

Pulmonary Function Tests

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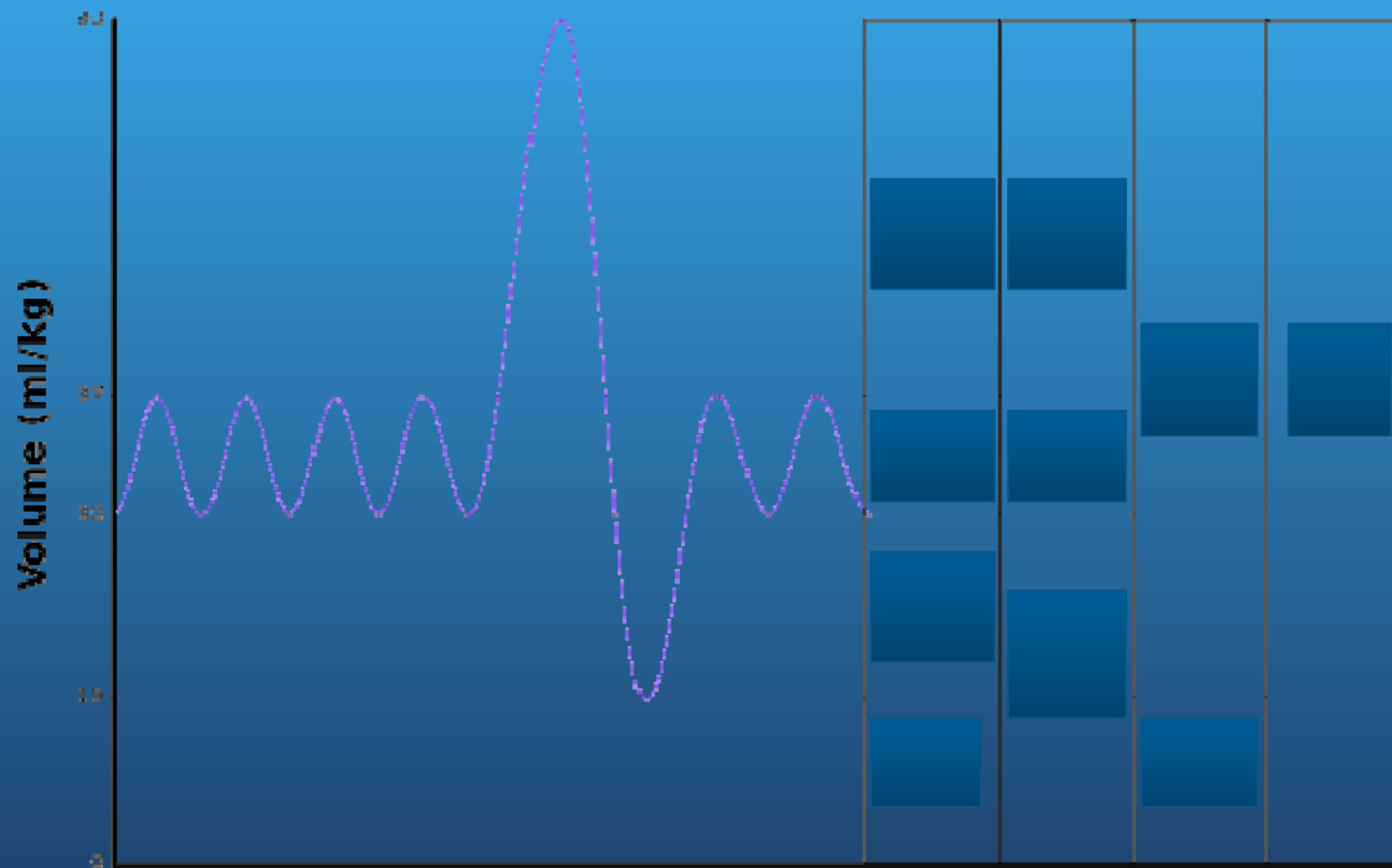
Indications for PFTs

- Evaluation of a pulmonary complaint or sign
- Quantification of impairment and/or monitoring in known disease
- Assess effectiveness of therapeutic interventions
- Preoperative assessment to estimate risk for postoperative complications or tolerance for lung resection

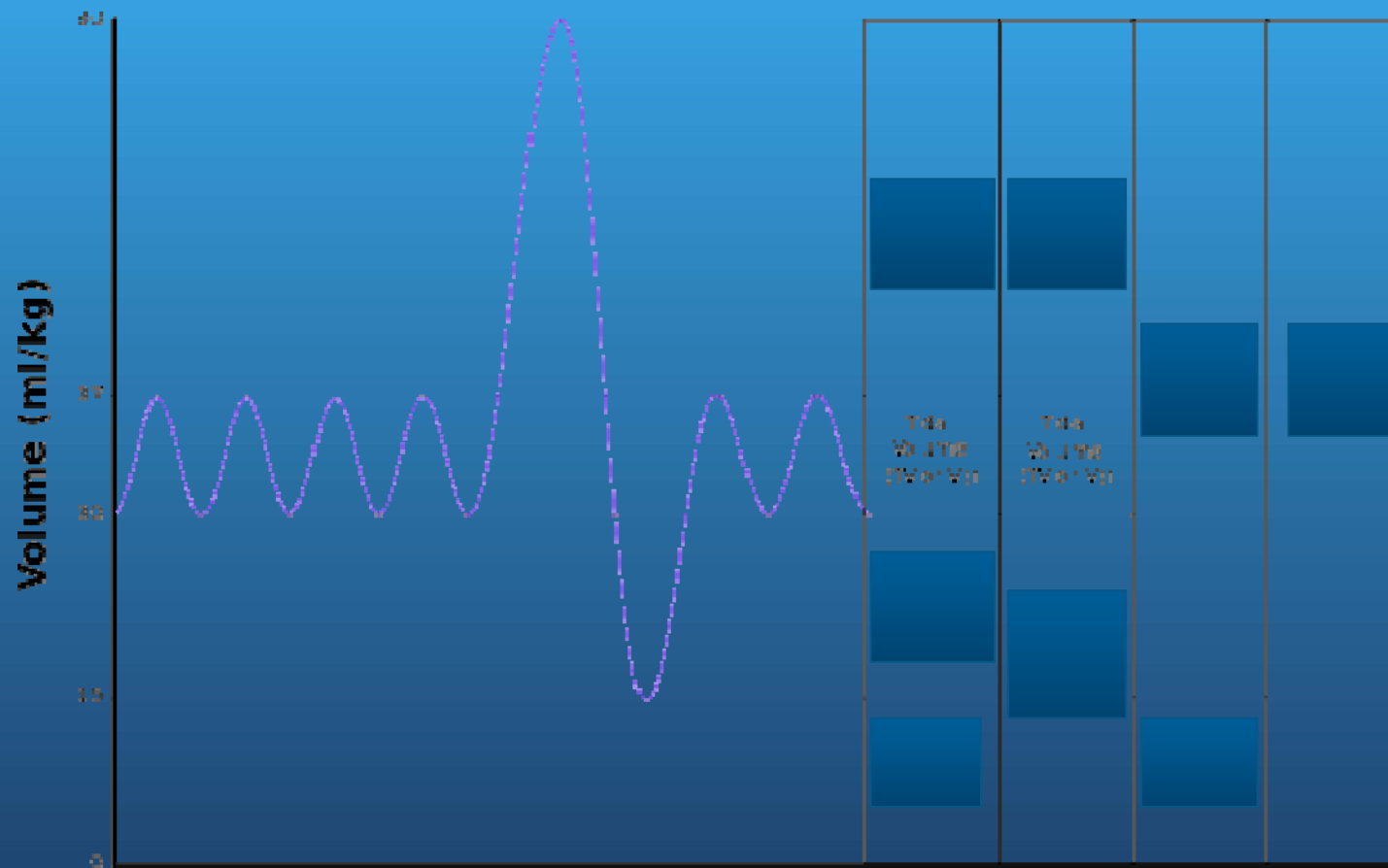
Types of PFTs

- Mechanical Evaluation
 - Spirometry – most of the time this is all you need!
 - Flow volume loops
 - Lung volumes
 - Bronchoprovocation
 - Respiratory muscle strength
- Gas exchange evaluation
 - DLco
 - ABG
 - Pulse oximetry

