Pulmonary Function Tests

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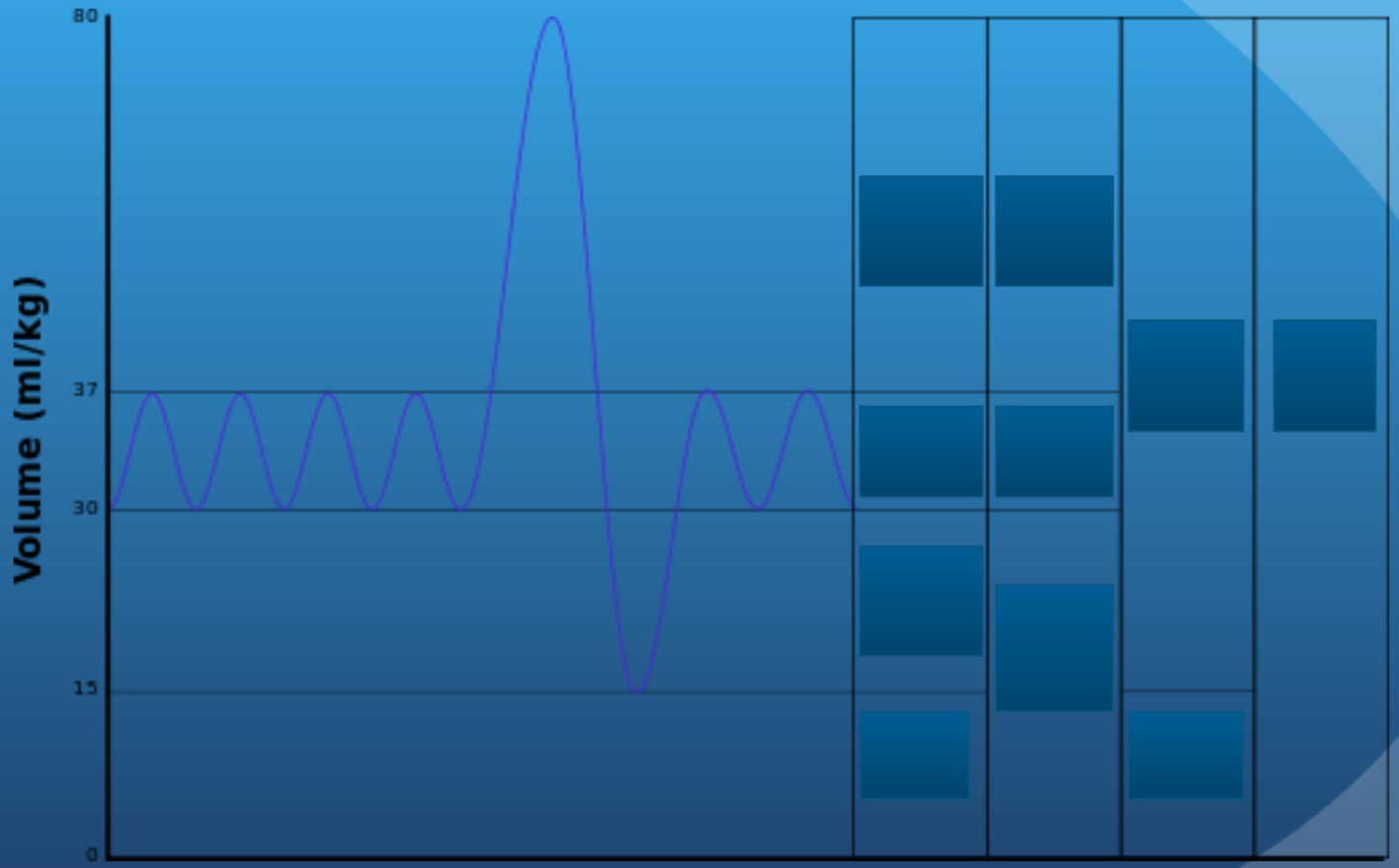
Indications for PFTs

