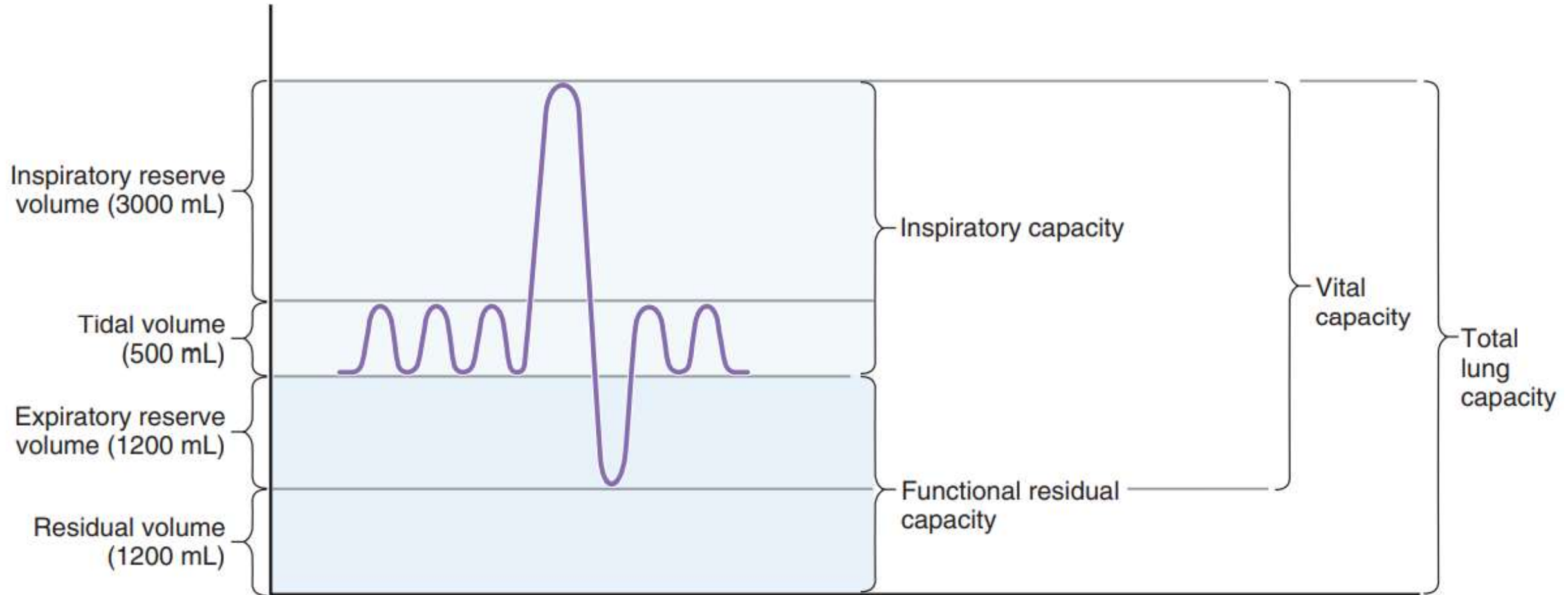


Pulmonary ventilation-3

Fatima Ryalat, MD, PhD

Lung volumes

Lung capacities



Forced vital capacity (FVC)

- Vital capacity is the volume that can be expired following a maximal inspiration.
- Forced vital capacity (FVC) is the total volume of air that can be forcibly expired after a maximal inspiration. (quickly and completely).
- The volume of air that can be forcibly expired in the first second is called FEV1.

Forced vital capacity (FVC)

- FVC, FEV1, and the fraction of the vital capacity that can be expired in the first second, FEV1/FVC, can be used to differentiate among diseases.

Respiratory disorders (inadequate ventilation)

- Obstructive lung disease: such as Asthma and Emphysema.
- Restrictive lung diseases: such as Tuberculosis.

Asthma

- The usual cause of asthma is contractile hypersensitivity of the bronchioles in response to foreign substances in the air.
- They tend to form abnormally large amounts of immunoglobulin E (IgE) antibodies.
- These antibodies are mainly attached to mast cells that are present in the lung interstitium in close association with the bronchioles and small bronchi.

Asthma

- The mast cells release several different substances such as histamine.
- That will produce the following:
 - (1) localized edema in the walls of the small bronchioles, as well as secretion of thick mucus into the bronchiolar lumens.
 - (2) spasm of the bronchiolar smooth muscle.
- Therefore, the airway resistance increases greatly.

