing the presence and severity of respiratory dysfunction, they include:

1. Forced vital capacity (FVC). This is the amount of air exhaled forcefully and quickly after maximum inspiration.

2. Forced expiratory volume in one second (FEV1). This is the volume of air expired during the first second of the FVC test.

3. FEV1/FVC: the ratio of FEV1 to FVC X 100 (expressed as a percent); an important value because a reduction of this ratio from expected values is specific for obstructive rather than restrictive diseases.

4. Peak expiratory flow rate (PEFR). This is the maximum volume during forced expiration.

Some PFTs involve the use of a spirometer which is an instrument that measures the amount of air breathed in and/or out and how quickly the air is inhaled and expelled from the lungs while breathing through a mouthpiece. The measurements are recorded on a device called a spirograph. Spirometer can be used to diagnose lung diseases & to

differentiate between obstructive & restrictive lung diseases. Spirometer cannot measure residual volume (RV) & dead space. It is measured by whole body plethysmography & Helium dilution method & many other methods.

The normal values for PFTs vary from person to person. The amount of air inhaled and exhaled in your test results are compared to the expected average in someone of the same age, height, sex, and race. In addition, results are compared to your previous test results, if previous testing has been done. If you have abnormal PFT measurements or if your results are different from previous tests, you may be referred for other diagnostic tests to establish a medical diagnosis.

Interpretation of Spirometry:

Step 1: obstruction or not?

Low FEV1/FVC (<70%) = obstruction

Step 2: Interpret severity (based upon FEV1)

Restriction: FEV1 and FVC reduced in proportion (i.e. normal FEV1/FVC ratio)

Flow/Volume Loops

Obstruction – concave, scooped appearing

Restriction – decreased VC, normal shape

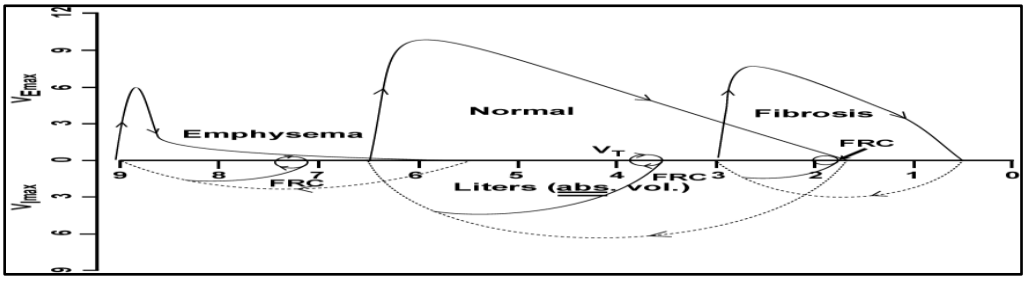
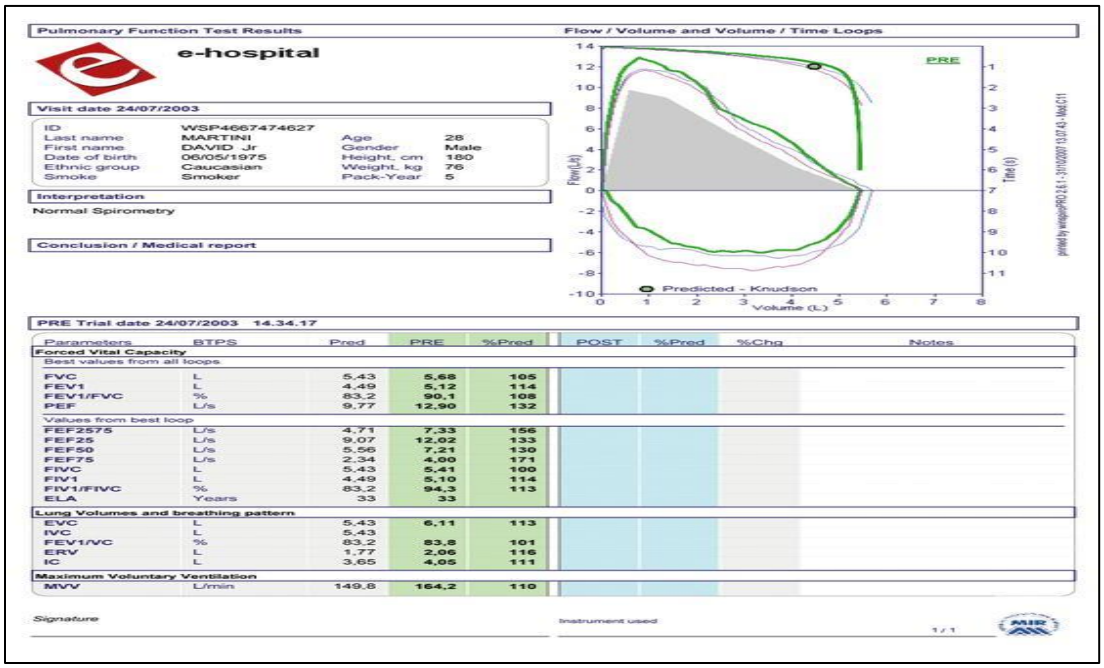


Figure 6-2: shape of spirograph



Pulmonary Function Test Results

e-hospital

Visit date 24/07/2003

ID	WSP4667474627		
Last name	MARTINI	Age	28
First name	DAVID Jr	Gender	Male
Date of birth	06/05/1975	Height, cm	180
Ethnic group	Caucasian	Weight, kg	76
Smoke	Smoker	Pack-Year	5

Interpretation

Normal Spirometry

Conclusion / Medical report

Flow / Volume and Volume / Time Loops

PRE Trial date 24/07/2003 14.34.17

Parameters	BTPS	Pred	PRE	%Pred	POST	%Pred	%Chg	Notes
Forced Vital Capacity								
Best values from all loops								
FVC	L	5,43	5,68	105				
FEV1	L	4,49	5,12	114				
FEV1/FVC	%	83,2	90,1	108				
PEF	L/s	9,77	12,90	132				
Values from best loop								
FEF2575	L/s	4,71	7,33	156				
FEF25	L/s	9,07	12,02	133				
FEF50	L/s	5,56	7,21	130				
FEF75	L/s	2,34	4,00	171				
FIVC	L	5,43	5,41	100				
FIV1	L	4,49	5,10	114				
FIV1/FIVC	%	83,2	94,3	113				
ELA	Years	33	33					
Lung Volumes and breathing pattern								
EVC	L	5,43	6,11	113				
IVC	L	5,43						
FEV1/VC	%	83,2	83,8	101				
ERV	L	1,77	2,06	116				
IC	L	3,65	4,05	111				
Maximum Voluntary Ventilation								
MVV	L/min	149,8	164,2	110				

Signature

Instrument used

1 / 1

Figure 6-3: Spirograph

Figure 6-4: Spirobank 2

Figure 6-5:Spirolab

Objective:

Measurement of respiratory volumes and function tests.

Materials and instruments:

1- Subject.

2- Spirometer.

Procedure:

1- The subject is sitting.

2- Use clean disposable mouthpiece.

3- Ask subject to breath in or out of the spirometer.