Pulmonary Function and Structure

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Pulmonary Ventilation

- The process by which ambient air is brought into and exchanged with the air in the lungs.

Lungs

- Provide the surface between the blood and the external environment.
- Lung volume: 4 - 6 L. (about the amount of air contained in a basketball).
- They are located inside the chest cavity by means of numerous infoldings so that lung membranes fold over onto themselves.

The Alveoli

- 300 million alveoli
- Elastic, thin-walled provide the vital surface for gas exchange between the lungs and the blood.
- Alveolar tissue has the largest blood supply on any organ in the body.

The Alveoli

- Millions of short, thin-walled capillaries and alveoli lie side by side with air moving on one side and the blood on the other.
- Diffusion occurs through the extremely thin barrier of these alveolar and capillary cells.

The Alveoli

- Also, small pores within each alveolus enable the interchange of gas between adjacent alveoli.
- This provides for the indirect ventilation of some alveoli that may have been damaged or blocked as a result of disease.

Mechanics of Ventilation

- Lungs: adhere to the interior of the chest wall and literally follow its every movement.
- Any change in the volume of the thoracic cavity causes a corresponding change in lung volume.
- The lungs depend on a accessory means for altering their volume because they contain no muscles.

Mechanics of Ventilation

- The volume of the lungs is altered during inspiration and expiration by the action of voluntary muscles.

Inspiration

- Diaphragm: a large dome-shaped sheet of muscle.
- It makes an airtight separation between the abdominal and thoracic cavities.
- Inspiration: diaphragm muscle contracts, flattens out, and moves downward toward the abdominal cavity by as much as 10 cm.

Inspiration

- The air in the lungs expand / inflate.
- Inspiration is completed when thoracic cavity expansion ceases and the intrapulmonic pressure increases to equal atmospheric pressure.

Inspiration-Exercise

- During exercise, the ribs and sternum also assist in the action of inspiration.
- The contraction of the scaleni and external intercostal muscles between the ribs causes the ribs to rotate and lift up and away from the body.

Inspiration-Exercise

- The descent of the diaphragm, the upward swing of the ribs, and the outward thrust of the externum all cause the volume of the chest cavity to increase with a subsequent inhalation of ambient air.

Expiration

- Process of air movement from the lungs.
- It results from the recoil of the stretched lung tissue and the relaxation of the inspiratory muscles.
- This cause the sternum and ribs to swing down and the diaphragm to move back toward the thoracic cavity.

Expiration

- These movements decrease the size of the chest cavity and compress alveolar gas so that air moves out through the respiratory tract into the atmosphere.
- Expiration is completed when the compressive forces of the expiratory musculature are no longer acting ,and intrapulm. pressure decreas. to atmospheric pressure.

Ventilatory Mechanisms

- No major # between M and F or between people of # ages.
- Supine Position: abdominal or diaphragmatic breathers.
- Upright position: action of ribs and sternum becomes more apparent.

Valsalva Maneuver

- The increase in intrathoracic pressure during a VM is transmitted through the thin walls of the veins that pass through the thoracic region.
- Because venous blood is under relatively low pressure, these veins are compressed, and blood flow into the heart is signif. reduced.

Valsalva Maneuver

- This reduction in venous return can diminish blood supply to the brain and frequently produce dizziness, fainting....normal blood flow is reestablished once the glottis is opened and intrathoraci pressure is released.

Valsalva Maneuver

- At the start of the lift: Increas. BP as the increas. intrathoraci pressure forces blood from the heart in to the arterial system.
- BP then decrease due to a decreas. venous return from the thoracic veins.

Valsalva Maneuver

- The temporary increase in BP within the heart and arteries of the chest is probably compensated for by a proportionate pressure increase on their outside walls caused by the elevated intrathoracic pressure.
- Isometric: increas. arterial BP and work-load of the heart, even if the VM is not performed.