Asthma

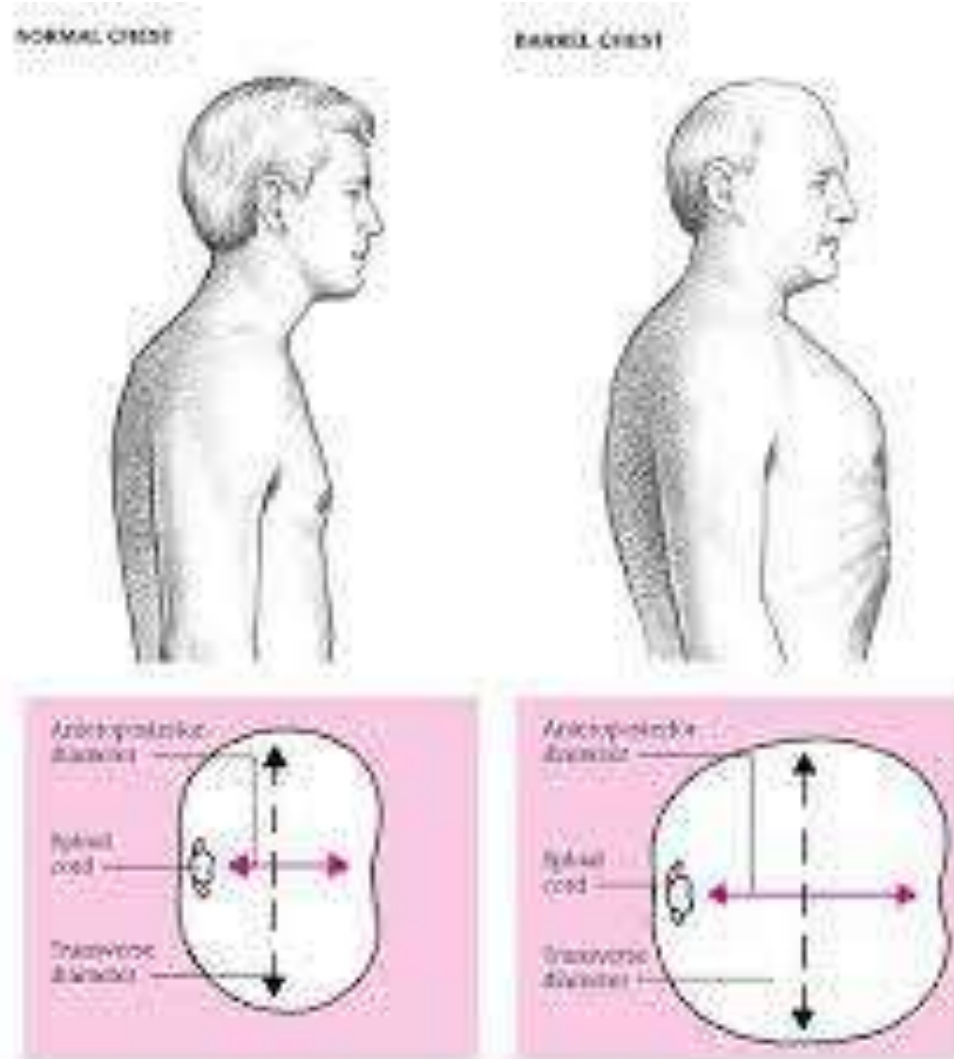
- The bronchiolar diameter becomes reduced more during expiration than during inspiration in persons with asthma as a result of bronchiolar collapse during expiratory effort that compresses the outsides of the bronchioles.
- Because the bronchioles are already partially occluded, further occlusion resulting from the external pressure creates especially severe obstruction during expiration.

Asthma

- The asthmatic person often can inspire quite adequately but has great difficulty expiring.
- Clinical measurements show greatly reduced maximum expiratory rate.
- The TLC, FRC and RV of the lung become especially increased during an acute asthma attack because of the difficulty in expiring air from the lungs.

Asthma

- Over a period of years, the chest cage becomes permanently enlarged, causing a so-called **barrel chest**, and FRC, TLC, and RV become permanently increased.



Emphysema

- The pulmonary emphysema literally means excess air in the lungs.
- It is a complex obstructive and destructive process of the lungs caused by many years of smoking.

Emphysema

- The major pathophysiological changes:
- Chronic inhalation of smoke or other substances that irritate the bronchi and bronchioles will derange the normal protective mechanisms of the airways:
- Partial paralysis of the cilia of the respiratory epithelium by nicotine. As a result, mucus cannot be moved easily out of the passageways.
- Stimulation of excess mucus secretion occurs.

Emphysema

- Inhibition of the alveolar macrophages, so they become less effective in combating infection.
- inflammatory edema of the bronchiolar epithelium.
- All together cause chronic obstruction of many of the smaller airways which makes it especially difficult to expire, thus causing entrapment of air in the alveoli and overstretching them. ,
- This effect, combined with the lung infection, causes marked destruction of the alveolar walls.

