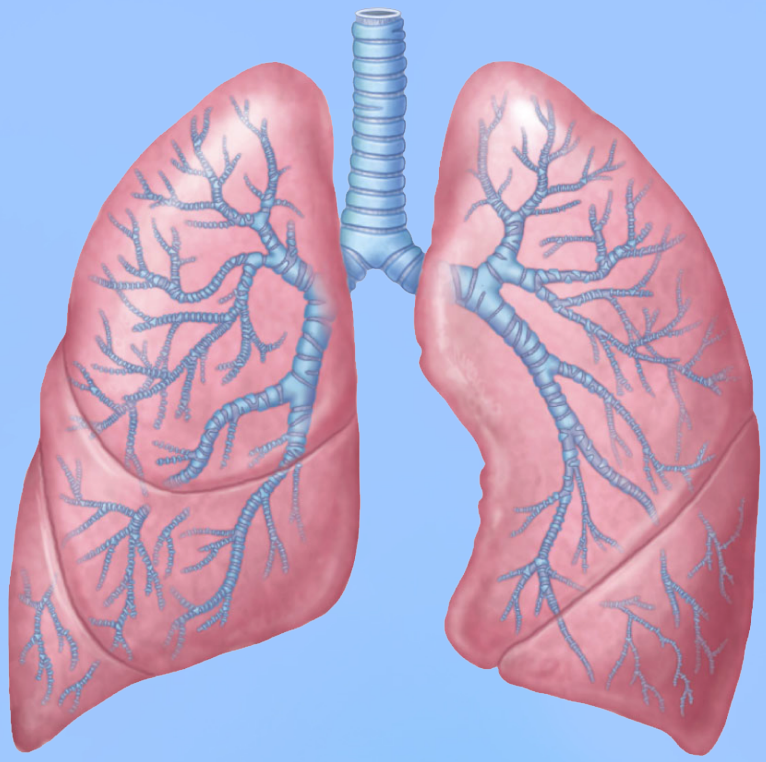
3 RESPIRATORY VENTILATION

Physiology Team 433



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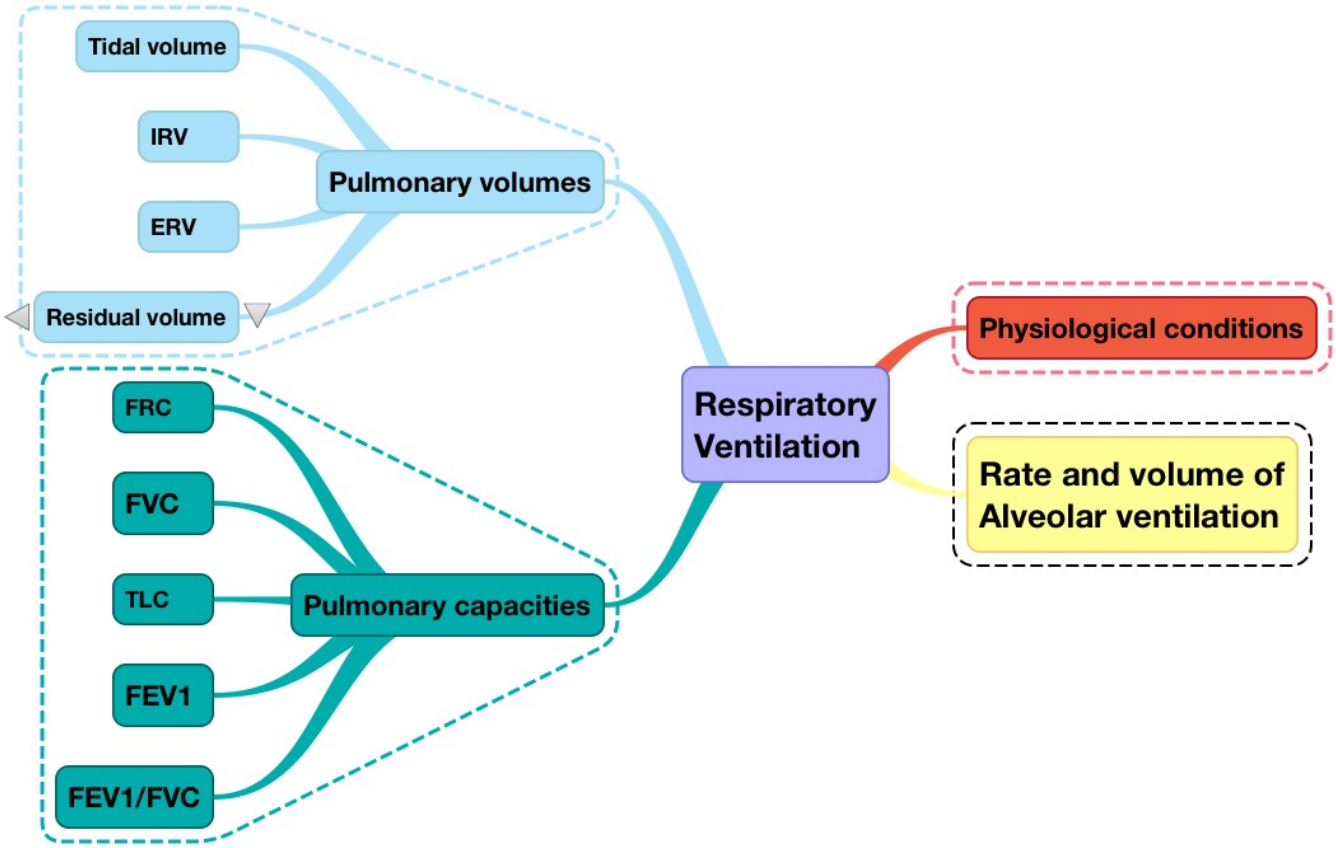
Respiratory Block

