Aspects of pulmonary function:

- **Perfusion** - Blood flow.
- **Diffusion** - Movement of O2 & CO2.
- **Ventilation** - Air exchange between alveolar spaces & the atmosphere.
LUNG VOLUMES AND CAPACITIES

- Tidal Volume (TV)
- Inspiratory Reserve Volume (IRV)
- Inspiratory Capacity (IC)
- Functional Residual Capacity (FRC)
- Expiratory Reserve Volume (ERV)
- Residual Volume (RV)
- Vital Capacity (VC)
- Alveolar Ventilation
**PURPOSE OF TEST**

- **Assessment** of various aspects of pulmonary physiology.
- **Detect & quantify** the respiratory disease.
- **Evaluation** of the disease & its response to therapy.
- Provide valuable **clinical information**.
PULMONARY FUNCTION TEST

- Spirometry
- Bronchial provocation test
- Static lung volumes
- Carbon monoxide diffusing capacity
- Alveolar arterial oxygen gradient
- Exercise testing
SPIROMETRY

- Measures the volume of air inspired or expired & records the time the volume change occurs.
- Mechanical signal → electrical signal → records the amount of gas breathed in & out → SPIROGRAM.

2 major categories:

- mechanical or volume-displacement
- electronic or flow sensing

Determines the effectiveness of various mechanical forces involved in lung & chest wall movement.

The values obtained provide quantitative information about the degree of obstruction to expiratory airflow or the degree of restriction of inspired air.
- Metal container with 2 chambers.
- Outer chamber (water chamber) has a floating drum.
- Drum is counter balanced by weight-string.
- Pen attached to counter wt-writes on calibrated paper, fixed to a recording device.
- Inner chamber inverted with small hole at the top & long metal tube passes through it.
- Top end of the tube penetrates into outer chamber above level of water & other end is mouthpiece.

Respiration-closed nose by nose clip (5-30 min).
The forced expiratory volumes exhaled within 1, 2, 3 seconds – timed vital capacities (FEV1, FEV2 & FEV3 res).

- FEF25-75 – forced expiratory flow between 25% & 75%.

Measurements are useful for evaluating a patient’s response to bronchodilators.

- If FEV1 < 80% of predicted or FEF25-75% is < 60% of predicted, bronchodilators are administered – nebulizer; spirometry is repeated.
- Measured (actual) spirometry values are compared with predicted values—age, height, weight & gender; expressed as a % of predicted value. (>80% normal limits).

- During expiration floating drum moves up, counter wt comes down, downward deflection on the graph.

- Inspiration the drum moves down, counter wt comes up, upward deflection on the graph.

- **Spirometry test**—measured twice both before and after given a bronchodilator.

- Improvement in measurements means patient will respond well.
DISADVANTAGE

- Only for single use due to CO2 accumulation & O2 cannot be supplied.

- Residual Volume, Functional Residual Capacity and Total Lung Capacity cannot be measured.
USEFULNESS OF SPIROMETRY

- To establish baseline ventilatory function.
- To detect disease.
- To follow course of disease.
- Evaluation of impairment.
- Pre-operative evaluation.
- Occupational surveys.
**BRONCHIAL CHALLENGE TEST**

- Provocative material is given by inhalation & bronchospasm provoked in the laboratory.

3 Types of provocative materials used:

- **1) Nonspecific pharmacologic** - Histamine, Methacholine.
- **2) Nonspecific irritant** - Sulphur dioxide, smoke, citric acid.
- **3) Specific** - Individual allergen.
- 20% fall in FEV1 from basal values – positive response.
- Histamine solution by nebulisation - 8mg/ml.

**INDICATIONS FOR TESTING:**
- To identify patients with hypersensitive or hyper reactive airways- diagnosing asthma.
- To identify specific provocative factors.
- Research tool to study pathophysiology of acute reversible bronchospasm.
LUNG VOLUMES

- 3 Basic techniques for measurement of lung volumes:
  - Gas dilution methods.
  - Body plethysmography.
  - Radiographic techniques.
INDICATIONS FOR STATIC LUNG VOLUMES

Restrictive lung diseases –
- Confirming diagnosis.
- Establishing baseline & quantitating the level of impairment.
- Evaluating response to therapy & following the course of the disease.

Obstructive lung diseases –
- To assess severity of disease.
- Assess clinical course and response to therapy.
CARBON MONOXIDE DIFFUSING CAPACITY

Diffusing capacity – the rate at which gas enters the blood divided by the driving pressure of the gas.

FACTORS AFFECTING DIFFUSING CAPACITY-

- Changes in alveolar capillary membrane.
- Ventilation to perfusion distribution.
- Hemoglobin concentration.
- Pulmonary circulation.
Reduced diffusing capacity is seen in:-

Anemia, multiple pulmonary emboli, emphysema, pulmonary resection interstitial lung disease & severe bronchospasm.