Emphysema

- The bronchiolar obstruction increases airway resistance and results in greatly increased work of breathing.
- It is especially difficult for the person to move air through the bronchioles during expiration because the compressive force on the outside of the lung not only compresses the alveoli but also compresses the bronchioles, which further increases their resistance during expiration.

Emphysema

- The marked loss of alveolar walls greatly decreases the diffusing capacity of the lung.
- This reduces the ability of the lungs to oxygenate the blood and remove CO₂ from the blood.
- Abnormal ventilation-perfusion ratios will occur.

Emphysema

- Loss of large portions of the alveolar walls also decreases the number of pulmonary capillaries through which blood can pass.
- As a result, the pulmonary vascular resistance often increases markedly, causing pulmonary hypertension, which in turn overloads the right side of the heart and frequently causes right-sided heart failure.
- hypoxia and hypercapnia develop at later stages.

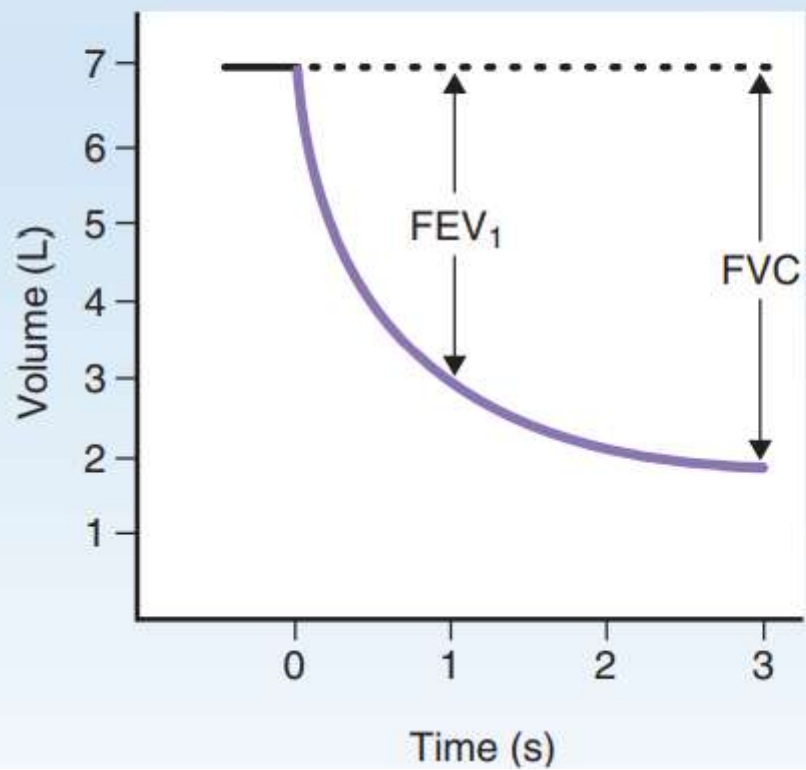
Tuberculosis

- The tuberculosis in its late stages is characterized by many areas of fibrosis throughout the lungs, as well as by reduced total amount of functional lung tissue.
- These effects cause the following:
 - (1) increased “work” on the part of the respiratory muscles to cause pulmonary ventilation and reduced vital capacity and breathing capacity.

