Balqa Applied University
Faculty of Medicine

Physiology lab 1 Respiratory system
Pulmonary function test

Respiration Function Test
or
PULMONARY FUNCTION TEST
(PFT)

Objectives:

The purpose of this lab is to introduce some basic principles and techniques of respiratory physiology.

Students should be able to:

1. Perform various pulmonary function tests to determine some static and dynamic volumes of the lung.
2. Identify the equipment: spirometer, peak flow meter and the use of these instruments.
3. State and define lung volumes and capacities that can be measured by spirometer.
4. Identify the peak flow meter importance in asthma action plan.

Introduction:

Ordinarily, our breathing activities are so automatic that we are not conscious of the changes in the lunges volumes that occur from time to time.

Lung Volumes and Capacities:

By convention, the volumes of the lung are divided into: defined volumes and capacities. Volumes are integral units whereas capacities consist of 2 or more volumes. There are basically four lung volumes and three lung capacities. **Table 1** summarizes the various lung volumes and capacities.

Lung volume	Definition
Tidal volume (TV)	The volume of air moved during normal quiet breathing (about 0.5 L).
Inspiratory reserve volume (IRV)	The volume of air that can be forcefully inspired following a normal quiet inspiration. (about 2.5 - 3.5L).
Expiratory reserve volume (ERV)	The volume of air that can be forcefully expired after a normal or resting expiration (about 1.0L).
Residual volume (RV)	The volume of air remaining in the lungs after a forceful expiration (about 1.0L).
Vital capacity (VC)	The summation of Tidal volume, Inspiratory reserve volume and Expiratory reserve volume. VC= IRV+ERV+TV.
Inspiratory capacity (IC)	The amount of air that the lungs will hold after a normal expiration (i.e. inspiratory reserve + tidal volume). IC= IRV+TV.

Functional residual capacity (FRC)	The amount of air remaining in the lung after normal expiration. FRC= RV+ERV.
Total Lung Capacity (TLC)	The total amount of air in the lungs following a maximal inspiration. TLC= IRV+ERV+TV+RV.

Table 1: Definitions of lung volumes and capacities

Spirometer

You will be using a device called the spirometer to measure some lung volumes and capacities on a volunteer subject. But in clinical settings, this device is used on patients with respiratory disorders (e.g. Asthma, COPD,,,) to determine their respiratory function. While the spirometer may appear intimidating at first, it functions quite simply. The basic idea is that there is an Oxygen source and a Carbon Dioxide sink that allows the subject to inhale and exhale solely within the apparatus (providing a closed breathing system). **Figure 1** gives an idea for the spirometer and its parts.

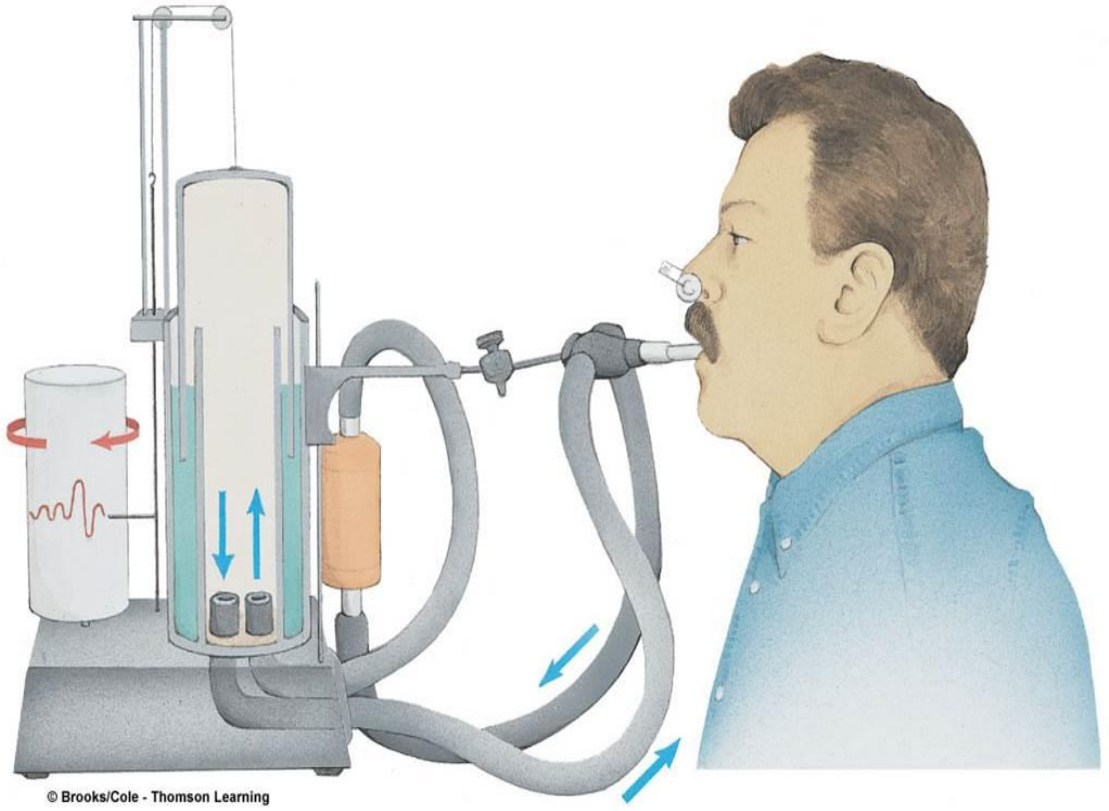

Figure 1: the principle of the spirometer.

