Esophageal Pressure Monitoring in Ventilation

The routine management of mechanical ventilation in the ICU includes monitoring of peak airway pressures, plateau pressures and determining airway resistance.

When volume or pressure is pushed through an airway, a peak pressure is generated. This peak pressure is the sum of the amount of pressure necessary to get through the airways, inflate the alveoli and displace the chest wall and diaphragm. An inspiratory hold is performed on the ventilator to measure how much this pressure (plateau pressure) is actually being sensed in the alveoli once the lungs are inflated. By subtracting the plateau pressure from the peak pressure, we can calculate the resistance from the airways.

In managing mechanical ventilation, we routinely look at the plateau pressure to determine the limits to which we can increase our ventilating volumes. For the majority of patients, the chest wall and diaphragm are relatively compliant so are not a major factor in ability to ventilate patients. In cases of stiff chest wall or distended abdomens, the plateau pressure may be misleading as the pressure sensed within the alveoli is in part due to the pressures from the stiff chest wall or diaphragm.

Recently, esophageal catheters have been used to help optimize ventilation of patients with concerns re. stiff chest walls or diaphragms (distended abdomens). A catheter inserted in the esophagus is in close proximity to the pleural space. Esophageal pressures can be used as a surrogate to pleural pressures. Use of esophageal pressure monitoring can then help to differentiate between:

- pressure in the pleural space, attributable to chest wall and diaphragm and
- pressure distending the lungs (transpulmonary pressure) which might result in barotrauma

$$\text{Ptpt (transpulmonary)} = \text{Paw (plateau)} - \text{Pes (esophageal)}$$

Insertion

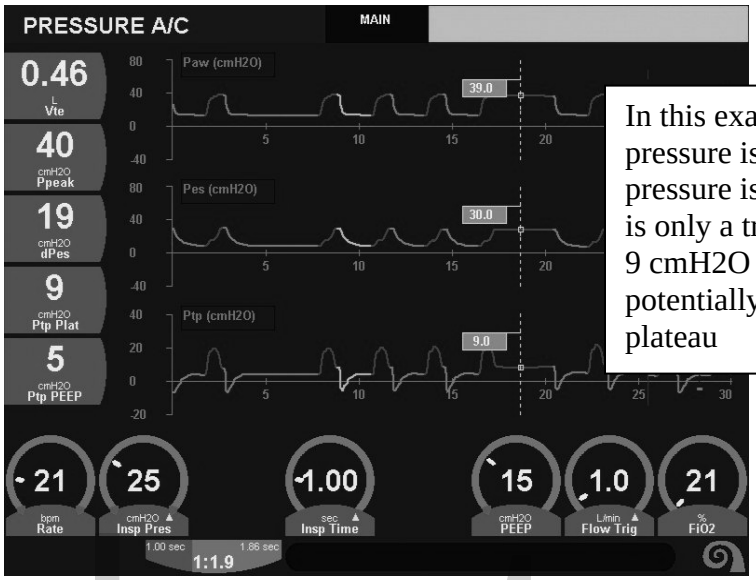
The esophageal catheter is inserted on physician order by the respiratory therapist. Contraindications are similar to those for entube or NG insertion, esophageal varices, recent trauma or surgery, coagulopathy etc. The catheter is measured and inserted to position in the lower third of the esophagus. Initial verification of placement is done by confirming cardiac oscillation on the ventilator screen. Placement is then confirmed by x-ray.

Monitoring

Following insertion, the clinician will monitor esophageal pressures on both inspiratory and expiratory holds. These results are then compared with the plateau pressures to determine how much of the plateau pressure is truly being used to distend the alveoli (transpulmonary pressure) and how much is a result of external factors (chest wall, abdomen).

Inspiratory hold

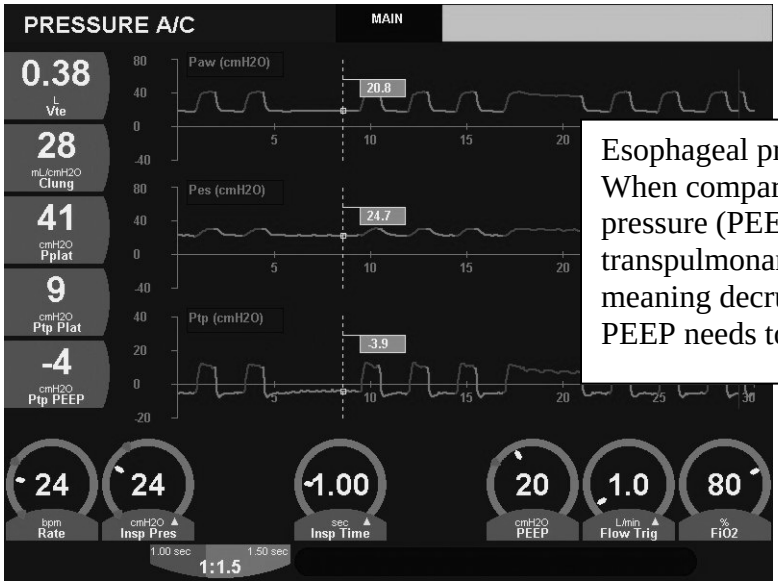
Esophageal balloon pressure (pressure from walls/abdomen) is subtracted from inspiratory plateau pressure to determine true distending pressures in alveoli. If this pressure is low, ventilating pressures (pressure control/tidal volume) can be increased despite an elevated plateau pressure.



In this example, inspiratory plateau pressure is 40 cmH2O but esophageal pressure is 31 cmH2O meaning there is only a transpulmonary pressure of 9 cmH2O . Ventilation could be potentially increased despite the high plateau

Expiratory hold

Esophageal pressure (pressure from walls/abdomen) is compared to expiratory plateau pressure (equals PEEP set). Goal is to match these two pressures to keep alveoli recruited. If esophageal pressure is higher than plateau/PEEP then alveoli will collapse (derecruit). This is indicated by a negative transpulmonary PEEP. When expiratory plateau (PEEP) is greater than esophageal pressure, alveoli will stay recruited. The goal is usually to maintain Ptp PEEP between 0-10 cmH2O.



Esophageal pressure is 24 cmH2O. When compared to expiratory plateau pressure (PEEP) of 20 cmH2O, transpulmonary pressure is – 4 cmH2O meaning decruitment is occurring. PEEP needs to be increased further