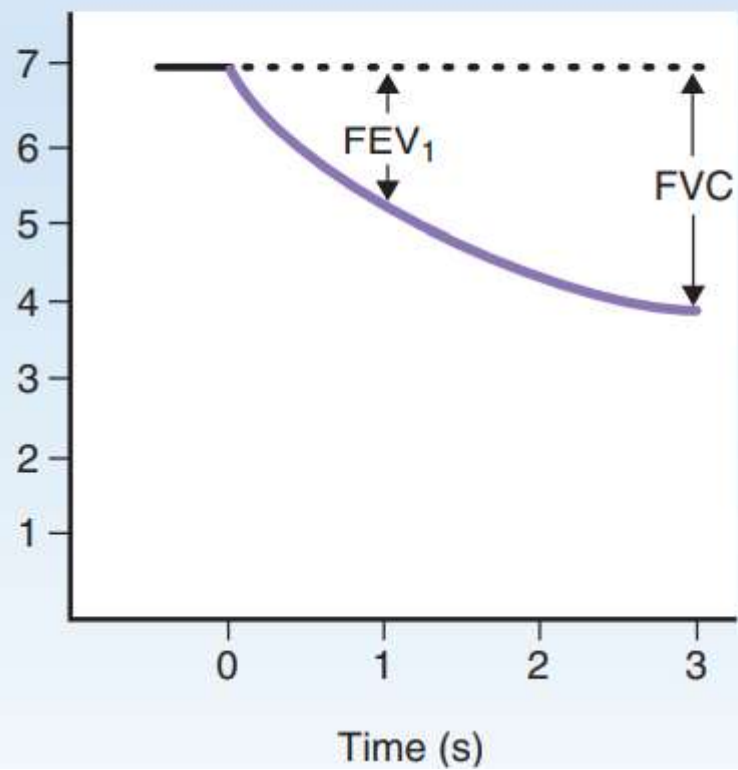
Tuberculosis

- (2) reduced total respiratory membrane surface area and increased thickness of the respiratory membrane, causing progressively diminished pulmonary diffusing capacity.
- (3) abnormal ventilation-perfusion ratio in the lungs, further reducing overall pulmonary diffusion of O₂ and CO₂.

