ICU

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L2

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Respiratory Monitoring

Pulse Oximetry

- **Pulse oximetry is a noninvasive use of the change of hemoglobin absorption spectrum** to determine the relative amount of arterial blood saturated with oxygen.
- .Pulse oximetry is used in many clinical settings, including the **operating room**, **emergency department**, and **intensive care unit (ICU).**

A. Pulse oximeters can monitor for **impaired oxygenation.**

B. Pulse oximeters can also be used to **assess therapeutic interventions**, such as **adjustments to ventilator settings**.

C. Pulse oximetry is also useful for assessing the presence of pulsatile circulation and effective ventilation

What is an arterial blood gas (ABG)?

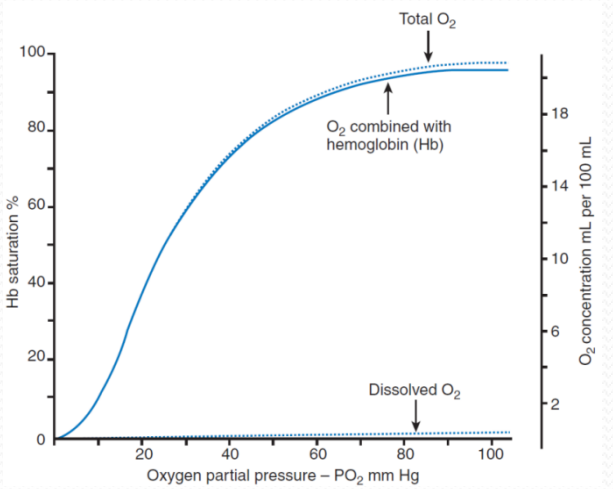
- ABG is a laboratory measure of O_2 partial pressure, CO_2 partial pressure, and pH in an arterial blood sample. The ABG has the unique advantage of identifying acidbase status. Many blood gas laboratory machines will also measure electrolytes such as **Ca, K, and Cl** as well as **BUN** and **creatinine**.

Why measure PaO2 if pulse oximetry is so good?

- Pulse oximetry gives a faster response and a relatively accurate measurement, at least in the range of 70% to 99% hemoglobin saturation. When supplemental oxygen is supplied, PaO_2 above 100 torr will continue to read 100% by pulse oximetry. If accurate measurements in this range are needed (**perhaps to assess early lung dysfunction**), only ABGs will be accurate. There is some evidence that avoiding hyperoxia is advantageous in critically ill patients and can reduce mortality.

What is the relationship between the saturation and partial pressure of oxygen?

Oxygen in the blood is either freely dissolved or bound to hemoglobin. Hemoglobin is well designed to bind and release oxygen at partial pressures encountered on earth, with small effects from pH and CO2. Fully saturated blood, with a normal hemoglobin concentration will have over 95% of its oxygen bound to hemoglobin



Monitoring During mechanical Ventilation

Monitoring the mechanical properties of the respiratory system during passive ventilation is helpful to understand the pathophysiology of respiratory failure, set the mechanical ventilator, and minimize ventilator-induced lung injury

Auto-PEEP or intrinsic

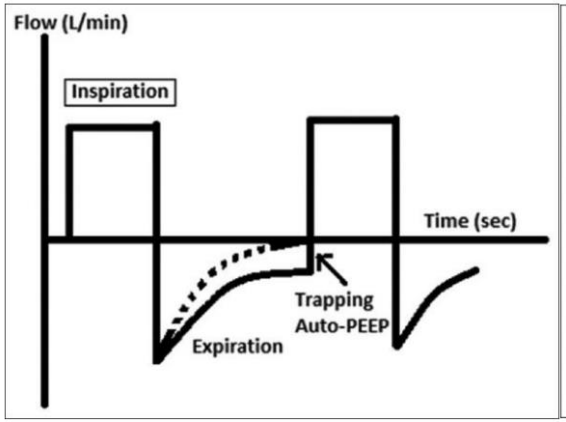
Auto-peep is the positive end-expiratory pressure caused by the progressive accumulation of air (air trapping), due to **incomplete expiration** prior to the initiation of the next breath. This occurs when expiration is limited by airway narrowing or obstruction, or when expiratory time is limited. **Total end-expiratory pressure** is the sum of the auto-peep and the extrinsically applied PEEP, in the mechanically ventilated patient

