# Pulmonary Volumes and Capacities

(Spirogram)

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## OBJECTIVES

- Describe normal spirogram, labeling, defining and mentioning the normal values of lung volumes and capacities.

- Discuss and identify volume and capacities that cannot be measured by spirometry and discuss their significance and factors affecting them.
- Define dead space, identify its different types and mention its significance.
- Describe the changes in these volumes and capacities in obstructive and restrictive pulmonary diseases.

# Spirometry

Describe the measurement of lung volume

# Basic tools to know respiratory status.

- In patients with pulmonary disease,

- As a first diagnostic test employed In pre-operative evaluation,

3.In managing patients with pulmonary disease,

4. In quantifying pulmonary disability.

5.In evaluation of allergic status for drug therapy

6.As epidemiological survey to know normal values

7.To assess impact of an occupational exposure

# Spirogram

# Volumes

- Tidal Volume (Minute)T.V
- Residual Volume R.V
- Inspiratory Reserve Volume I.R.V
- Expiratory Reserve Volume E.R.V

Capacities

- Vital Capacity V.C
- Total Lung Capacity T.L.C
- Function Residual Capacity F.R.C
- Inspiratory Capacity I.C

-Lung volume can be measured by;-

1. Changes of the lung volume during one breathing at static conditions, called static/ Primary lung volume

Or

# 2. Same / unit time called dynamic/ secondary lung volume

## 2. Indirect Spirometry

Gas dilution

Body plethysmography

## Gas dilution techniques

All operate on a principle SIMILAR to Boyle's Law

(P1 V1 = P2 V2),

$C_1 V_1 = C_2 V_2$

NOTE;- 1. Can only measure lung volumes in communication with conducting airways

2. Obstruction or bullous disease can have trapped, noncommunicating air within the lungs

(FRC may be measured is less than its actual volume)

i.e, **Closed-Circuit** Helium dilution method for RV, FRC, TLC

Usually first FRC is calculated

1. FRC= ([He]i/([He]f-1)Vi

[He]i=initial concentration of helium in spirometer

[He]f=final concentration of helium in spirometer

Vi=initial volume of air in bell of spirometer

2. RV = FRC- ERV

3. TLC= RV + VC

# Obstructed Airflow

limitation of expiratory airflow so that airways cannot empty as rapidly compared to normal

- Narrowing of the airways due to bronchial smooth muscle contraction i.e. Asthma

- Narrowing of the airways due to inflammation and swelling of bronchial mucosa and the hypertrophy and hyperplasia of bronchial glands i.e, bronchitis

- Material inside the bronchial passageways physically obstructing the flow of air i.e

excessive mucus plugging, inhalation of foreign objects or the presence of pushing and invasive tumors

- Destruction of lung tissue with the loss of elasticity and hence the loss of the external support of the airways i.e. Emphysema

- External compression of the airways i.e.Tumors, trauma

# Restricted Airflow

Characterized by reduced lung volumes/decreased lung compliance

## A. Intrinsic Restrictive Lung Disorders

1. Sarcoidosis 2. Tuberculosis 3. Pnuemonectomy (loss of lung) 4. Pneumonia

## B. Extrinsic Restrictive Lung Disorders

1. Scoliosis, Kyphosis 2. Ankylosing Spondylitis 3. Pleural Effusion 4. Pregnancy 5. Gross Obesity 6. Tumors 7. Ascites 8. Pain on inspiration - pleurisy, rib fractures

## C. Neuromuscular Restrictive Lung Disorders

1. Generalized Weakness – malnutrition 2. Paralysis of the diaphragm
3. Myasthenia Gravis - in which the nerve impulses fail to induce muscular contraction. 4. Muscular Dystrophy 5. Poliomyelitis 6. Amyotrophic Lateral Sclerosis

# Flow/Volume Loops in Obstruction and Restriction How is a flow-volume loop helpful clinically?

Helpful in evaluation of air flow limitation on inspiration and expiration

In addition to obstructive and restrictive patterns, flow-volume loops can show provide information on upper airway obstruction:

Fixed obstruction: constant airflow limitation on inspiration and expiration—such as in tumor, tracheal stenosis

Variable extrathoracic obstruction: limitation of inspiratory flow, flattened inspiratory loop—such as in vocal cord dysfunction

Variable intrathoracic obstruction: flattening of expiratory limb; as in malignancy or tracheomalacia

# Spirometry Interpretation: What do the numbers mean?

## FVC

| | |
|---|---|
| 80-120% | **Normal** |
| 70-79% | Mild reduction |

| | |
|---|---|
| 50%-69% | Moderate |
| <50% | Severe |

FEV1

| |
|---|
| >75% |
| 60%-75% |
| 50-59% |
| <49% |

# Classification of Ventilative Function Disorder

**obstruction**

**restriction**

**mixed**

**FEV1/FVC**

**N or**

**MVV**

**or N**

**VC** **N or**

**RV**
**uncertain**

**TLC** **N or**
**N or** **uncertain**

Effects of Aging

- VC and MVV ↓
- RV and DS ↑

- Ability to remove mucus from respiratory passageways ↓

- Gas exchange across respiratory membrane ↓

Critical Thinking

In the advanced stages of pulmonary emphysema, the FRC and the RV are increased; in addition the VC is often decreased. Why do these changes occur