Critical Care Management of the Vascular Surgical Patient

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Disclosures

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Central Pressurized Cadaver Model (CPCM)
ICU
Outline

• Acute Kidney Dysfunction (AKD)
• Mesenteric ischemia
• Extremity ischemia

• rAAA/rTAA

• Mechanical Ventilation
• Medications
• What the ICU wants to know
Acute Kidney Dysfunction (AKD)

- decline in GFR (rate of ultrafiltration across capillaries)
- leads to ARF
- >70% ICU patients have AKD
- 5% renal replacement therapy (RRT) – mortality >40%

- Risk factors:
  - DM, hypotension/hypovolemia, CKD, cardiac/hepatic dysfunction, nephrotoxins (rhabdo), sepsis

- Severity (RIFLE)
  - Risk, injury, failure, loss, ESRD
Acute Kidney Dysfunction (AKD)

- **Types**
  - Pre-renal (most common): RAS, hypotension, hypovolemia
  - Intra-renal: drug or cytokine mediated
  - Post-renal: any obstruction, compression (compartment sx)

| Biochemical indices useful to distinguish a pre-renal from a renal ARF episode |
|---------------------------------------------------|---|---|
|                  | pre-renal | renal  |
| osm u (mOsm/kg)  | > 500      | < 400  |
| Na u (mmol/L or meq/L) | < 20      | > 40   |
| BUN/s creatinine | > 20       | < 10   |
| u/s creatinine   | > 40       | < 20   |
| u/s osmolality   | > 1.5      | > 1    |
| FeNa (%)*        | < 1        | > 2    |

* ( (u Na / s Na) / (u creat / s creat) ) X 100

u for urinary, s for serum, Fe = fractional excretion
Acute Kidney Dysfunction (AKD)

- **Risk**: Increased creatinine x 1.5 or GFR decrease >25%
  - **Urine Output Criteria**: UO < 0.5 ml/kg/hr x 6 hours
- **Injury**: Increased creatinine x 2 or GFR decrease >50%
  - **Urine Output Criteria**: UO < 0.5 ml/kg/hr x 12 hours
- **Failure**: Increased creatinine x 3 or GFR decrease >75% or Serum Creatinine ≥ 4mg/dl
  - **Urine Output Criteria**: UO < 0.3 ml/kg/hr x 24 hours or anuria x 12 hours
- **Loss**: Persistent ARF = complete loss of renal function >4 weeks
- **ESRD**: End-stage renal disease (>3 months)

**Early Initiation**
Acute Kidney Dysfunction (AKD)

CRRT Modes of Therapy

SCUF - Slow Continuous Ultrafiltration

CVVH - Continuous Veno-Venous Hemofiltration

CVVHD - Continuous Veno-Venous HemoDialysis

CVVHDF - Continuous Veno-Venous HemoDiaFiltration
Acute Kidney Dysfunction (AKD)

Molecular Weights

Daltons

100,000
50,000
10,000
5,000
1,000
500
100
50
10
0

- Albumin (55,000 - 60,000)
- Inflammatory Mediators (1,200-40,000)
- Myoglobin (17,800)
- Beta 2 Microglobulin (11,800)
- Inulin (5,200)

- Vitamin B12 (1,355)
- Aluminium/Desteroxamine Complex (700)
- Glucose (180)
- Uric Acid (168)
- Creatinine (113)
- Phosphate (80)
- Urea (60)
- Potassium (35)
- Phosphorus (31)
- Sodium (23)

“large”

“middle”

“small”
Acute Kidney Dysfunction (AKD)

Acidosis
- Massive blood product resuscitation, ischemia/reperfusion

Continuous VenoVenoHemoDialysis (CVVHD)
  - Dialysate countercurrent clears smaller molecules

Rhabdomyolysis
- Ischemia (muscle – vessel occlusions/ injury, crush injury)
- CK >5000, myoglobin, brown urine
- UA: hematuria but (-) micro, myoglobin (+)
- Indication for RRT

Continuous VenoVeno Hemofiltration (CVVH)
  - Convection (osmotic drag across membrane)
  - For mid-large size molecules (myoglobin, Cr, BUN)

All patients without contraindication will need AC on CRRT
RRT for AKD

- CRRT better for hemodynamically labile patients
- Early RRT leads to better outcomes (Ronco, Gettings, ADQI)
- Fastest way to get ICU to initiate RRT?
  - Place quinton in OR (or Cordis)
- Catheter length and location is crucial to RRT due to high volumes and flow
- RIJ and femoral best

