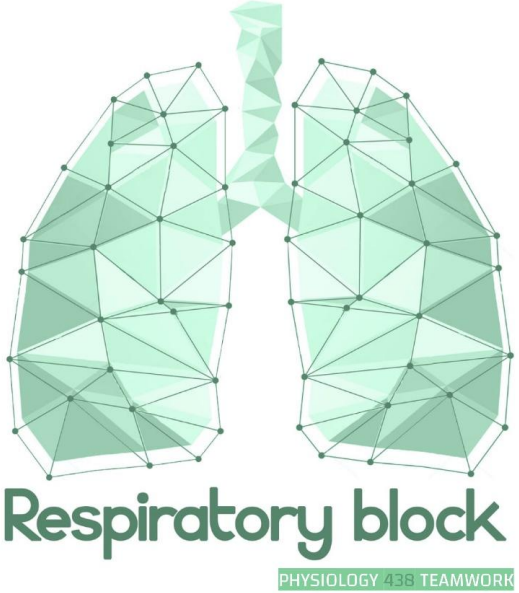
Lung function in health and disease



- Red: important
- Black: in male / female slides
- Pink: in female slides only
- Blue: in male slides only
- Yellow: notes
- Gray: extra information
- Textbook: Guyton + Linda

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Objectives

1. Describe the structure of the spirometry.
2. Identify the physiological factors that influence the pulmonary function tests (PFTs).
3. List the different indications of pulmonary function tests (PFTs).
4. Compare between PFTs in obstructive and restrictive pulmonary diseases.
5. Interpret the changes in PFTs in smokers in comparison to nonsmokers.

Types of lung function tests include

Spirometry

It is the measurement of the speed and the amount of air that can be exhaled and inhaled.

Body Plethysmography test

The patient is required to sit in an airtight chamber that resembles a small telephone booth. Inside the chamber is an affixed spirometer, which is used to determine the flow properties of the patient.

Cardiopulmonary Stress Testing

Used for evaluation of dyspnea that is out of proportion to findings on static pulmonary function tests.

Diffusing Capacity of Lung for Carbon Monoxide

To evaluate the presence of possible parenchymal lung disease.

Pulse Oximetry

The principle is measurement of O_2 saturation by spectrophotometry.

Spirometry

is a method to record volume movement of air into and out of the lungs.

Spirometry is a simple most commonly used test to:

- Assess the lung performance.
- Measure the physiological parameters:
  - Lung volumes
  - Capacities
  - Flow rate
- Play a critical role in the diagnosis, differentiation and management of respiratory diseases.
- Differentiate between the obstructive and restrictive lung conditions.

Physiological conditions affecting lung functions:

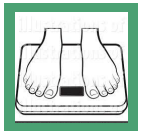
1- Age

2- Gender

In females it is 20%-25% less than males because females have greater body fat mass. And they are greater in large and athletic people.

3- Height

Increased height will result in longer chest cavity thus it increases lung volume



4- Weight

Excessive fat in the abdomen will put pressure on the diaphragm so it will limit the lung function.

5- Ethnic group

6- Pregnancy

Enlarged uterus will also put pressure on the diaphragm.

Indications of Spirometry *in which conditions you will suggest spirometry?

Symptoms

- Dyspnea (Difficulty or shortness in breathing)
- Cough
- Sputum production
- Chest pain (NOT in acute chest pain)

Abnormal chest X Ray

Signs

1-Cyanosis (Bluish or purplish discoloration of the skin)

2- Clubbing: is a clinically descriptive term, referring to the bulbous uniform swelling of the soft tissue of the terminal phalanx of a digit with subsequent loss of the normal angle between the nail and the nail bed.

3- Chest deformity ex.Kyphosis

4- Diminished chest expansion

5- Hyperinflation: occur when air gets trapped in the lungs and causes them to overinflate. It's can be caused by blockages in the air passages or by air sacs that are less elastic, which interferes with the expulsion of air from the lungs.