- Diagnosis
- Quantification
- Therapeutic monitoring
- Preoperative assessment

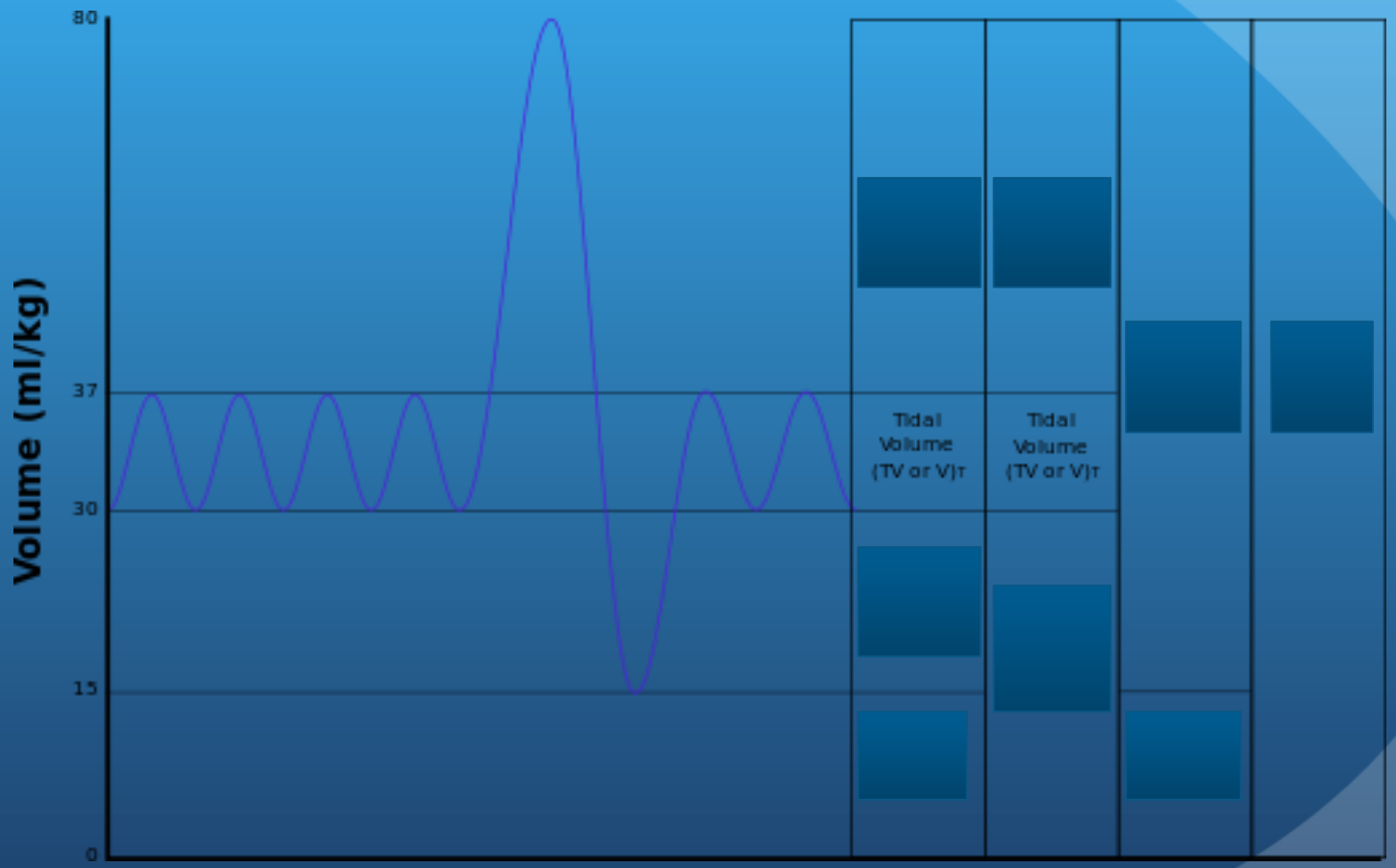
Types of PFTs

- 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



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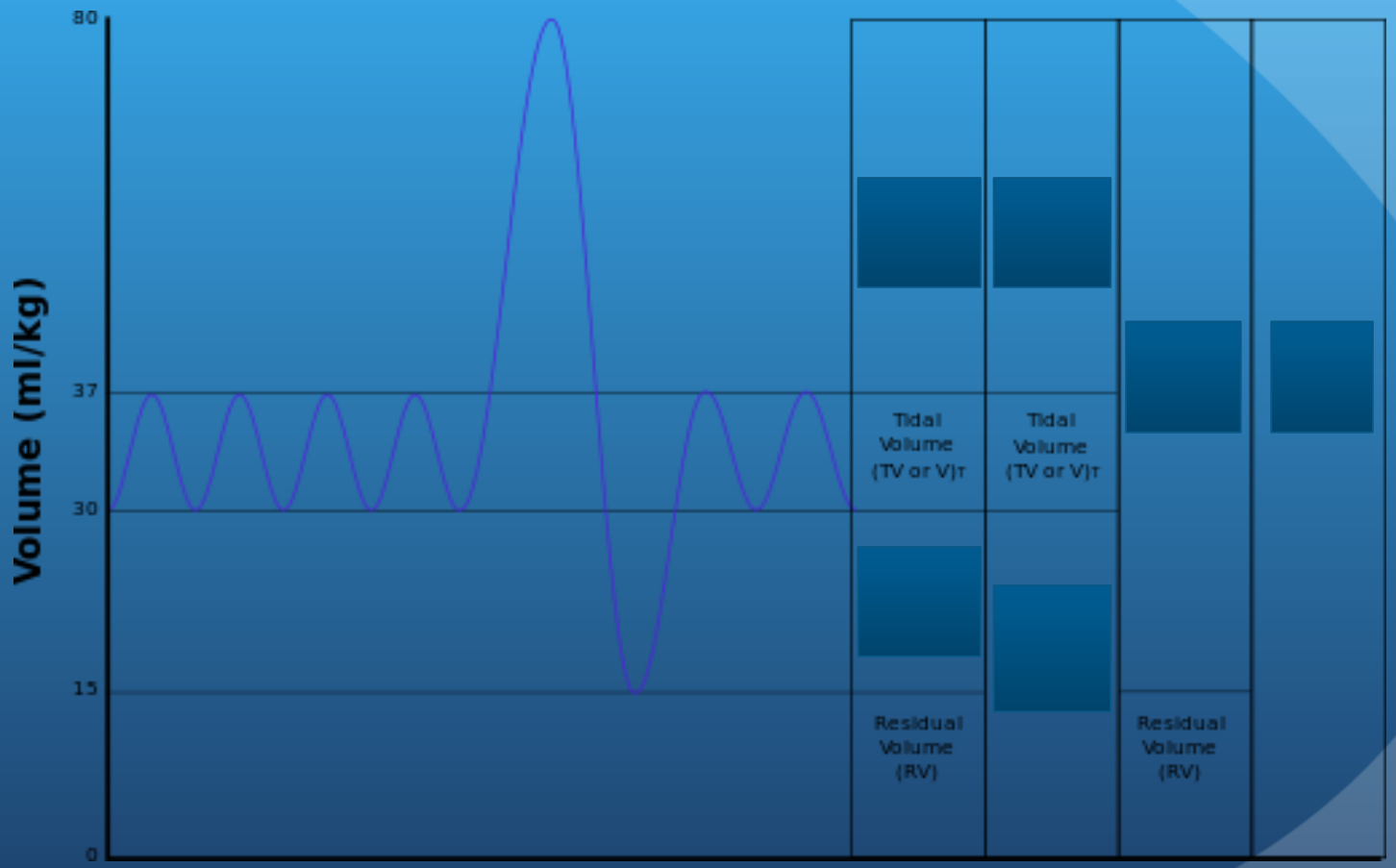

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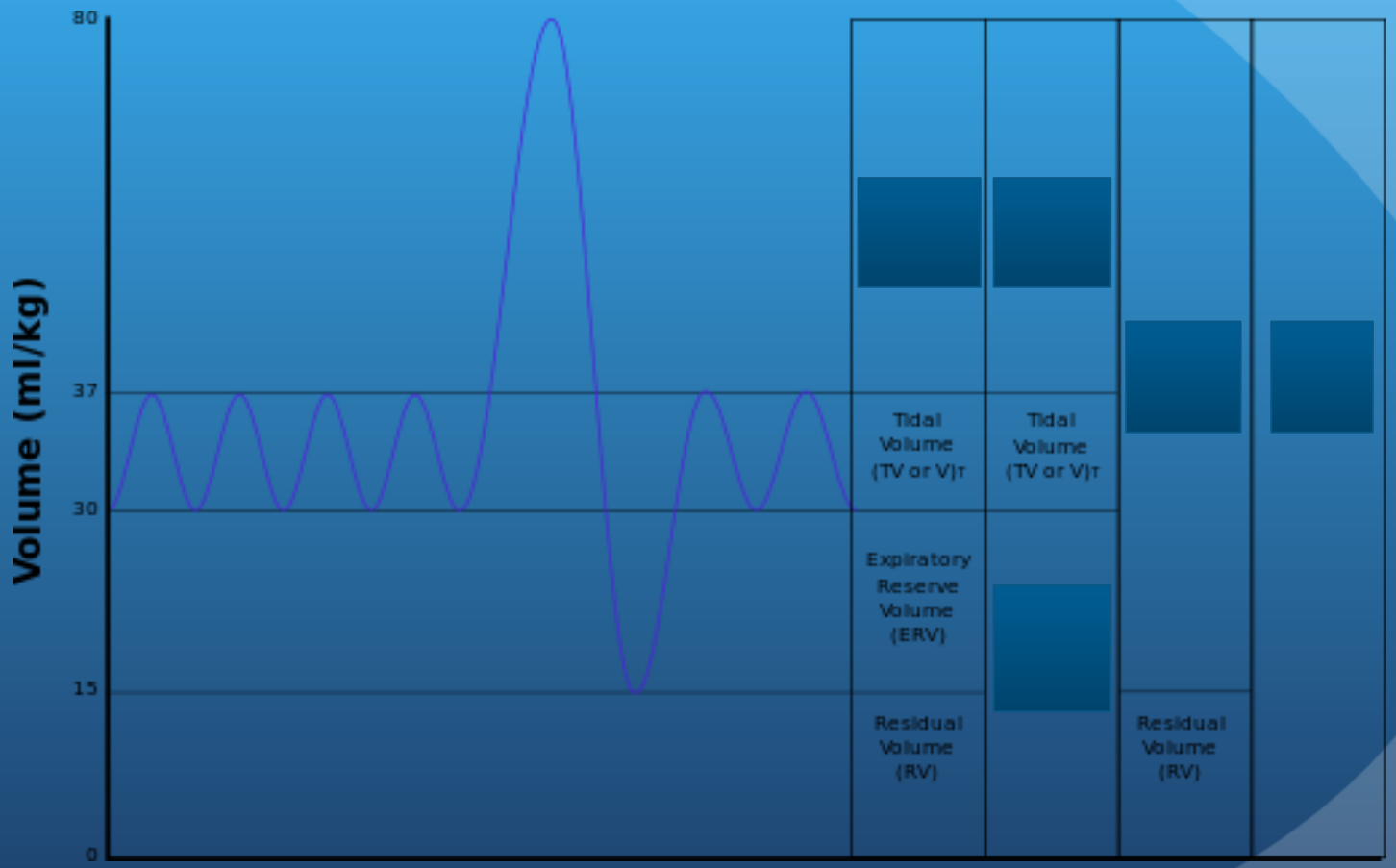