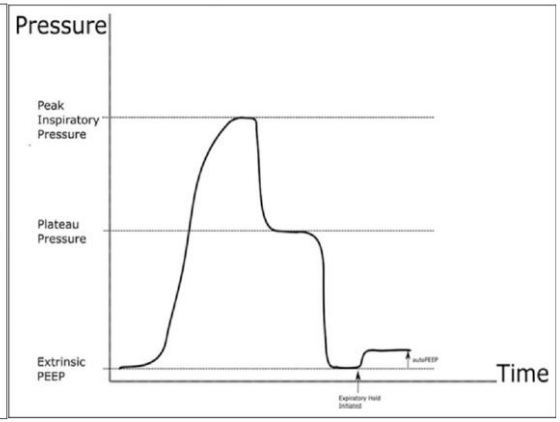
Pathophysiology of auto-PEEP

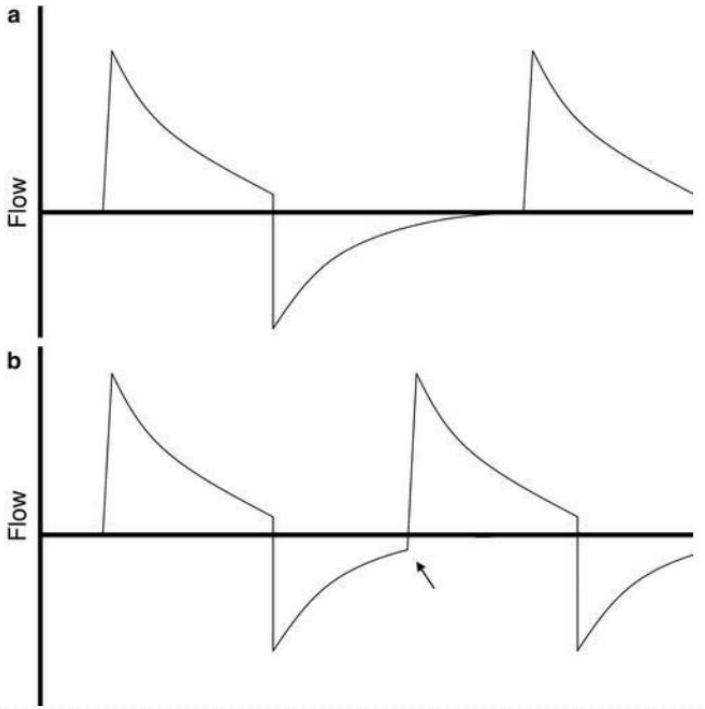
Inability to fully exhale a tidal volume before the next breath may be caused by increased minute ventilation (i.E., Increased tidal volume or respiratory rate) or due to obstruction to exhalation (i.E., Airway obstruction or extrinsic resistance), and usually a combination of both. Elevated minute ventilation: a large tidal volume requires a longer expiratory time to exhale, and increased respiratory rate will shorten the expiratory time

Factors leading to auto-peep

- Airway inflammation and mucus plugs generate dynamic airflow obstruction
- - High lung compliance as in chronic obstructive pulmonary disease (COPD)
- High tidal volume ventilation, where the tidal volume may be too high to be exhaled in a set amount of time,
- The high respiratory rate is generating a short exhalation time.
- Slow inspiratory flow generating a higher inspiratory to expiratory time ratio







Treating auto-PEEP

Assuring enough time for exhalation so that all the air in the lungs can get out is the most important principle governing the prevention of auto-peep. This may be achieved by multiple methods:

1-Decreasing respiratory rate will increase the time between breaths and decrease the inspiratory to expiratory (I:E) ratio to 1:3 to 1:5.

2-Increasing the flow rate to 60 to 100 l/min will assure fast delivery of air during inspiration, lending more time for exhalation.

