10 Expert Tips

Esophageal Pressure Measurement in ARDS patients

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Content overview

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Esophageal pressure in ARDS patients

Acute respiratory distress syndrome (ARDS) is characterized by a decrease in respiratory system compliance due to a collapsed lung and/or a decrease in chest wall compliance. When mechanical ventilation is used, the pressure shown on the ventilator display is the airway pressure and does not distinguish between the lung and chest wall components.

The measurement of esophageal pressure, used as a surrogate for pleural pressure, allows calculation of the pressure required to distend the lung and the chest wall. The distending force applied to the lung, called the transpulmonary pressure, is the pressure difference between the alveoli and the esophagus, measured during a 5-second end-inspiratory or end-expiratory occlusion.

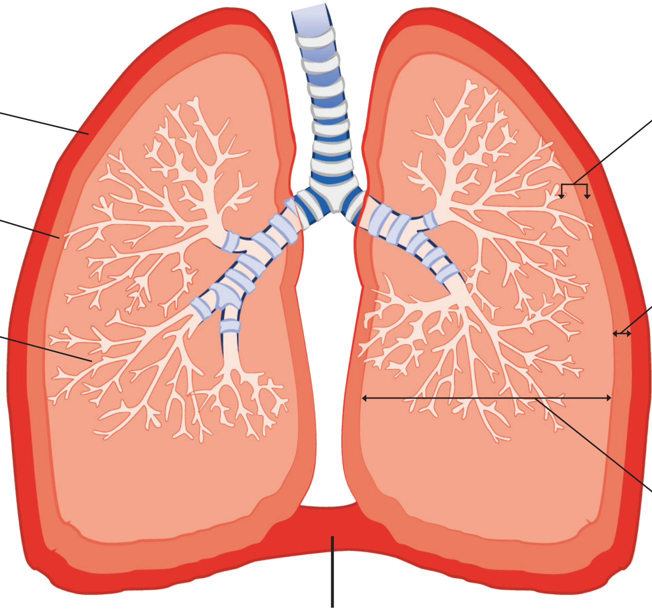
For a given alveolar pressure, transpulmonary pressure decreases when esophageal pressure increases; that is, as the chest wall becomes stiffer, the proportion of airway pressure that distends the lung decreases.

10 Expert Tips

On the following pages, you will find clinically proven recommendations about what to do and what to avoid when using esophageal pressure in ARDS patients.

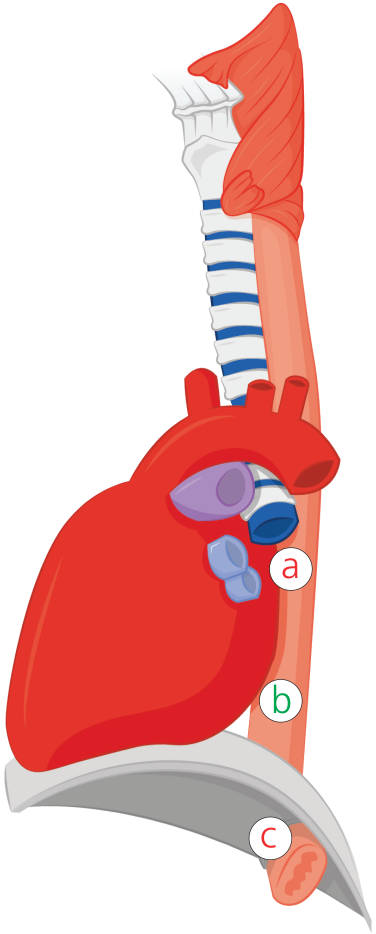
Tip 1

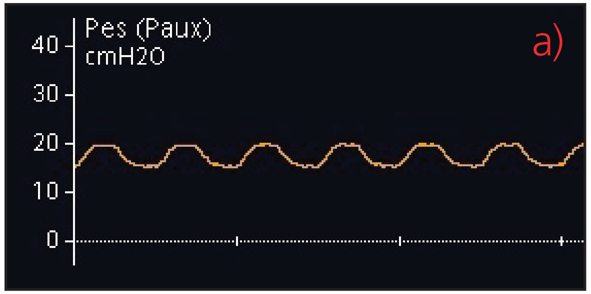
Insert esophageal catheter in severely hypoxemic ARDS patients

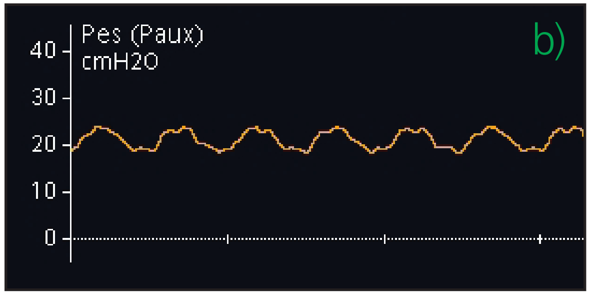


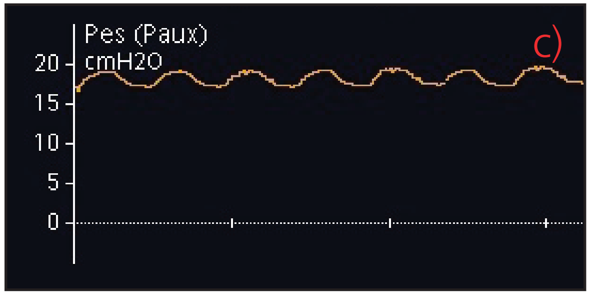
Chest wall mechanics can be severely abnormal. Partitioning the respiratory system between the lungs and the chest wall at the bedside is useful to optimize ventilator settings. It may help to improve oxygenation.

