First-year – Ashur Medical College 2023/2024
Module: systemic (physiology)

RESPIRATORY INVESTIGATIONS PART 2

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1- SPIROMETRY

Instrument	Measures	Function
Spirometer	Forced vital capacity (FVC)	Volume of air that is exhaled after maximum inhalation
	Forced expiratory volume (FEV)	Volume of air exhaled in one breath
	Forced expiratory flow, 25–75 percent	Air flow in the middle of exhalation
	Peak expiratory flow (PEF)	Rate of exhalation
	Maximum voluntary ventilation (MVV)	Volume of air that can be inspired and expired in 1 minute
	Slow vital capacity (SVC)	Volume of air that can be slowly exhaled after inhaling past the tidal volume

- **Spirometer measures :**

A- Volumes and capacities:

- **FEV1 (forced)** in 1 second.
- FVC (Force vital capacity) : It denotes the full amount of air that you can expire with effort during a complete breath. **FVC=VC: tidal volume + inspiratory volume + expiratory volume.**
- **VC: in gentle slow expiration.**
- **Inspiratory and expiratory reserve volumes.**
- **Inspiratory capacity**

B- Rates :

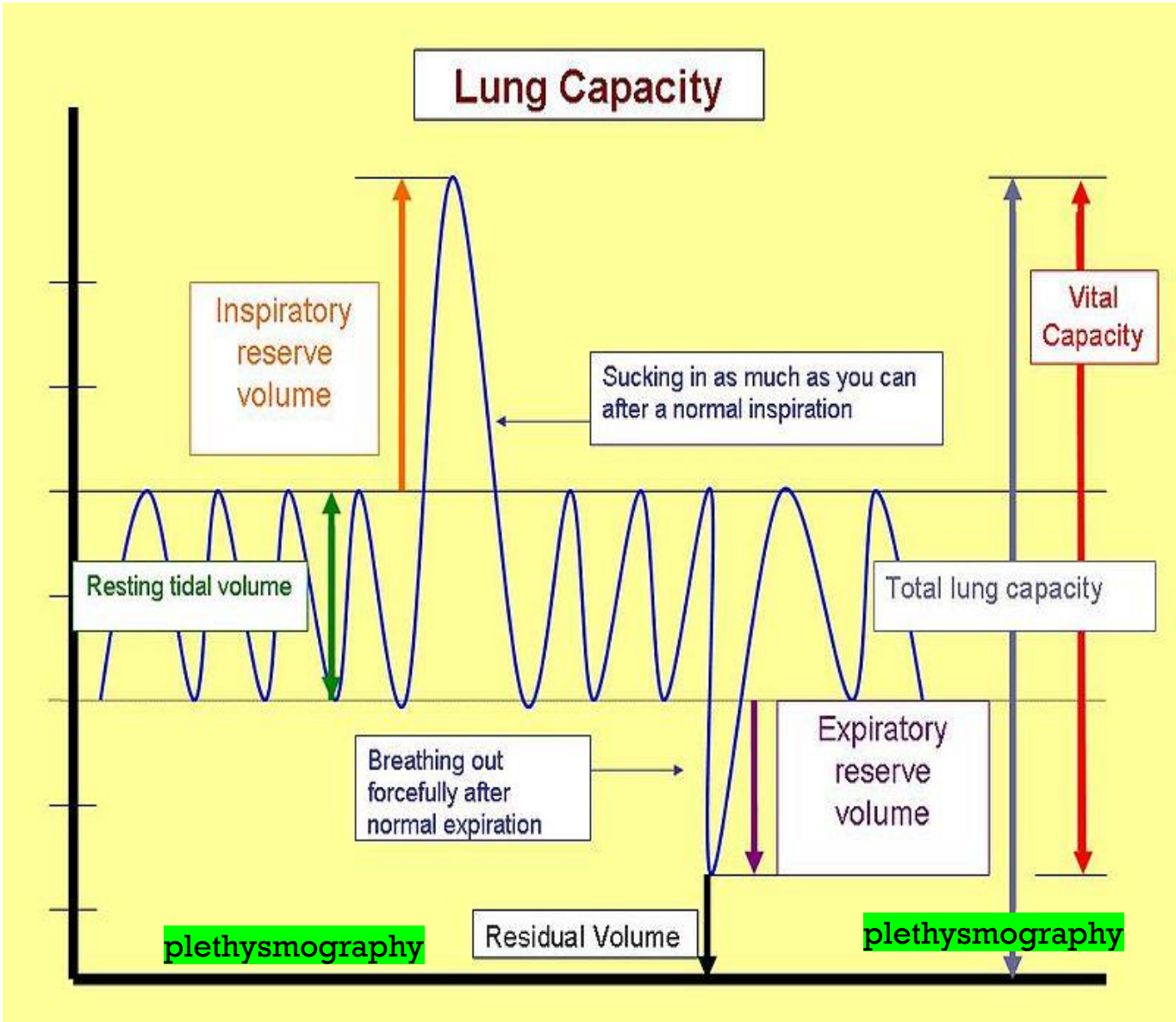
- The mid-expiratory flow rate ($FEF_{25-75\%}$) is the average forced expiratory flow rate over the middle 50 percent of the FVC. It can help in the diagnosis of an obstructive ventilatory pattern. Forced expiratory flow, also known as mid-expiratory flow.
- FEV1(Forced expiratory volume in the first second).
- Peak expiratory flow (PEF): **It is a** maximum expiratory flow.