3-Utilize a square waveform for ventilation delivery. This is uncomfortable for the patient but speeds the inspiration process.

4-Decrease tidal volume. When there is less air being pushed into the lungs, there is less air needed to be pushed out and less time is required to finish a full exhalation.

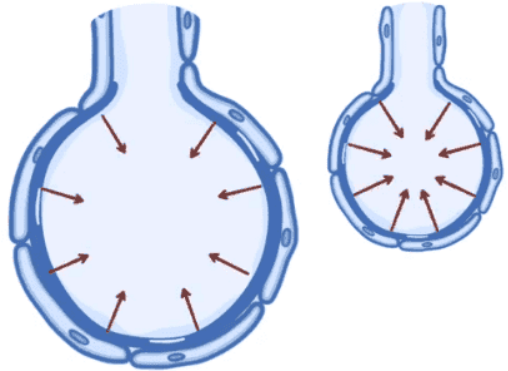
5- Decrease respiratory demand by decreasing co2 and lactate production (minimize work of breathing, control fever and pain, ensure adequate sedation, control anxiety, treat sepsis)

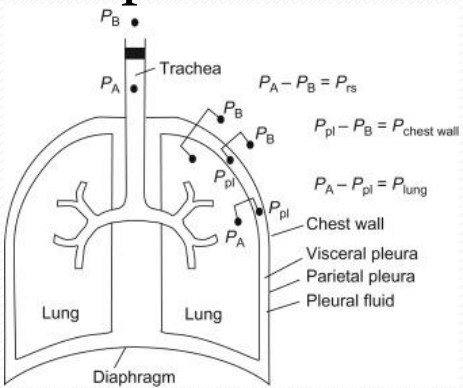
Alveolar Pressure- The Air Pressure Inside the Lung Alveoli.

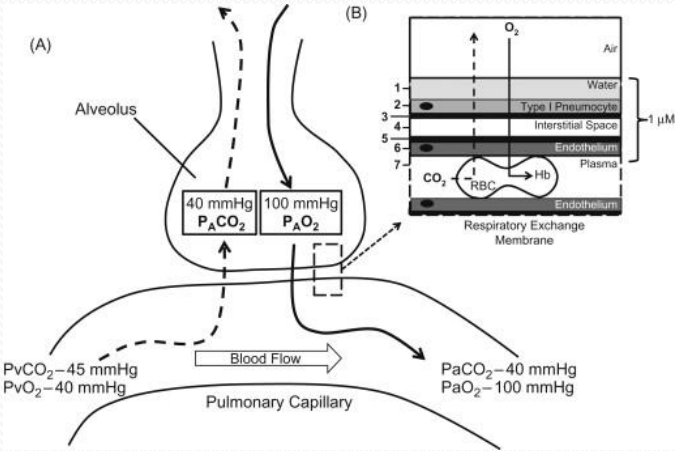
When the glottis is open and no air is flowing into or out of the lungs, the pressures in all parts of the respiratory tree, all the way to the alveoli, are equal to atmospheric pressure.

1- During normal inspiration, alveolar pressure decreases to about 1 centimeters of water. This slight negative pressure is enough to pull 0.5 liter of air into the lungs in the 2 seconds required for normal quiet inspiration.

2- During expiration, alveolar pressure rises to about +1 centimeter of water, which forces the 0.5 liter of inspired air out of the lungs during the 2 to 3 seconds of expiration.







