INTERACTIVE CLINICAL CASE MODULES

AKI & CRRT 2017
CRRT Faculty
Audience Preparation

• This interactive session is designed to provide participants with the knowledge and understanding for decision making for the effective utilization of CRRT to manage critically ill patients.

• Please review the case and answer the questions during the session.

• The panel of faculty will participate in the discussion.
Case Presentation

• 52 year old male with history of systolic heart failure (EF<15%), HTN, DM and CKD stage 3 was admitted with complaints of shortness of breath. Creatinine at admission was 1.6 mg/dl. Weight is 90 kg. Height is 170 cm.

• Admission Exam: BP 92/50 mm Hg on dobutamine drip, CVP 16 cm H₂O, lungs with bilateral crackles, lower extremities with 3+ pitting edema.

• The patient was bolused with bumetanide and then started on a bumetanide drip (2 mg/h) and metolazone (10 mg) daily. He initially diuresed on this regimen with net negative status of 1 L/day and 1.5-2 L of urine output daily.

• On Day 4, he was noted to have 2.4 L of volume in and only 750 ml of urine output in the preceding 24 hours. Swan Ganz catheter parameters are consistent with persistent volume overload (PCWP 34).

• He is intubated for hypoxic respiratory failure.

• Creatinine is 1.9 mg/dl. HCT 30%. Liver function tests: Bili Total 1.8 mg/dL (high), Bili Direct 1.0 mg/dL (high), Bili Indirect 0.8 mg/dL, Alk Phos 86 Units/L, ALT 123 Units/L (high), AST 100 Units/L (high)
Case Presentation: Day 4

<table>
<thead>
<tr>
<th>LABS</th>
<th>Admission</th>
<th>Current (after intubation)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sodium</td>
<td>124</td>
<td>122</td>
</tr>
<tr>
<td>Potassium</td>
<td>4.2</td>
<td>5.3</td>
</tr>
<tr>
<td>Bicarbonate</td>
<td>28</td>
<td>34</td>
</tr>
<tr>
<td>BUN</td>
<td>55</td>
<td>87</td>
</tr>
<tr>
<td>Cr</td>
<td>1.5</td>
<td>1.9</td>
</tr>
<tr>
<td>HCT</td>
<td></td>
<td>30%</td>
</tr>
<tr>
<td>pH</td>
<td></td>
<td>7.43</td>
</tr>
</tbody>
</table>

Preceding 24 hours:
Total Intake: **2400 ml** / Total Output: **750 ml (urine)**
How will you manage this patient?

A. Increase dose of bumetanide
B. Add dopamine
C. Start patient on SCUF
D. Start patient on IHD
E. Start patient on CRRT
Case Presentation

• The decision to start SCUF was made and a consent was obtained for placement of a dialysis catheter.

• The patient has a Swan Ganz catheter in the right IJ with dobutamine infusing.

• PCWP remains elevated.
What is the next best option for dialysis catheter placement?

A. Femoral vein Catheter  
B. Left subclavian vein Catheter  
C. Left IntraJugular Catheter  
D. Right subclavian Catheter

What is the proper length of the catheter?
The patient was placed on SCUF:

- SCUF Parameters:
  - Prismaflex
  - SCUF
  - BF: 200 ml/min
  - Replacement fluid: 0 ml pre filter, 200 ml post filter 0.9% NS
  - Net fluid removal: 100 ml/hr
  - Anticoagulation: Citrate (ACD-A: 300 ml/hr, CaCl 4 g/l of NS: 70 ml/hr)

- Lab Orders:
  - BMP, Ca, Mag, Phos q 6 hrs
Points for Discussion: CRRT Prescription

What are your thoughts on prescription?
  • Use of SCUF?
  • Rate of fluid removal?
  • Use of citrate anticoagulation in SCUF?
  • Nursing issues?