INDICATIONS FOR CO DIFFUSING CAPACITY:-

✓ Unexplained dyspnoea due to early interstitial lung disease.
✓ Differentiating emphysema from chronic bronchitis & asthma.
✓ Diagnosis & follow up of patients with interstitial lung disease.
✓ Diagnosis of recurrent multiple pulmonary emboli.
ALVEOLAR ARTERIAL OXYGEN GRADIENT (AAOG)

- Alveolar oxygen tension is calculated & arterial oxygen tension measured by blood gas estimation.

- Difference between the two gives a measurement of alveolar to arterial oxygen gradient. In normal → 5-15 mm Hg.

*Increased AAOG is due to 3 mechanisms:*

  i. Ventilation perfusion mismatch.

  ii. Increased right to left shunt.

  iii. Diffusion block.
- Alveolar arterial oxygen gradient are measured after exercise.
- Gradient reduces but if it increases it indicates ventilation perfusion mismatch.
- Absolute shunt fraction is also calculated when AAG are measured 10 min after 100% oxygen.
- Increased gradient after 100% oxygen with an increased shunt, indicate presence of right to left shunt.
EXERCISE TESTING

- Cardiopulmonary stress test, with the addition pulmonary factors are also evaluated during exercise.
- Evaluate the response of the cardiovascular & respiratory systems to exercise, allows measurement of gas exchange.
- It categorizes disorders that limit exercise tolerance by documenting their pathophysiology.
- Allows for an objective assessment of the patients symptoms, accurate prescription.
# LUNG FUNCTION VALUES

<table>
<thead>
<tr>
<th>Lung Function Test</th>
<th>Obstructive Disease</th>
<th>Restrictive Disease</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forced Vital Capacity (FVC) 4800ml = IRV + TV + ERV</td>
<td>Normal Or Lower Than Predicted Value</td>
<td>Lower Than Predicted Value</td>
</tr>
<tr>
<td>Forced Expiratory Volume (FEV) 50 – 60 ml/Kg Or 0.75 – 5.5 l</td>
<td>Lower</td>
<td>Normal Or Lower</td>
</tr>
<tr>
<td>Forced Expiratory Flow 25 – 75 %</td>
<td>Lower</td>
<td>Normal Or Lower</td>
</tr>
<tr>
<td>Peak Expiratory Flow (PEF) men:400–800 l/min. Women:200 – 600 l/min.</td>
<td>Lower</td>
<td>Normal Or Lower</td>
</tr>
<tr>
<td>Maximum Voluntary Ventilation (MVV) Male:150 – 170 l/min. Female:80 – 100 l/min</td>
<td>Lower</td>
<td>Normal Or Lower</td>
</tr>
<tr>
<td>Parameter</td>
<td>Normal Or Higher</td>
<td>Lower</td>
</tr>
<tr>
<td>---------------------------------------------------------------</td>
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<tr>
<td>Slow Vital Capacity (SVC)</td>
<td></td>
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<tr>
<td>Total Lung Capacity (TLC) 6000ml = IRV + TV + ERV + RV</td>
<td>Normal Or Higher</td>
<td>Lower</td>
</tr>
<tr>
<td>Functional Residual Capacity (FRC) 2200ml = ERV + RV</td>
<td>Higher</td>
<td>Normal or Lower</td>
</tr>
<tr>
<td>Residual Volume (RV) 1200ml Male: 1.2 L</td>
<td>Higher</td>
<td>Normal, Lower Or Higher</td>
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<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Expiratory Reserve Volume (ERV) 1000ml Men: 1.0 L</td>
<td>Normal Or Lower</td>
<td>Normal Or Lower</td>
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</table>
DRUGS AFFECTS RESPIRATORY SYSTEM

BRONCHOSPASM:-

- Aspirin
- ACE inhibitors :- Ramipril, Captopril, Enalapril etc.
- Beta adrenergic receptor blockers:- Acebutolol, Atenolol, Metaprolol, Celiprolol.
- Inhalational agents/Aerosols:- Beclomethasone, Fluticasone, Flunisolide.
- Nonsteroidal Anti-inflammatory drugs.
- Penicillin.
PULMONARY EDEMA:
- Dextran
- Heroin
- Hydrochlorothiazide
- Methadone
- Tricyclic Antidepressants.

INTERSTITIAL PNEUMONITIS:
- Etoposide
- Phenytoin
- Procarbazine
- Sulphonamides.

PULMONARY FIBROSIS:
- Amiodarone
- Bleomycin
- Bromocriptine
- Cyclophosphamide
- 6-Mercaptopurine
- Methotrexate

Nitrofurantoin
THANK YOU

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