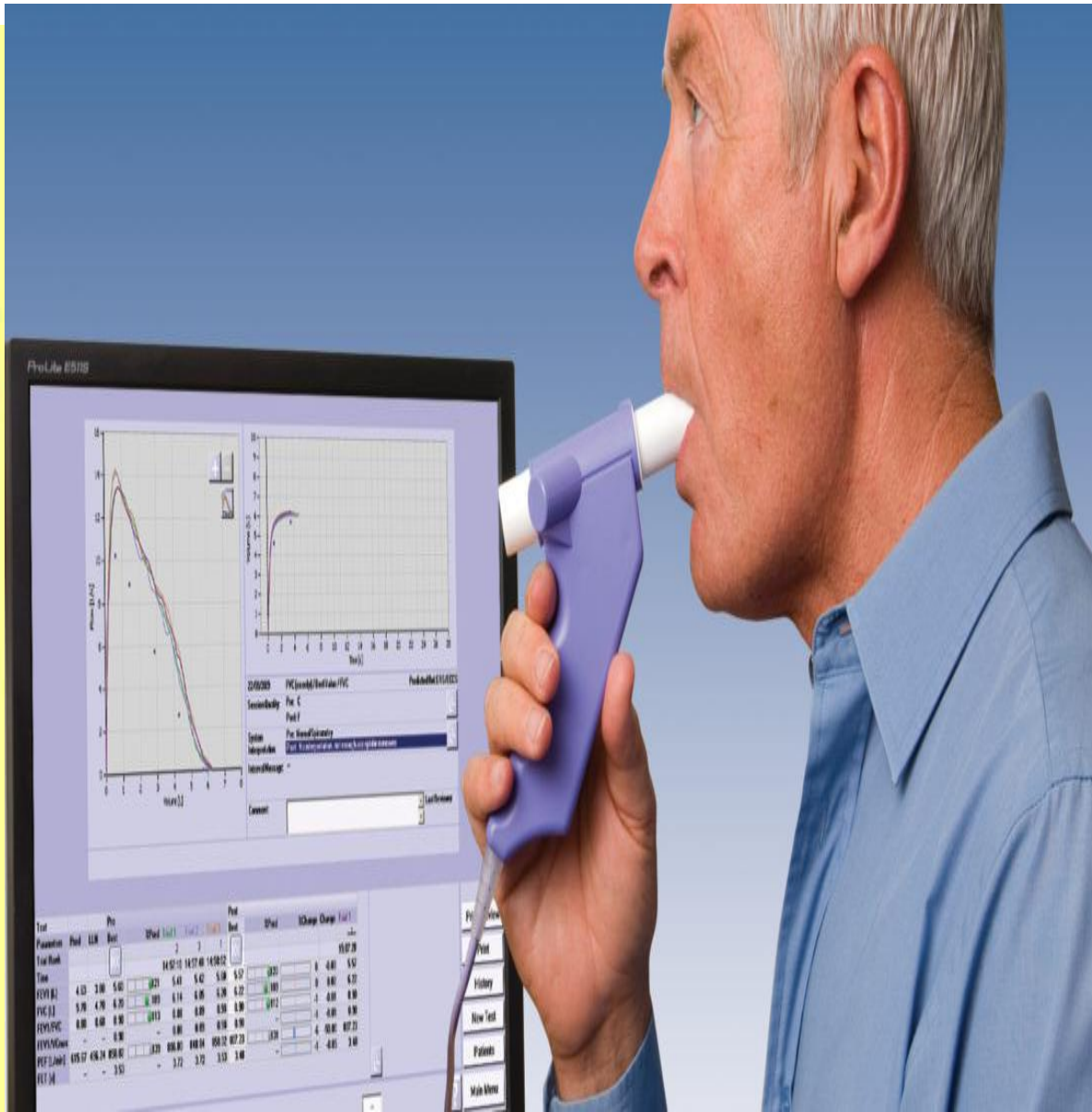
C-Ratio:

- FEV1/FVC ratio

D-Spirometry did not measure Residual volume, Functional residual capacity, and TLC. lung plethysmography

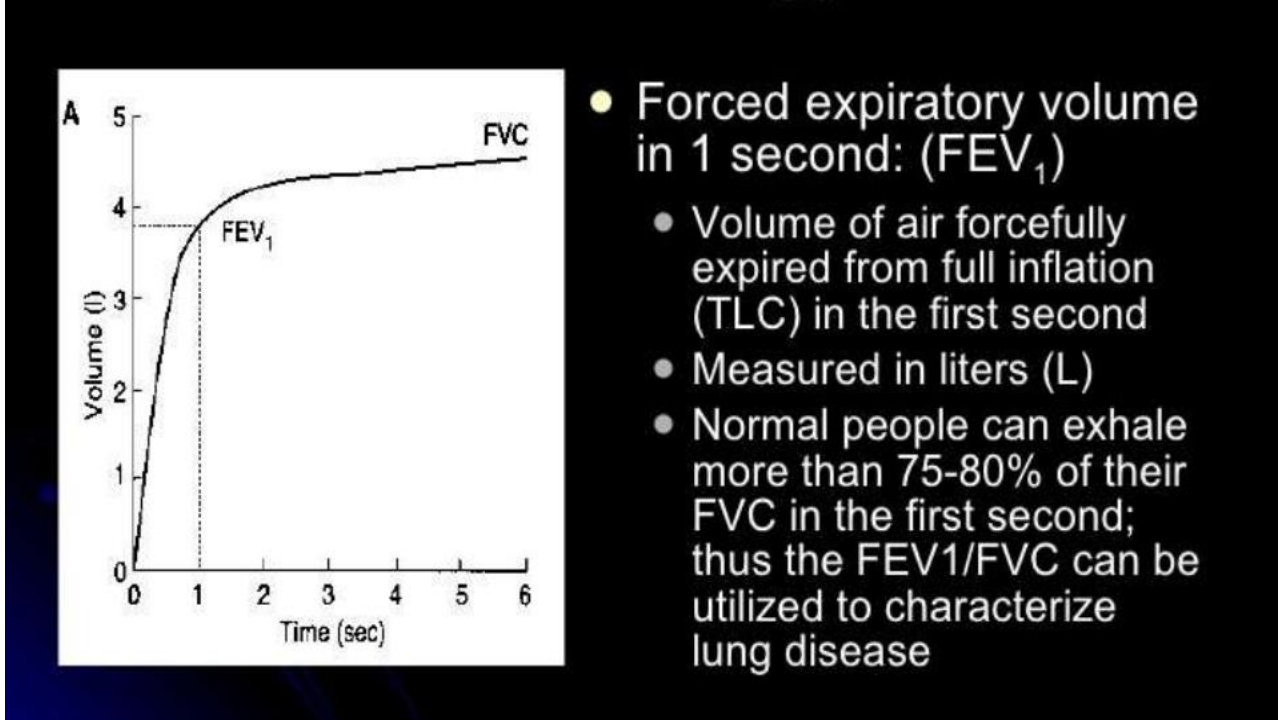
SPIROMETRY


Lung Capacity
Inspiratory reserve volume
Sucking in as much as you can after a normal inspiration
Vital Capacity
Resting tidal volume
Total lung capacity
Breathing out forcefully after normal expiration
Expiratory reserve volume
Residual Volume
plethysmography
plethysmography



A-FEV1