Position the balloon correctly





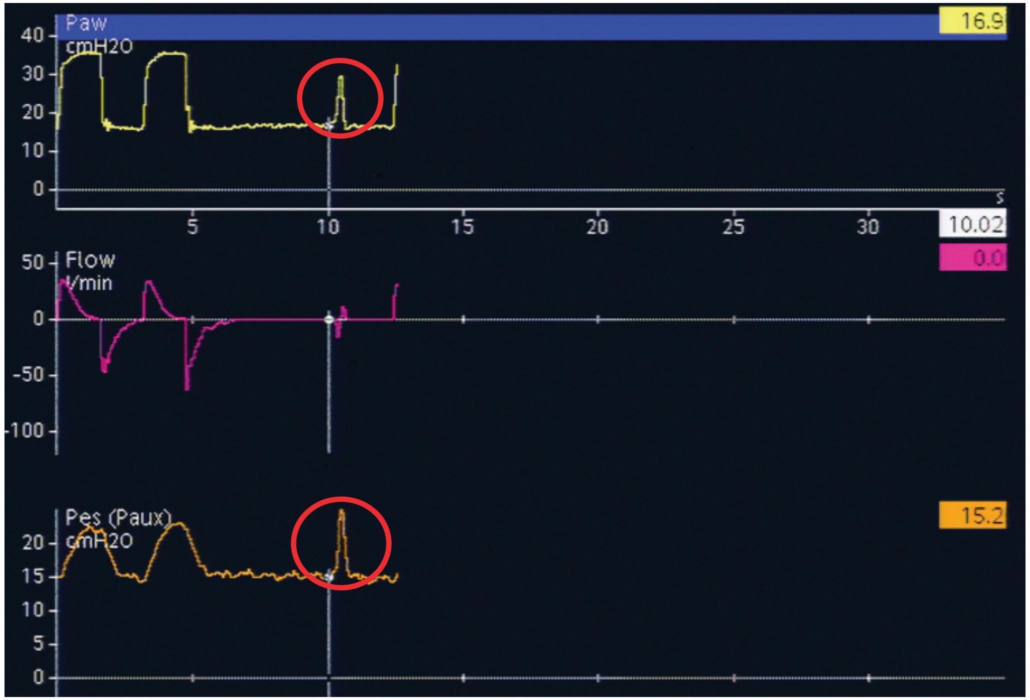




The displays on the left show you what the esophageal pressure waveforms typically look like when the catheter placement is:

a) too shallow
b) optimal
c) too deep

Tip 3 Perform an occlusion test

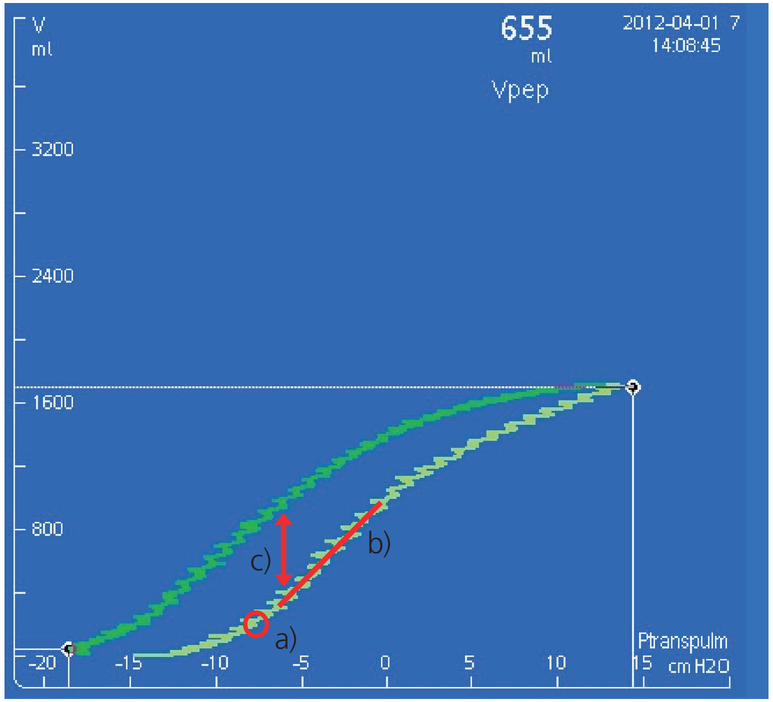


Position the balloon according to cardiac oscillation to be in the lower third of the esophagus, and verify the exact position using the occlusion test: during an end expiratory occlusion, press the chest gently.

The correct position is confirmed if the positive swings in esophageal and airway pressure are the same.