Objectives:

1. Define the various lung volumes and capacities and provide values for each.
2. Define ventilation rate, their typical values and their measurement.
3. Describe FEV_1 and its role in differentiating obstructive and restrictive lung diseases
4. Define the term minute ventilation and state a typical value.
5. Distinguish minute ventilation from alveolar ventilation.

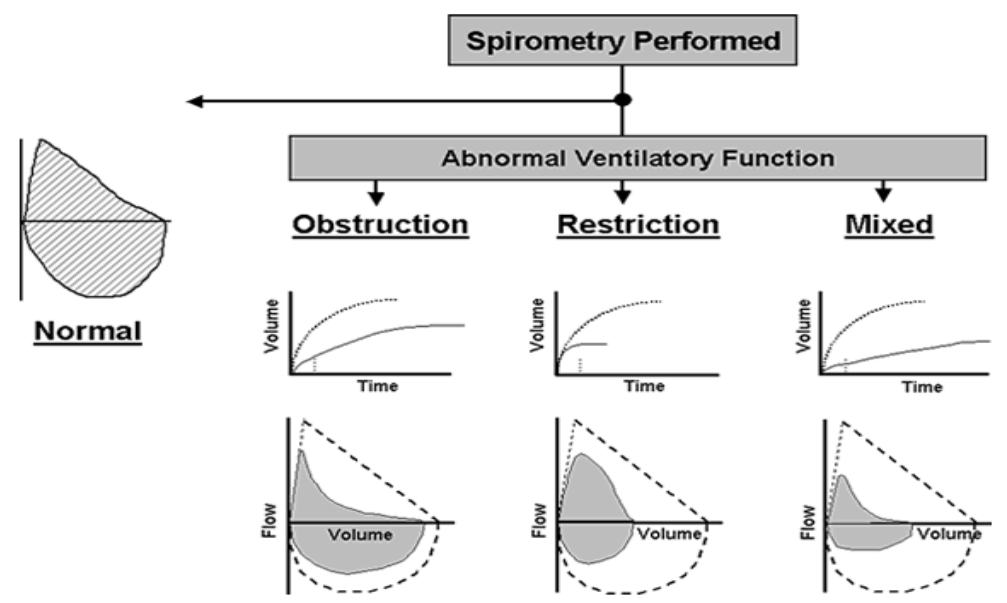
Mind Map:



Physiological condition in which we can see changging in pulmonary volumes

Age, gender, weight and hight	Ethnic group (races)	Exercise	Posture	Pregnency	Diurnal variation, seasonal, climate	Diurnal variation, seasonal, climate	Geographical location

All pulmonary volumes and capacities are about 20 to 25 % less in women than in men, and they are greater in large and athletic people than in small and asthenic people, because of greater respiratory muscles in males.