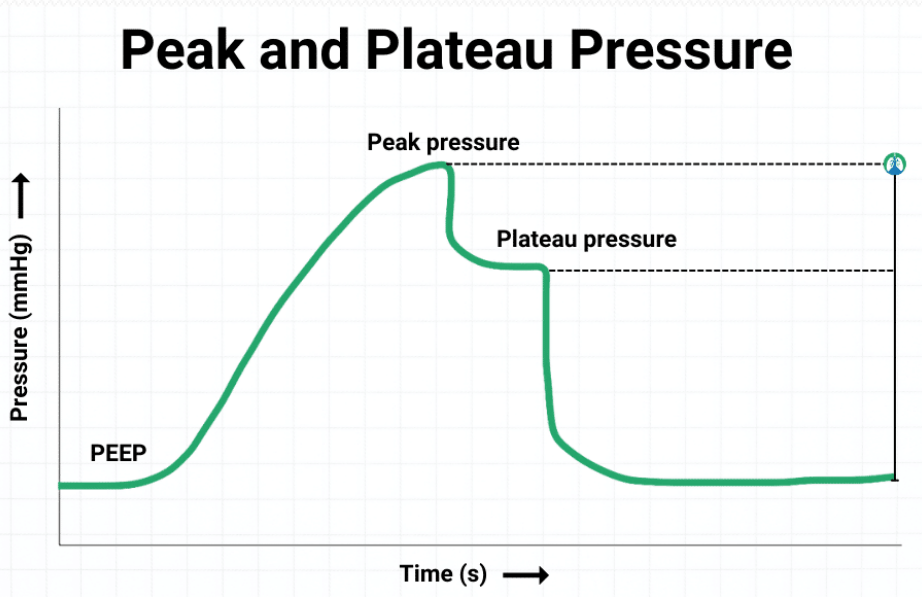
Peak Pressures vs Plateau Pressures

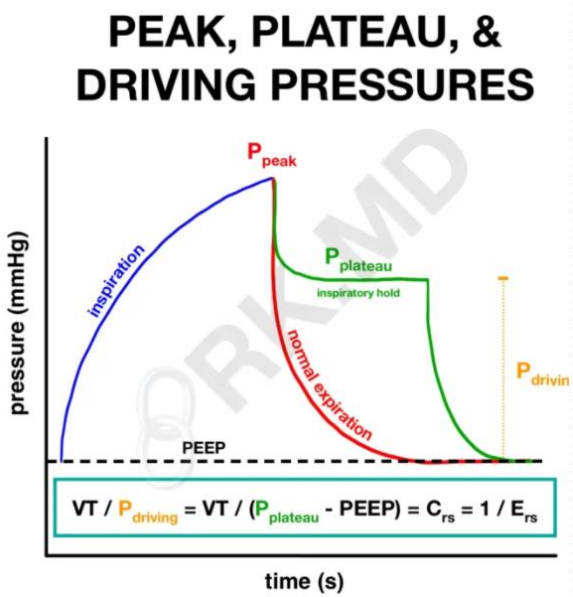
-The plateau pressure : reflects the pressure the alveoli and small airways of the lung are exposed to during mechanical ventilation. This is sometimes referred to as the transpulmonary pressure.

-The plateau pressure is one of the most important parameters to monitor during mechanical ventilation.

- Excessively high plateau pressures may put the patient at risk for barotrauma and atelectotrauma during mechanical ventilation.

- The plateau pressure is measured during peak inspiration and while there is no air movement inside the lungs. To accomplish this an inspiratory pause maneuver is performed for 0.5 to 1 second at peak inspiration





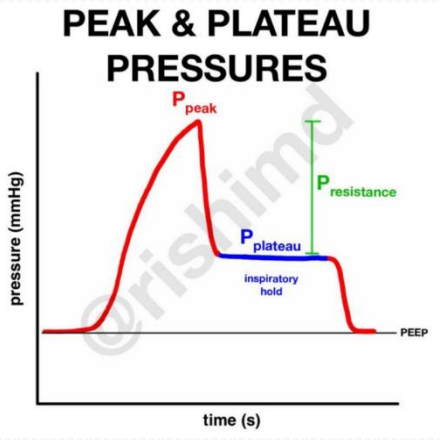
What is the difference between peak inspiratory pressure and plateau pressure?

- The peak inspiratory pressure (PIP) records the highest pressure that occurs inside the lungs at peak inspiration. The PIP should always be higher than the plateau pressure because of the effect airway resistance has on the PIP as air flows through the lungs.
- Airway secretions, inflammation, bronchoconstriction, and even a kinked endotracheal tube can all increase airway resistance and increase the PIP as a result.
- Unlike the PIP, the plateau pressure records the pressure inside the lungs when no air is moving by performing an inspiratory pause at peak inspiration. As a result, the plateau pressure does not factor in airway resistance. The plateau simply reflects the pressure it takes to hold a given volume inside the lungs. This is the pressure the small airways and alveoli are subjected to, also known as the **trans pulmonary pressure**.