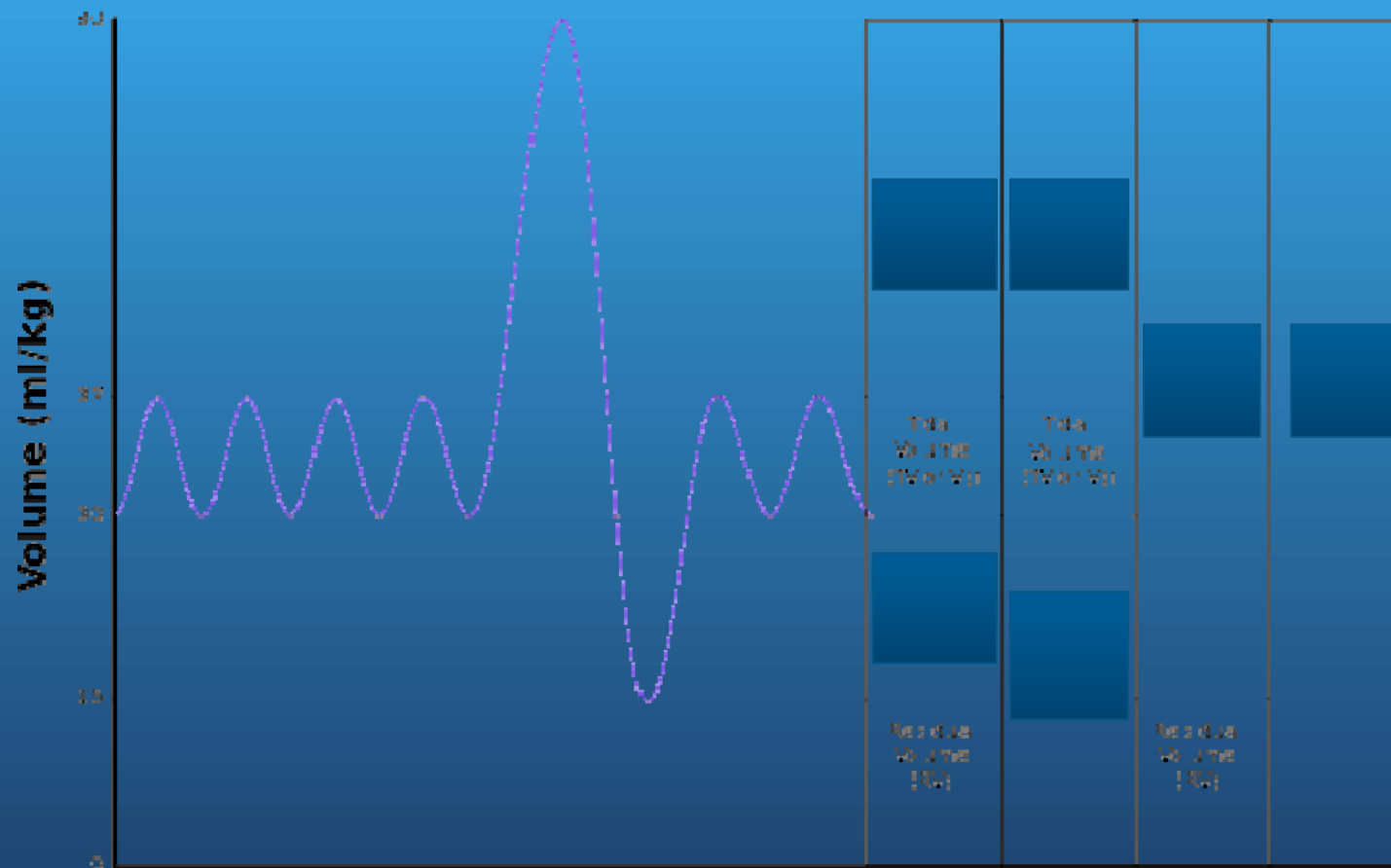
Definitions of Lung Volumes



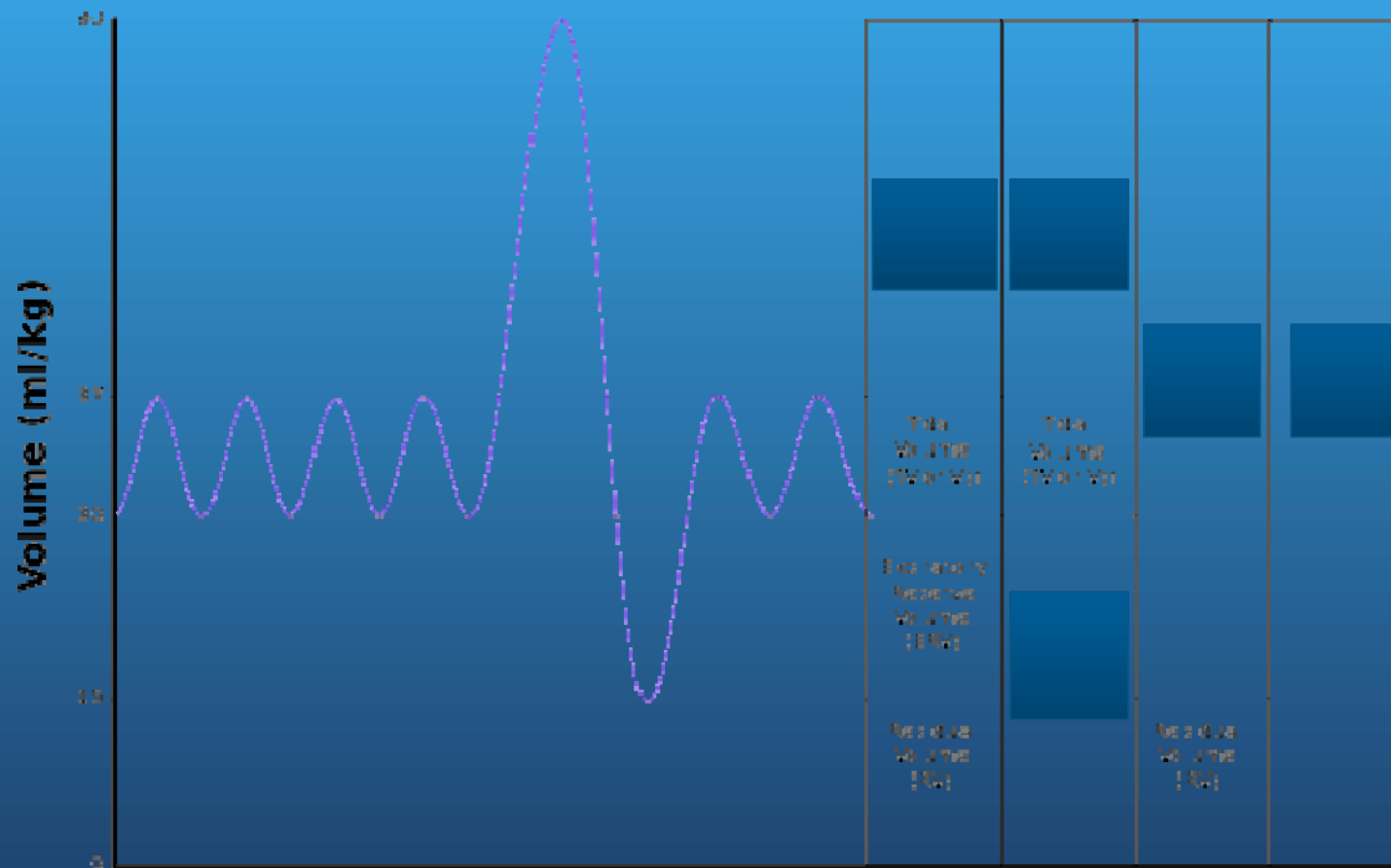
Definitions of Lung Volumes



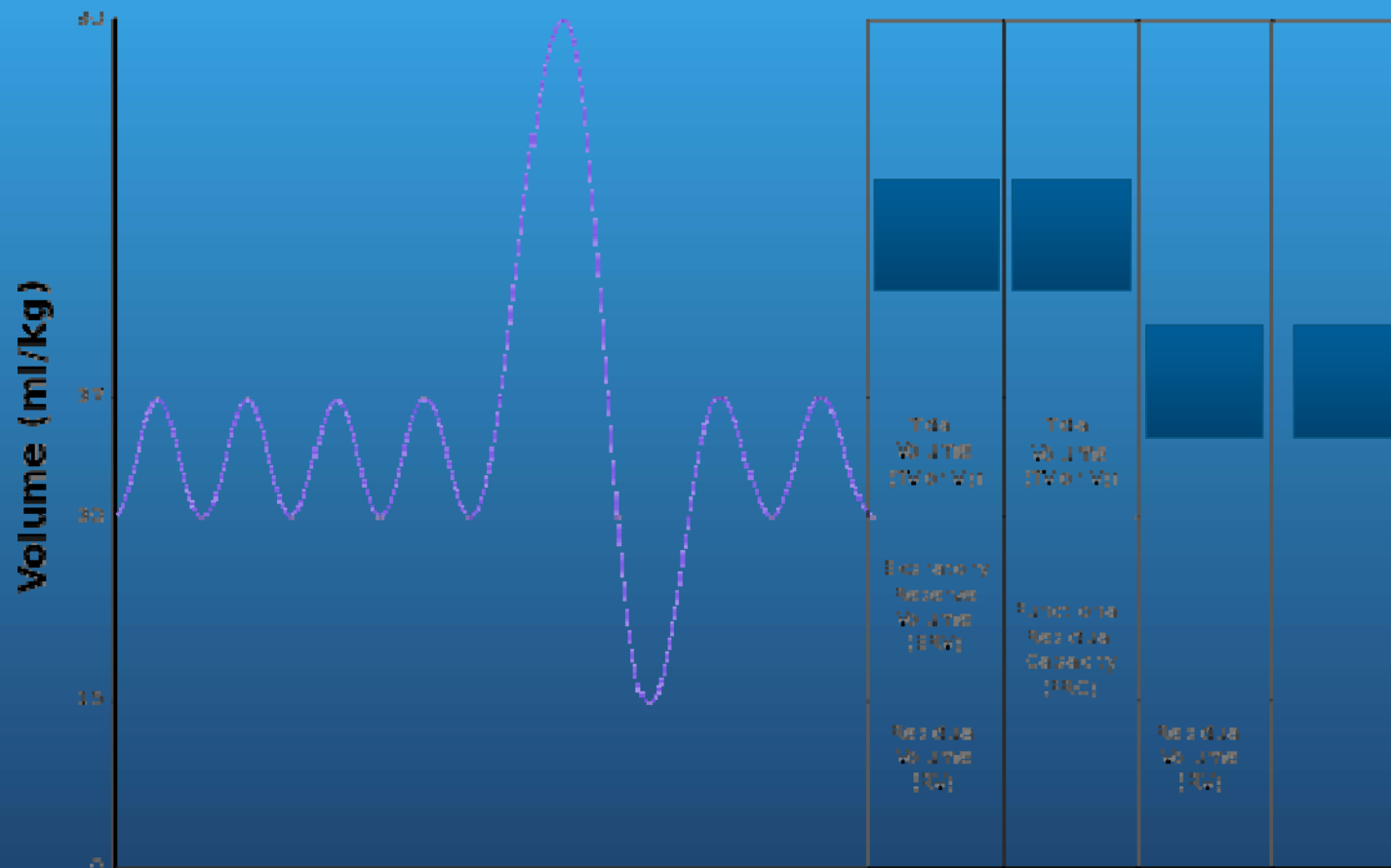
Definitions of Lung Volumes



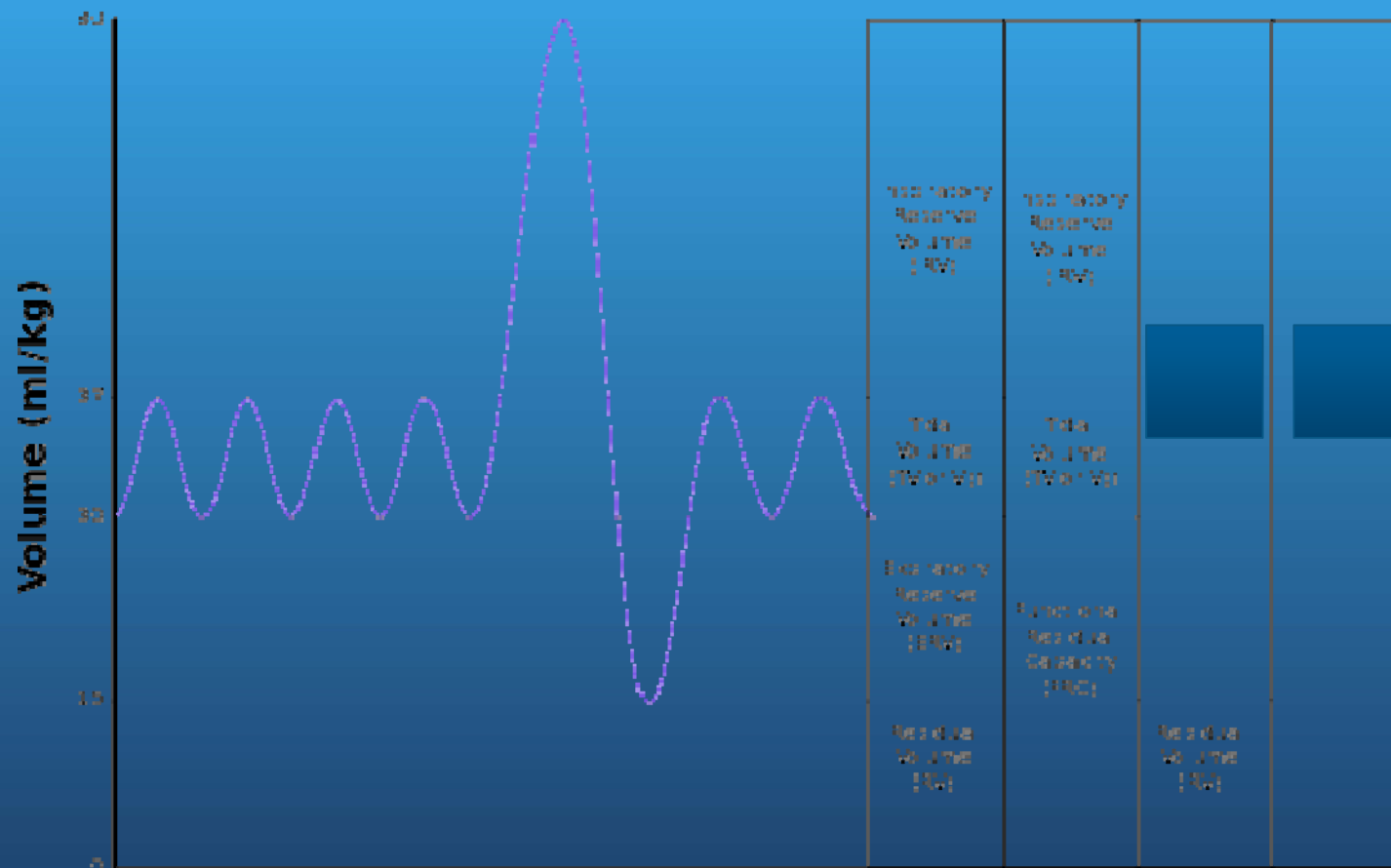
Definitions of Lung Volumes



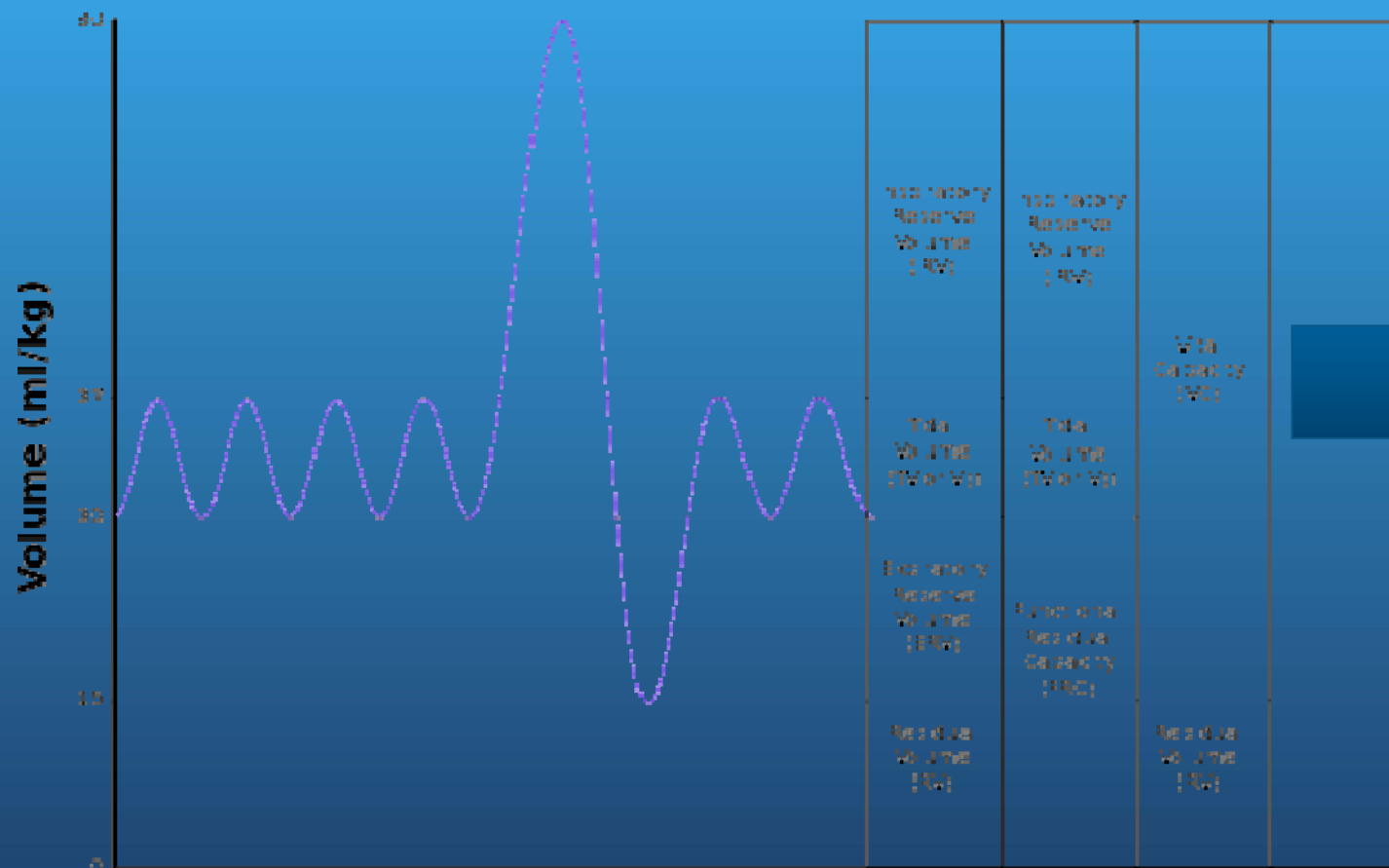
Definitions of Lung Volumes



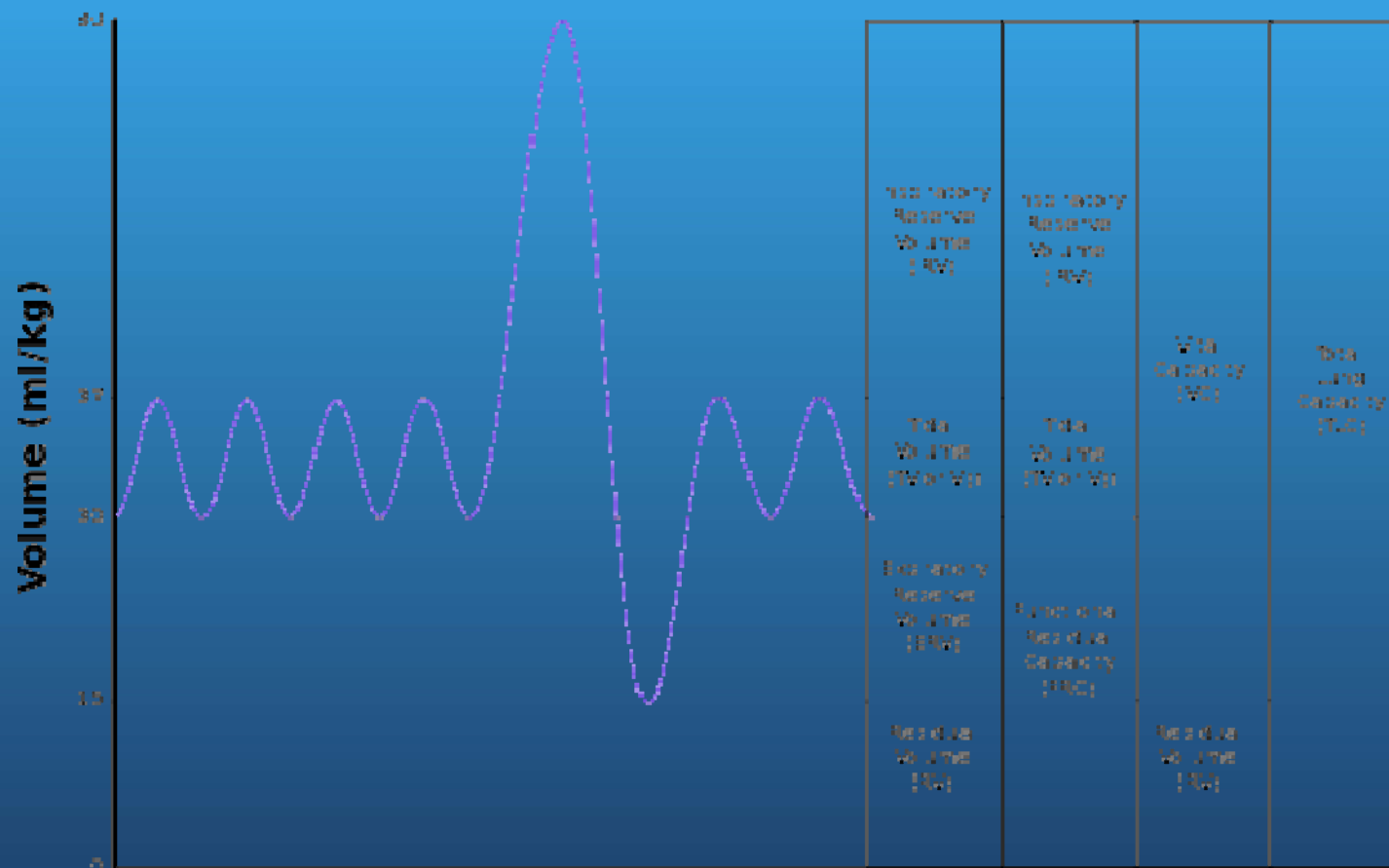
Definitions of Lung Volumes



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Definitions of Lung Volumes



Definitions

- FVC: volume of gas that can be forcibly exhaled after fully inflating the lungs
- FEV: volume of gas exhaled at a specified time after beginning the FVC maneuver (like FEV1)
- FEV/FVC: ratio of timed expiratory volume to forced vital capacity (like FEV1/FVC)
- FEF_x: forced expiratory flow rate during a specified portion of the FVC (like FEF25-75%)

Definitions

- DL: diffusing capacity of the lung – expressed as the volume of gas transferred per minute per unit of alveolar-capillary pressure difference for the gas used (like D_{lco} in ml/min/mmHg)

Static Lung Volume Determination

- Gas dilution (helium or nitrogen washout)
- Plethysmography (body box)
- Radiographic planimetry

How do we measure RV??

- We measure FRC
- FRC is a reproducible lung volume (ok, capacity) in the resting lung
- A balance between the inward force of the lung and the outward force of the chest wall
- Once a SVC maneuver is done, every lung volume and capacity can then be computed from the FRC and SVC

Body Plethysmography

- Performed with patient seated in airtight box, breathing through mouthpiece
- At end expiration a shutter closes off the mouthpiece, and the patient is asked to make respiratory efforts
- As the patient inhales across the closed shutter, the volume (FRC) in the patient's lungs expands slightly, compressing the gas in the box
- Now you know the Thoracic Gas Volume (or FRC)

