Peak Inspiratory Pressure (PIP)

By maintaining an adequate PIP, we are able to reduce mortality in management of ARDS. It is measured breath-by-breath on the vent.

Barotrauma used to be a really big area of study, but now they look more at volutrauma (damage to the alveolus d/t overextension).

What exactly is PIP?

PIP = (Vt/Compliance) + (Resistance of Airway x Flow)

Tidal Volume (Vt)

If you increase Vt from 5-15 mL/kg..you will see progressive increase in PIP. (5-7 mL/kg is our physiologic tidal volume). The goal is to keep the Vt low...will have a less negative impact on PIP and the lung. PIP and Vt are *directly related.*

Compliance of lung and thorax

Compliance and PIP are *inversely related.* As we increase compliance, we will see decrease in PIP, and when compliance is decreaed, PIP will increase. Most disease processes will decrease compliance of the lung or the thorax. Oh, and in case you wer wondering, compliance is measured as a change in pressure in relationship to the change in volume.

What will decrease compliance of thorax?

- Large volume resuscitation
  - Results in edema of chest wall.
- Also, occurs in the OR...when surgeon leans on chest.
- In burn patients
  - In addition to the ongoing fluid resuscitation...the development of chest wall eschars will result in decrease in the compliance of the thorax. So, at a given Vt, as the eschar sets up and tightens...the PIP will rise. If PIP goes from 25-40 d/t resuscitation and eschar, it does <u>not result</u> in alveolar overdistention. However, if pt is on pressure control as you do the eschartotomy, need to be careful because you will increase the compliance....as the compliance gets better, the PIP will go down...and you will see marked spike in Vt (need to be careful of that according to Dr. Guy)
- If a lot of edema in abdominal wall--leads to decreased compliance
  - upper abdomen packed, ascites, gravid uterus, abdominal compartment syndrome
  - All these will limit the downward excursion of the diaphragm, decreasing compliance and increasing PIP...again, alveolar dimension is unchanged. All these things would explain WHY you are seeing the high PIP. What is the doc going to do? Treat the cause of the decreased thoracic compliance. ARDS will decrease compliance of lung paranchyma, and you will see increase in PIP...and not so much increase in alveolar dimension.

Resistance of the Airway

What will increase resistance? Most likely source is size of ETT (in vented pt). You want the largest size tube possible without causing injury to the pt. The smaller the tube, the greater the resistance (which will increase PIP). Poiseuille's law says that an increase in the radius has a PROFOUND increase in the flow. If you are ventilated someone through a 6.0 tube vs. an 8.0 tube...the person with the smaller tube will have higher PIP...the alveolar dimensions will be unchanged. If you are managing a pt who was a difficult

intubation and needed a smaller tube...and the respiratory therapist is telling you the PIP is 45...what would you do? Best thing would be to change out the tube to a larger size. Airway edema will also cause resistance.

Flow of the Gas

How fast we put the gas into the patient is measured in volume per time (mL per minute). With normal physiology, our I:E ratio is 1:3 (inspiratory time: expiratory time).

Ex: our mechanically ventilated pt is breathing with a ratio of 1:1, on a set rate of 10 bpm on vent. The cycle time for each breath is 6 seconds (in and out)...3 second for inspiration, 3 seconds for expiration. Let's say we're giving the pt a L/breath (just for the sake of the example, you would never give this much). 1 L of gas is going into the pt over 3 seconds. What is the flow rate? 1L/3 seconds x 60 seconds = 20 L per minute.

Let's take same patient with same vent, take breath from 10 to 15 breaths per minute. Our cycle time is 60/15 = 4 seconds per cycle. I:E ratio is still 1:1...inspiratory time is 2 seconds, expiratory time is 2 seconds. How does this impact the flow? 1 L/2 seconds x 60 seconds = 30 L per minute...so, keeping all things equal, all we changed was the rate and we've changed our flow rate from 20 - 30. As you increase rate, you increase the flow, and that will increase PIP.

In summary, four variables that impact PIP:

1. TV
2. Compiance of lung and thorax
3. Resistance of airway
4. Flow of gas

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