Tip 4

Assess the lung recruitability using transpulmonary low flow pressure/volume curve (P/V curve)



Here you see a transpulmonary low flow pressure/volume curve (P/V curve). A large potential of recruitability is predicted if there is:

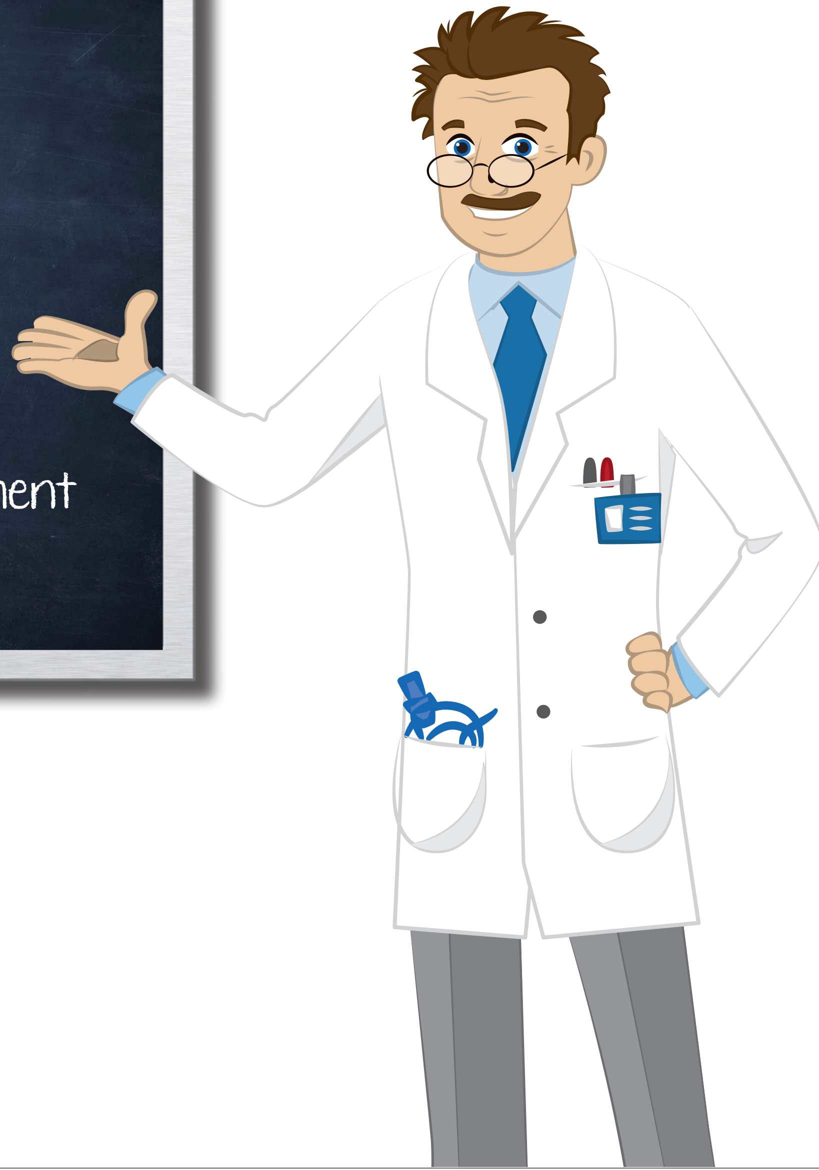
a) **A low inflection point (LIP)**
During inflation, LIP shows the pressure at which the lungs start to recruit.

b) **A high linear compliance**
Linear compliance is measured in the range of pressures where the maximum recruitment occurs during inflation.

c) **A large hysteresis**
Hysteresis is the surface enclosed between inflation and deflation limb of the P/V curve. Hysteresis is large in ARDS because pressures to recruit during inflation are higher than pressures to derecruit during deflation.

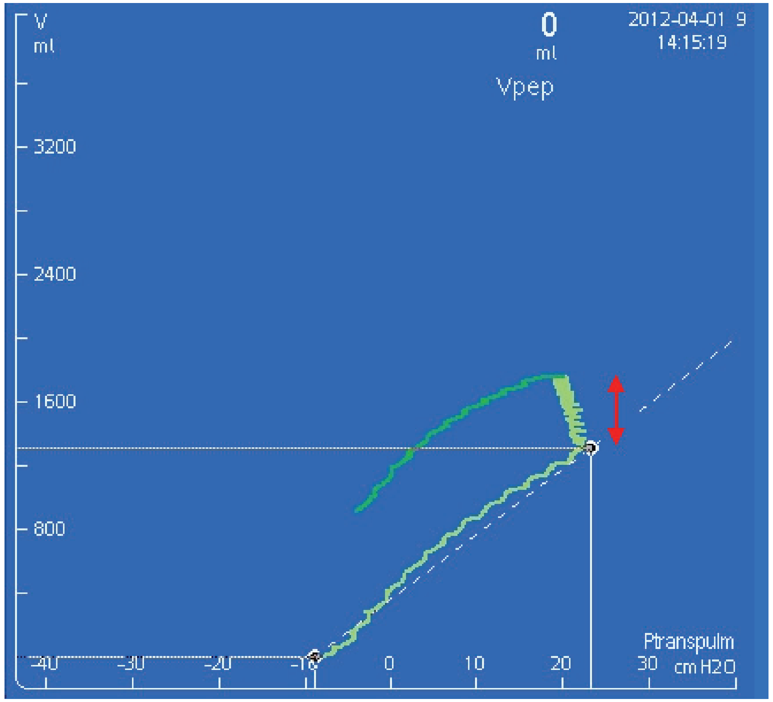
Dr. Hamilton's extra tip:

The P/V Tool, available on the HAMILTON-S1 and the HAMILTON-G5, performs a respiratory mechanics maneuver that records a quasi-static pressure/volume curve showing both the inflation and deflation curves. This data can then be analyzed to determine the lung recruitability and recruitment strategy to apply.



Tip 5

Use recruitment maneuver to reach the upper limit of transpulmonary pressure



The P/V Tool can be used to perform a sustained inflation recruitment maneuver. The transpulmonary pressure achieved during the recruitment maneuver can be measured and titrated.

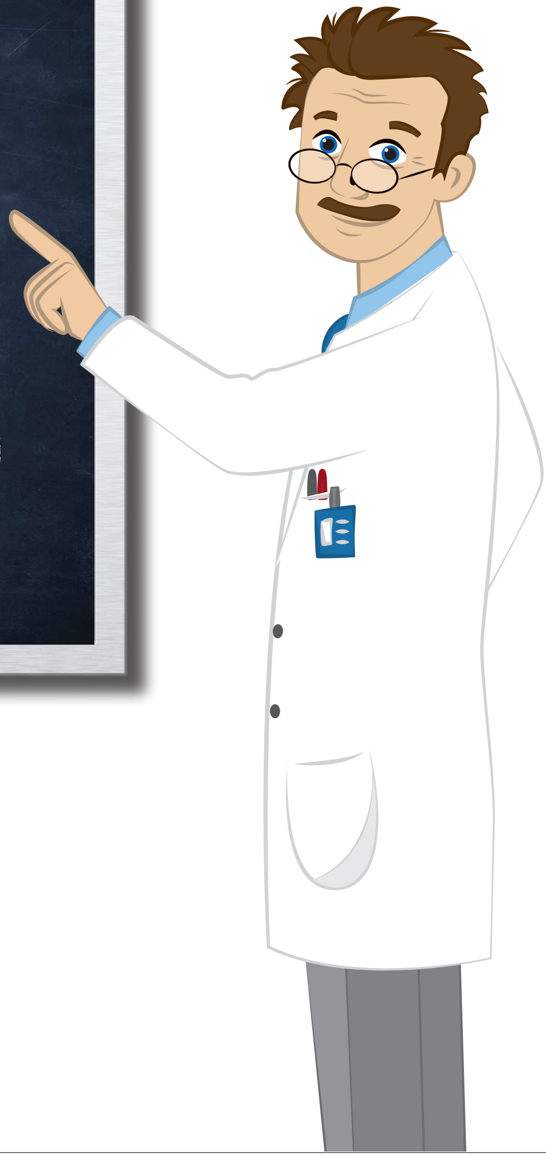
Perform a recruitment maneuver targeting 25 cmH_2O of transpulmonary pressure to reach the upper physiological limit of transpulmonary pressure.

In addition, the volume increase during the recruitment maneuver is an assessment of the volume recruited.

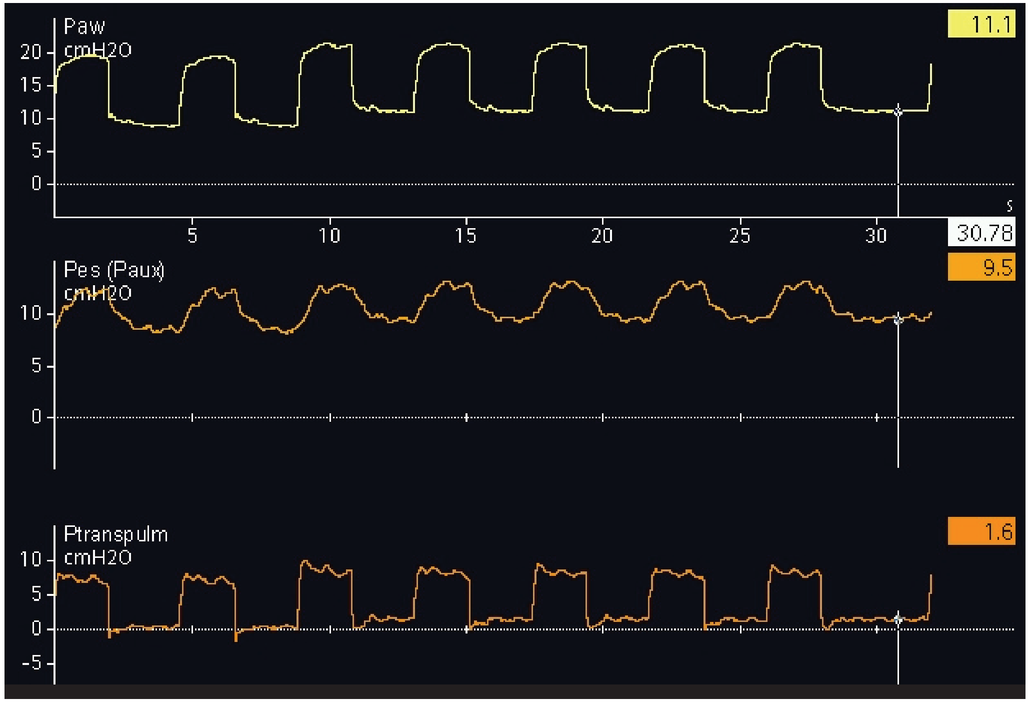
Dr. Hamilton's extra tip:

The P/V Tool can also be used to apply a sustained-inflation lung-recruitment maneuver.

Once completed, the volume of the lung effectively recruited is displayed. This is particularly helpful for ARDS patients, as appropriate lung recruitment and correct setting of PEEP are critical.



Tip 6 Set a PEEP to result in positive end expiratory transpulmonary pressure



Setting PEEP according to transpulmonary pressure increases oxygenation and respiratory system compliance.

This ventilator display shows airway pressure (Paw), esophageal pressure (Peso), and transpulmonary pressure (Ptranspulm).

Ptranspulm = Paw - Pes

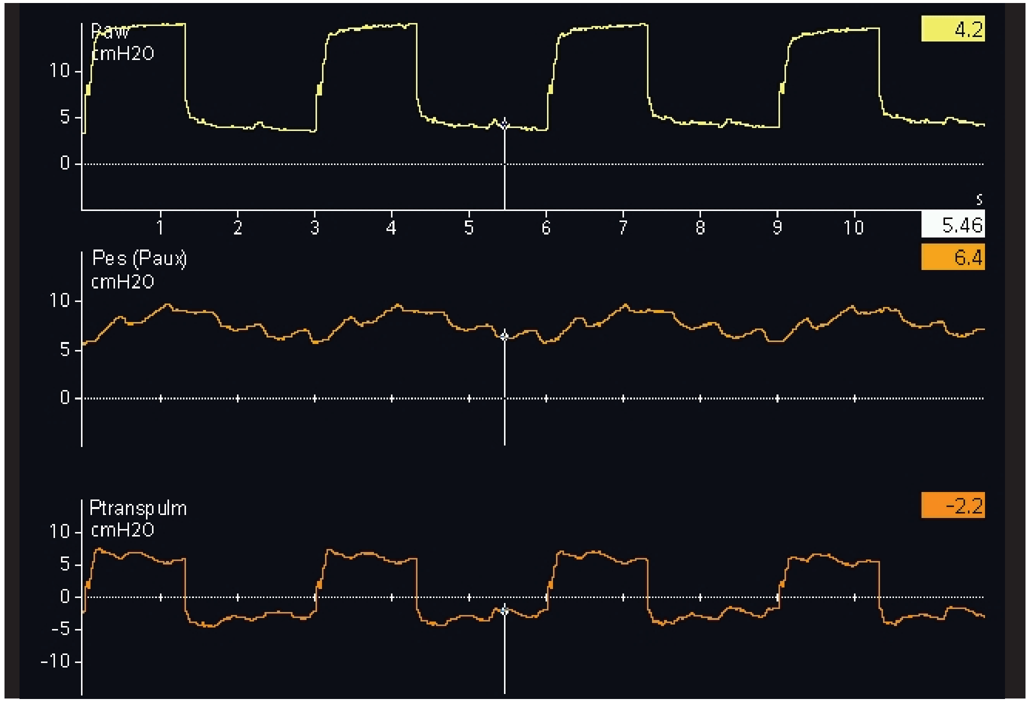
Make sure to set PEEP so that Ptranspulm is above 0 cmH_2O at the end of expiration.

Dr. Hamilton's extra tip:

Combining the use of the P/V Tool and esophageal pressure measurement is useful for fine tuning the recruitment maneuver. Doing so allows for the appropriate setting of PEEP and tidal volume to adequately ventilate the patient without injuring the lungs.

Tip 7

Avoid negative end expiratory transpulmonary pressure



Negative end expiratory transpulmonary pressure can cause ventilator-induced lung injury due to atelectrauma.

Tip 8 When NOT to use esophageal pressure measurement and when to use with caution

When NOT to use

Do not use an esophageal catheter in the presence of contraindications to nasogastric tube insertion, such as pharyngeal or esophageal lesions.

When to use with caution

The interpretation of transpulmonary pressure under the following conditions has not been studied. Therefore, esophageal pressure measurement should be used with caution.

