Hemoconcentrator Priming and the Impact on Efficiency

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CT Surgery Quality and Safety Officer

Overview

History
Background
Methods
Results
Conclusions

History

Brull, L. - 1928

Introduced the concept of removing excess fluid from the intravascular space in patients with renal failure by the filtration of blood through an ultraporous membrane.

Disclosures

No disclosures
History

The 1st use associated with CPB

“External hemoconcentration after deliberate hemodilution.”

1979 - Darup

Hemofiltration can be used to:

1. Balance fluids during ECC/ reversal of hemodilution
2. Treat renal insufficiency on CPB
3. Treat acute hyperkalemia

1980's

• Concept of CUF, volume overload
• More widespread use on CPB
• Emergence of products

1990 - Wheeldon

• Technique paper
• Conclusions:
  • Simple
  • Efficient
  • Inexpensive
• Blood volume control
• Blood conservation
1995- Groom et al

Paediatric perfusion practice in North America: an update*

Robert C. Groom, Aaron E. Groom The Virginia Heart Center, Fairfax Hospital, Falls Church, Virginia, Mark Rennie The University of Texas Southwestern Medical Center, Dallas, Texas, Nathan Maroo, Roberta G. Mennenga, Judith J. Ficca, Watch Jr, Alan Spall and Edward A. Libon The Virginia Heart Center at Fairfax Hospital, Falls Church, Virginia

76% use hemoconcentration during CPB

Why?

• Removal of complement and cytokines
  - TNF-α, IL-6, IL-8

• Decrease tissue edema

• Increase HCT

• Decrease total body water

• Improve pulmonary compliance

Pediatric Perfusion

• Groom survey, 2017
  - 86% of respondents utilize UF during CPB

• Decreasing prime volumes

• Hemofilter can be significant volume to add routinely into circuit

• HPH Jr

HPH® Jr

<table>
<thead>
<tr>
<th>Product</th>
<th>HPH Junior</th>
</tr>
</thead>
<tbody>
<tr>
<td>Membrane Surface Area (m²)</td>
<td>0.69</td>
</tr>
<tr>
<td>Membrane Material</td>
<td></td>
</tr>
<tr>
<td>Prime Volume (ml)</td>
<td>750</td>
</tr>
<tr>
<td>Molecular Weight cut-off (Daltons)</td>
<td>100000</td>
</tr>
<tr>
<td>Pressure Drop (mmHg)</td>
<td>150</td>
</tr>
<tr>
<td>Overall Unit Length (cm)</td>
<td>131</td>
</tr>
<tr>
<td>Internal Unit Diameter (mm)</td>
<td>2.8</td>
</tr>
<tr>
<td>Filtration (m²)</td>
<td>10</td>
</tr>
<tr>
<td>Blood Flow (ml/min)</td>
<td>100</td>
</tr>
<tr>
<td>Filtrate Flow (ml/min)</td>
<td>200</td>
</tr>
</tbody>
</table>

Male Liver
Female Liver
**The “Burnside” Method**

- Lower efficiency of the HPH Jr
- Primed with Albumin
- Anecdotally better fluid removal rate

**Methods**

- All congenital cardiac patients
- < 15 kgs (HPH Jr)
- Undergoing CPB
- Requiring cross clamp (circuit design)

**Methods**

- Randomized into 2 groups:
  - Coated: 50 mls 25% Albumin/ 200 mls prime
    - Circulated for 5 minutes
    - Clamped off until after 1st dose of CPG
    - Measured fluid removal over 30 minutes
    - Standard flow: 70 ml/min, Vacuum: -150 mmHg
  - Uncoated: Normosol® only

**Results**

<table>
<thead>
<tr>
<th>Variable</th>
<th>All (N=42)</th>
<th>Non-coated (n=22)</th>
<th>Coated (n=20)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Height</td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>Weight</td>
<td>128</td>
<td>8.7</td>
<td>6.6</td>
<td>2.9</td>
</tr>
<tr>
<td>CPB</td>
<td>50</td>
<td>51.5</td>
<td>48</td>
<td>35.5</td>
</tr>
</tbody>
</table>
### Results

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<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>UF Volume</td>
<td>412.8</td>
<td>66.4</td>
<td>387.6</td>
<td>59.3</td>
</tr>
</tbody>
</table>

### Conclusion

- Albumin coating of the HPH Jr significantly improves the efficiency of fluid removal.

### Discussion

- Low HCT center - lower than 35%
- HMS: routine heparin concentration monitoring
- Coagulation contribution?
- Standard flow maintained
- Continuous flow through device (CUF)
Future Directions

- Contrast:
  - HCT
  - TMP
  - Heparin Concentration

- Time analysis- loss of efficiency over time without albumin

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