“When physiology is disrupted, attempts at restoring anatomy are futile.”

- Schein’s
Outline

Preoperative Optimization

Why, what, who, how do we optimize?

Assessment of Volume Status

CVP

Dynamic Monitoring Tests

Ultrasound

Passive Leg Raise

Bioreactance
Preoperative Optimization
Get the patient ‘ready’...

Why do we optimize at all?

What are the goals of optimization?

Who needs it?

How do we do it?

How do we tell when we are done?
Why do we optimize?

Surgical patients are volume-depleted
Induction of anesthesia causes vasodilation
Laparotomy causes venous pooling
Intraoperative fluid losses are unpredictable
What are the goals of optimization?

Intraabdominal sepsis and hypovolemia both cause underperfusion of tissues.

Goal is to improve oxygen delivery.

In surgical patients, this means volume.
Who needs it?

Surgical patients often look ‘sick’

- Vital Signs
- Altered mental status
- Poor peripheral perfusion
- Lab abnormalities - H&H, urine specific gravity, electrolytes, BUN:Cr, pH, lactate, base deficit...
How do we do it?

**Oxygenation**

- Supplemental $\text{O}_2$
- Consider intubation
- Consider nasogastric tube
How do we do it?

**Restore intravascular volume**

- Lactated Ringer’s, Normal Saline
- No need for colloids
- Hypertonic saline is theoretical
- Consider blood products
How do we know we are done?

Physical exam

Normalization of vital signs, mental status

Urinary Output

Foley, 0.5 -1.0 ml/hr

Labs

Correction of electrolytes, acidosis, base deficit, lactate
“Fluid Nonresponders”

What if the patient doesn’t improve?

How do I know more fluid is going to help rather than hurt?

What about the elderly? Cardiac disease? Renal dysfunction?
Assessment of Volume Status
The theory...

Fluids increase preload and right ventricular end-diastolic volume

RVEDV determines LVEDV

Depending on position on F-S curve, increase SV and CO

Then, measuring preload would help guide fluid resuscitation… CVP!
Central Venous Pressure

Most common parameter for guiding fluid management

Belief that CVP reflects intravascular volume

CVP is a good approximation of right atrial pressure and RV filling/preload

Problems…

Changes in venous tone, intrathoracic pressures, ventricular compliance, valvular function

CVP $\neq$ RVEDV
Meta-analysis on 24 studies, 803 patients

5 studies compared CVP with measured blood volume

19 compared CVP with changes in cardiac performance (SV, CI)
CVP vs. Circulating Blood Volume

Correlation coefficient = 0.16
More results...

Baseline CVP and cardiac performance: Correlation coefficient = 0.18

Pooled area under ROC curve = 0.56

Change in CVP vs change in performance: Correlation coefficient = 0.11

Baseline CVP Responders: 8.7 ± 2.32 mmHg

Baseline CVP Nonresponders: 9.7 ± 2.2 mmHg
Receiver Operating Characteristic
Nevertheless...

CVP is still part of resuscitation guidelines

A patient with low urine output and low CVP will likely respond to fluid
Dynamic Monitoring

Stroke Volume Variation

Pulse Pressure Variation

Pulse Ox Plethysmographic Waveform
Pulse pressure MAXIMUM at the end of inspiration

Pulse pressure MINIMUM during expiratory period
PPV > 12% is highly predictive of volume responsiveness!
### Predictive Value of Techniques to Assess Fluid Responsiveness

<table>
<thead>
<tr>
<th>Method</th>
<th>Technology</th>
<th>AUC*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pulse pressure variation (PPV)</td>
<td>Arterial waveform</td>
<td>0.94 (0.93-0.95)</td>
</tr>
<tr>
<td>Systolic pressure variation (SPV)</td>
<td>Arterial waveform</td>
<td>0.86 (0.82-0.90)</td>
</tr>
<tr>
<td>Stroke volume variation (SVV)</td>
<td>Pulse contour analysis</td>
<td>0.84 (0.78-0.88)</td>
</tr>
<tr>
<td>Left ventricular end-diastolic area (LVEDA)</td>
<td>Echocardiography</td>
<td>0.64 (0.53-0.74)</td>
</tr>
<tr>
<td>Global end-diastolic volume (GEDV)</td>
<td>Transpulmonary thermodilution</td>
<td>0.56 (0.37-0.67)</td>
</tr>
<tr>
<td>Central venous pressure (CVP)</td>
<td>Central venous catheter</td>
<td>0.55 (0.48-0.62)</td>
</tr>
</tbody>
</table>
Shortcomings...

 Doesn’t work in patients with arrhythmias

 Doesn’t work in patients who are spontaneously breathing
Ultrasound

Transesophageal echocardiography

Respiratory variation in aortic flow velocity = fluid responsiveness
Passive Leg Raise

- Spontaneously breathing
- Valid in arrhythmia pts
- 500cc bolus
- AUC = 0.95

Transfer of blood from the legs and abdominal compartments = test for fluid responsiveness.
Bioreactance: NiCOM
Tying it together

Much of the preoperative assessment and care continues during and after the operation.

Volume assessment can be hard.

Clinical judgement and experience are required.

Must spend time at the bedside.