- Ventilation in prone position
- Unilateral lung injury
- Large pleural effusion

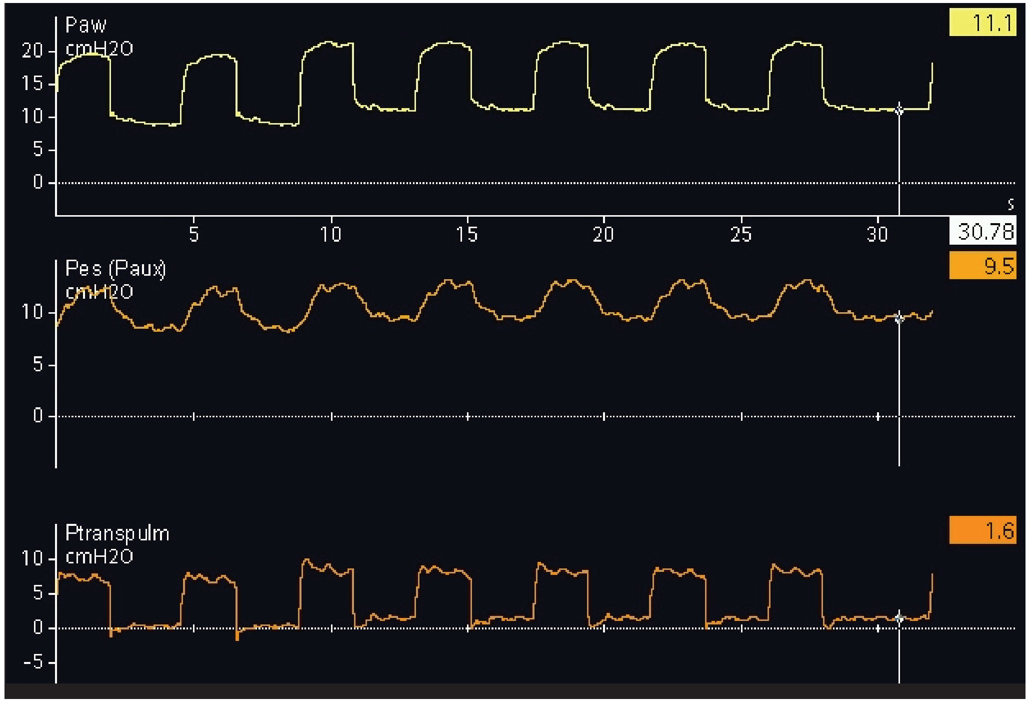
Tip 9

Keep tidal transpulmonary pressure variations under 15 cmH_2O

Avoid tidal transpulmonary pressure variations above 15 cmH_2O to limit global lung stress.

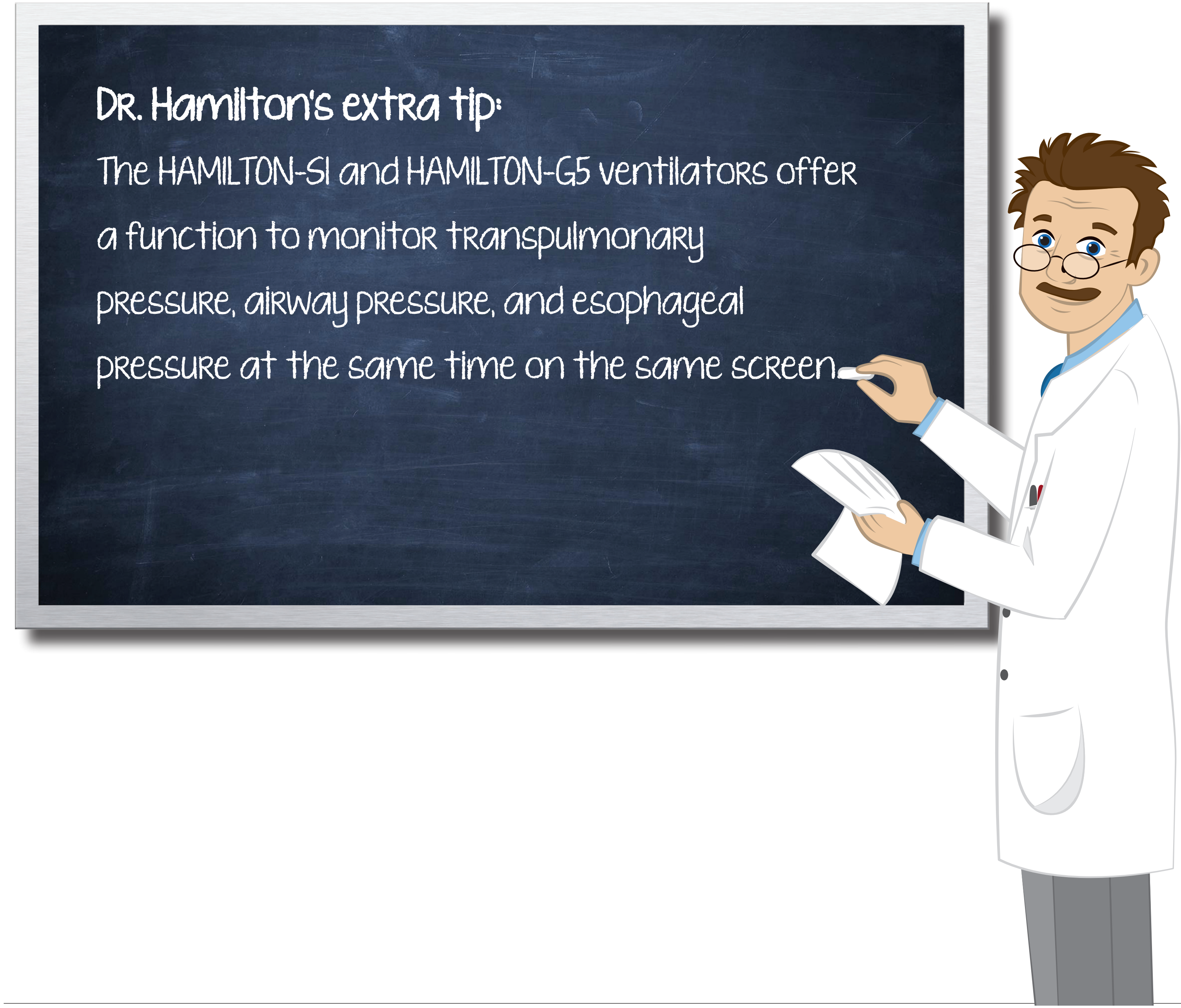
Cyclic opening and closing of parts of the lung may directly induce the release of inflammatory mediators and noxious proteinases.