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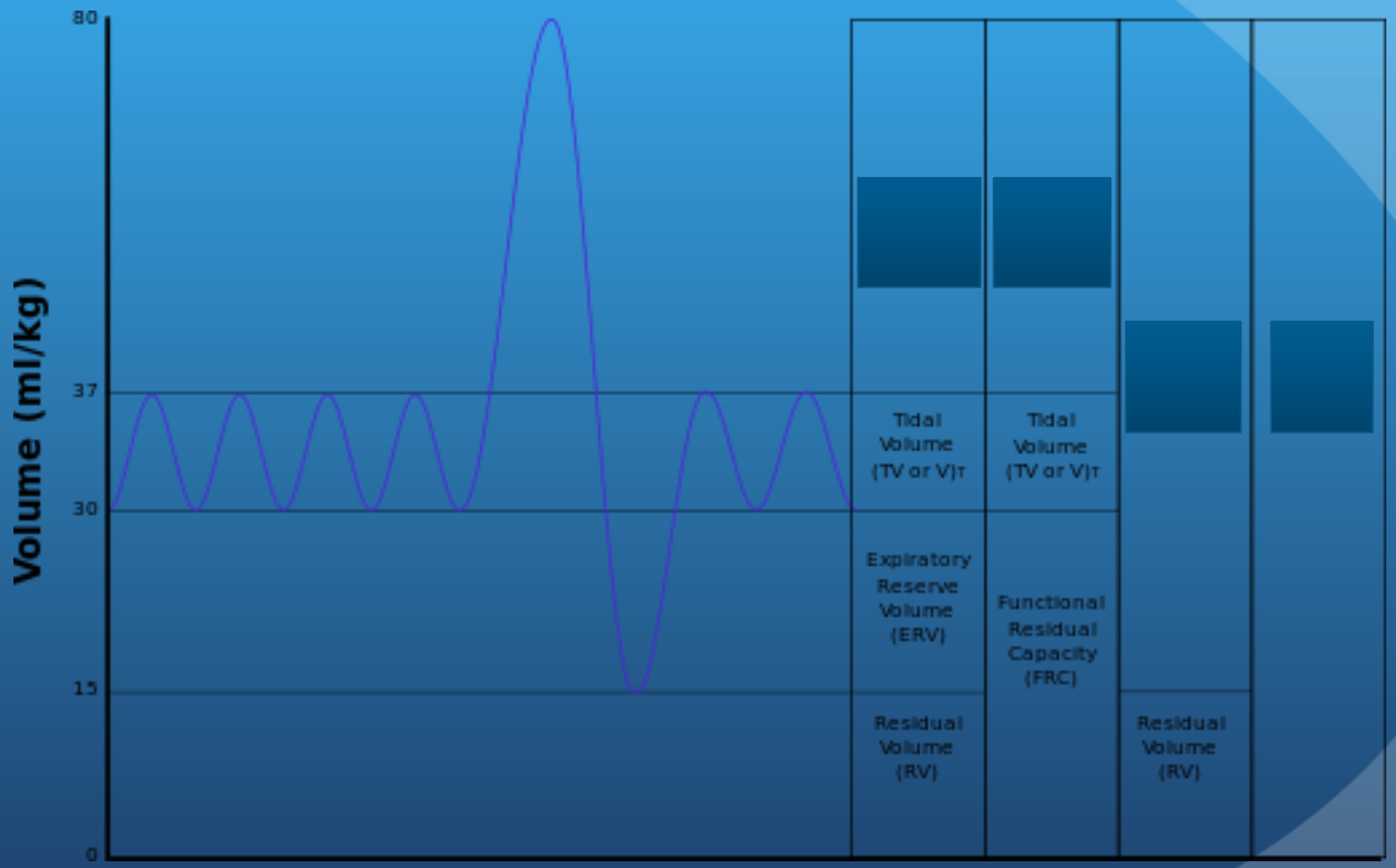

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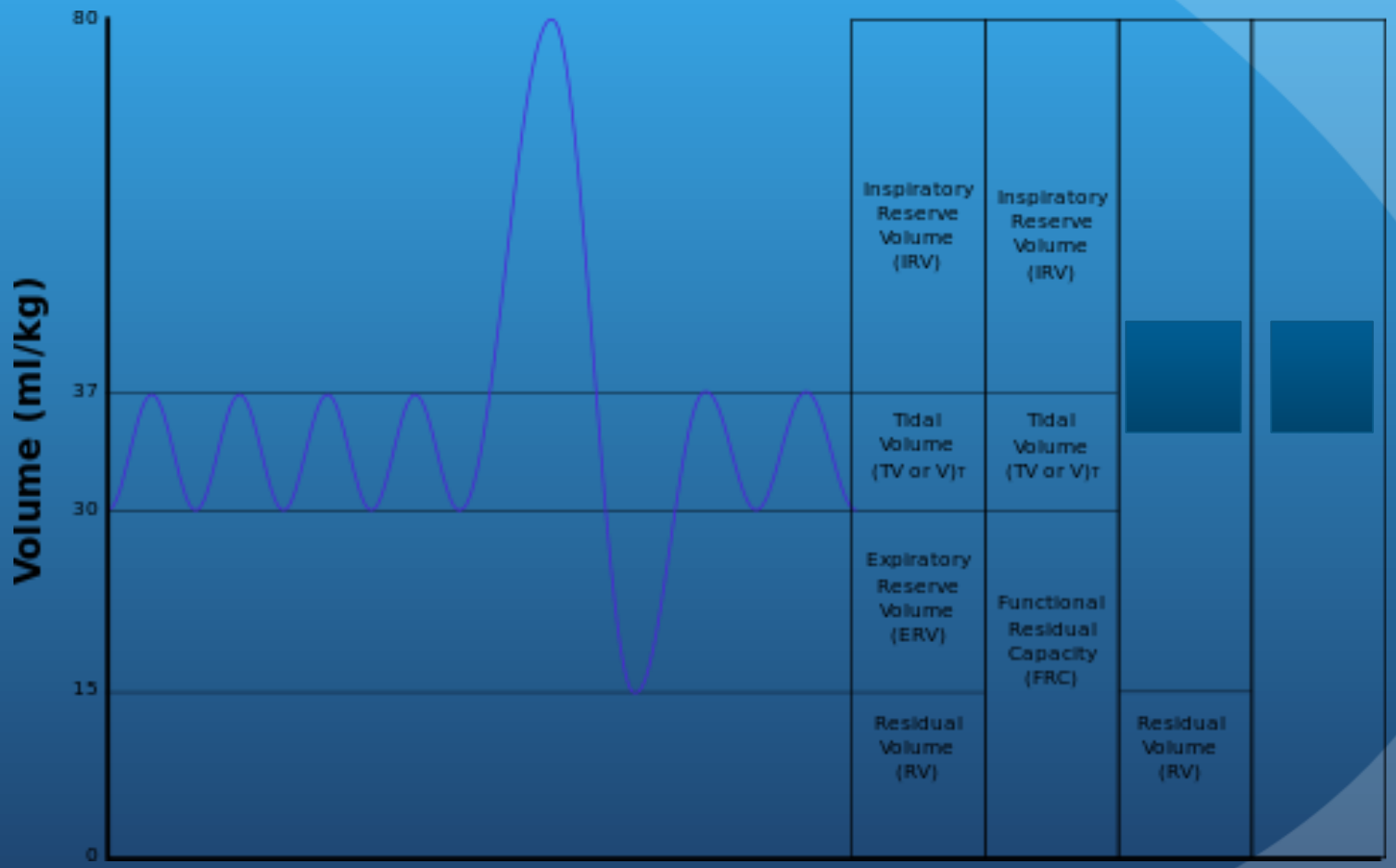

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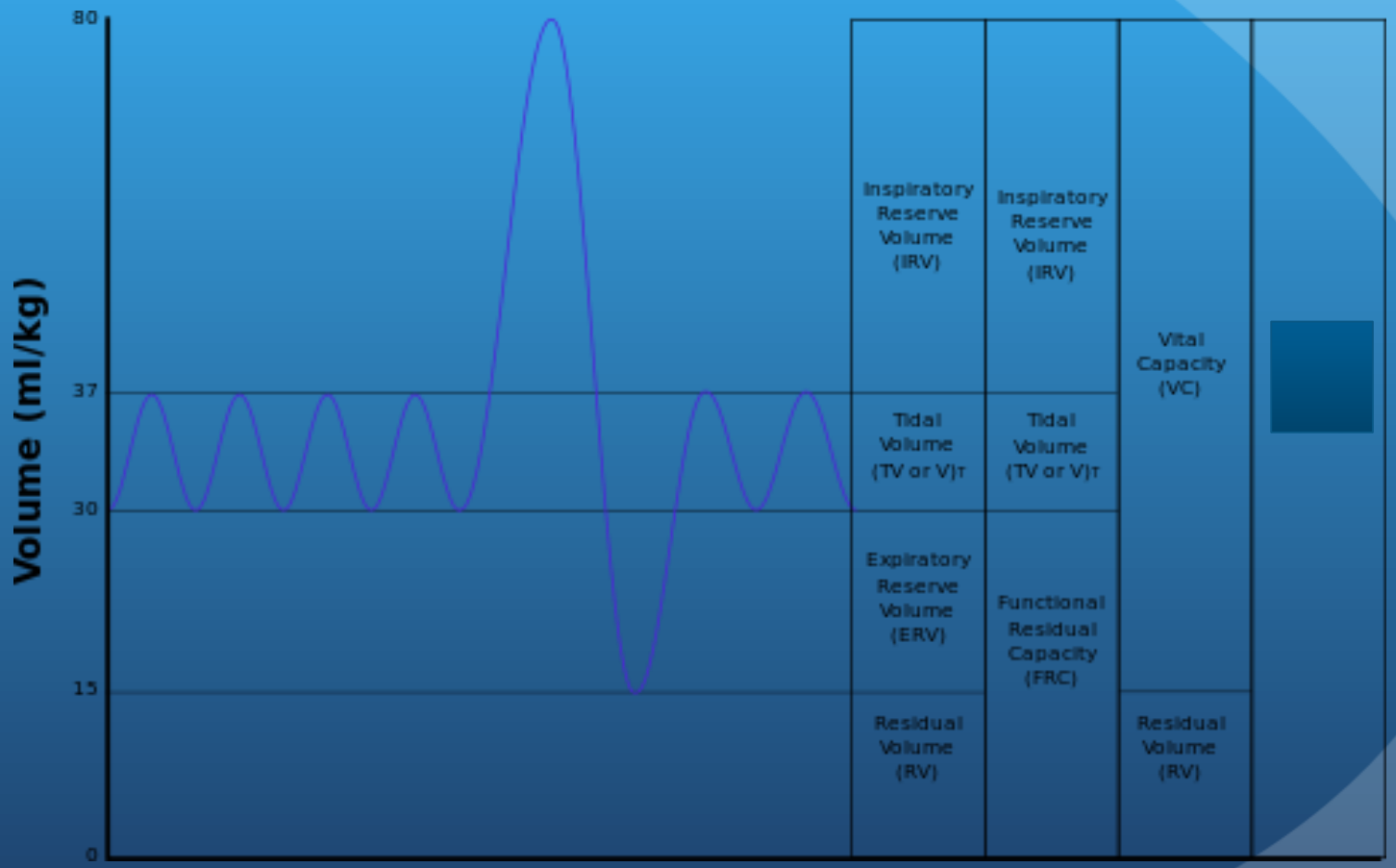