Useful to categorize the severity of obstructive lung diseases, such as asthma and chronic obstructive pulmonary disease (COPD.
FEV1 can also be helpful in the interpretation of the reversibility test, also known as the bronchodilator test.



Obstructive vs Restrictive defect Spirometry/PFT

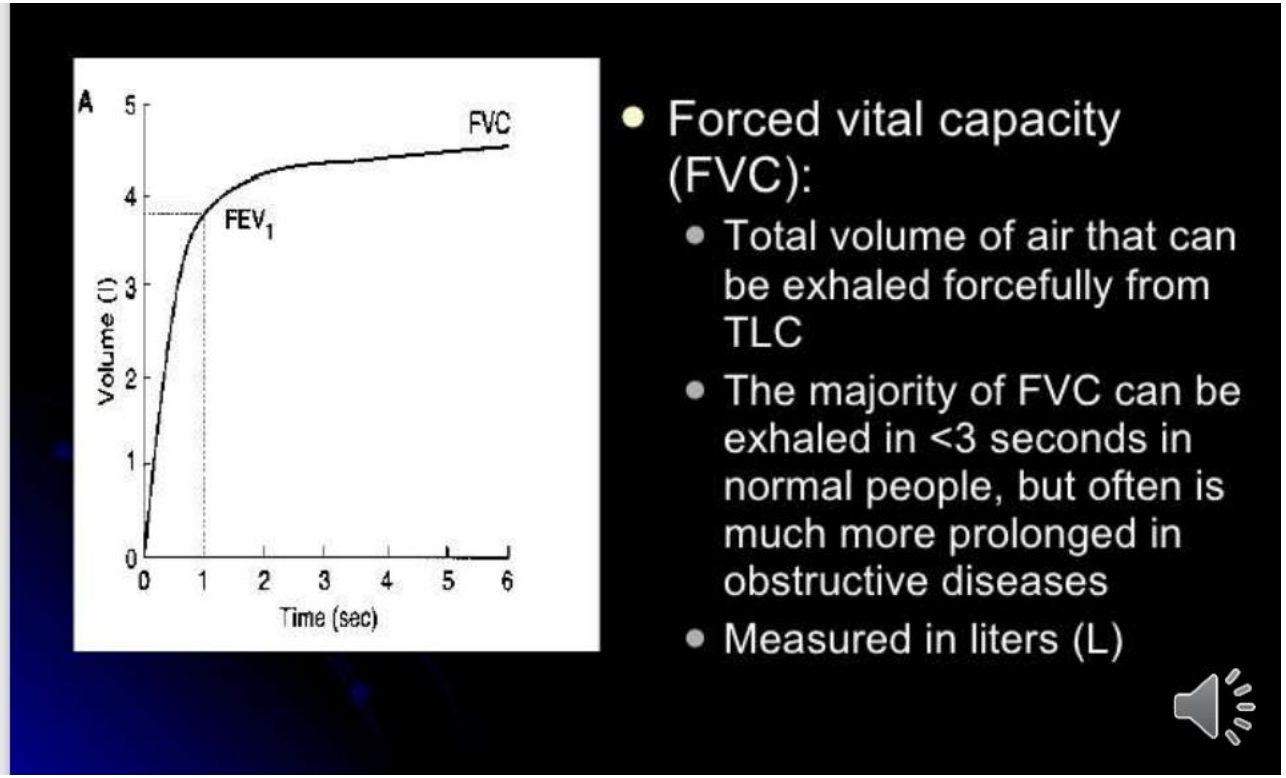
	FEV1	FVC	FEV1/FVC
Obstructive lung disease	Decreased (<80%)	Decreased	Decreased (<0.7)
Restrictive lung disease	Decreased	Decreased (<80%)	Normal (>0.7) or increased