Fluid Removal is increased to 200 ml/hr
Case Presentation:
Labs 24 hrs after starting SCUF with fluid removal 200 ml/hr

<table>
<thead>
<tr>
<th>LABS</th>
<th>Start of SCUF</th>
<th>After 24 hrs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sodium</td>
<td>122</td>
<td>134</td>
</tr>
<tr>
<td>Potassium</td>
<td>5.3</td>
<td>3.8</td>
</tr>
<tr>
<td>Bicarbonate</td>
<td>34</td>
<td>37</td>
</tr>
<tr>
<td>BUN</td>
<td>87</td>
<td>72</td>
</tr>
<tr>
<td>Cr</td>
<td>1.9</td>
<td>1.8</td>
</tr>
<tr>
<td>Ca</td>
<td>8.2</td>
<td>10.6</td>
</tr>
<tr>
<td>Systemic iCa^{++}</td>
<td>1.2</td>
<td>0.9</td>
</tr>
</tbody>
</table>

Preceding 24 hours:
Net I/O: -1.7 L (UOP 1 L)
Points to remember:

• Identify signs of citrate accumulation.
• Citrate clearance depends on the effluent flow rate.
• Effluent flow rate during SCUF is very small.
• Most of the citrate reaches the patient and caused citrate accumulation

• Signs of citrate toxicity:
  • Metabolic alkalosis (if liver function intact)
  • Metabolic acidosis (If shock liver or severe lactic acidosis present)
  • Increasing rate of calcium infusion
  • Increased total calcium
  • Decreased systemic ionized calcium
  • Increase in total to ionized calcium ratio > 2.5
Case Presentation:
SCUF with no anticoagulation; post filter RF NS at 200 ml/hr

<table>
<thead>
<tr>
<th>LABS 2 days after discontinuing ACD-A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sodium 130</td>
</tr>
<tr>
<td>Potassium 5</td>
</tr>
<tr>
<td>Bicarbonate 24</td>
</tr>
<tr>
<td>BUN 70</td>
</tr>
<tr>
<td>Cr 1.8</td>
</tr>
<tr>
<td>Ca 8.2</td>
</tr>
<tr>
<td>Systemic iCa++ 1.1</td>
</tr>
<tr>
<td>Net I/O: -3 L (UOP 1 L)</td>
</tr>
</tbody>
</table>
Case Presentation

- Over the next 3 days the patient has intermittent hypotension with systolic BPs occasionally 80’s and decreasing urine output. He remains on dobutamine but no pressors.

- **LABS**
  - Sodium 130
  - Potassium 5.5
  - Bicarbonate 16
  - BUN 90
  - Ca 8.2
  - iCa++ 1.1
  - Lactate 2.5

- **Liver function tests:**
  - Bili Total 2.2 mg/dL (high),
  - Bili Direct 1.5mg/dL (high),
  - Bili Indirect 0.7mg/dL,
  - Alk Phos 100 Units/L (high)
  - ALT 200 Units/L (high)
  - AST 250 Units/L (high)

**Intake:** 2100 ml / **Output:** 1600 ml
**Urine Output:** 180 ml
How will you manage this patient?

A. Increase dose of bumetanide
B. Add dopamine
C. Stop SCUF
D. Start patient on IHD
E. Start patient on CRRT
The patient was placed on the following CRRT prescription:

- **CRRT Parameters:**
  - Prismaflex
  - CVVH
  - BF: 100 ml/min
  - Post-filter RF: 1500 ml/hr
  - Fluid Removal: 100 ml/hr
  - No anticoagulation

- **CRRT Fluids**
  - PF RF: Prismasate BK0/3.5: Na 140, Cl 109.5, Mg 1.0, Ca 3.5, lactate 3, bicarbonate 32

- **Lab Orders:**
  - BMP, Ca. Mag. Phos q 6 hrs
Points for Discussion: CRRT Prescription

What are your thoughts on prescription?

- CRRT solution composition?
- CRRT modality?
- Dose?
- Filtration fraction?
- Nursing issues?
Dose?