Lung Volume and Capacities Spirometry

- Tidal Volume: volume of air moved during either the inspiratory or expiratory each breath (0.4 and 1.0 L of air per breath).
- Rise and fall of spirometer.

Inspiration Reserve Volume

- Subject is asked to inspire as deeply as possible following a normal inspiration (additional volume of about 2.5 to 3.5 L above the inspired tidal air represents one's ability for inhalation and is termed IRV).
- After IRV, normal breathing, then ERV.

Expiratory Reserve Volume

- normal exhalation followed by a forced exhalation (1.0 to 1.5 L).
- FORCED VITAL CAPACITY: total volume of air that can be voluntary moved in one breath, from full inspiration to max. expiration, or vice versa.
- FVC=TV+IRV+ERV

Residual Lung Volume

- Amount of air left in lungs after maxim. exhalation.
- 1.0 and 1.2 L for women
- 1.0 and 1.4 L for men
- AGE: increas.(due maybe to a decrease in the elastic components of the lung tissue with aging).
- RV (IRV and ERV decrease).

Residual Lung Volume

- Important function: it allows for an uninterrupted exchange of gas between the blood and alveoli; (this prevents fluctuation in blood gases during phases of the breathing cycle, including deep breathing)
- TLC=RV + FVC

Functional Residual Capacity

- Known expiratory reserve volume and the unknown residual volume.

Lung Volumes

- Varies with: age, sex, body size, especially height.
- Should be evaluated in relation to norms based on age, sex, and size.

Dynamic Lung volumes

- Important consid: individual's ability to sustain increased levels of airflow, rather than the quality of air brought into the lungs in one breath.

Dynamic Ventilation

- the maxim. “stroke volume” of the lungs, or the vital capacity.
- The speed with which this volume can be moved. The velocity of air flow, in turn, depends on the resistance offered by the respiratory passages to the smooth flow of air and the resistance offered by both the chest and lung tissue to a change in shape during breathing

Dynamic Measure

- % of VC that can be expired in 1 second (FeV1.0)- provides an indication of expiratory power and overall resistance to air movement in the lungs.
- Normal about 85% of FVC can be expelled in 1 second.

Dynamic Measure

- Obstructive lung disease, emphysema, bronchial asthma: less than 40% of FVC.
- Cut off point for air obstruction: less than 70% - FVC1.0.

Dynamic Test

- Max. voluntary ventilation: MVV
- test of ventil. capacity; rapid and deep breathing 15 seconds.
- This 15 sec. volume is then extrapolated to the volume that would have been breathed had the subject continue for 1 minute, and represents MVV.

MVV

- college-aged men: 140 - 180 L of air per/min.
- Women: 80 - 120 L.
- Obstruct. lung disease- can only achieve about 40% of the predicted normal for their age and size.
- exercise: increas. strength and end. of respir. muscles.
- increas. capacity for exerc./

Static and Dynamic Lung tests

- function are of little used in predicting fitness and exercise performance, provided that the values fall within a normal range.
- Minute Ventilation: is s function of breathing and TV. It averages 6 to 10 L, whereas in max. exercise, increases in breathing rate and depth may produce ventilations as high as 200 L per min.

Alveolar Ventilation

- it is the portion of the min. ventilat. that enters the alveoli and is involved in gaseous exchange with the blood.
- Anatomic Dead Space: a portion of the air in each breath does not enter the alveoli and thus is not involved in gaseous exchange with the blood.

Alveolar Ventilation

- This air, which fills the nose, mouth, trachea,and other nondiffusable conducting portions of the respiratory tract, is contained within the anatomic dead space.
- Health sub.: 150 to 200 ml or about 30% of the resting TV.

Physiologic Dead Space

- In certain instances, a portion of the alveoli may not function adequately in gas exchange due to either (1) an underperfusion of blood or (2) an inadequate ventilation relative to the size of the alveoli.This portion of the alveolar volume with a poor ventilation-perfusion ration is = Phys. Dead Space
- healthy lung: small/negligible.