Obstructive vs Restrictive defect Spirometry/PFT

Parameter	*Obstructive Disorders*	*Restrictive Disorders*
FVC	N or ↓	↓
FEV_1	↓	↓
$FEF_{25-75\%}$	↓	N to ↓
FEV1/FVC	↓	N or ↑
PEFR	↓	N to ↓

B- FVC

•**Forced vital capacity (FVC).** This is the largest amount of air that is forcefully exhaled after maximum deep breathing.



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FORCED VITAL CAPACITY

- FVC is Low in :
- Restrictive lung disease
- Deformities of the chest: Associated with scoliosis and other congenital defects
- Lobectomy
- Neurological disorders: Such as amyotrophic lateral sclerosis (ALS) which limits lung expansion
- Pleural effusion
- Ascites

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PEFR	↓	N to ↓

C- FEV1/FVC RATIO

A decreased FEV1/FVC ratio with a normal FVC indicates an obstructive lung condition. The diagnosis is usually reached when the ratio is less than 70% in adults and less than 85% in children



When both the FEV1/FVC ratio and FVC are decreased, it is a sign of a mixed defect involving obstruction and restriction

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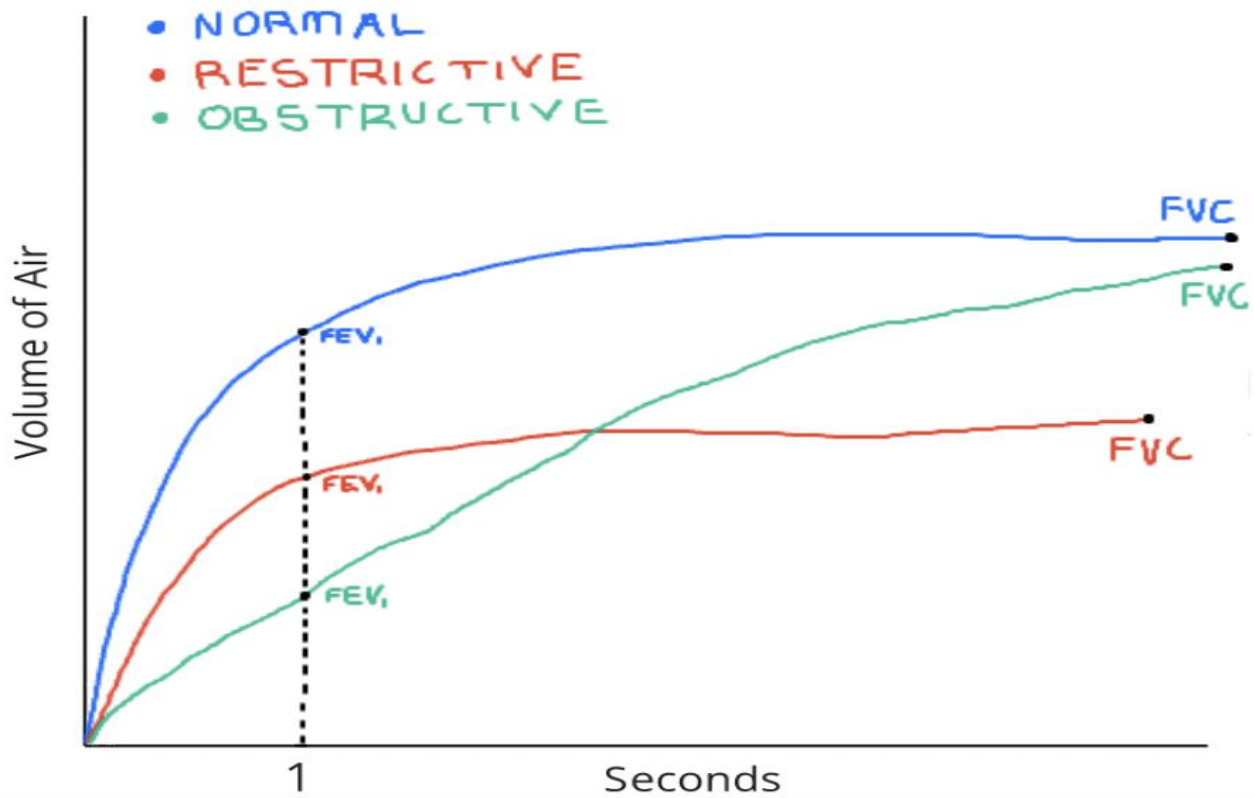