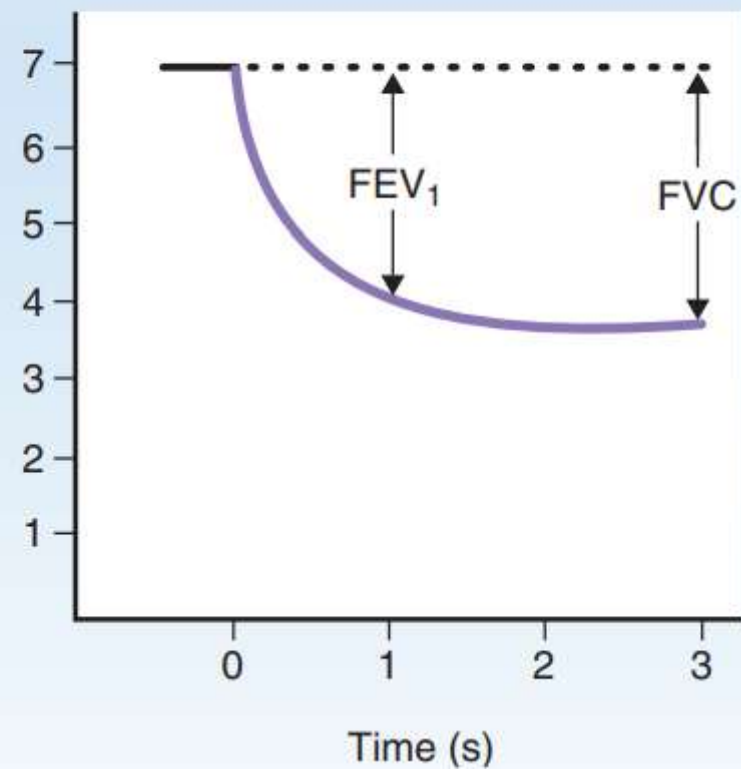
Normal



**Obstructive disease
(asthma and COPD)**



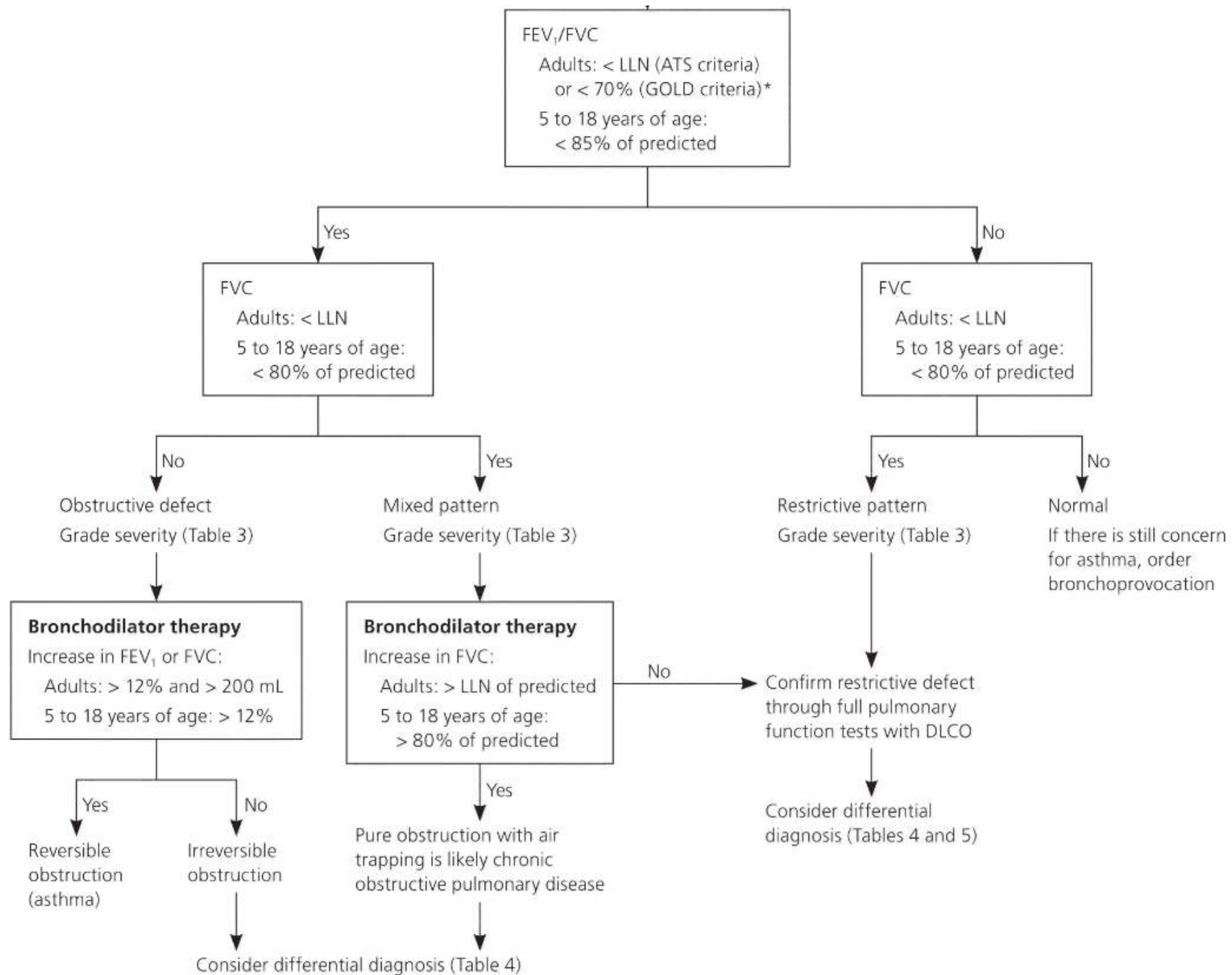
**Restrictive disease
(fibrosis)**

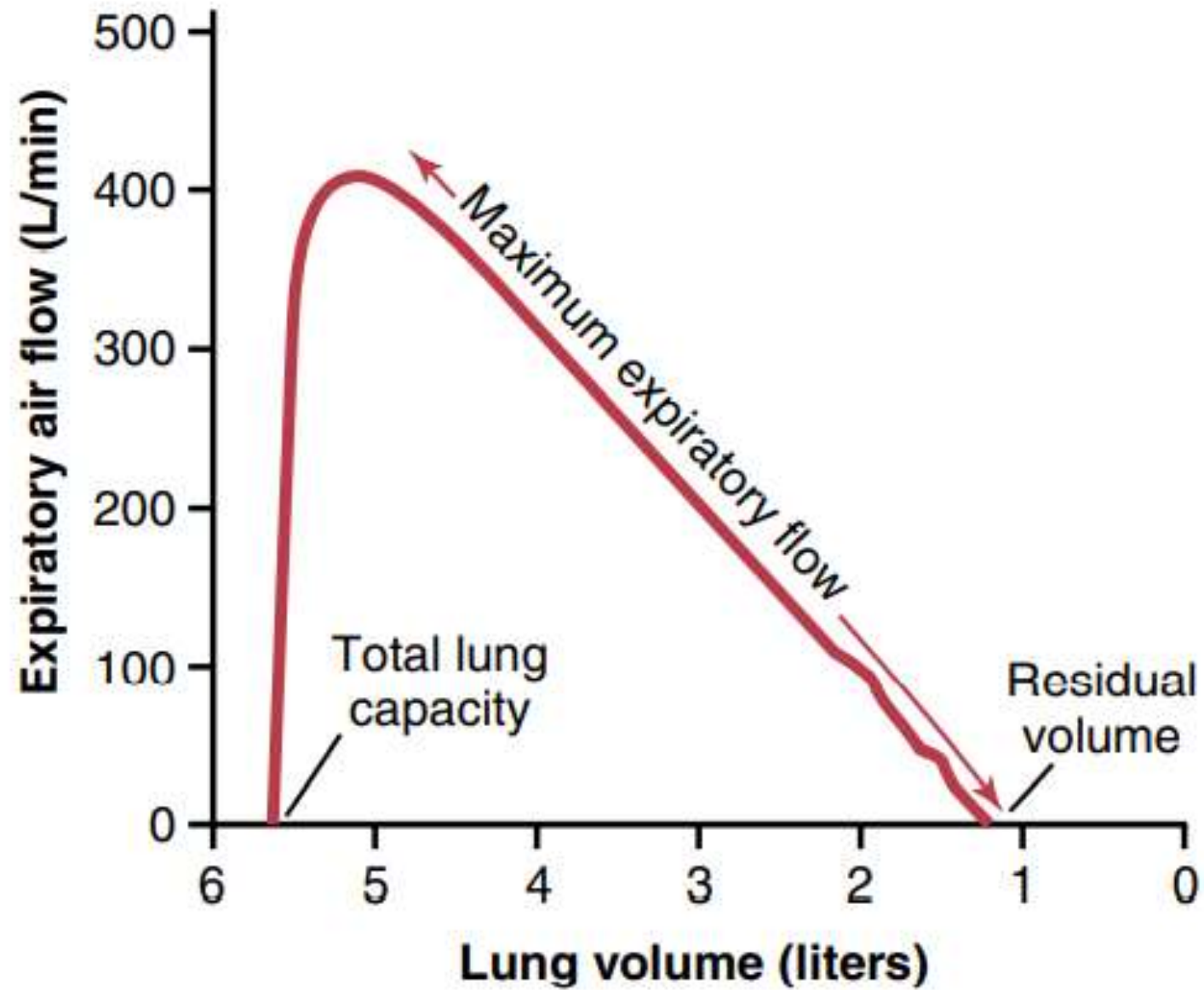