6- Diminished breath sounds

7- Prolongation of expiratory phase & crackles especially in asthma

1-

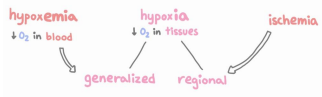
2-

4-

Arterial blood gas analysis

Hypoxemia

low level of O_2 in blood.



Hypercapnia

High level of CO_2 in blood.

Indications of Spirometry

1. To detect respiratory disease in patients presenting with symptoms of breathlessness, and to distinguish respiratory from cardiac disease.

2. To diagnose or manage asthma & diagnose and differentiate between obstructive and restrictive lung disease.
(also you can see the effect of the treatment)

3. To conduct pre-operative risk assessment before anesthesia & measure response to treatment of conditions which spirometry detects.

4. **Describe the course of diseases affecting PFTs** (Pulmonary Function Tests) click here to read about it
   - **Neuromuscular diseases:**
     Guillain Barrè Syndrome, Myasthenia gravis
   - **Pulmonary diseases:**
     Obstructive and Restrictive airway diseases, Interstitial lung diseases
   - **Adverse reactions:**
     Drugs with known pulmonary toxicity [Pulmonary fibrosis]

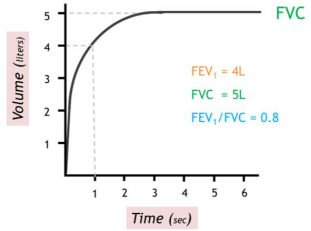
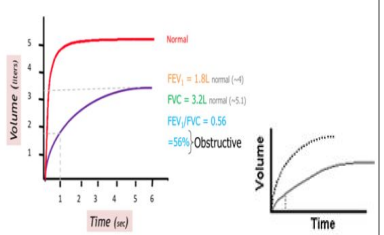
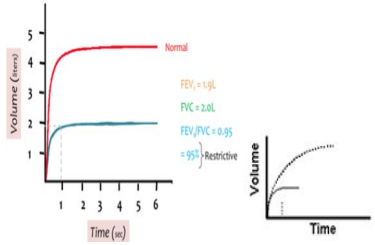
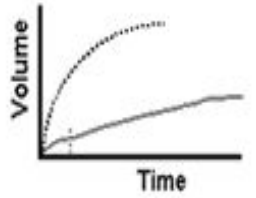
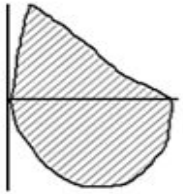
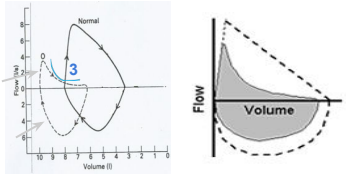
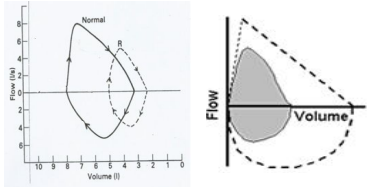
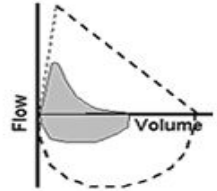
5. **To assess the therapeutic interventions**
   - Bronchodilator therapy
   - Steroid treatment for asthma
   - Chronic obstructive lung disease
   - Interstitial lung disease

6. **PRE OPERATIVE INDICATIONS**
   To determine the suitability of patients for anesthesia & To assess the risk for surgical procedures known to affect lung function.

Anesthesia (from Greek "without sensation") is a state of controlled, temporary loss of sensation or awareness that is induced for medical purposes. It may include analgesia (relief from or prevention of pain), paralysis (muscle relaxation), amnesia (loss of memory), or unconsciousness.

Guillain-Barré syndrome (GBS): is a rare neurological disorder in which the body's immune system mistakenly attacks part of its peripheral nervous system (antibodies against Schwann cells) the network of nerves located outside of the brain and spinal cord. GBS can range from a very mild case with brief weakness to nearly devastating paralysis, leaving the person unable to breathe independently.