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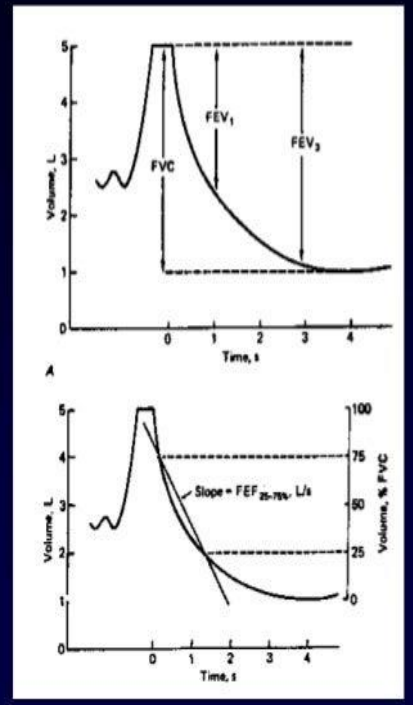
D- FORCED EXPIRATORY FLOW BETWEEN 25% AND 75% OF VITAL CAPACITY (FEF 25-75%)

Forced Expiratory Flow 25%-75%

- The $FEF_{25\%-75\%}$ is the average flow rate that occurs during the middle 50 percent of an FVC measurement.
- Normally 4.5 L/sec for men, 3.5 L/sec for women.
- Decreased with age and obstructive lung disease.
- Reflects defects with **medium to small** airways.

Impairment might suggest earlier asthma recognition in symptomatic subjects even in the absence of other abnormal spirometry values.

Spirometry and Flows



FEF 25-75%: mean forced expiratory flow during middle half of FVC; sensitive to small airways disease

