Understanding Esophageal Pressure

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Why the esophagus?

- Indirect measure of pleural pressure (Ppl)
- Real objective is Ppl

Why care about pleural pressure?
- Allows partitioning of lung vs chest wall effects
  - Key for understanding “plateau pressure”
- Work of breathing
- Transmural pressure
Some reminders of respiratory physiology

• Explain transpulmonary
  – Allows partitioning lung vs chest wall
  – Work of breathing – later show eg
  – Significance - talmor
Spontaneous breath

\[ P_{tp} = 0 - (-10) \]
\[ = +10 \]

\[ P_{pl} = -2 \]

\[ P_{tp} = P_{av} - P_{pl} \]
\[ = 0 - (-2) \]
\[ = 2 \]

Diagram showing lung structures with labels for \( P_{tp} \), \( P_{av} \), and \( P_{pl} \).
Positive pressure breath

\[ P_{tp} = 20 - (10) = +10 \]

\[ P_{tp} = Palv - P_{pl} = 2 - 2 = 0 \]
Decreased chest wall compliance

\[ P_{tp} = Palv - P_{pl} = 30 - 20 = +10 \]

\[ P_{pl} = 20 \]

\[ P_{tp} = 30 \]

Inflate

Ptp = Palv - Ppl
5
= 2 - 2
= 0
What is more important for the heart—Ppl or Ptm?
Improved technique for estimating pleural pressure from esophageal balloons

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Technique for Peo

- Advanced 35-45 cm from nares
- Observe cardiac artefact
- ~ 5 ml inflated and 4.5 withdrawn
- Check with occlusion test
Occlusion Test

A

\[ V(t) \]
\[ P_{lp} \] (cmH\(_2\)O)
\[ P_{es} \] (cmH\(_2\)O)
\[ P_{m} \] (cmH\(_2\)O)

Occlusion

B

\[ \Delta P_{m} \text{ (cmH}_2\text{O)} \]

\[ \Delta P_{m} \text{ (cmH}_2\text{O)} \]

0 5 10

0 5 10
Review articles by Zin and Milic-Emile

- **Physiologic Basis of Respiratory Disease** ed Hamid, Shanon and Martin, Chapter 55
  BC Decker Inc Hamilton 2005

- **Principles and Practice of Intensive Care Monitoring** ed Tobin, Chapter 29
  McGraw-Hill, Inc 1997
Limitations

• Measures “change” in Ppl with good accuracy – less reliable for actual Ppl

• Affected by:
  – esophageal contractions
  – Weight of the heart
  – Secretions in esophagus
  – Regional pleural pressure differences

• Has been primarily used in upright posture (less cardiac compression)

• However, delta pressure can still be used in supine posture
Alternative approaches

- Pulmonary artery occlusion pressure
- Delta pressure with Mueller or Valsalva
Pulmonary artery occlusion pressure

Patient extubated post thoracotomy

Inspiratory fall in Ppao = 15 mmHg (20 cmH$_2$O)
Assist-control ventilation

-ve -10 mmHg on inspiration

Consider - excess drive
- secretions
- bronchospasm
$\Delta$ Transmural $Pw = -10 - (-40) = +30$ mmHg!
A

B

C

100 mmHg

0

-40

+40

TM = 100 mmHg

140 mmHg

60 mmHg
Implications Ppl

- Managing ventilator
- Respiratory effort
- Transmural pressure
Pulmonary artery occlusion pressure

Patient extubated post thoracotomy

Likely rise in inspiratory transmural Ppao pressure

mmHg
Mechanical Ventilation Guided by Esophageal Pressure in Acute Lung Injury

Physiological rational for Talmor’s result

- Depends whether high plateau pressure is produced by decreased lung compliance versus decreased chest wall compliance
- Measurement of Ppl allows one to distinguish these two conditions
TP = 2
+1

Palv
+3

RV
+1

LV
Variations in pulmonary artery occlusion pressure to estimate changes in pleural pressure
\[ \frac{dPeso + dPpao}{2} \text{ (cmH}_2\text{O)} \]

\[ \frac{dPeso - dPpao}{2} \text{ (cmH}_2\text{O)} \]

\[ \frac{dPeso + dCVP}{2} \text{ (cmH}_2\text{O)} \]

\[ \frac{dPeso - dCVP}{2} \text{ (cmH}_2\text{O)} \]
Positive pressure breaths

\[
\frac{(d\text{Peso}+d\text{Ppao})}{2} \text{ (cm H}_2\text{O)}
\]
What about Pulmonary Artery Pressure?

- Can give insights
- However, harder to identify the respiratory swings
  - Pulse pressure also affected by the breath
Summary

• Changes pleural pressure have important implications for cardiac function
• Give insights into work of breathing
  – Consider ventilator set up
  – Sedation
• Can be assessed from Ppao in patient who has a PA catheter in place
\[ Ptp = Palv - Ppl \]
\[ = -2 - 0 \]
\[ = -2 \]