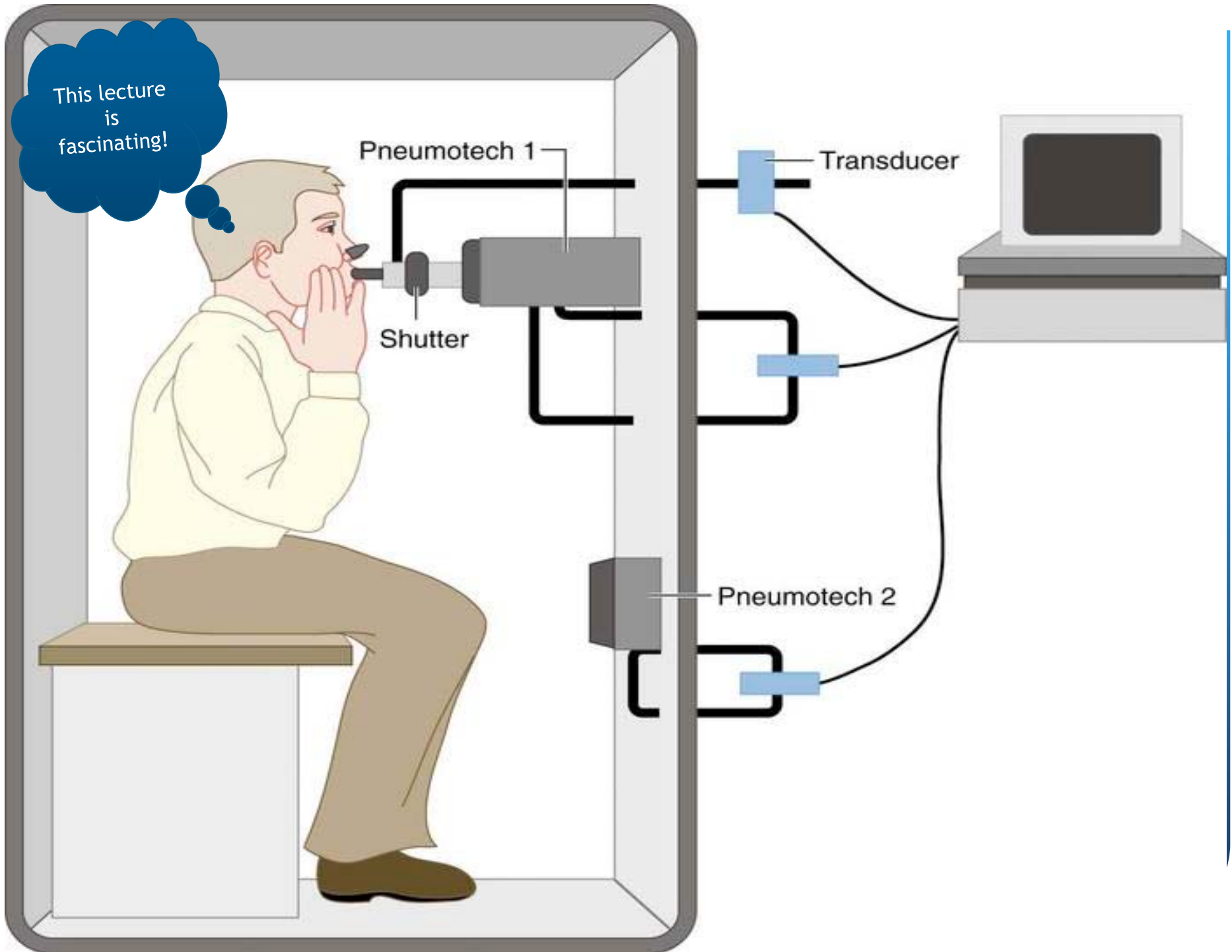
This lecture
is
fascinating!

Pneumotech 1

Shutter

Transducer

Pneumotech 2



Common “special” studies

- Diffusing capacity
- Bronchoprovocation (methacholine challenge)

DLco

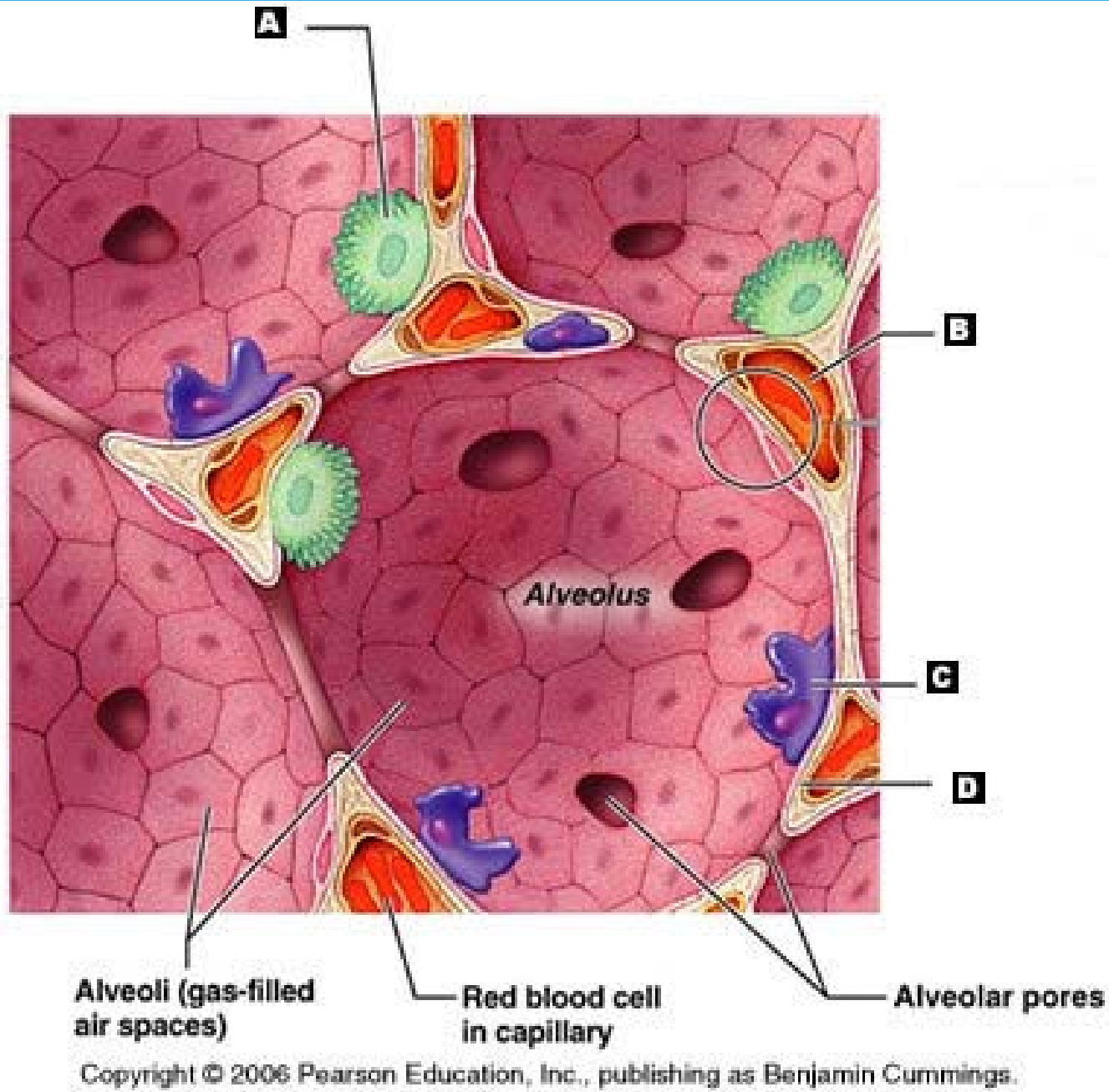
- Measures alveolar-capillary interface in the lung
- Dependent on Hgb concentration
- Patient breathes one breath of known concentration of CO gas and holds inspiration for 10 seconds
- It's not all CO (0.3% CO, 10% He, 21% O₂, 68.% N₂)
- Exhaled gas mixture is then analyzed for amount of CO absorbed into lung

Why carbon monoxide?

- CO has a high affinity for Hgb, 210 times that of O₂, thus the partial pressure of CO dissolved in plasma remains very low
- Available binding sites for CO are so numerous that they cannot possibly be saturated by the number of CO molecules that diffuse during the test
- CO transfer is only limited by the alveolar membrane diffusion rate

Clinical correlation of DLco

- **Decreased** in conditions that disrupt alveolar-capillary gas transfer
 - COPD
 - ILD
 - Anemia
 - Pulm vasc disease
 - Pneumectomy



Clinical correlation of DLco

- **Increased** in conditions with increased pulmonary blood volume
 - L→R shunts
 - alveolar hemorrhage (IF active bleeding/intact Hgb molecules in alveoli)
 - obesity
 - asthma
 - polycythemia
 - exercise