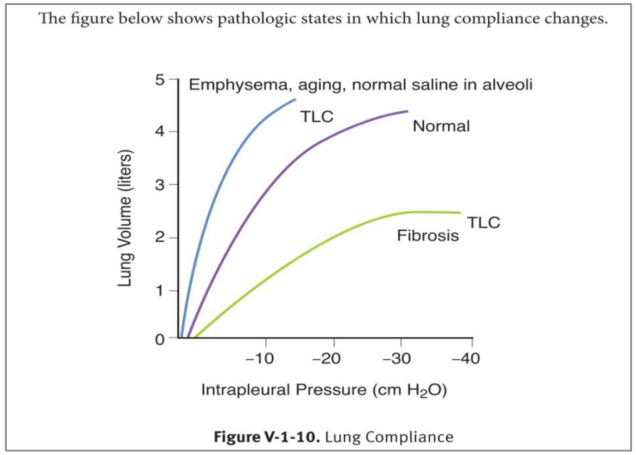
Results classification in Spirometry

Normal	Obstructive LD	Restrictive LD	Combined (Mixed)
			
	- The curve rises slowly and needs more than 2 sec to reach its highest point (normal in 1-2 sec)	-Expire fully in 2 sec similar to normal	-OLD and RLD characteristic
			
	1-Inspiratory loop Normal (down) 2-The problem in the expiratory loop (up) **Why?** Because in inspiration there's no resistant, but in expirations there is. 3- Effort independent part of curve: concave (Curvilinear)	1-Miniature loop (elliptical) 2- All flow parameters ↓	1- small 2- concave 3- OLD and RLD characteristic

Helpful video

Restrictive and Obstructive Lung Diseases

Extra information
(You should be able to differentiate between OLD and RLD)



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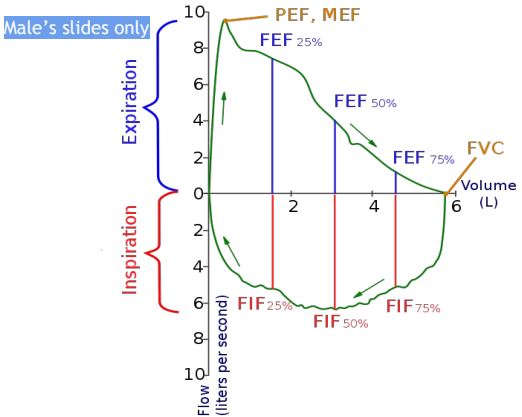


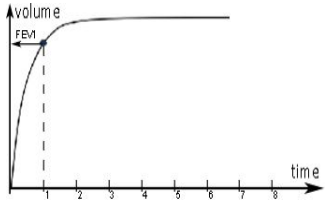
Obstructive and Restrictive diseases:
Now that you know the different pressures at the different steps of respiration, Obstructive and Restrictive diseases can be explained in a very simple concept.

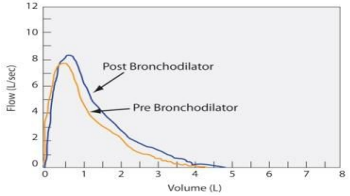
Obstructive disease (Emphysema):
the patient will have difficulty creating a positive alveolar pressure (+1) during expiration. That is caused by the decrease in elasticity (recoil) in the lung, and thus an increase in compliance.

Restrictive disease (Fibrosis):
the patient will have difficulty creating a negative alveolar pressure (-1) during inspiration. That is caused by an increase in elasticity (recoil) in the lung, and thus a decrease in compliance.
As you can see in the graph, emphysema has a higher TLC because of the increased compliance, while Fibrosis has a decreased TLC.