Tip 10 Use the same device for airway and esophageal pressure monitoring



To calculate the transpulmonary pressure, airway pressure and esophageal pressure have to be synchronized on the same screen.

When two different devices are used, the calculation is cumbersome due to different units and time scales on each device used. The calculations have to be done manually and synchronisation is difficult to achieve.


Dr. Hamilton's extra tip:
The HAMILTON-S1 and HAMILTON-G5 ventilators offer a function to monitor transpulmonary pressure, airway pressure, and esophageal pressure at the same time on the same screen.

Protective Ventilation Tool (P/V Tool) - 1/3

The P/V Tool performs a respiratory mechanics maneuver that records a quasi-static pressure/volume curve showing both the inflation and the deflation curves. This data can then be analyzed to determine the lung recruitability and recruitment strategy to apply. The P/V Tool can also be used for lung recruitment maneuvers to display the volume of the lung that is effectively recruited. This is particularly useful for ARDS patients, as appropriate lung recruitment and correct setting of PEEP is critical.

The benefits of P/V Tool

- Easy for the operator and safe for the patient
- No disconnection of the breathing circuit, and no changes to ventilation settings
- Simple and safe way to perform lung recruitment maneuvers
- Easily repeatable process to monitor changes in the patient's condition and treatment effectiveness over time
- Interpretation is assisted by automatic calculations and cursors to assist with analysis

Protective Ventilation Tool (P/V Tool) - 2/3

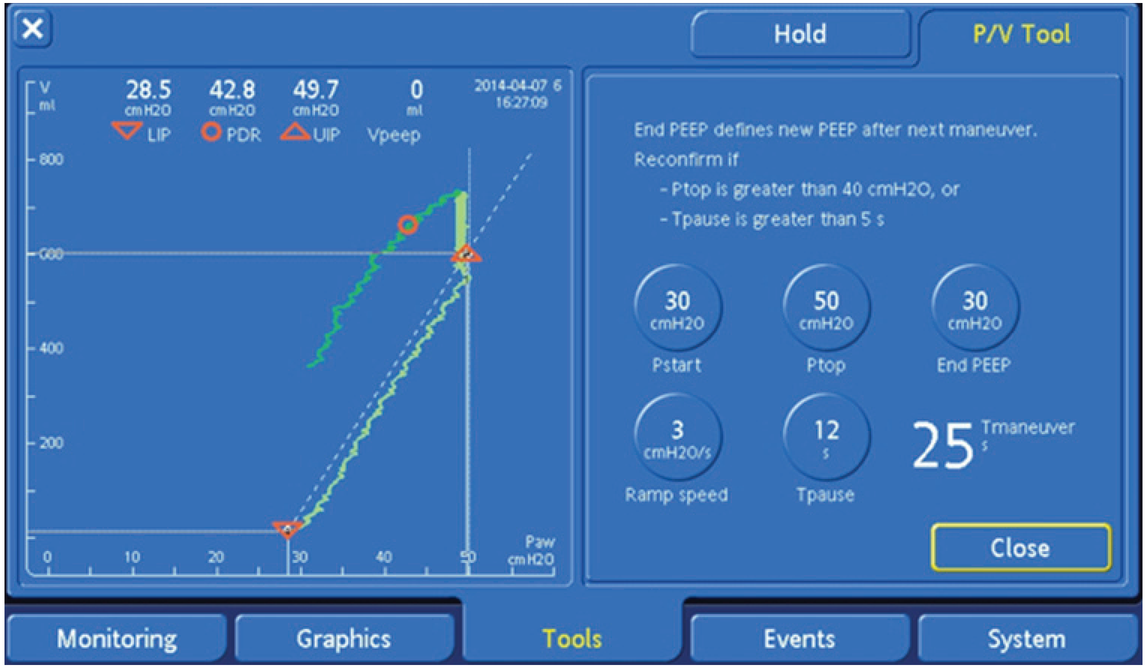
Quasi-static P/V curve

The P/V Tool records the pressure-volume relation of the lungs at low flow conditions using a patented pressure-ramping technique. This method allows the P/V Tool to not only be a diagnostic tool, but also a therapeutic lung-recruitment tool. The breathing circuit is pressurized linearly to the operator-set pressure target. When the pressure reaches the target, pressure is reduced back to the starting pressure.