Obstructive vs Restrictive defect Spirometry/PFT

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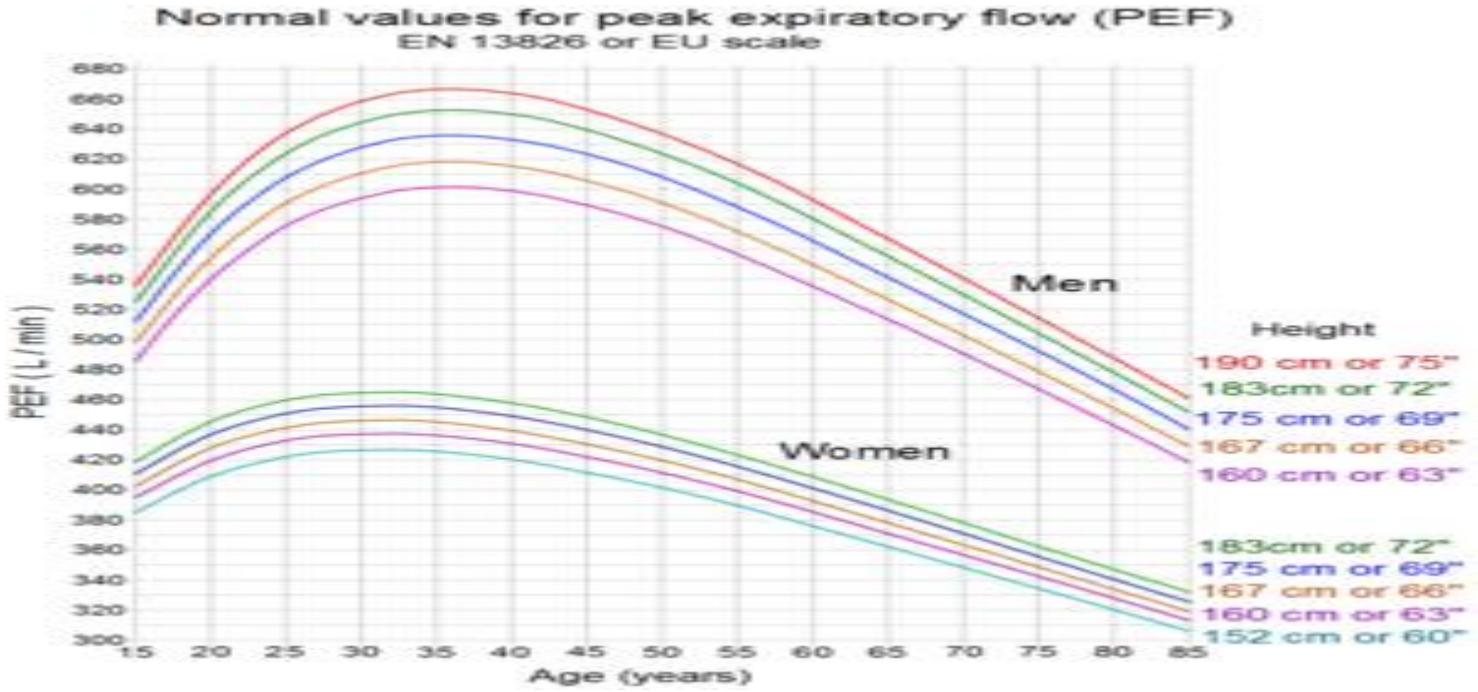
PEFR	↓	N to ↓



E- PEAK EXPIRATORY FLOW RATE (PEFR)

- Also called The **peak expiratory flow** (**PEF**), and **peak flow measurement** is a person's maximum speed of expiration.
- It can be measured with a spirometer or **peak flow meter.**
- It is classically reduced in obstructive lung disorders such as asthma



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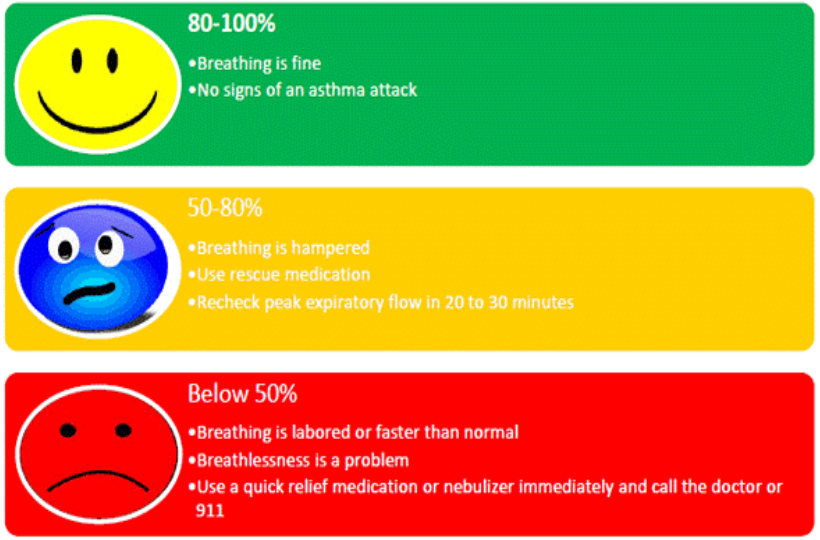