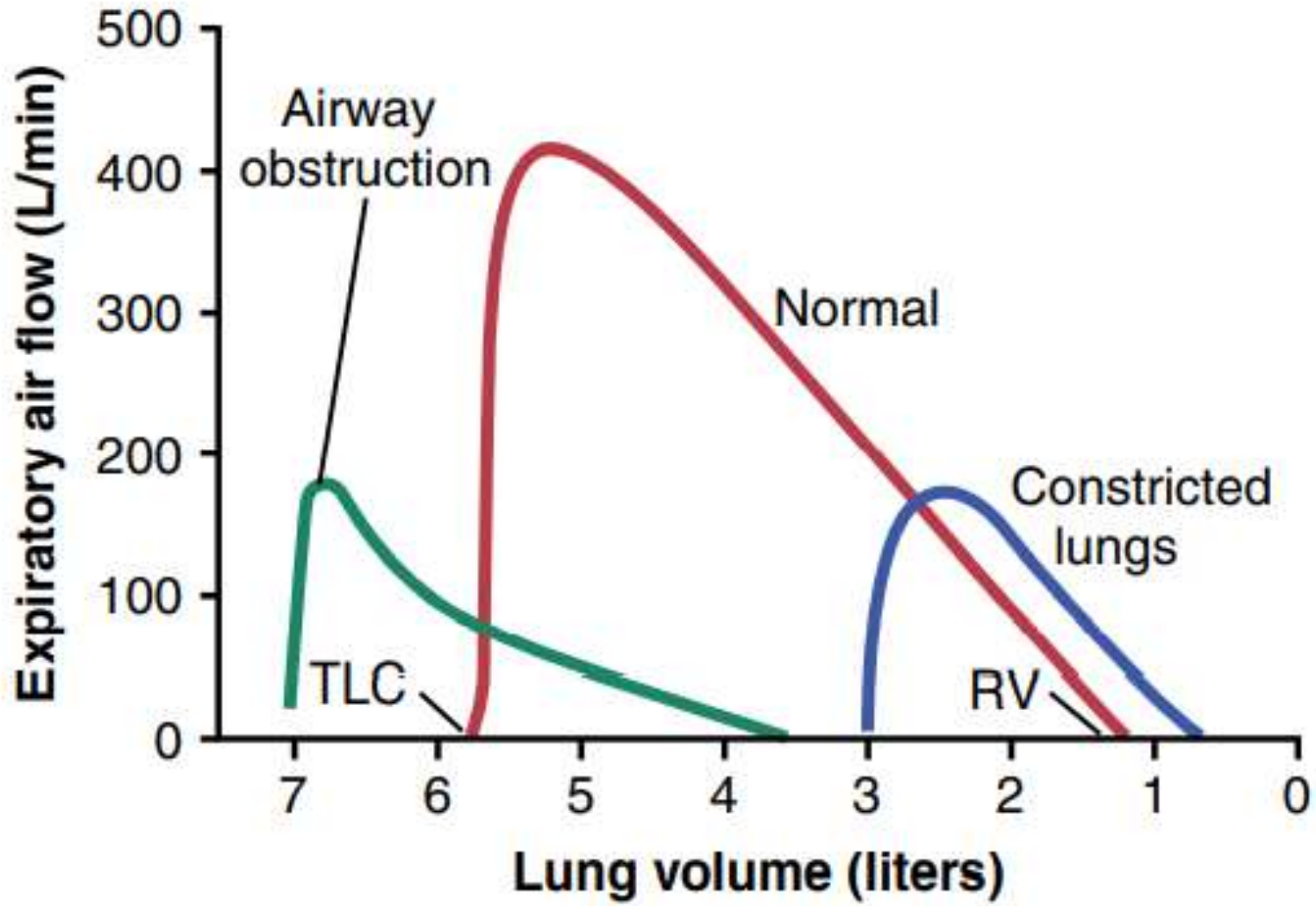
FEV1/FVC

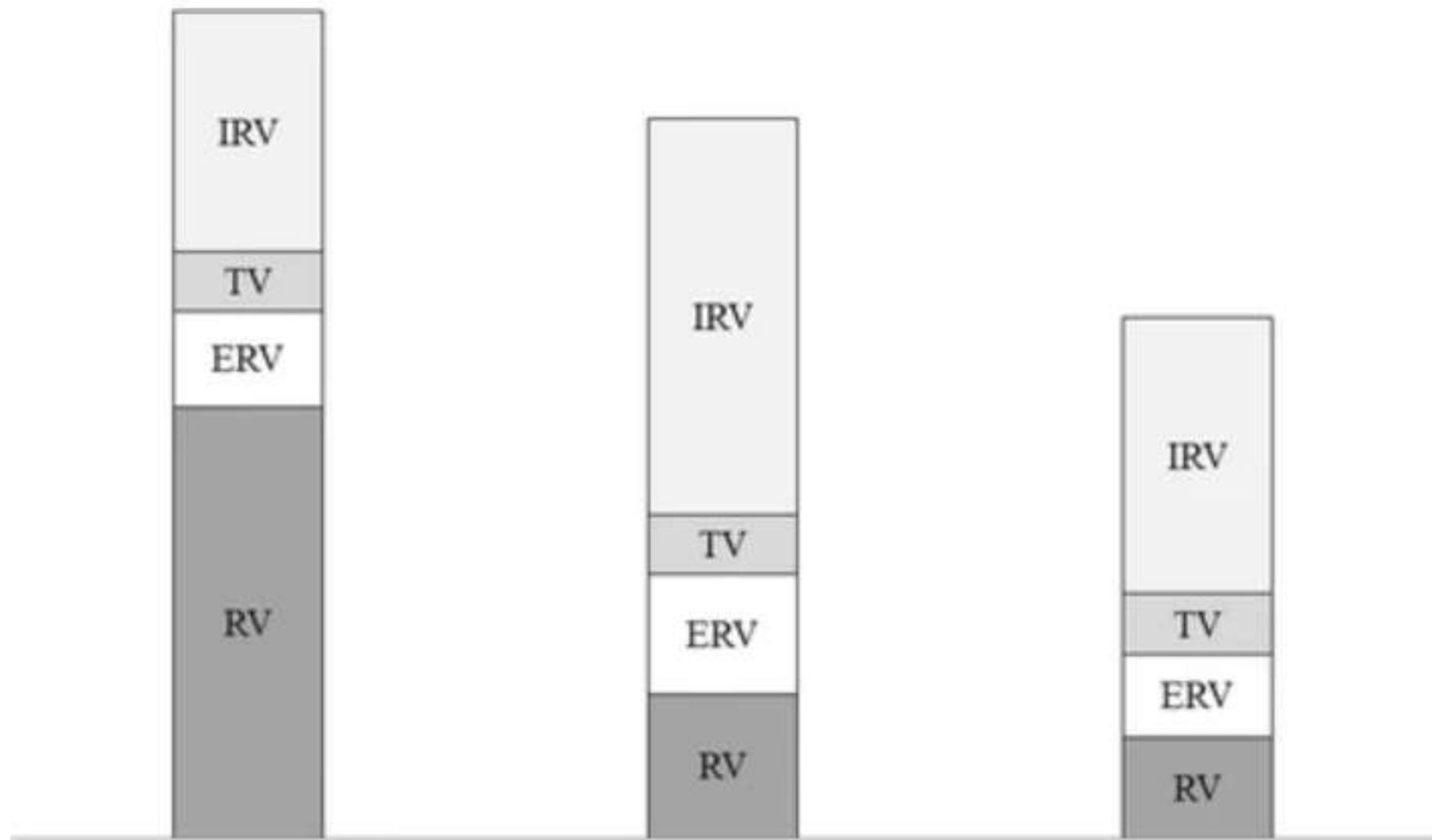
- In obstructive lung diseases:
 - both FVC and FEV1 are decreased, but FEV1 is decreased more than FVC is. Thus FEV1/FVC is decreased.

- In restrictive lung disease such as fibrosis:
 - both FVC and FEV1 are decreased but FEV1 is decreased less than FVC is. Thus, FEV1/FVC is actually increased.