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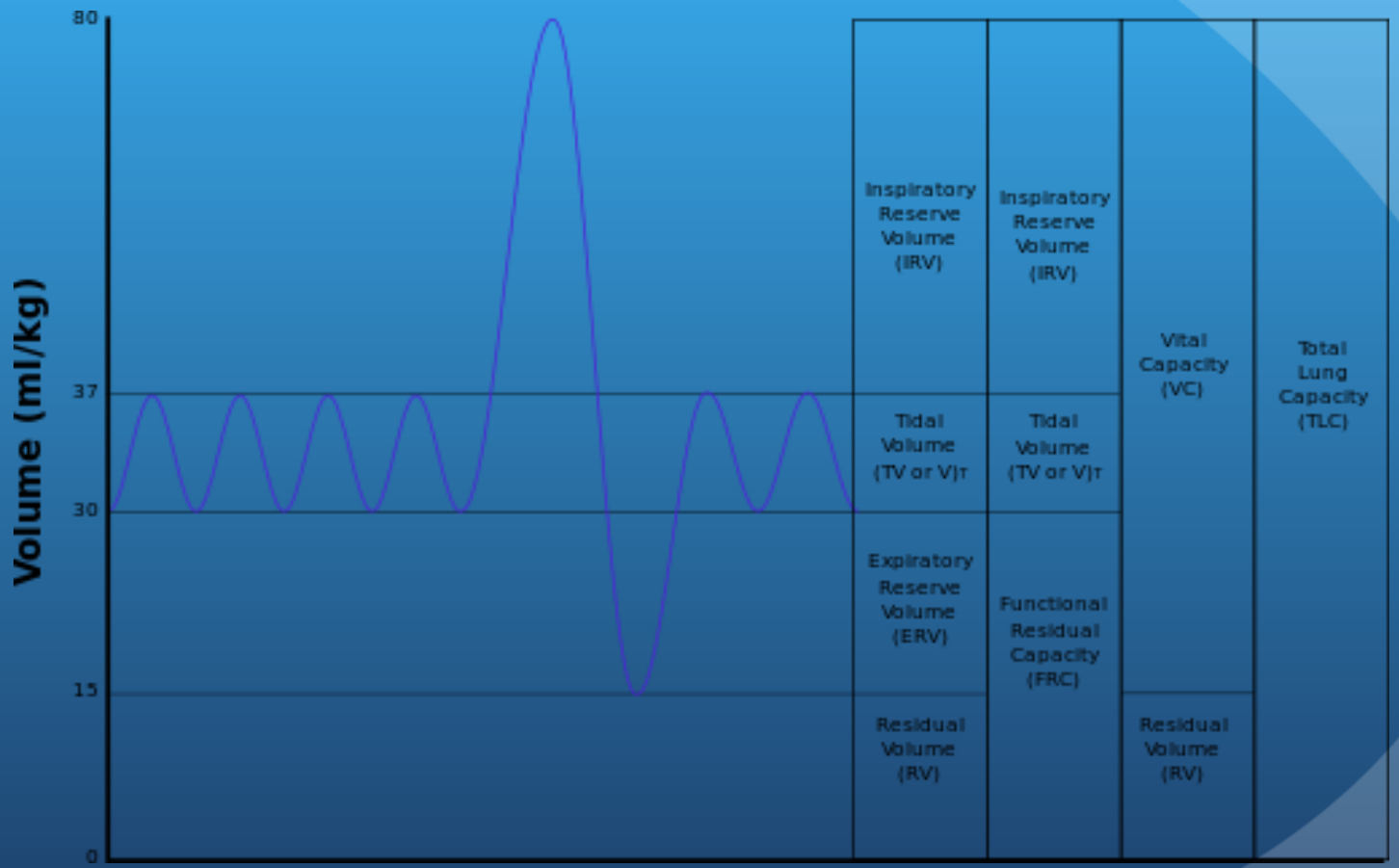
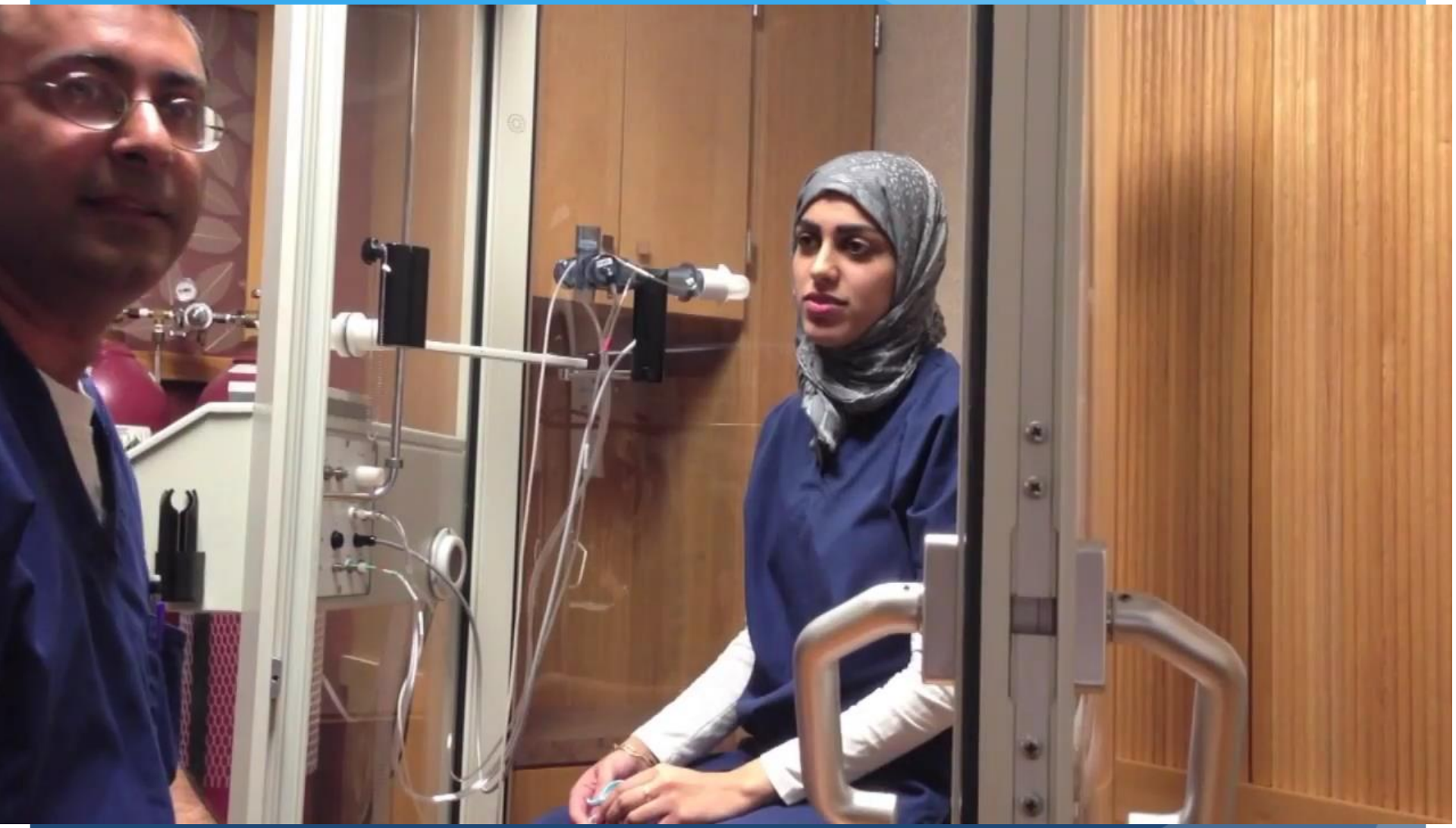


Can EVERY lung volume be measured?