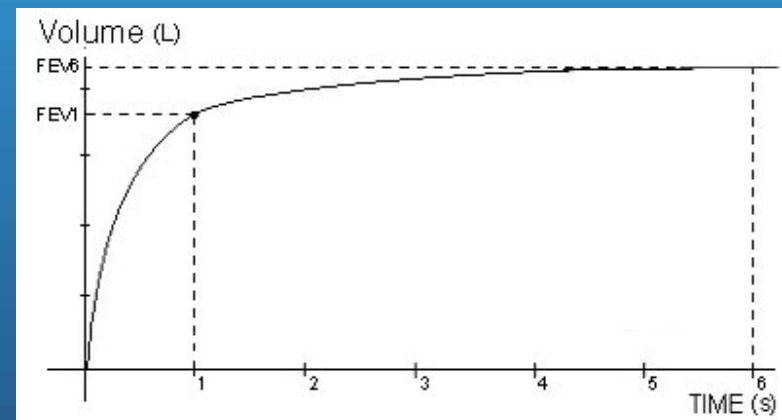
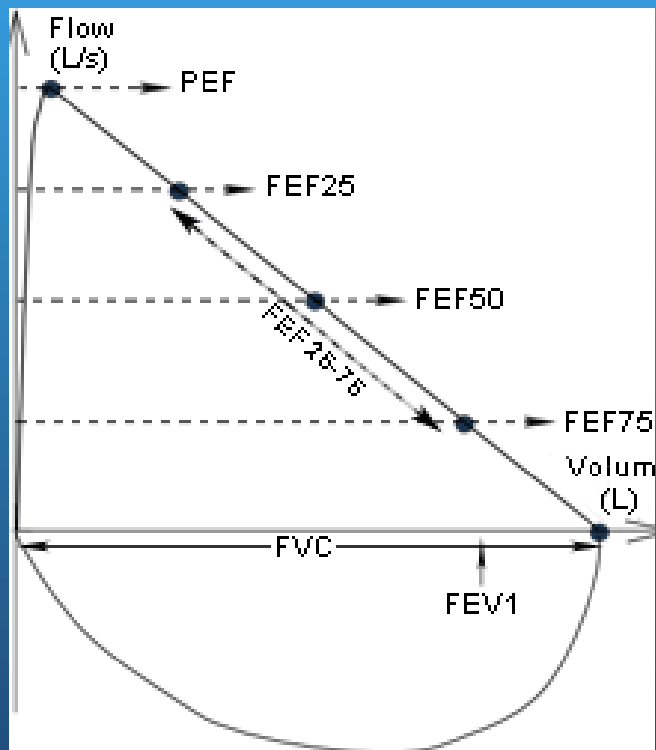
Approach to Interpretation of PFTs

- Is this test interpretable?
- Are the results normal?
 - The most useful predictive values in an individual patient are baseline measurements made when the patient was free of disease
- What is the pattern and severity of the abnormality?
- What does this mean for the patient?
- Normals adjusted for age, height, gender, race

Normal range as % Predicted

FEV1	80-120%
FVC	80-120%
FEV1/FVC	>70%
FEF25-75	>50%
TLC	80-120%
RV	75-120%
Dlco	75-120%

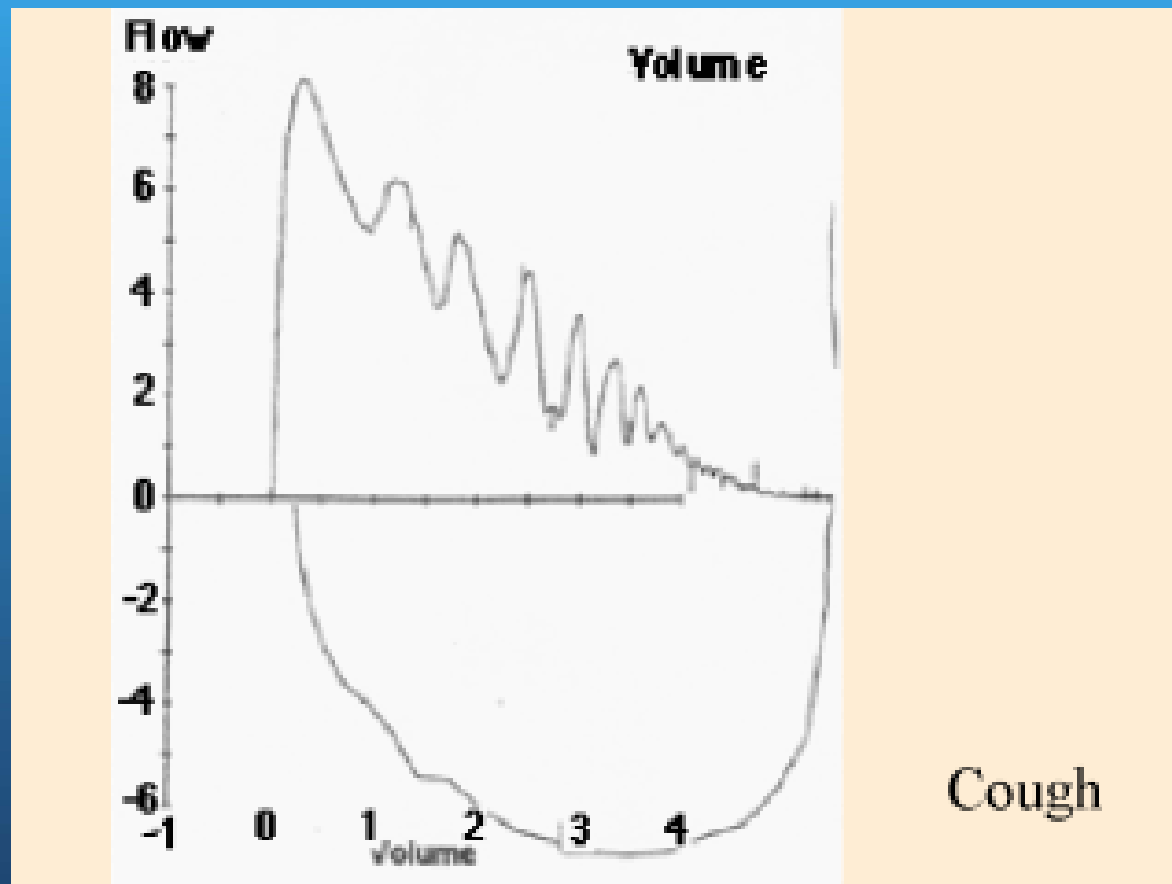
Normal Flow Volume Loop



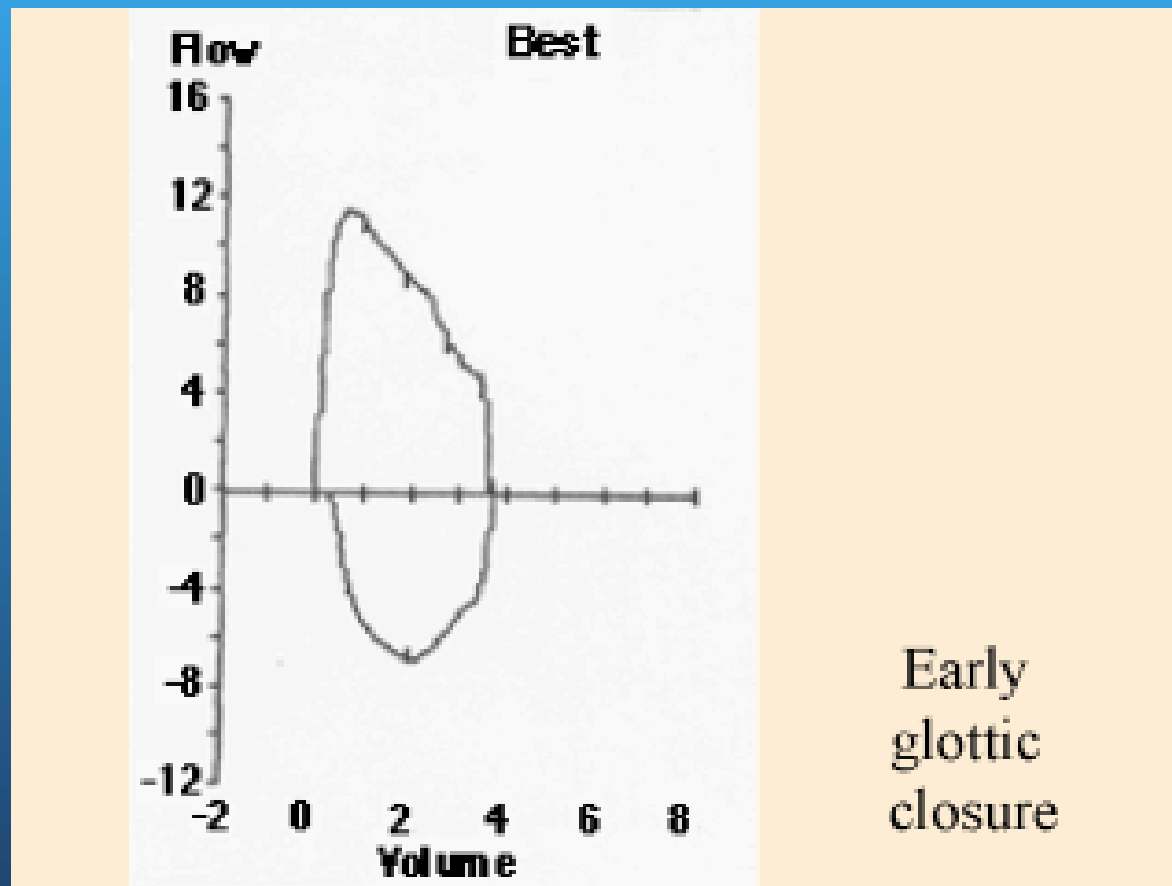
Is this test Interpretable?