- Effluent Rate = 1500 ml/hr + 100 ml/hr = 1600 ml/hr
- Dose = 1600 / 90 kg = 18 ml/kg/hr

- BF: 100 ml/min
- Post-filter RF: 1500 ml/hr
- Fluid Removal: 100 ml/hr
- Patient weight: 90 kg
What is the Filtration Fraction?

• FF = Ultrafiltrate / Plasma Flow Rate
• FF = \( Q_{UF} / Q_p \)
• \( Q_p = [Q_B \times (1 - \text{Hct})] \)
• FF = \( (Q_R + FR)/ [Q_B (1- 0.3)] \)
• FF = \( (1500 + 100)/[(6000 \times 0.7)] \) = 38%
• FF > 25-30%, clotting can occur
Patient is placed on new CRRT prescription:

- CRRT Parameters:
  - CVVH
  - BF: 200 ml/min
  - Post-filter RF: 2000 ml/hr
  - Fluid Removal: 100 ml/hr
  - ACD-A citrate AC on PBP: 300 ml/hr
  - Ca gluc infusion 60 ml/hr
- CRRT Fluids
  - PF RF: Duosol 4556: Na 136, Cl 117, K 4.0, Mg 1.5, bicarbonate 25, Ca 0
- Lab Orders:
  - BMP, Ca. Mag. Phos, patient and filter iCa q 6 hrs
Points for Discussion: CRRT Prescription

What are your thoughts on new prescription?

- CRRT solution composition?
- CRRT modality?
- Dose?
- Filtration fraction?
- Nursing issues?
Dose?

- Effluent Rate = 300 ml/hr + 2000 ml/hr + 100 ml/hr = 2400 ml/hr
- Dose = 2400 / 90 kg = 27 ml/kg/hr

- BF: 200 ml/min
- Post-filter RF: 2000 ml/hr
- Fluid Removal: 100 ml/hr
- ACD-A: 300 ml/hr
- Patient weight: 90 kg

ACD A
Rate: 300 ml/hr

Prismaflex HF1000

Post-filter Replacement Fluid
Rate: 2000 mL/hr

Calcium drip 60 ml/hr
What is the Filtration Fraction?

- FF = Ultrafiltrate / Plasma Flow Rate
- FF = \( Q_{UF} / Q_p \)
- \( Q_p = [Q_B \times (1- \text{Hct})] + Q_R \)
- FF = \( (Q_R + FR)/ [Q_B (1- 0.3) + 300] \)
- FF = \( (2400)/[(12000 \times 0.7) + 300] = 28\% \)
- FF > 25-30%, clotting can occur
Case Presentation

• Over the next 3 days the patient was continued on CRRT with net cumulative volume removed 3.8 L

• The patient develops fevers overnight and WBC increases to 14000/mm$^3$, and the patient is more hypotensive.

• Blood cultures are obtained, and patient is started on IV antibiotics and norepinephrine is added.

• All his lines are changed and Swann Ganz Catheter removed.

• He is still volume overloaded by exam.
Case Presentation

LABS on CRRT

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sodium</td>
<td>136</td>
</tr>
<tr>
<td>Chloride</td>
<td>98</td>
</tr>
<tr>
<td>Potassium</td>
<td>5.2</td>
</tr>
<tr>
<td>Bicarbonate</td>
<td>14</td>
</tr>
<tr>
<td>BUN</td>
<td>22</td>
</tr>
<tr>
<td>Cr</td>
<td>1.2</td>
</tr>
<tr>
<td>Lactate</td>
<td>7</td>
</tr>
<tr>
<td>pH</td>
<td>7.14</td>
</tr>
<tr>
<td>Systemic iCa</td>
<td>0.9</td>
</tr>
<tr>
<td>Post filter iCa</td>
<td>&lt; 0.25</td>
</tr>
<tr>
<td>Total Ca</td>
<td>9.8</td>
</tr>
</tbody>
</table>

Intake: **3600 ml** / Output: UOP **90 ml**; CRRT **3000 ml**
What do you do next?