- What about RV??
- RV = FRC - ERV
- FRC is a reproducible lung volume (ok, capacity) in the resting lung
- Once a VC maneuver is done, every lung volume and capacity can then be computed from the FRC and VC



DLco

- Measures alveolar-capillary interface in the lung
- 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?

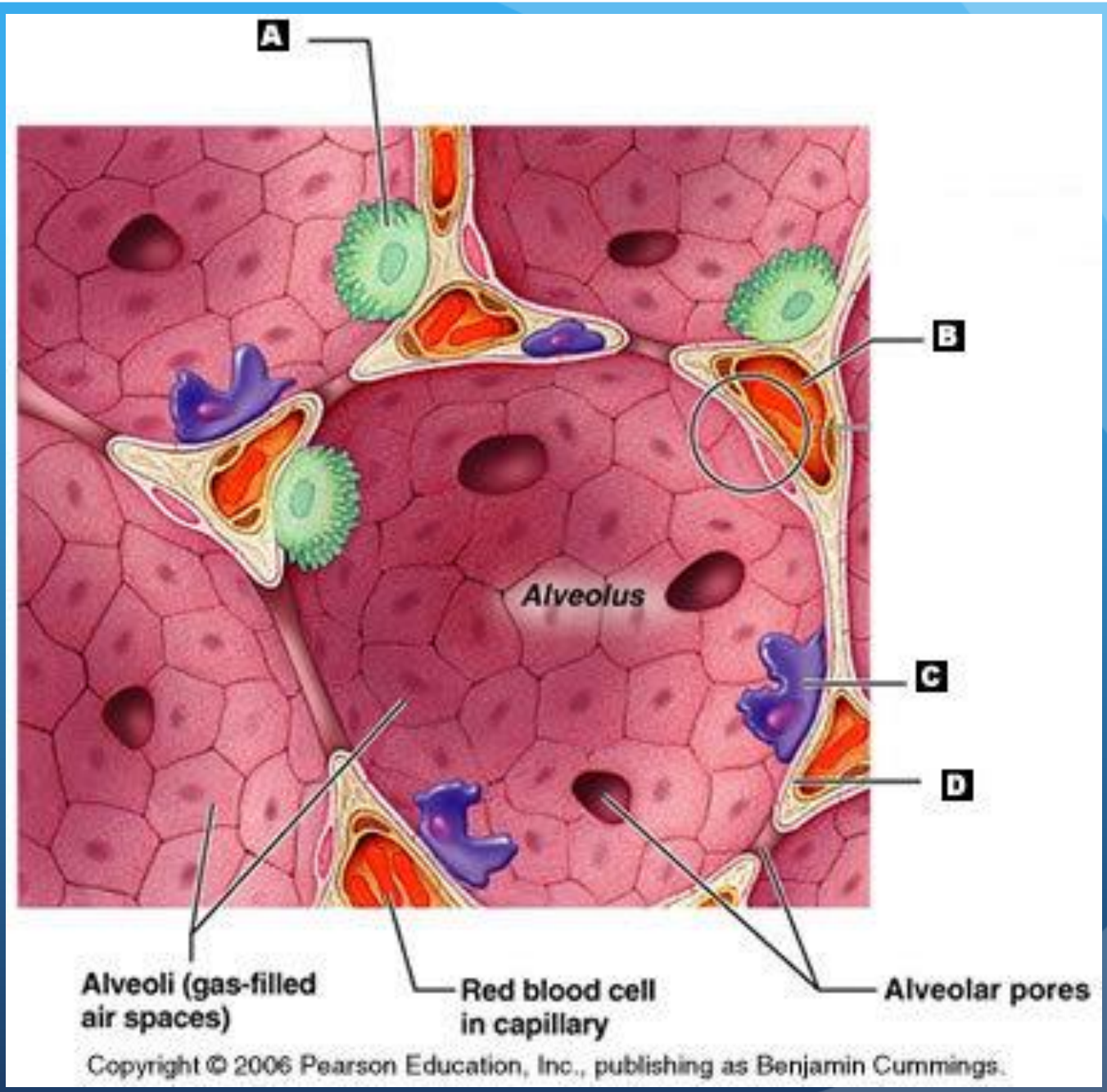
- CO has a high affinity for Hgb
- CO transfer is only limited by the alveolar membrane diffusion rate

Which one of these conditions does NOT cause a decrease in DLCO?

- A) Obesity
- B) COPD
- C) Interstitial lung disease
- D) Anemia

Clinical correlation of DLco

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



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 (increased pulmonary blood volume)
  - 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

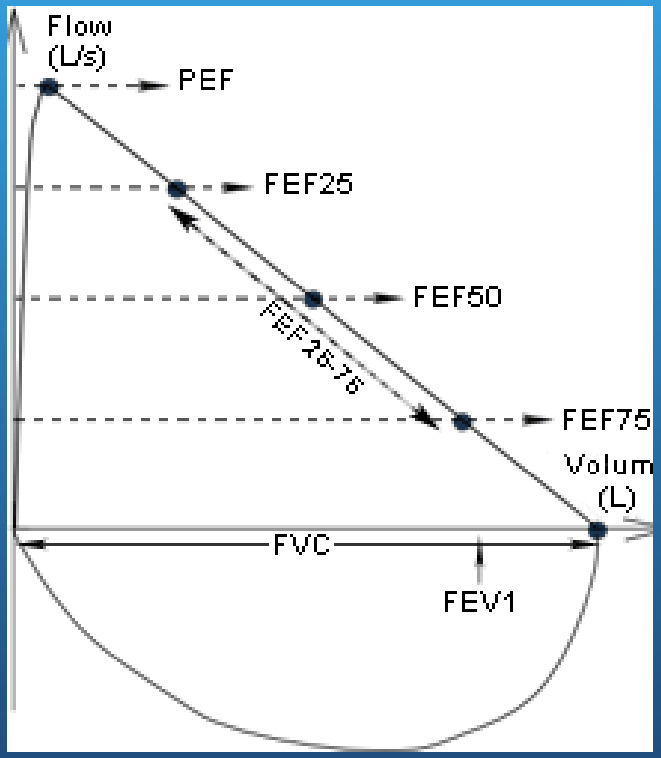
Terms used in Spirometry

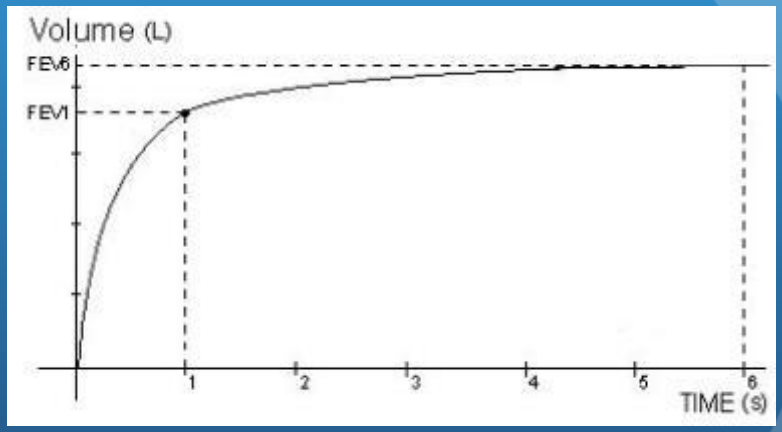
- FVC: volume of gas that can be forcibly exhaled after fully inflating the lungs
- FEV: volume of gas exhaled at a specified time after beginning the FVC maneuver (like FEV1)
- FEV/FVC: ratio of timed expiratory volume to forced vital capacity (like FEV1/FVC)
- FEFx: forced expiratory flow rate during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