FORCED EXPIRATORY RATIO (FEV1/FVC) : The forced expiratory ratio is a sensitive index in differentiating obstructive from restrictive pulmonary disease. It is decreased in obstruction and is normal or increased in restriction

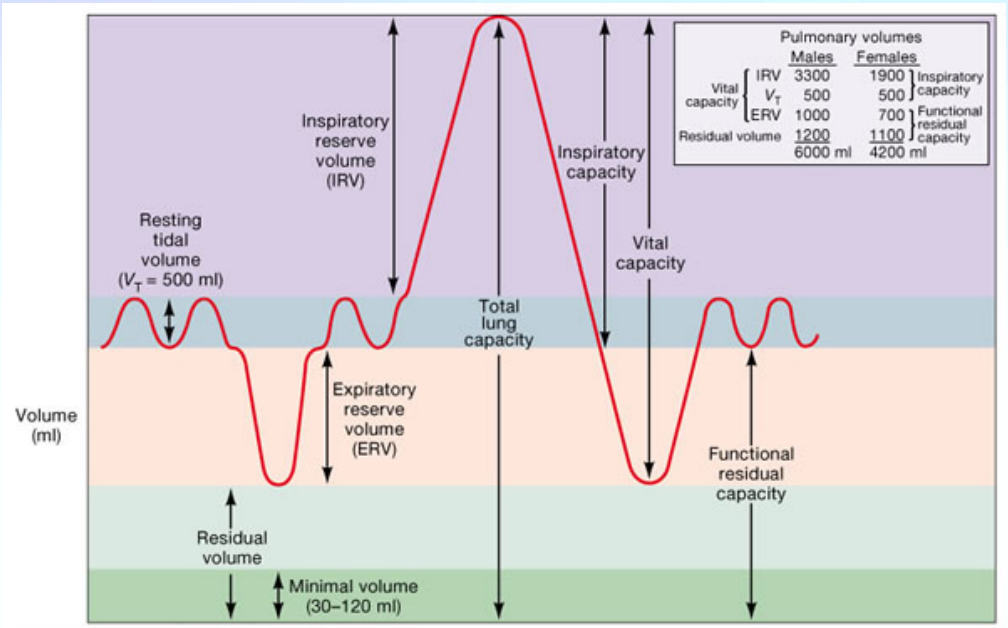
RESTRICTIVE LUNG DISEASES: FEV1/FVC = 80%:

FEV1/ FVC is normal (=80%) but the volumes themselves are lower like in **interstitial pulmonary Fibrosis**.

OBSTRUCTIVE LUNG DISEASES: FEV1/FVC LOWER THAN 80%

FEV1/FVC is decreased, (FEV) is normal but there is a high air resistance decreases FEV1 ends with a low percentage like in **emphysema & bronchial asthma.**

Spirogram



Lung Volumes		
Tidal volume [TV]	Volume of air inspired or expired in each normal breath	**= 500 ml**
Inspiratory reserve volume [IRV]	It is the extra volume of air, that can be **inspired** forcefully beyond the normal tidal volume	**= 3000 ml**
Expiratory reserve volume [ERV]	It is the extra volume of air that can be **expired** forcefully beyond the normal tidal volume	**= 1100 ml**
Residual volume [RV]	It is the volume of air still **remaining** in the lungs after a forceful expiration. (It's always found in the lung even after expiration)	**= 1200 ml**

Lung Capacities		
The functional residual capacity [FRC]	**This is the amount of air that remains in the lungs at the end of tidal expiration.** FRC = ERV + RV	**= 1000 + 1200 ≈ 2300 ml**
FORCED Vital Capacity [FVC]	This is the maximum amount of air that a person can expel (expire) forcefully from the lungs after taking a deep inspiration. **FVC = TV + IRV + ERV**	**500 + 3000 + 1100= 4600 ml**
Total lung capacity [TLC]	The maximum volume of air that can fill the lungs where they can expend with the greatest possible effort.**TLC=all the volumes.**	**500 + 3000 + 1100 + 1200 = 5800 ml**
inspiratory capacity [IC]	Is the amount of air a person can breathe in, beginning at the **normal expiratory level** and **distending** the lungs to the maximum amount. IC= TV+ IRV	**500+ 3000= 3500 ml**

Forced expiratory volume in one second (FEV_1)	**This is the volume of air expelled during the first second of a forced expulsion after a maximum inspiration(timed vital capacity)** This is a very useful volume to test for the diagnosis of obstructive lung diseases, such as emphysema and asthma in which FEV_1 is significantly reduced. **It is 80%-90% of the vital capacity.**	**= 3680 ml**

If you still don't get it. This video may help: http://youtu.be/UvIYdGdyCBc

MINUTE VENTILATION RATE AND VOLUME

Respiratory rate: Number of breaths taken per minute.

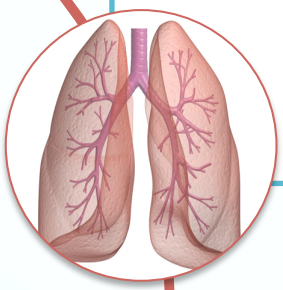
Minute ventilation: Total amount of air moved into and out of respiratory system per minute.

Minute respiratory volume "MRV": The total amount of new air that moves into the respiratory passages in each minute is called the minute respiratory volume.