Male's slides only

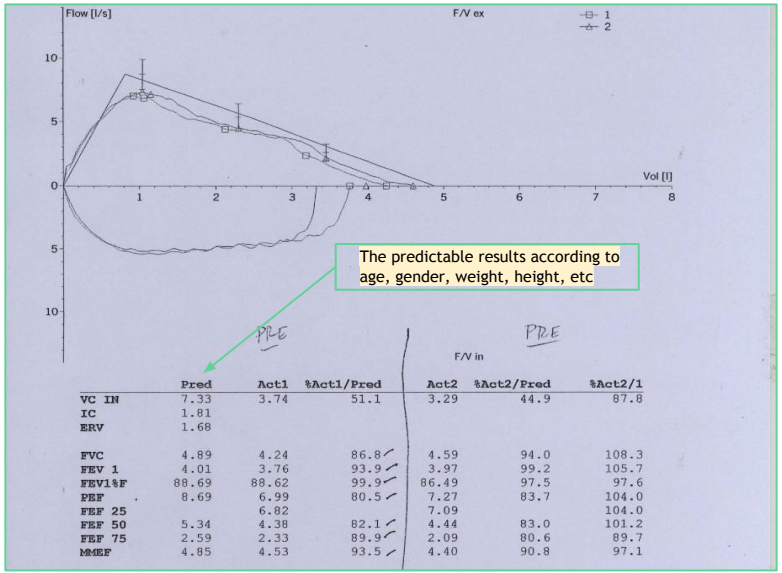
Spirometry In Respiratory Diseases





	Pred	Act1	%Act1/Pred	Act2	%Act2/Pred	%Act2/1
VC IN	4.19	3.14	74.9	3.25	77.6	103.6
IC	2.28					
ERV	1.52					
FVC	3.99	4.61	115.5	4.92	123.3	106.7
FEV 1	3.50	3.37	96.4	3.59	102.5	106.4
FEV1%F	85.83	73.20	85.3	72.94	85.0	99.6
PEF	8.09	8.57	105.9	7.59	93.9	88.6
FEF 25		6.87		7.59		110.5
FEF 50	4.62	2.73	59.0	2.83	61.2	103.6
FEF 75	2.02	0.90	44.5	0.91	44.9	100.9
MMEF	4.02	2.29	57.1	2.40	59.8	104.7

	Pred	Act1	%Act1/Pred	Act2	%Act2/Pred	%Act2/1
VC IN	2.53	1.38	54.7	1.40	55.3	101.1
IC	1.88					
ERV	1.20					
FVC	3.01	2.21	73.5	2.35	78.3	106.5
FEV 1	2.77	1.94	70.3	1.92	69.5	98.9
FEV1%F	92.90	88.00	94.7	81.73	88.0	92.9
PEF	5.69	3.15	55.3	3.38	59.4	107.5
FEF 25	5.57	3.15	56.5	2.90	52.1	92.3
FEF 50	4.55	2.04	44.9	1.89	41.5	92.5
FEF 75	1.86	1.20	64.9	0.98	53.0	81.6
MMEF	3.71	1.91	51.4	1.74	46.8	91.0



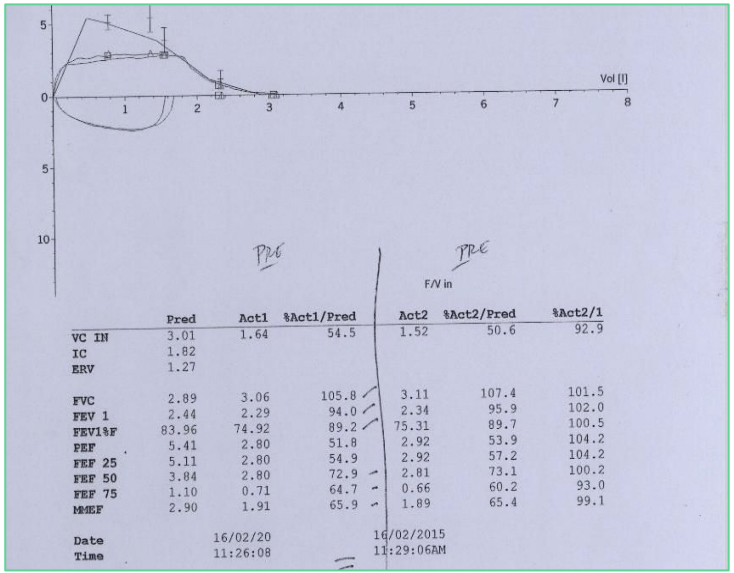
The predictable results according to age, gender, weight, height, etc