- 1) Volume-time curve reaches a plateau, and lasts 6 seconds
- 2) Results of the 2 best efforts on the spirometry are within 0.2L of each other
- 3) Flow-volume loops are free of artifacts

Cough



Early Glottic Closure



Obstructive Lung Disease

--a FLOW problem!

- Spirometry
 - Decrease in FEV1
 - Normal or decreased FVC
 - This, decreased FEV1/FVC
- Lung Volumes
 - Increased TLC (hyperinflation)
 - Increased RV or increased RV/TLC > 35% (air trapping)
- Dlco
 - Decreased in COPD, normal in asthma

Bronchodilator Response

- Increase of 12% AND 200ml in the FVC or FEV1

Mild Obstruction

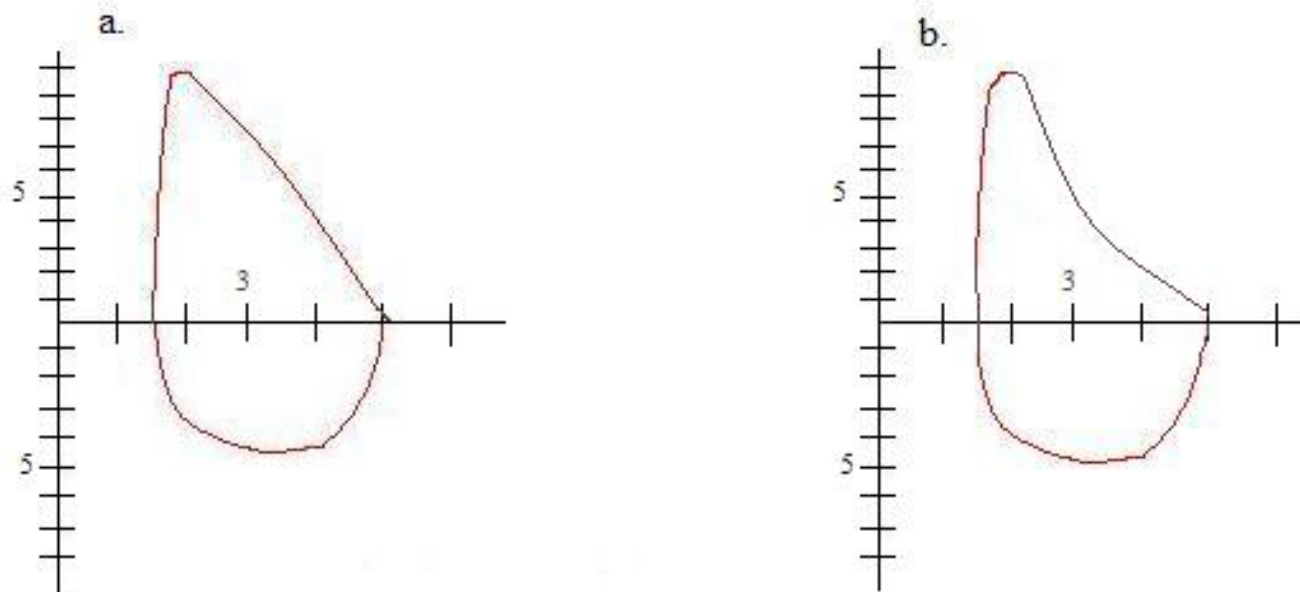
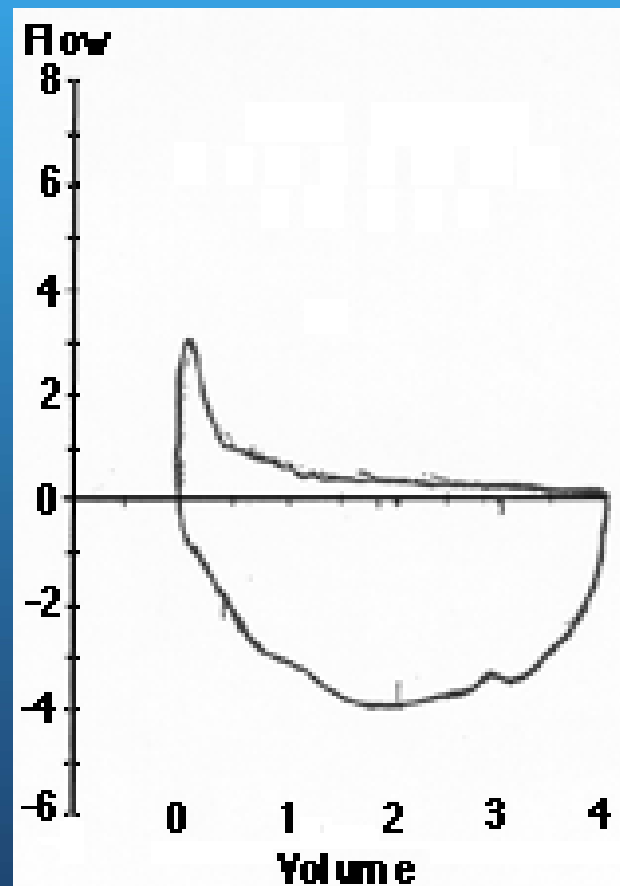


Figure 2 - A normal flow-volume loop is shown in Figure 2a. Figure 2b shows an obstructive defect, with marked scooping. X-axis is volume, Y-axis is flow.