The result diagram is called **spirogram** which will be used to calculate the different static lung volumes and capacities. Spirometry can measure volumes of lung either directly or indirectly. Because we cannot expire all the gas from our lungs, we cannot measure Residual Volume (RV) directly, but we can calculate it using the following formula.

RV= TLC-VC

Figure 2 is an example of a spirogram.

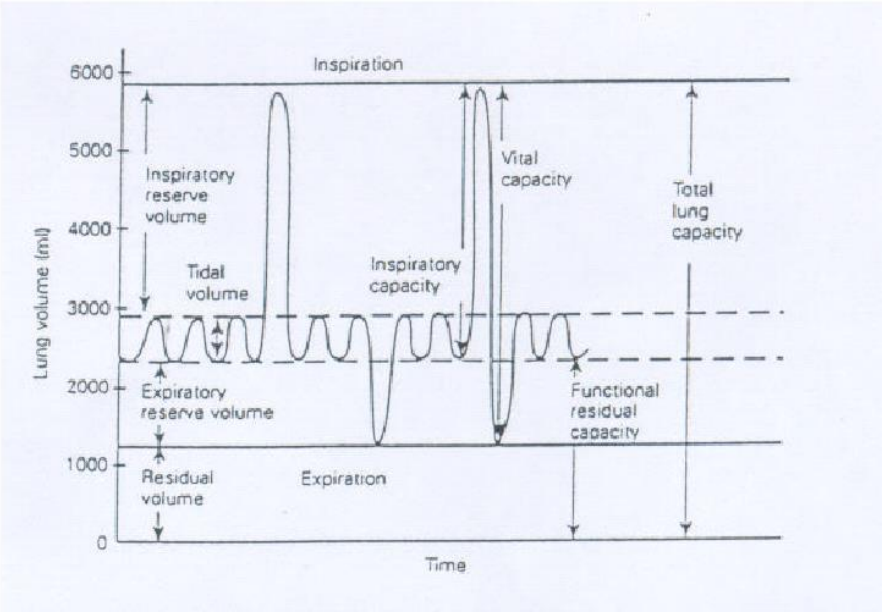

Figure 2: The spirogram, not all volumes and capacities appear on the chart.

The main volume fractions of the lung (**static lung volumes**) can be measurable e.g. (tidal volume, the Inspiratory Reserve Volume, and the expiratory reserve volume). There are additional parameters which can be determined only by estimating them. The measurable or calculated static lung volumes are (Inspiratory capacity, vital capacity, Functional Residual capacity and Residual Volume).

Measurable fraction (Directly measured)	Tidal volume Inspiratory Reserve Volume Expiratory reserve volume
Calculated static lung volumes (Indirectly measured)	Inspiratory capacity Vital capacity Functional Residual capacity Residual Volume

Table 2: The static lung volumes

Pulmonary function tests (PFTs) are a wide variety of tests that are essential in the evaluation of the entire respiratory system. These tests are useful in the assessment and diagnosis of pulmonary disease and aid in determining the necessary course of treatment. PFTs are essential in diagnosing obstructive pulmonary disease (OPD) e.g. (asthma, emphysema) versus restrictive lung diseases including pneumonia and pulmonary fibrosis.

Pulmonary function tests allow the determination of **lung volumes and airflow rates** which provides information in the evaluation of various lung diseases. These tests include determination of static and dynamic lung volumes. **The reference standard values** for pulmonary functions are the function of age, body build, gender & emotional state.

Lung volumes that depend upon the rate at which air flows out of the lungs are **termed dynamic lung volumes**. The various dynamic volume fractions are listed in **Table 3**

Measurable fraction	**FVC(Forced Vital Capacity)**	Volume achieved by the quickest possible exhalation after maximal inhalation
	FEV1 (Forced expiratory volume in the first second)	Volume achieved in the first second by the quickest possible exhalation after maximal inhalation
	SVC(Slow Vital Capacity)	Lung volume measured from a complete expiration following a deep inspiration
	MVV(Maximum Voluntary ventilation)	Maximum volume of air which can be moved on inhalation and expiration while breathing as deeply and as rapidly as possible.
	MV(Minute Ventilation)	Volume of inspired or expired air in liters per minute measured over a minimum of one minute. MV= Tidal volume* Respiratory rate
	AV(Alveolar ventilation)	Volume of air which involve in the alveolar exchange per minute. AV=Pulmonary ventilation – dead space