PRE

F/V in

PRE

	Pred	Act1	%Act1/Pred	Act2	%Act2/Pred	%Act2/1
VC IN	7.33	3.74	51.1	3.29	44.9	87.8
IC	1.81					
ERV	1.68					
FVC	4.89	4.24	86.8	4.59	94.0	108.3
FEV 1	4.01	3.76	93.9	3.97	99.2	105.7
FEV1%F	88.69	88.62	99.9	86.49	97.5	97.6
PEF	8.69	6.99	80.5	7.27	83.7	104.0
FEF 25		6.82		7.09		104.0
FEF 50	5.34	4.38	82.1	4.44	83.0	101.2
FEF 75	2.59	2.33	89.9	2.09	80.6	89.7
MMEF	4.85	4.53	93.5	4.40	90.8	97.1



PRE

F/V in

PRE

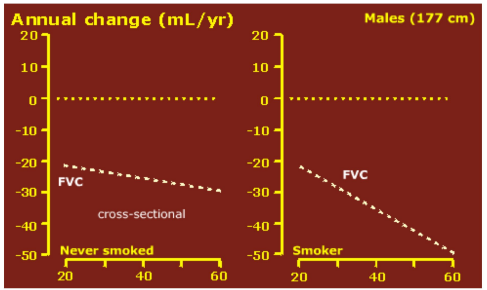
	Pred	Act1	%Act1/Pred	Act2	%Act2/Pred	%Act2/1
VC IN	3.01	1.64	54.5	1.52	50.6	92.9
IC	1.82					
ERV	1.27					
FVC	2.89	3.06	105.8	3.11	107.4	101.5
FEV 1	2.44	2.29	94.0	2.34	95.9	102.0
FEV1%F	83.96	74.92	89.2	75.31	89.7	100.5
PEF	5.41	2.80	51.8	2.92	53.9	104.2
FEF 25	5.11	2.80	54.9	2.92	57.2	104.2
FEF 50	3.84	2.80	72.9	2.81	73.1	100.2
FEF 75	1.10	0.71	64.7	0.66	60.2	93.0
MMEF	2.90	1.91	65.9	1.89	65.4	99.1
Date		16/02/20		16/02/2015		
Time		11:26:08		11:29:06AM		

Smoking and Spirometry

Effect of smoking on lung function

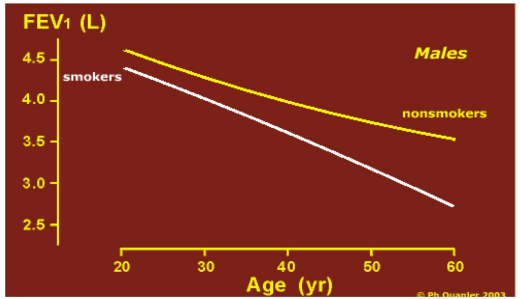
Non Smoker

In normal healthy non smoker subject after the age of 30 the expected decline in Lung function parameter [FEV1] is 25–30 ml/ year.



Smoker

The average rate of decline of lung function in smokers as measured by Forced Expiratory Volume in 1 sec [FEV1] is 60-70 ml / year.



Maintaining accuracy

The most common reason for inaccurate results

- Inadequate or incomplete inhalation.
- Additional breath taken during the test.
- Lips not sealed around the mouth piece.
- Slow start to forced exhalation.
- Some exhalation through the nose.
- Coughing.