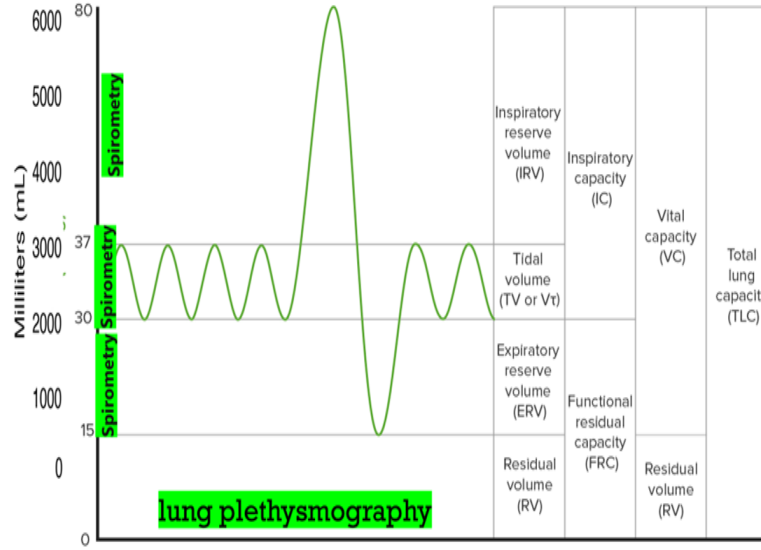
F- MAXIMUM VOLUNTARY VENTILATION

While Minute volume = Tv X RR

Maximal Voluntary Ventilation (MVV) or Maximum Breathing Capacity (MBC):

1. It is the maximum volume of air that can be breathed in and blown out per minute using the fastest and deepest respiratory effort as ever.
2. Procedure :Breathing as rapid & as deep as possible for 15 sec then multiply the result x 4.
3. Equals 80-160 L/min in ♂ and 60-120 L/min in ♀

Used for the follow-up of neuromuscular diseases

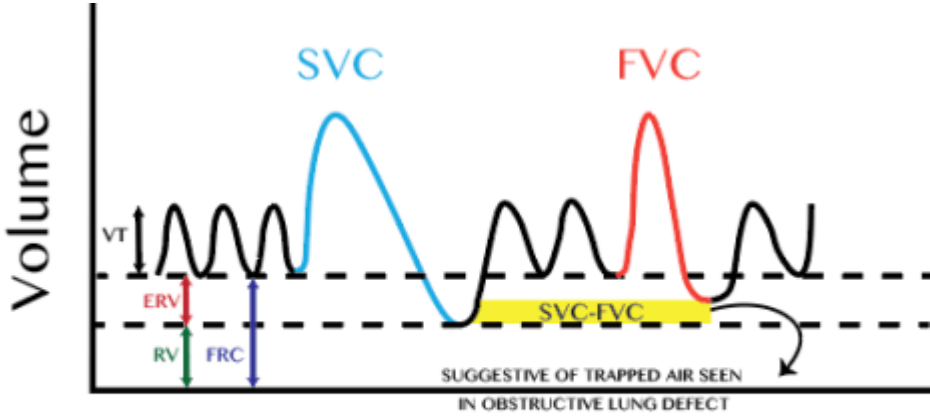


F- SLOW VITAL CAPACITY

Exhalation should be terminated after 15 seconds.

In some patients with obstructive airways disease, the forced vital capacity (FVC) will underestimate the true vital capacity (VC). This is because the increase in intrathoracic pressure during the forced manoeuvre compresses airways, causing early airway closure and gas trapping. This does not happen in normal lungs.

If suspected, it can be detected by measuring the vital capacity (from full inspiration to full expiration) without trying to force the air out (sometimes called a slow or relaxed vital capacity, SVC).



2- MEASURING RESIDUAL VOLUME (RV) AND TOTAL LUNG CAPACITY(TLC)

A- The **helium dilution technique(Measure administered Helium%)**

B- The nitrogen washout test: under (100%)O2 , measure nitrogen %.

C- LUNG PLETHYSMOGRAPHY

Functional residual capacity after normal quit breathing can also be measured

- The patient sits inside a fully enclosed rigid box and breath through mouthpiece connected through a shutter to the internal volume of the box
- while breathing in and out again into a mouthpiece. The volume of all gas within the thorax can be measured by Changes in pressure inside the box and allow determination of the lung volume(Boyles Law)