A. Start D₅W with 3 amps Na bicarb at 150 cc/hr
B. Increase dose of CRRT by increasing replacement fluid
C. Change CRRT replacement solution to higher bicarbonate concentration
D. None of the above
Case Presentation

- Patient’s liver function tests reveal elevated transaminases with ALT 1020 Units/L (high), AST 950 Units/L (high)

- He also has an escalating calcium infusion rate and evidence of citrate toxicity

- His citrate and calcium infusion is discontinued

- His RF rate is increased
New CRRT Prescription

- CRRT Parameters:
  - CVVH
  - BF: 200 ml/min
  - Post-filter RF: 2500 ml/hr
  - Fluid Removal: 100 ml/hr
  - Anticoagulation: None

- CRRT Fluids
  - PF RF: Duosol 4556: Na 136, Cl 117, K 4.0, Mg 1.5, bicarbonate 25, Ca 0

- Lab Orders:
  - BMP, Ca. Mag. Phos, patient and filter iCa q 6 hrs
Points for Discussion: CRRT Prescription

What are your thoughts on new prescription?

• CRRT solution composition?
• CRRT modality?
• Dose?
• Filtration fraction?
• Nursing issues?

FF = 2600 / (200 * 60 * 0.7) = 31%
Dose = 2600 / 90 = 29 ml/kg/hr
Case Presentation

**LABS on new Rx**

<table>
<thead>
<tr>
<th>Component</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sodium</td>
<td>135</td>
</tr>
<tr>
<td>Chloride</td>
<td>100</td>
</tr>
<tr>
<td>Potassium</td>
<td>4.9</td>
</tr>
<tr>
<td>Bicarbonate</td>
<td>19</td>
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<tr>
<td>BUN</td>
<td>19</td>
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<tr>
<td>Cr</td>
<td>1.0</td>
</tr>
<tr>
<td>Lactate</td>
<td>4</td>
</tr>
<tr>
<td>pH</td>
<td>7.3</td>
</tr>
<tr>
<td>Systemic iCa</td>
<td>0.7</td>
</tr>
</tbody>
</table>

Why is systemic iCa low?
Case Presentation

• The patient’s CRRT prescription is corrected
• He is switched to a high bicarbonate containing RF with Calcium
• The patient is still hypotensive BP 80/42 mm Hg on norepinephrine 35 mcg/min
• He has worsening hypoxia with FiO₂ 80%, PaO₂ 62 mm Hg
• C-Xray: Increased venous congestion, bilateral pleural effusions
What is the next appropriate step?

A. Volume expansion with NS bolus
B. Add vasopressin and/or epinephrine and stop volume removal with CRRT
C. Add vasopressin and/or epinephrine and continue volume removal with CRRT
D. Add vasopressin and/or epinephrine and start lasix drip
E. Volume expansion with Plasmalyte
Case Presentation

• Over the next 3 days the patient becomes more stable
• BP is 108/56 and norepinephrine weaned to 8 mcg/min
• There is significant improvement in pulmonary edema and respiratory failure

• The primary team asks if you could stop CRRT as the labs look good.
# Case Presentation

<table>
<thead>
<tr>
<th>LABS</th>
<th>Current</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sodium</td>
<td>136</td>
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<tr>
<td>Chloride</td>
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<td>Bicarbonate</td>
<td>24</td>
</tr>
<tr>
<td>BUN</td>
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</tr>
<tr>
<td>Cr</td>
<td>0.8</td>
</tr>
<tr>
<td>Lactate</td>
<td>&lt; 1</td>
</tr>
<tr>
<td>pH</td>
<td>7.4</td>
</tr>
</tbody>
</table>

Intake: **2300 ml** / Output: Urine **1000 ml**; CRRT **2400 ml**
What are the predictors of successful discontinuation of CRRT and renal recovery?

A. Return to baseline Cr on CRRT
B. Normal potassium and bicarb concentration
C. Urine output > 400 ml within 24 hours
D. 2 hour creatinine clearance > 23 ml/min
E. 24 hour creatinine clearance > 15 ml/min
F. C, D, E
G. A, B, C and D