- **Ppeak= Pplat+ Presistance**

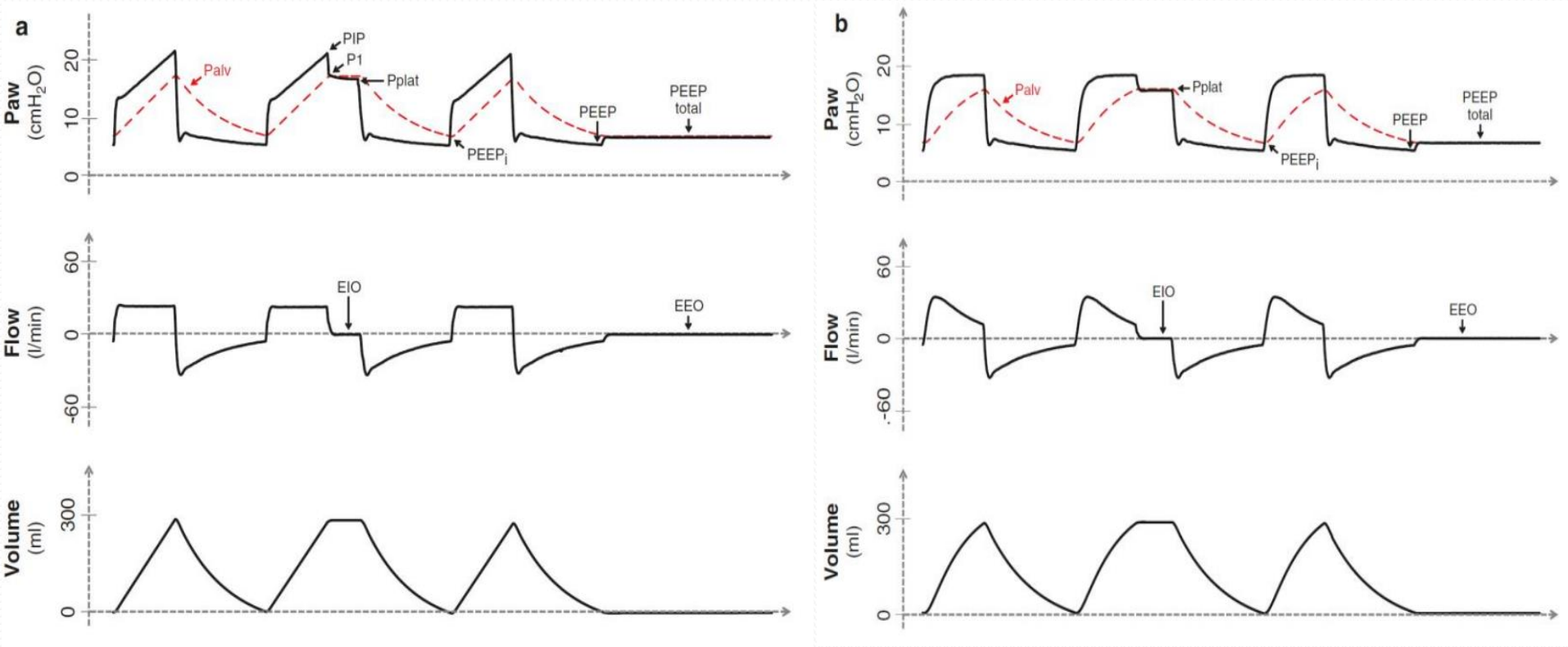
What are plateau pressure normal values?

the plateau pressure less than or equal to 30 cm H_2O.



What causes elevated plateau pressures?

- **Lung conditions** that stiffen the lungs, such as ARDS or pulmonary fibrosis may cause high plateau pressures during mechanical ventilation.
- **Inappropriate ventilator settings**, particularly excessively large tidal volumes used during volume control ventilation can also increase the plateau pressure.




Thank you!