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

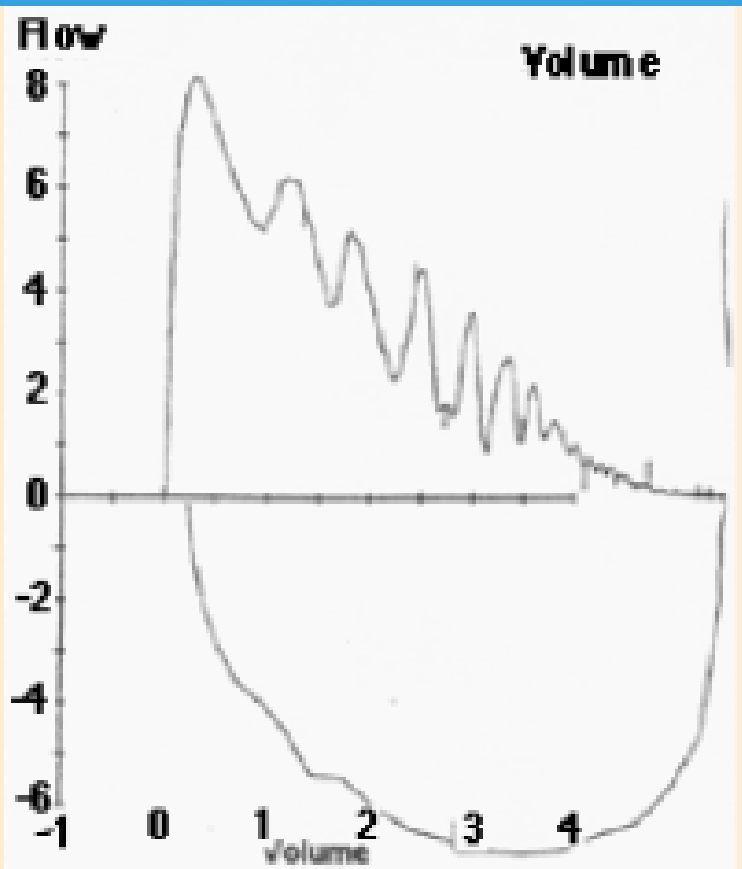




Is this test Interpretable?

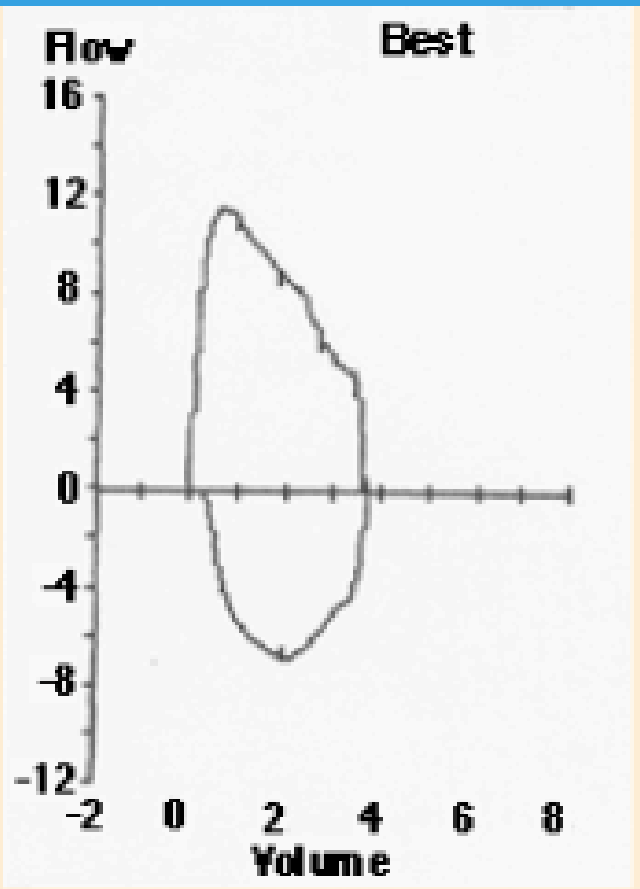
- 1) Volume-time curve reaches a plateau, and lasts 6 seconds
- 2) Results of the 2 best efforts on the spirometry are within 0.2L of each other
- 3) Flow-volume loops are free of artifacts

Cough



Cough

Early Glottic Closure



Early glottic closure

Obstructive Lung Disease --a FLOW problem!

- Spirometry
  - Decrease in FEV1
  - Normal or decreased FVC
  - Thus, 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

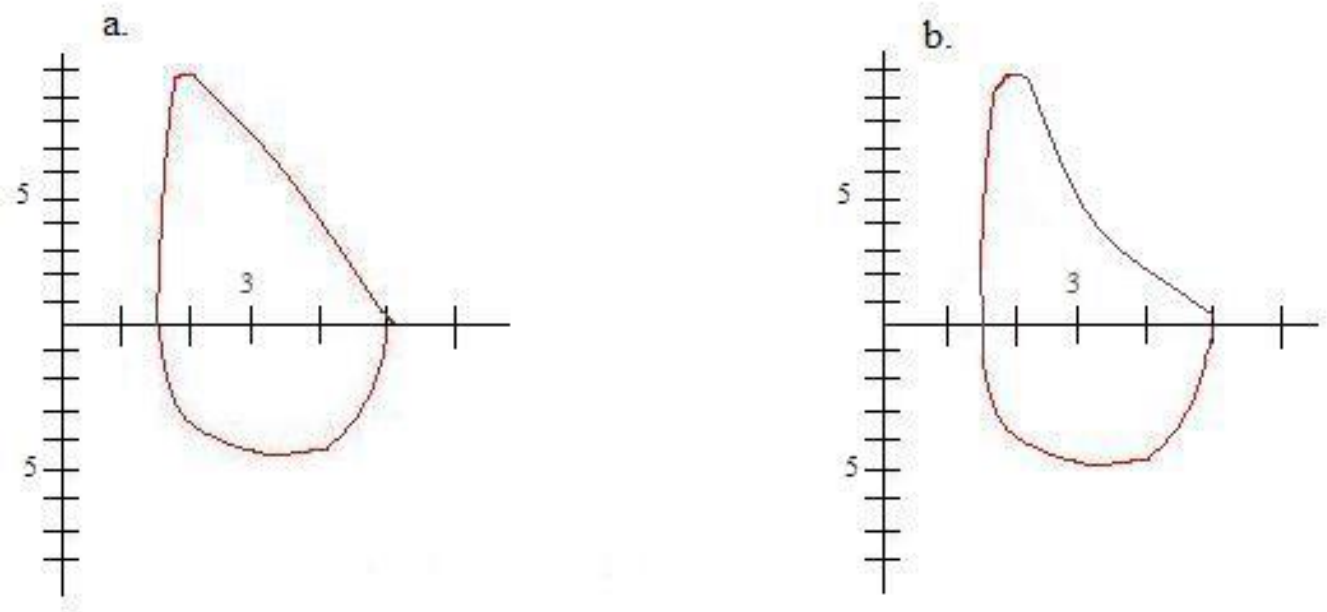
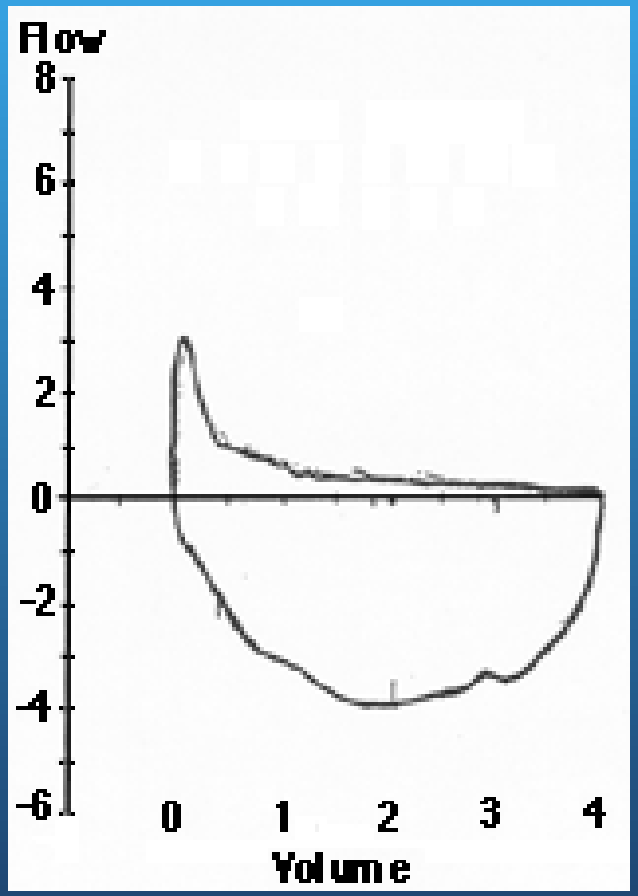


Figure 2 - A normal flow-volume loop is shown in Figure 2a. Figure 2b shows an obstructive defect, with marked scooping. X-axis is volume, Y-axis is flow.