<table>
<thead>
<tr>
<th>Line Location</th>
<th>Line Length</th>
<th>Line Lumen Diameter</th>
<th>Ideal Placement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right Internal Jugular</td>
<td>15-20 cm</td>
<td>11-14 Fr</td>
<td>Cavoatrial Junction</td>
</tr>
<tr>
<td>Femoral</td>
<td>25 cm</td>
<td>11-14 Fr</td>
<td>Inferior Vena Cava</td>
</tr>
<tr>
<td>Left Internal Jugular</td>
<td>20 cm</td>
<td>11-14 Fr</td>
<td>Cavoatrial Junction</td>
</tr>
<tr>
<td>Subclavian Vein</td>
<td>20 cm</td>
<td>11-14 Fr</td>
<td>Cavoatrial Junction</td>
</tr>
</tbody>
</table>
Acute Lung Injury/Mechanical Ventilation

- APRV (or SIMV at high PEEP)
  - For ARDS type
  - Phigh (set peak pressure)
  - Increases intra-thoracic pressure
  - Decreases pre-load
  - Hypotension
  - Increases resuscitation (volume/pressor) requirements
  - CRRT best for RRT due to hemodynamic volatility
Glucocorticoid Response to Stress

- Gluconeogenesis
- Glycogenolysis
- Proteolysis
- Lypolysis
- Insulin resistance
- Goal <110
- DM
- DKA
  - Fluid resuscitation
  - Insulin drip (not ISS!)
  - Electrolyte replacement
Acute Mesenteric Ischemia (AMI)

Colon (IMA)
- Bloody stool, stool immediately after OR
- Bedside flex sigmoidoscope

Small bowel (SMA)
- high rates of MSOF
- ischemia-reperfusion injury
- watch for refeeding syndrome
- start slow (10cc/hr)
- initiate feeding (or TPN) EARLY
# Acute Mesenteric Ischemia (AMI)

## Table 2: Effect of vasopressors on digestive system circulation.

<table>
<thead>
<tr>
<th>Agent</th>
<th>Receptors</th>
<th>Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dobutamine</td>
<td>Beta 1</td>
<td>Increases cardiac output and blood flow to the mucosa</td>
</tr>
<tr>
<td></td>
<td>1 a 4 mcg/kg/min: dopaminergic receptors</td>
<td></td>
</tr>
<tr>
<td>Dopamine</td>
<td>5 a 10 mcg/kg/min: beta 1</td>
<td>Increases cardiac output, redistributes flow to the serous</td>
</tr>
<tr>
<td></td>
<td>11 a 20 mcg/kg/min: alpha</td>
<td></td>
</tr>
<tr>
<td>Norepinephrine</td>
<td>Alpha and beta 1</td>
<td>Increases splanchnic flow (up to certain doses)</td>
</tr>
<tr>
<td>Epinephrine</td>
<td>Alpha</td>
<td>Decreases splanchnic flow</td>
</tr>
<tr>
<td>Vasopressin</td>
<td>Direct vascular receptors</td>
<td>Generates intestinal vasoconstriction</td>
</tr>
</tbody>
</table>

![Diagram](image)

Best predictor of feeding tolerance is clinical signs....

(±distention)
Extremity Ischemia

- embolic, arterial thrombosis/venous thrombosis
- high rates of MSOF
- ischemia reperfusion injury
- thrombolysis – check coagulation profiles
- high rates of rhabdomyolysis
- compartment syndrome
  - Clinical diagnosis
  - Exam, physiology
  - Low threshold for fasciotomy
  - Missing it is devasting physiologically and functionally
  - Multi factorial in trauma (penetrating)
  - LIFE BEFORE LIMP
• Anti-platelet/anti-coagulation
• SBP parameters after repair
  – Stop the esmolol!
• Lumbar drains – AP/AC/ppx
• Neuro exam
  – Sedatives can greatly alter the neurologic exam
  – More difficult in intubated patients, TBI, delirium

• ICU patient with TBI needing TEVAR for trauma
  – ok to do without AC
  – ok to cover SCA without bypass
  – better earlier - SBP
Abdominal Compartment syndrome
- Clinical diagnosis
- High peak pressures (ensure adequate sedation), renal dysfunction, bladder pressures >20
- Blood versus bowel distention
- Consider paracentesis if from blood and hemorrhage is controlled (use ultrasound)
- Decompressive ex-lap if bowel, bedside if needed!
- Low threshold in OR if endo repair
What the ICU wants to know

- When can we start DVT prophylaxis?
- Do we need to stop heparin/gtt before the OR?
- SBP parameters for AAA/TAA pre and post op
- Goals for AC

Improve communication

- Draw a picture
- Post signs
- Advocate for your patient
- Be part of the discussions (GOC/palliative)
- Be a colleague, get to know the ICU attending (they will need you when on trauma call!)
Summary

- Early RRT improves outcomes
- CRRT is best for hemodynamically labile patients
- Large molecules (myoglobin) need CVVH
- Early enteral feeding improves outcomes
- Mode of ventilation with high pressures can impact fluid balance and hemodynamics significantly
- Adrenal insufficiency after EVAR is unstudied but