The resulting curves can be used to analyze:

- The lower and upper inflection points (LIP, UIP) of the inflation pressure/volume curve
- The deflection point of the deflation pressure/volume curve
- The linear compliance of the inflation pressure/volume curve
- The hysteresis (the difference in volume between the two curves)
- The hysteresis, LIP and linear compliance allow you to assess the lung recruitability and determine the recruitment strategy

Protective Ventilation Tool (P/V Tool) - 3/3



A cursor function permits graphical analysis of the curve, including identification of inflection points. The optimum volume-pressure relationship is between the lower inflection point (LIP) and the upper inflection point (UIP).

Sustained inflation recruitment maneuver

The breathing circuit is pressurized linearly to the operator-set target pressure at the operator-set ramp speed, and the resulting volume changes are recorded.

When the pressure reaches the target, an operator-set pause is executed.

After the pause, pressure is released linearly to the operator-set end-PEEP level. The integration of the flow during the pause is the recruited volume.

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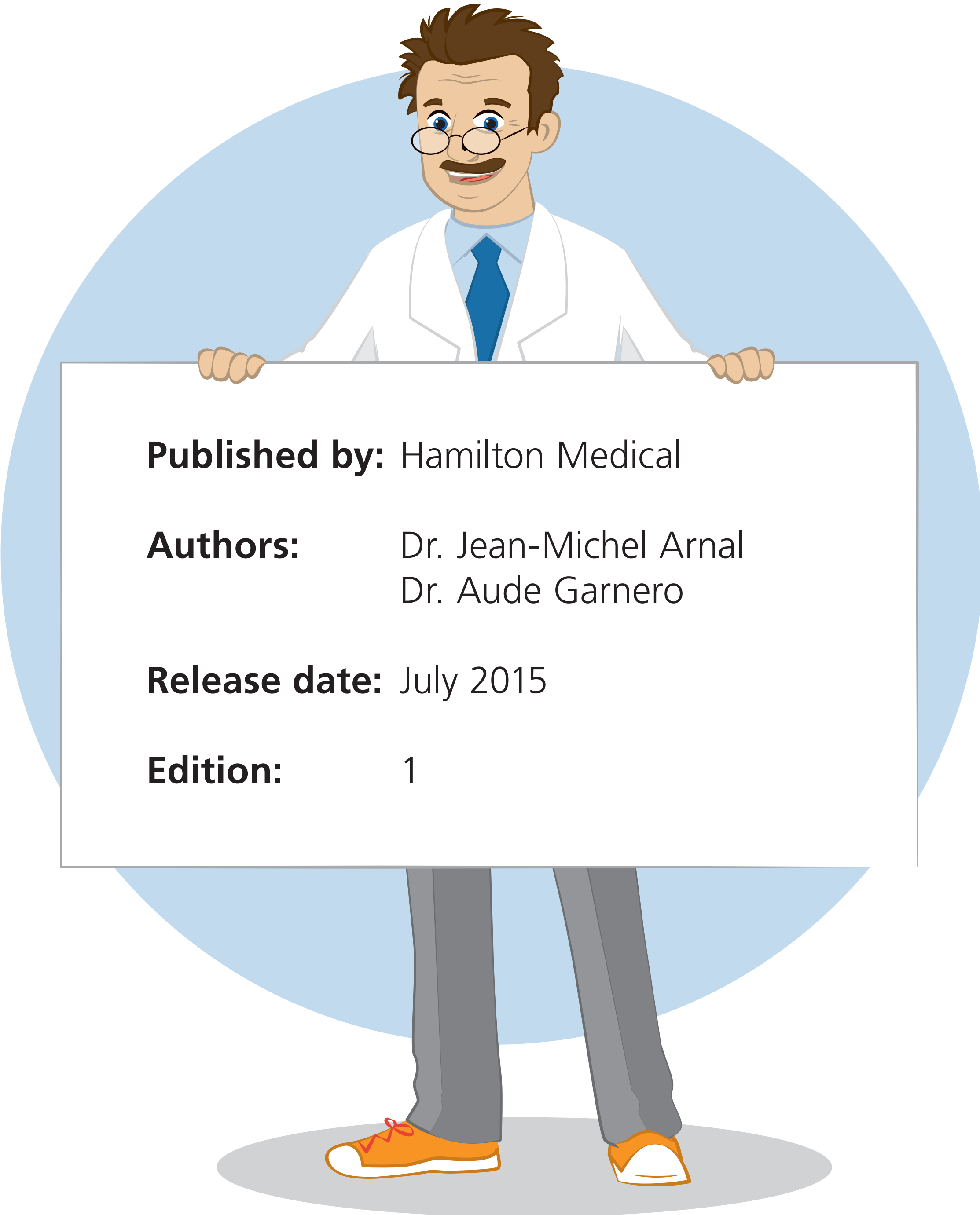

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