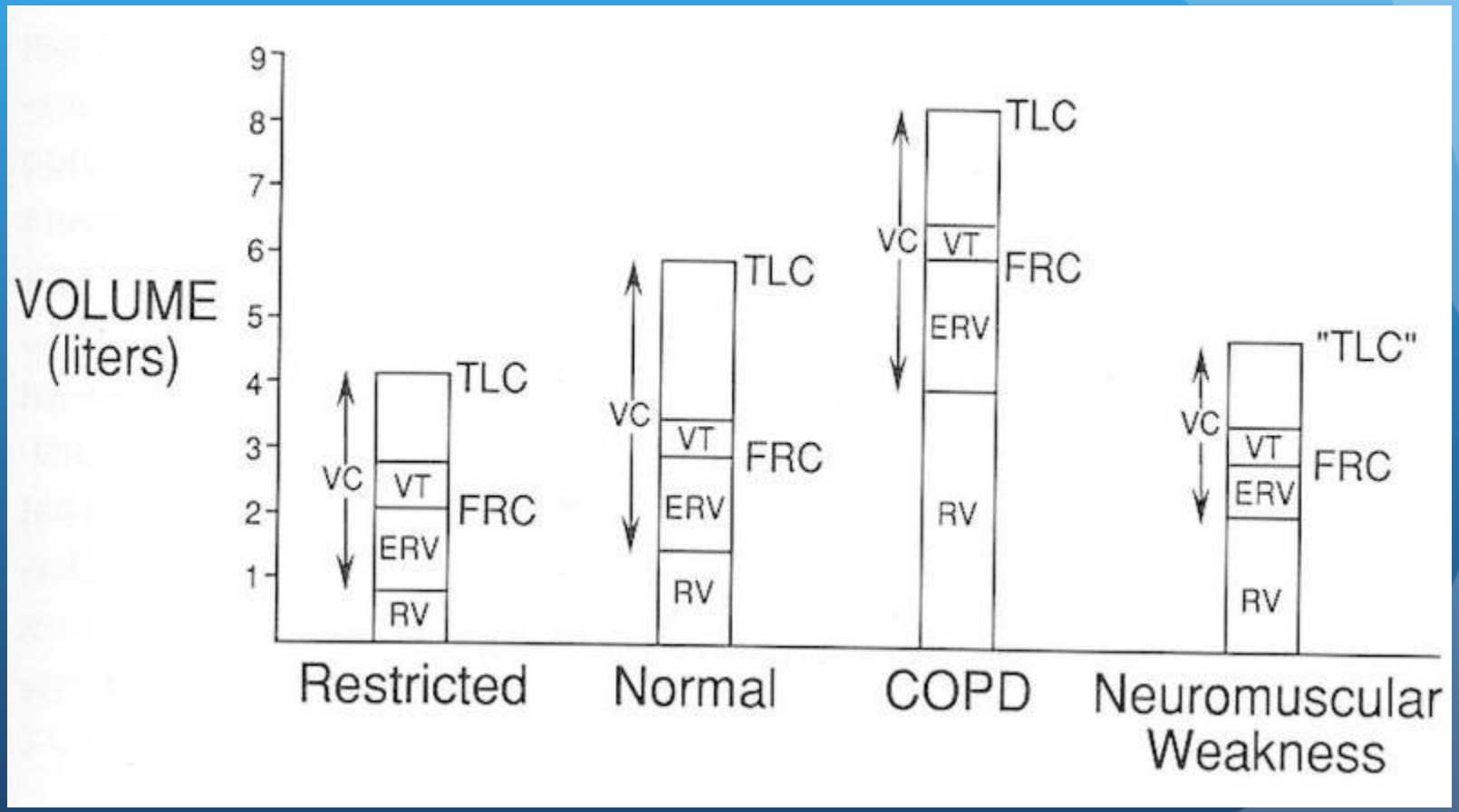
Severe Obstruction



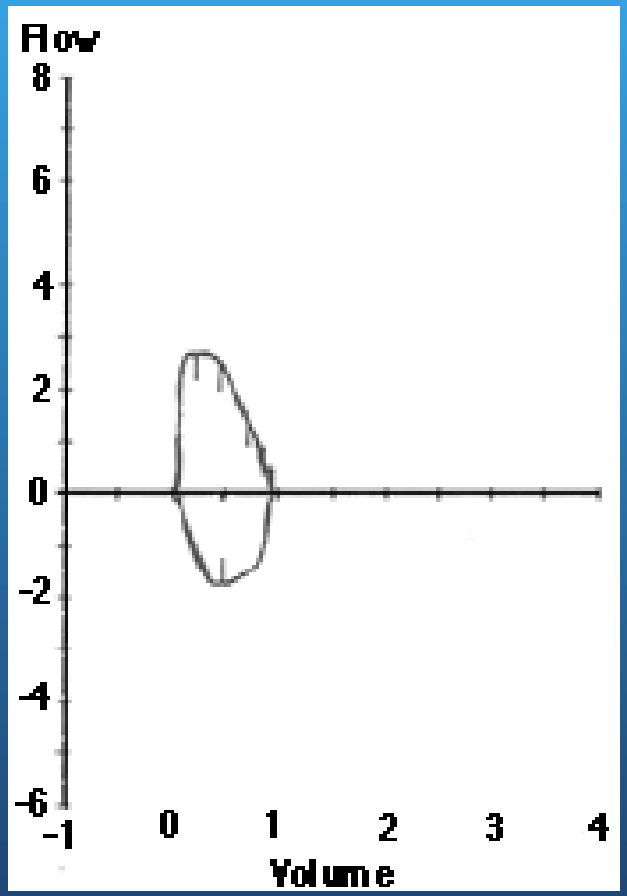
Restrictive Lung Disease -a VOLUME problem!