Table3: Dynamic lung volumes

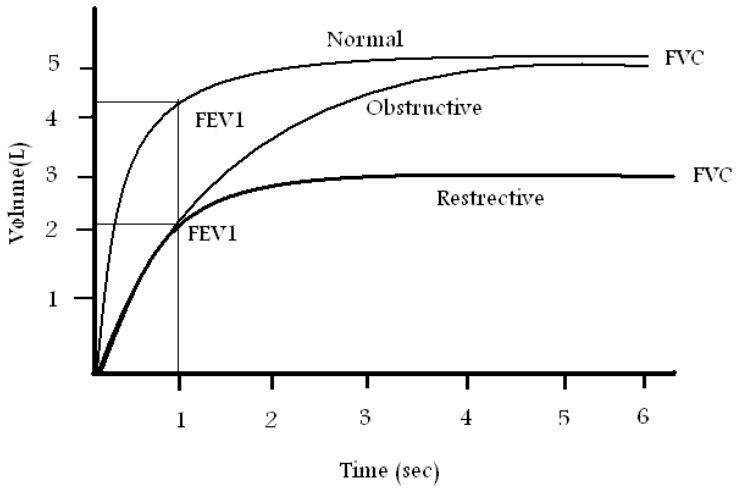

Figure 3: The results of FVC for normal, Obstructive and restrictive patients.

Spirometer type you will use is Cosmed

This spirometer is compact unit with a liquid crystal display and high quality thermal printer. Measurements are made with a lightweight and hygienic open pneumotacho sensor. With this instrument you can do the following:

1. **Spirogram:** from which we can measure: TV, IRV, ERV**,** IC, VC**.**
2. **FVC (Forced Vital Capacity):** from which we can measure FEV1.
3. **SVC (Slow Vital Capacity).**
4. **MVV (Maximum Voluntary Ventilation).**
5. **MV (Minute Ventilation).**

Peak flow meter

A "normal" peak flow rate is based on a person's age, height, sex and race.
It is used to help the patient to be part of his asthma treatment plan.
The patient must exhale as fast as possible after a deep inhalation through the mouth piece.
According to the reading the patient will fall into certain zone.
Figure 4 shows a peak flow meter.
The following measures are determined between the patient & his physician:

- Green Zone:

80 to 100 percent of your usual or "normal" peak flow rate signals all clear. A reading in this zone means that your asthma is under reasonably good control. Continue your prescribed program of management.

- Yellow Zone:

50 to 80 percent of your usual or "normal" peak flow rate signals caution. It is time for decisions. Your airways are narrowing and may require extra treatment. Your symptoms can get better or worse depending on what you do, or how and when you use your prescribed medication. You and your healthcare provider should have a plan for yellow zone readings.

- Red Zone:

Less than 50 percent of your usual or "normal" peak flow rate signals a Medical Alert. Immediate decisions and actions need to be taken. Severe airway narrowing may be occurring. Take your rescue medications right away. Contact your healthcare provider now and follow the plan they have given you for red zone readings.

Figure 4 Peak flow meter

Asthmatic patient test

My Asthma Action Plan

Name: _____ Date:_____

Parent/Guardian:_____

Healthcare Provider:_____

Medical Record #:_____

Phone for healthcare provider:_____

Phone for taxi or friend:_____

Traffic light colors help you learn about asthma symptoms and what to do.

RED means **I feel AWFUL**. Get help right away.

YELLOW means **I do NOT feel good**. Add a relief medicine to feel better fast.

GREEN means **I feel GOOD**. Use long-term control medicine.

I feel GOOD

- Breathing is easy.
- No cough or wheeze.
- Can work and play

☐ Use asthma long-term control medicine.

Medicine:	How taken:	How much:	When:
_____	_____	_____	_____ times a day
_____	_____	_____	_____ times a day
_____	_____	_____	_____ times a day

Peak Flow Numbers:
_____ to _____

20 minutes before exercise or sports, take _____puffs of this medicine:
_____

I do NOT feel good

- Cough
- Wheeze
- Hard to breathe
- Wake up at night.
- Can do some, but not all activities.

TAKE_____ puffs of quick-relief medicine. If not back in the Green Zone within 20 to 30 minutes, take _____more puffs.

Medicine:	How taken:	How much:	When:
_____	_____	_____	every_____ hours

KEEP USING long-term control medicine:

Medicine:	How taken:	How much:	When:
_____	_____	_____	_____ times a day
_____	_____	_____	_____ times a day

Peak Flow Numbers:
_____ to _____

Call healthcare provider if quick-relief medicine does not work OR if these symptoms happen more than twice a week.

I feel AWFUL

- Medicine does not help.
- Breathing is hard and fast.
- Can't walk well.
- Can't talk.
- Feel very scared.

Get help now! Take these quick-relief medicines until you get emergency care.

Medicine:	How taken:	How much:	When:
_____	_____	_____	_____
_____	_____	_____	_____

Peak Flow Number is Lower than _____

Call 911 if can't walk or talk because it is too hard to breathe OR if lethargic OR if skin is sucked in around neck and ribs during breaths OR if lips or fingernails are gray or blue.