Severe Obstruction

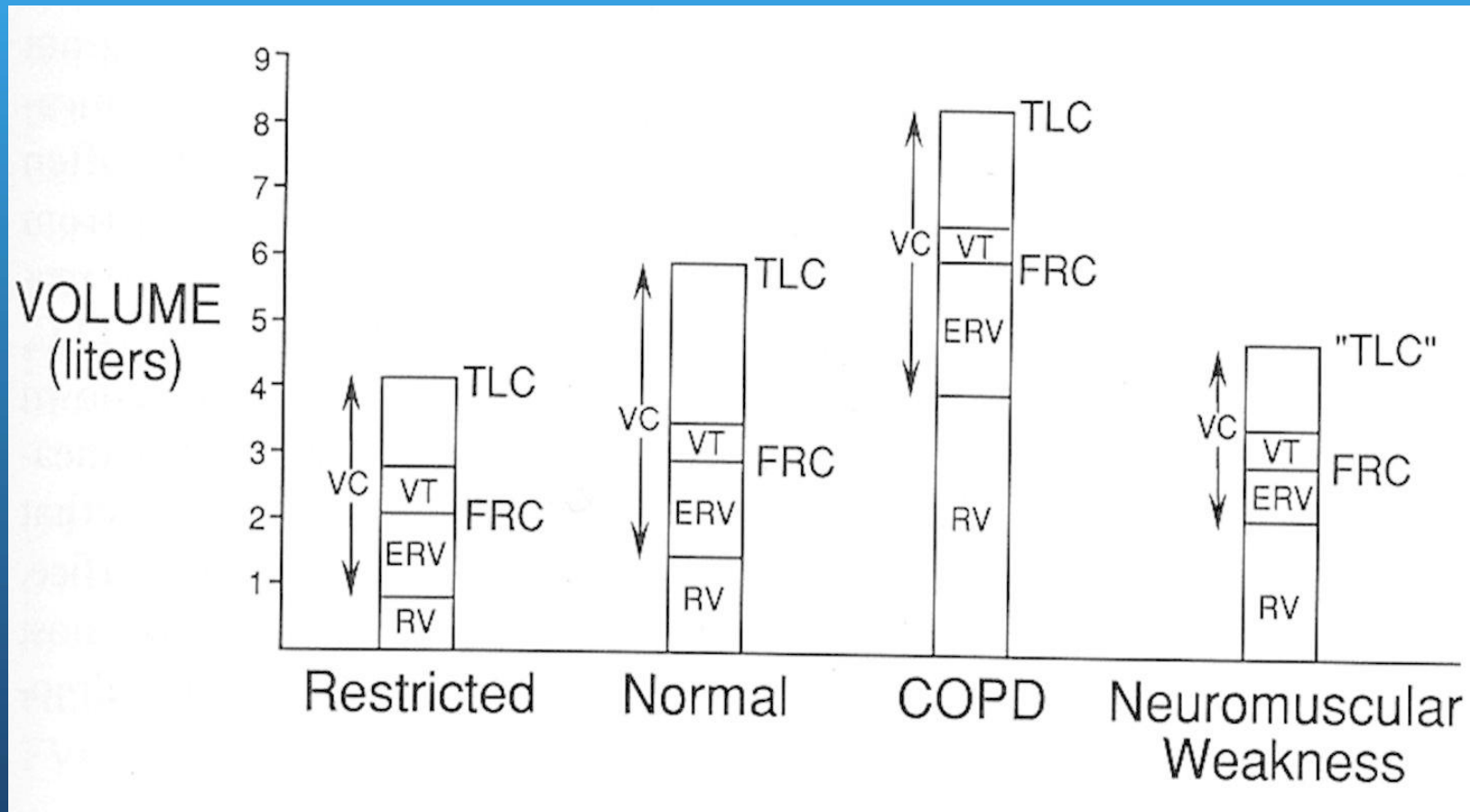


Restrictive Lung Disease

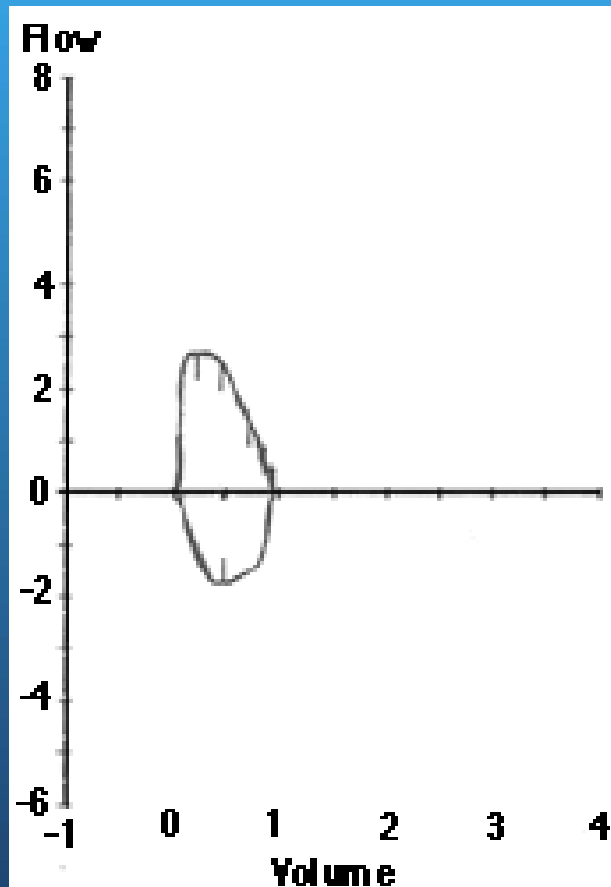
-a VOLUME problem!

- Spirometry
 - Decreased FEV1 and FVC
 - Normal or increased ratio of FEV1/FVC
- Reduction in TLC, RV
- Spirometry alone cannot diagnose restriction!
 - Why? VC can be reduced in either obstruction or restriction
 - Obstruction: low because RV is so high
 - Need lung volumes to confirm low TLC (RV cannot be measured with a spirometer) – may actually show air trapping/hyperinflation consistent with obstruction

Low VC in both obstruction and restriction??



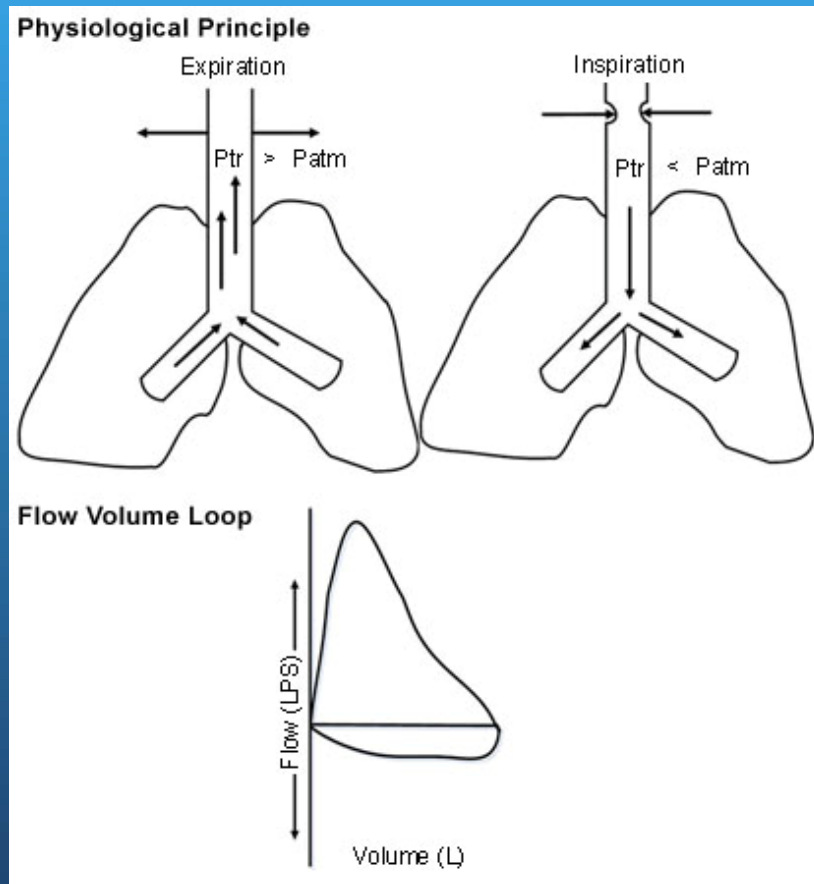
Restriction



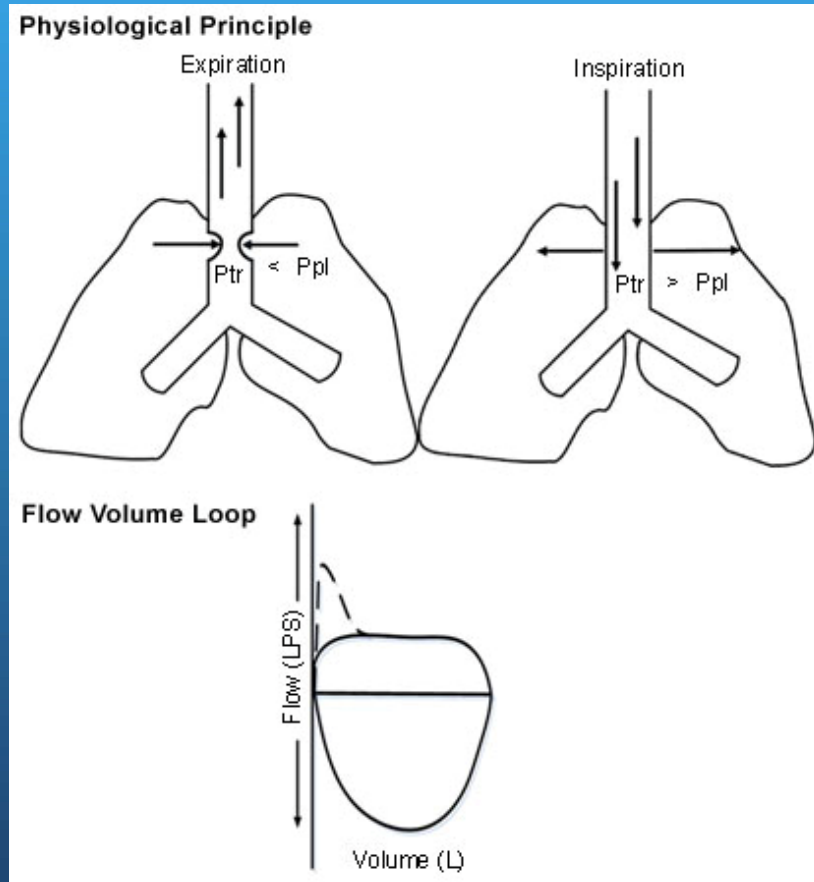
Special Situations

Variable Extrathoracic UAO

(VCD, goiter, tracheomalacia, tumor on one side, vocal cord edema)



Variable Intrathoracic UAO (low tracheal tumor)



Fixed Upper Airway Obstruction

(Tracheal stenosis, circumferential tracheal tumor)