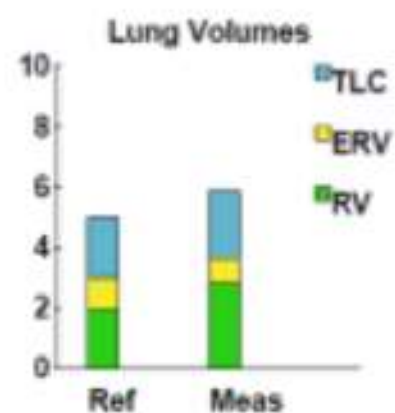
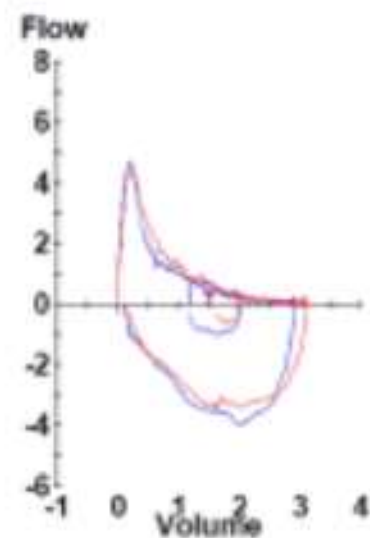




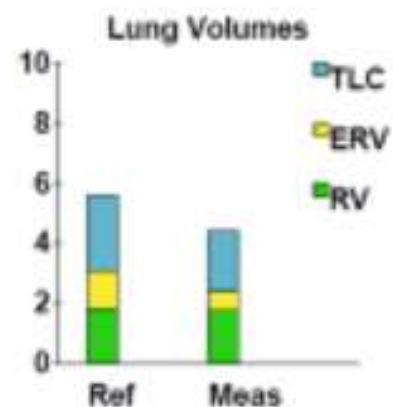
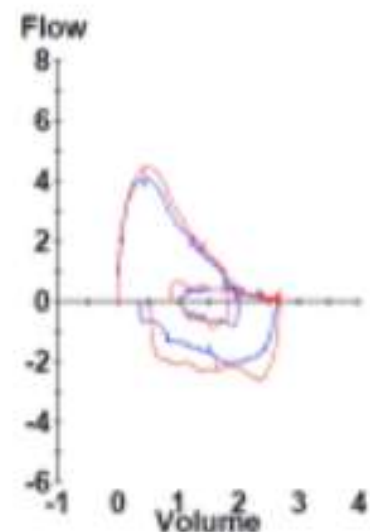




		Ref	Pre	% Ref	Post	% Ref	%Chg
Spirometry							
FVC	Liters	3.23	2.91	90	3.12	96	7
FEV1	Liters	2.47	1.31	53	1.42	57	8
FEV1/FVC	%	77	45		45		
FEF25-75%	L/sec	2.16	0.37	17	0.39	18	4
PEF	L/sec	6.08	4.71	77	4.71	78	0
FET100%	Sec		15.05		15.14		1
Lung Volumes							
TLC	Liters	4.97	5.84	117			
VC	Liters	3.23	3.04	94			
FRC PL	Liters	3.04	3.61	119			
ERV	Liters	1.01	0.79	78			
RV	Liters	1.94	2.79	144			
RV/TLC	%	39	48				
Diffusing Capacity							
DLCO	mL/mmHg/min	17.6	9.2	52			
DL Adj	mL/mmHg/min	17.6	9.2	52			
DLCO/VA	mL/mHg/min/L	3.74	1.91	51			
DLVA Adj	mL/mHg/min/L		1.91				
VA	Liters	4.97	4.84	97			
IVC	Liters		2.91				



		Ref	Pre	% Ref	Post	% Ref	%Chg
Spirometry							
FVC	Liters	3.44	2.67	78	2.71	79	2
FEV1	Liters	2.89	1.88	65	1.96	68	4
FEV1/FVC	%	85	71		72		
FEF25-75%	L/sec	3.29	1.23	37	1.36	41	11
PEF	L/sec	7.17	5.52	77	4.49	63	-19
FET100%	Sec		7.16		7.56		6
Lung Volumes							
TLC	Liters	5.54	4.40	79			
VC	Liters	3.44	2.67	78			
FRC PL	Liters	3.21	2.38	74			
ERV	Liters	1.31	0.64	48			
RV	Liters	1.76	1.73	98			
RV/TLC	%	30	39				
Diffusing Capacity (Hb 9.2)							
DLCO	mL/mmHg/min	22.3	10.4	47			
DL Adj	mL/mmHg/min	22.3	12.4	56			
DLCO/VA	mL/mHg/min/L	4.59	3.08	67			
DL/VA Adj	mL/mHg/min/L		3.66				
VA	Liters	5.54	3.39	61			
IVC	Liters		2.42				



Thank you