- 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

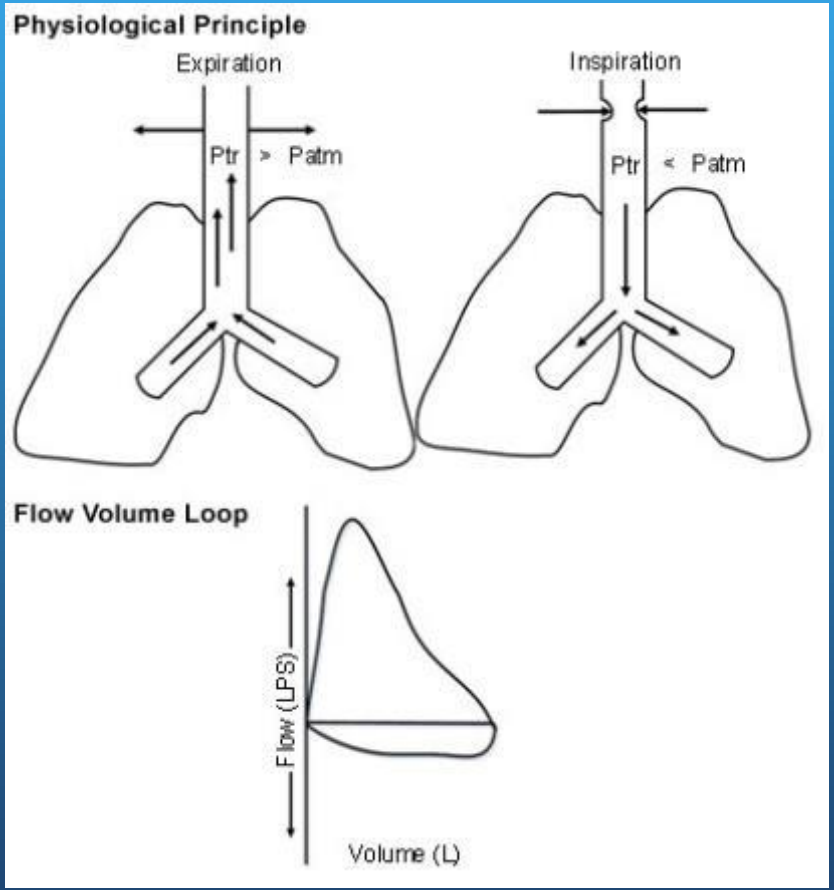


Upper Airway Obstruction

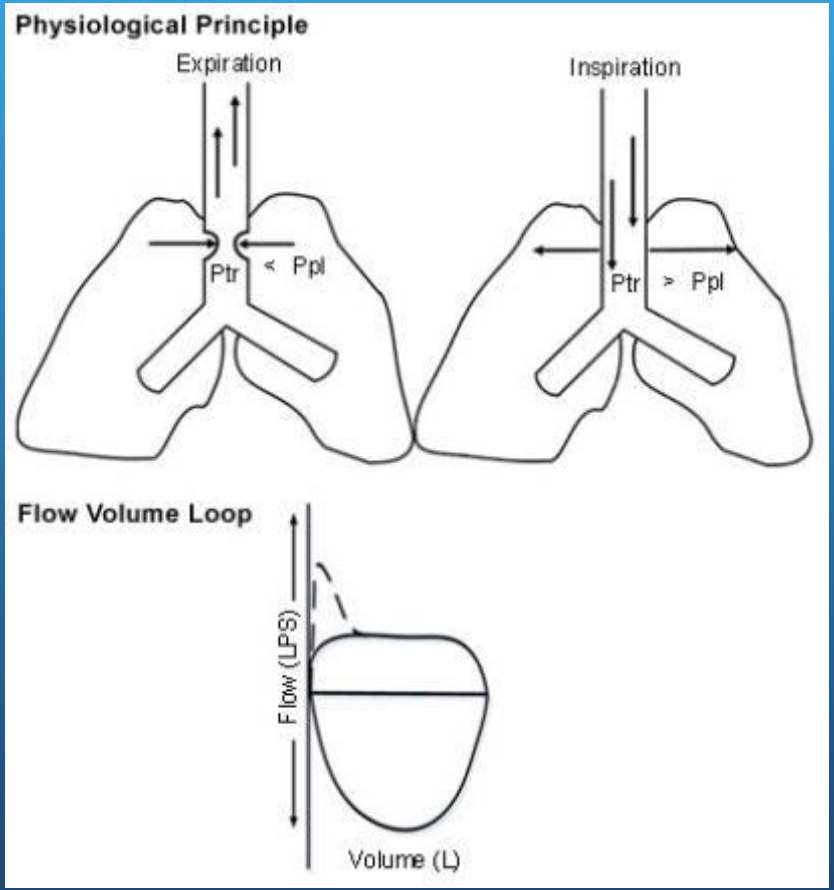
-Extrathoracic
-Intrathoracic

Variable Extrathoracic UAO

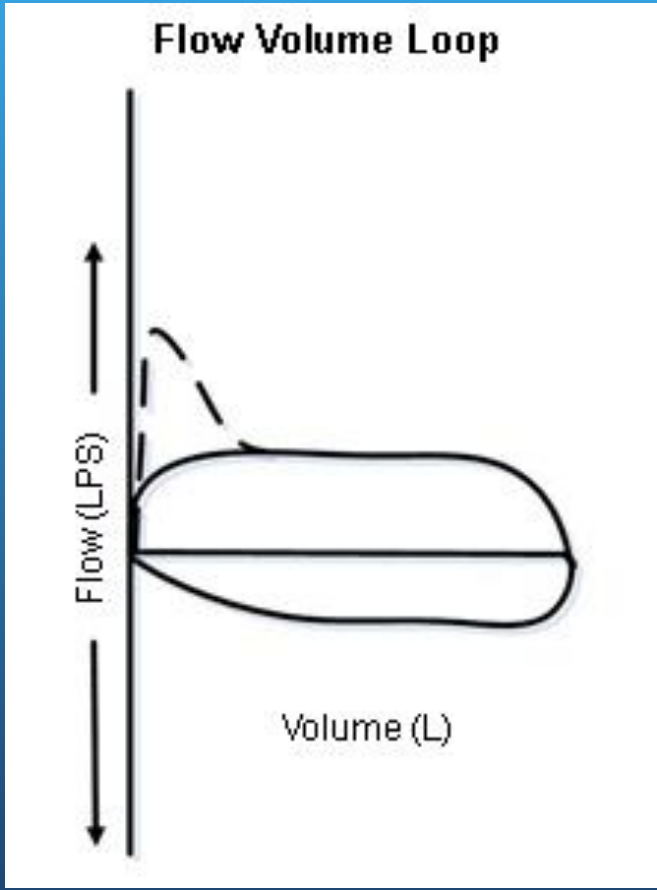
(VCD, goiter, tracheomalacia, tumor on one side, vocal cord edema)



Variable Intrathoracic UAO
(low tracheal tumor)



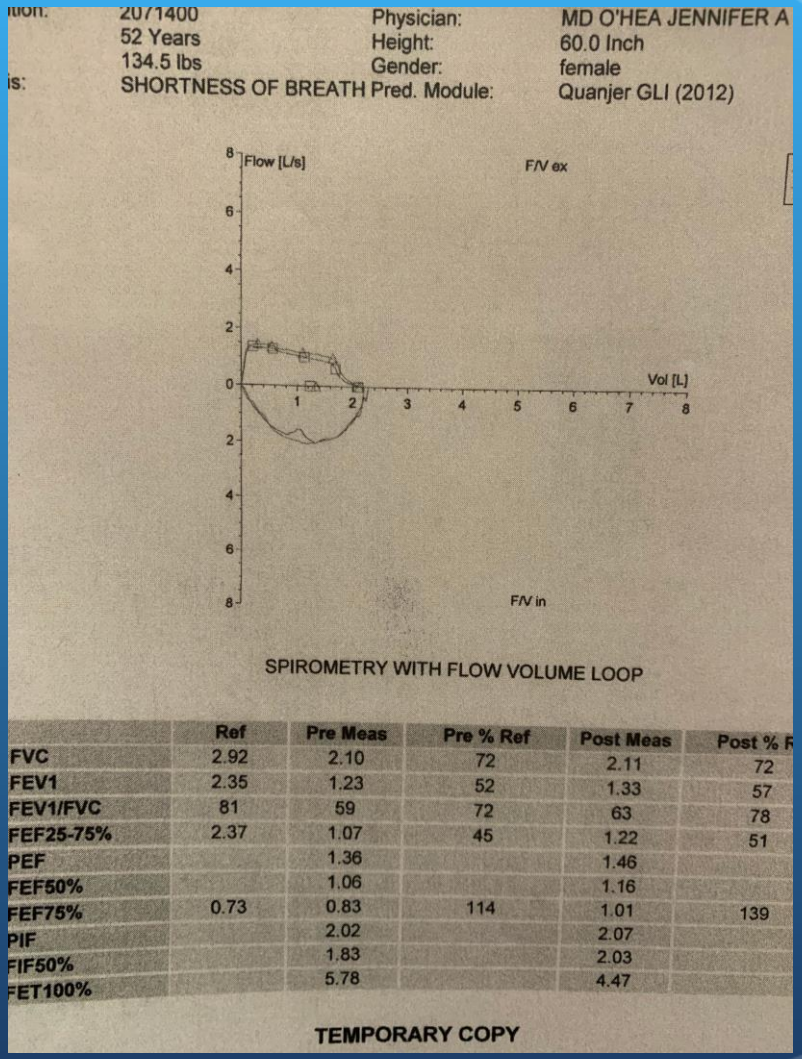
Fixed Upper Airway Obstruction
(Tracheal stenosis, circumferential tracheal tumor)



Case question

- 52 y/o woman who had a liver transplant 5 months ago, and had a difficult postoperative course, including prolonged ICU stay, trach, vent, PEG, dialysis.
- She presented with new onset dyspnea, and on exam, had expiratory wheezes.

What does this spirometry show?



	2071400		Physician:	MD O'HEA JENNIFER A	
	52 Years		Height:	60.0 Inch	
	134.5 lbs		Gender:	female	
is:	SHORTNESS OF BREATH		Pred. Module:	Quanjer GLI (2012)	

SPIROMETRY WITH FLOW VOLUME LOOP

	Ref	Pre Meas	Pre % Ref	Post Meas	Post % R
FVC	2.92	2.10	72	2.11	72
FEV1	2.35	1.23	52	1.33	57
FEV1/FVC	81	59	72	63	78
FEF25-75%	2.37	1.07	45	1.22	51
PEF		1.36		1.46	
FEF50%		1.06		1.16	
FEF75%	0.73	0.83	114	1.01	139
PIF		2.02		2.07	
FIF50%		1.83		2.03	
FET100%		5.78		4.47	

TEMPORARY COPY

Variable intrathoracic airway obstruction

Steps to Spirometry

- 1) Good shape curve, 6 seconds long? Does the curve look scooped like obstruction? Or small and short like restriction?
- 2) Any unusual UAO?
- 3) FEV1/FVC – less than 70%?
- 4) FVC – less than 80%?
- 5) If obstruction, grade severity of FEV1
- 6) If obstruction, is it reversible with BD?