DIAGNOSIS OF (COPD)
Chronic Obstructive Pulmonary Disease
By SPIROMETRY

01 SYMPTOMS

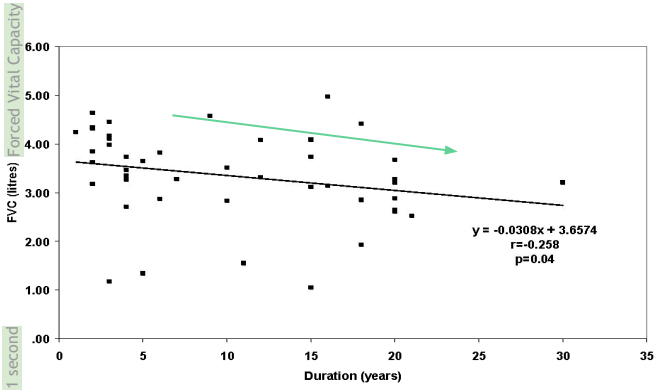
- cough
- sputum: a mixture of saliva and mucus coughed up from the respiratory tract
- dyspnea

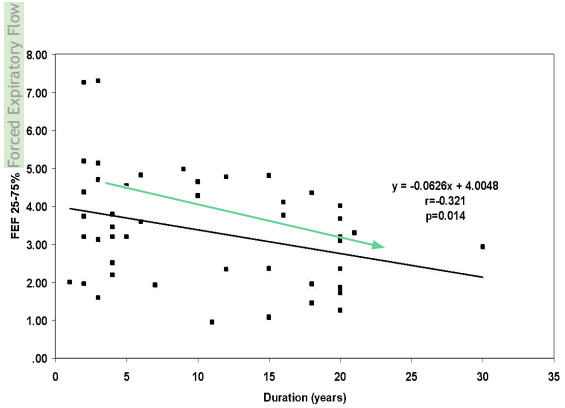
02 EXPOSURE TO RISK FACTORS

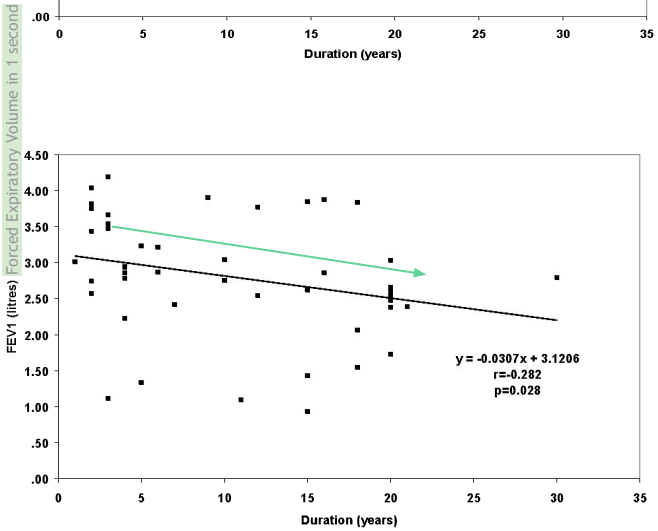
- tobacco
- occupation
- indoor/outdoor pollution

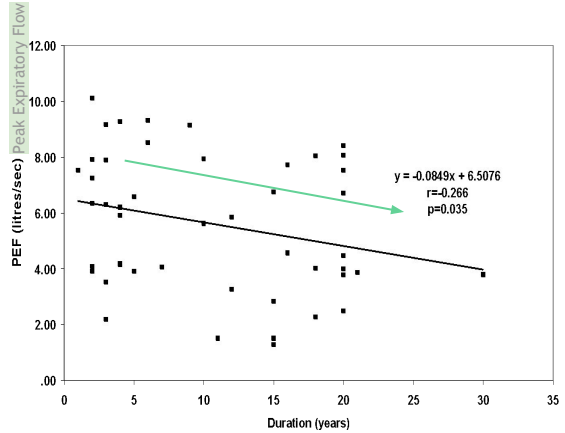
Male's slides only

Impaired lung function in DM (diabetes mellitus)









Extra information:

Some studies have shown abnormal respiratory parameters in patients of DM. Moreover, the duration of DM and glycemic control have varied impact on the pulmonary functions.

Peak Expiratory Flow: is a person's maximum speed of expiration

Male's slides only

Spirometry

Spirometry and Cement industry

Lung function parameters:

- FVC
- FEV1
- FEF 25-75%
- PEF were significantly decreased in cement mill workers compared to their matched controls.

