Central Venous Pressure to Guide Fluids

Myth

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Case Presentation

- 62 M with C Diff Colitis
- BP 75/50, P 120
- CVP = 23 mm Hg
Case Presentation

• 62 M with C Diff Colitis
• BP 75/50, P 120
• CVP = 23 mm Hg
• Urine output 0.2 ml/kg/hour (56 mL) over past 4 hours
• Few crackles at bases
• Tr-1+ pretibial edema, none in hips, thighs
• No cardiac gallop
• Abdomen distended with gas
CVP for Volume Assessment?

- Does my patient have too little, enough, or too much vascular volume?

- If my patient is in shock with low cardiac output, will giving additional fluids increase cardiac output and reduce shock?

- If my patient has pulmonary edema, is it from volume overload or increased vascular permeability?
Urban Legend
Frank-Starling Relationship

Ventricular Preload (End-Diastolic Volume)
End-Diastolic Pressure-Volume Relationship

RV End-Diastolic Pressure (mmHg) vs. RV End-Diastolic Volume (mL)
No Relationship Between CVP and RVEDVI in Normal Subjects

A Kumar, Crit Care Med 2004
No Relationship Between Right Atrial Pressure and RVEDV in Critically Ill Patients

Reuse. Chest 1990

Right Atrial Pressure

RV End-Diastolic Volume Index (mL)
No Relationship Between Blood Volume and CVP

Shippy CCM 1984
CVP Does Not Predict Fluid Responsiveness in Critically Ill Patients

Pre-Infusion CVP < 8 mmHg

For predicting fluid responsiveness

- Sensitivity 62% (many false negatives)
- Specificity 54% (many false positives)
- Pos Pred Value 51% (many false positives)
- Neg Pred Value 65% (many false negatives)

Determinants of RV Preload (End-Diastolic Volume)

RV End-Diastolic *Transmural* Pressure

\( \text{RVEDP} - P_{\text{PERICARD}} \)

![Graph showing the relationship between End-Diastolic Volume (mL) and Transmural Pressure (mmHg).](image)
Transmural Pressure = $P_{IN} - P_{OUT}$

- $P_{IN} = 10$
- $P_{OUT} = 0$

$P_{tm} = 10 - 0 = 10$

Volume = 250 mL

- $P_{IN} = 0$
- $P_{OUT} = -10$

$P_{tm} = 0 - (-10) = 10$

Volume = 250 mL
Pleural Pressure, Pericardial Pressure, and CVP
Problems with CVP for Assessing Volume Status

- High Pabd pushes diaphragm up. High Ppl and Ppericard
- High CVP measured relative to atmospheric pressure.
- Low RVED *Transmural Pressure*. Low preload.
Determinants of RV Preload (End-Diastolic Volume)

- RV End-Diastolic \textit{Transmural} Pressure (RVEDP – P_{\text{PERICARD}})
- RV End-Diastolic Compliance
End-Diastolic Pressure-Volume Relationships
End-Diastolic Pressure-Volume Relationships
How to Assess Volume?

- Blood Pressure
- Heart Rate
- Heart Rate/SBP
- Pulse bounding or weak
- Extremities warm or cool
- Edema
- Gallop
- Crackles
- **Urine output**
- Urine spec gravity, Na+
- Response to fluid challenge
Vascular Pedicle Width
VPW and Total Blood Volume

Vascular Pedicle Width (mm)

Total Blood Volume (ml)

Pistolesi. Radiology 1984
Pulse Pressure Variation on Mechanical Ventilation

\[ \Delta PP \% = \frac{PP_{\text{max}} - PP_{\text{min}}}{(PP_{\text{max}} + PP_{\text{min}})/2} \]
Pulse Pressure Variation on Mechanical Ventilation

Michard. AJRCCM 2000
Limitations to PPV

- Measure on ventilator with no respiratory effort
- Measure with tidal volumes of 8-12
- Arterial pressure curves often distorted or dampened
- Arrhythmias
Inferior Vena Cava Ultrasound

Expiration

Inspiration
Veritas Nocet
(The Truth Hurts)
Veritas Vos Liberabit
(The Truth Will Set You Free)
Urban Legends
Predictors of Fluid Responsiveness

Michard.
AJRCCM 2000
Jugular Veins
No Relationship Between PWP and LVEDVI

A Kumar, Crit Care Med 2004
Vena Cava Ptm-Diameter Relationship

Diameter

Transmural Pressure (Pin – Pout)
Spontaneous Inspiration

- $P_{ABD}$
- $P_{PL}$
- $P_{RA}$
- IVC
- Diaphragm