The normal rate of respiration in one minute is 12 [Approximately 12-18 / min].

The minute respiratory volume is equal to:

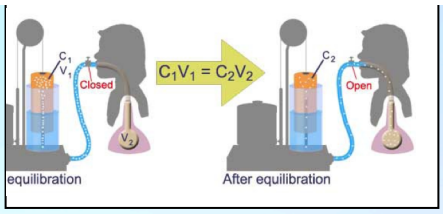
MRV = tidal volume x respiratory rate = 500 x 12 = 6000 ml/minutes



A person can live"minimum" for a short period with a minute respiratory volume as low as **1.5 L/min** and a respiratory rate of only **2** to **4** breaths per **minute**.

The respiratory rate occasionally rises to **40 to 50** per **minute**, and the tidal volume can become as **great** as the vital capacity about **4600 milliliters** in a young adult man. This can give a minute respiratory volume

Closed circuit helium dilution method



Determination of the FRC, RV, TLC. **IT MESURES ANY VALUE THAT contains residual.**

C1xV1 = C2xV2
C1: concentration of He in spirometry
V1: volume of air in the spirometry.
C2: Final concentration of helium
V2: Volume of spirometry + FRC

$$FRC = \left(\frac{Ci\ He\ (C1)}{Cf\ He\ (C2)} - 1\right) Vi\ Spi\ (V1)$$

Ci: initial concentration

Cf: final concentration

Rate of Alveolar Ventilation:

- Normal tidal volume of 500 ml
- Normal dead space of 150 ml
- Respiratory rate of 12 breaths per minute
- Alveolar ventilation equals 12 X(500 – 150) = 4200 ml/min.

- **Rate of Alveolar Ventilation:** Alveolar ventilation per minute is the total volume of new air entering the alveoli and adjacent gas exchange areas each minute.

- It is equal to the respiratory rate times the amount of new air that enters these areas with each breath
- A = Freq • (TV – VD)

A ➔ is the volume of alveolar ventilation per minute

Freq ➔ is the frequency of respiration per minute

TV ➔ is the tidal volume

VD ➔ is the physiologic dead space volume

Q1: The total lung capacity is?

A- 6000 ml
B- 4800 ml
C- 2300 ml
D- 5800 ml

Q2: All pulmonary volumes and capacities are?

A- 20 to 25 % more in women than in men
B- 20 to 30 % less in women than in men
C- 20 to 25 % less in women than in men
D- 20 to 25 % less in men than in women

3: FORCED EXPIRATORY RATIO is?

A- decreased in obstruction diseases
B- normal in obstruction diseases
C- decreased in restriction diseases
D- None of them

Q4: Alveolar ventilation equals?

A- 4000 ml/min
B- 3600 ml/min
C- 5200 ml/min
D- 4200 ml/min

5: The volume of air still remaining in the ungs after a forceful expiration?

A- Tidal volume
B- Residual volume
C- Inspiratory reserve volume
D- Expiratory reserve volume

Q6: Air in normal dead space will be?

A- 500 ml
B- 1100 ml
C- 150 ml
D- 1200 ml

7: Closed circuit helium dilution method an be used for?

A- Total lung capacity
B- Residual volume
C- Forced Vital capacity
D- All of them

Q8: Total amount of air moved into and out of respiratory system per minute?

A- Minute ventilation
B- Respiratory rate
C- Minute respiratory volume
D- Alveolar ventilation

Answers: 1-D 2-C 3-A 4-D 5-B 6-C 7-D 8-A

Summary

Tidal volume: normal breath = 500ml

Inspiratory reserve volume: inspiring forcefully = 3000ml

Expiratory reserve volume: expiring forcefully = 1200ml

Residual volume: volume inside the lung during expiration or inspiration = 1200ml

Functional residual volume: after normal expiration, what exist inside the lung = 2300ml

Forced vital capacity: the maximum amount of of air that can be expelled = 4600

Total lung capacity: what the lung can take afford = 5800

Forced expiratory volume in one second: volume of air expelled in one second = 3680 ml

Forced expiratory ratio: it's and index for pulmonary diseases (increase in restrictive & decrease in obstructive)

Respiratory rate: Number of breather in 1 minute. = 12-18

Minute ventilation: the air moved in and out respiratory system per minute = 6000ml/minute

The minimum amount of breath per minute = 2-4 per minute. And **the maximum** is about 40 or 60 per minute.

Rate of alveolar ventilation: gas enters exchanging area per minute = 4200ml/min

Pulmonary Volumes & Capacities
http://www.youtube.com/watch?v=ndf7Mn_eB0I