Spirometry and welding industry

Lung function parameters

- FVC
- FEV1
- PEF were significantly impaired in welding workers compared to their matched controls.

Spirometry and oil spill

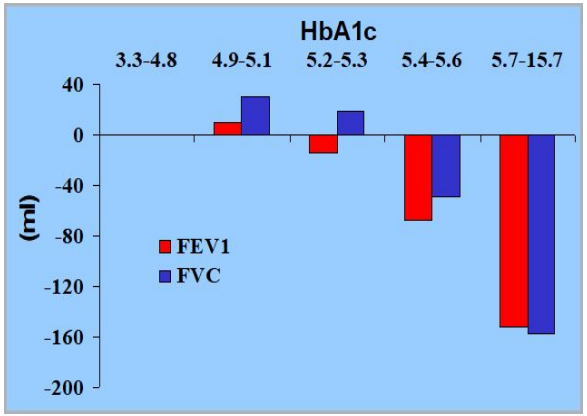
Lung function parameters

- FVC
- FEV1
- FEF 25-75% were impaired in subjects exposed to crude oil spill in sea water.

Male's slides only

Spirometry & HbA1c

- Increase in mean HbA1c: is associated with decrease in lung function parameters FEV1 and FVC.



Take home messages

- ➔ The incidence of respiratory diseases has been increased, hence the importance of lung function test can not be ignored.
- ➔ Respiratory assessment through Spirometry may be mandatory at ll the levels of respiratory care/clinical settings.
- ➔ As we can not treat the patient with high blood pressure without knowing the blood pressure.
- ➔ Similarly, we can not treat the patients with respiratory problems without knowing the lung function test (Spirometry).

Quiz

You don't understand why we choose this answer? Click here to read the explanations

1-50-years old male came to his GP with chest pain, GP ordered spirometry test, after compare his result with the previous result in the last year it showed that there is decline of lung function as measured by FEV1 is 60-70 ml/year. We conclude that man was ?

A. Heavy smoker
B. Non- smoker
C. Emphysema patient
D. Pulmonary fibrosis patient

2- 35-years old female complain from a cough with dyspnea after physician took her history we found that she live with a smoker after spirometry test we found that (FEV1= 0.9 L and FVC= 2.3 L). What is the diagnosis ?

A. Restrictive pulmonary disease
B. Obstructive pulmonary disease
C. Cardiac disease
D. None of above

3-Examiner explain the procedure to the patient for spirometry test. The patient during the test start slowly to forced exhalation. This will lead to?

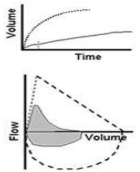
A. Best result
B. Normal result
C. Inaccurate result
D. None of above

4- In which case you should ask for spirometry test?

A. Diminished breath sounds
B. Increased heart rate
C. Repetitive breaths
D. Coughing

SAQ

1- What does the figure below show?

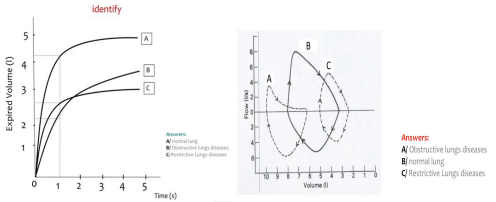


2- What are the tests could done to respiratory disease

Answers

1- Restrictive and obstructive (mixed) respiratory disease

2- Spirometry-Body Plethysmography test-Cardiopulmonary Stress Testing-Diffusing Capacity of Lung for Carbon Monoxide-Pulse Oximetry



Key answers:

1-A 2-B 3-C 4-A

TEAM LEADERS

Elaf Almusahel

Omar Alshenawy

TEAM MEMBERS

Done by:

- Arwa Al Emam
- Deema almaziad
- May Babaeer
- Njoud alali
- Noura Almazrou
- Noura Alturki
- Rema Almutawa
- Renad Almutawa
- Tarfah Alkaltham
- Abdulrahman Alhawas
- Aued Alanazi
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