Lung ventilation, volumes, and measurement

Overview of ventilation

Ventilation is the exchange of air between the lungs and the atmosphere via conducting passages. Several terms are used to describe ventilation that are based on the root *pnoea* (breathing) and various prefixes:

Eu-	Good (resting respiration)
Tachy-	Fast rate (*volume unchanged*)
Brady-	Slow rate (*volume unchanged*)
Dys-	Difficult (short of breath)
Ortho-	Upright (dyspnea happens while lying flat)
A-	Not (stop in breathing)
Hyper-	Increased rate *and* volume
Hypo-	Decreased rate *and* volume

Spirometrical Parameters

A spirometer measures *pressure differences* to find air flow velocity and then calculate inspired and expired volumes of air. These, in turn, are used to find several important parameters.

Static volumes

Static volumes depend on *alveolar space* and can inform about possible *restrictive* diseases.

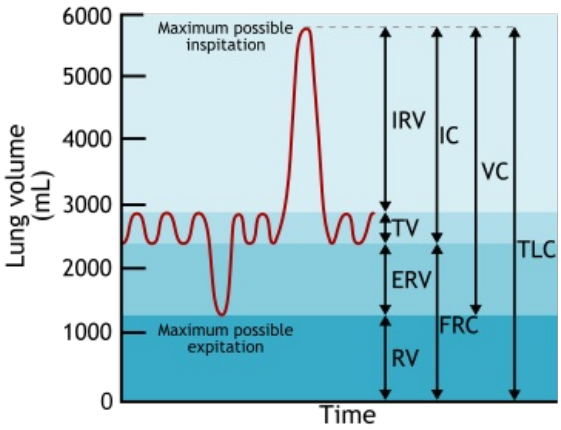
Tidal volume: amount of air that flows into the lungs during normal inspiration or out of them during expiration ~500 mL

Inspiratory reserve volume (IRV): volume that is inspired during maximal effort, ~ 3 L.

Expiratory reserve volume (ERV): volume that is expired after maximal effort, ~ 1.7 L.

Residual volume (RV): Air that remains in the lungs after maximal expiratory effort, ~1.2 L. Useful to keep airways inflated, so that gas exchange proceeds continuously. Must be found via methods other than spirometry:

Volume of distribution (ex. helium dilution): Helium of known concentration is released from a container of known volume into the lungs from after complete exhalation. The difference in measured concentration will allow one to calculate the extra space (RV) over which the gas became distributed.



Lung Volumes and Capacities

Static capacities

Static capacities are sums of above volumes

Inspiratory capacity (IC): Maximum inhaled air after normal expiration; IC = TV+ IRV

Vital capacity (VC): Maximum inspiration and after maximum expiration, ~ 5L.

- VC = TV + IRV + ERV

Expiratory capacity: EC = TV+ERV

Functional residual capacity (FRC): The amount of air that remains in the lungs at the end of normal expiration. FRC = ERV + RV

Total lung capacity: The maximum volume the lungs can contain, ~ 6L.

- TLC = VC + RV

Dynamic volumes

Dynamic volumes depend on *airflow* in the airways and can inform about *obstructive* or *restrictive* diseases.

One-second forced expiratory volume (FEV1): maximum volume forcibly expired after max. possible inspiration over one second. Decreases a lot in obstructive diseases.

Forced Vital Capacity (FVC): maximum volume that can be exhaled after max. inhale. Decreases a lot in restrictive diseases.

Tiffeneau index: FEV1/FVC ~ 0.7-1.0

See external graph for Tiffeneau index (https://erj.ersjournals.com/content/erj/6/Suppl_16/5/F1.large.jpg) and also for a comparison of obstructive and restrictive pulmonary diseases (https://www.wikidoc.org/index.php/File:Figure_39_03_05f.jpg)

Mandatory Minute Ventilation (https://en.wikipedia.org/wiki/Mandatory_minute_ventilation)

References

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