Fluid Resuscitating the Burn Patient

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What is burn shock?

- Hypovolaemia
  - Relative
    - Inflammation = vasodilation
  - Absolute
    - Inflammation = loss into interstitium
    - “open” skin = loss to environment

- Cardiac dysfunction
Principles

• Formulas guiding resuscitation:
  - Parkland (4)
  - Modified Parkland (3)
  - Modified Brooke (2)

• Give the least amount of fluid needed

• The volume given should be continuously titrated

• Permissive hypoperfusion
  - Slow resuscitation (24 hours)
My Practice

• Government hospital
• Not a closed unit
  – After hours staff restrictions
    • In general not mx ICU
    • Trauma & general surgery cover

• Moderate burns
  – MRL
  – Modified Brooke = 2mls/kg/%
  – Titrated to UO 0.5 – 1ml/kg/hr
  – Simple and available
  – Goal is to prevent burn wound conversion
Factors to consider

• Delayed presentation
  – Practical approach
• Inhalation injury
  – Usually need more
• Subset poor responders
  – Early sepsis?
  – Physiological response?
  – Colloids?
HES in Burns?

• 6S and CHEST study excluded burns patients
• VISEP included 30 patients with burns:
  – post hoc analysis by Béchir et al.
  – application of hyperoncotic HES within the first 24 hours after severe burns ‘may be associated with fatal outcome and should therefore be used with caution’
  – patients in the HES group were on average over 13 years older and had a higher prevalence of inhalation injury than those who were resuscitated with saline alone

IAH & ACS

- Fifty publications, 1616 patients
- Use of plasma and hypertonic lactated resuscitation may prevent IAH or ACS
- Colloids decrease resuscitation volume needs, but no benefit in preventing IAH was proven
- Surgical decompression measures are effective and often unavoidable
- Prevention is challenging but can be achieved by improving fluid resuscitation strategies

Other literature

- The development of compartment syndrome in burns patients is associated with total resuscitation volumes.
- Patients with severe burns who received part of their resuscitation fluid with HES required less fluid and showed less interstitial oedema versus entire fluid requirements as crystalloid solution.
- Lower incidence of renal impairment with the use of colloids.
- Current best evidence supports recommendations to reduce fluid-volume administration through use of colloids or hypertonic saline, especially if the required volumes would exceed a ‘volume ceiling’.

Dulhunty JM, Boots RJ, Budd MJ, Mulier MJ, Lipman J. Increased fluid resuscitation can lead to adverse outcomes in major-burn related patients, but low mortality is achievable. Burns 2008;34(8):1090-1097.
### Table 1 - Preferred resuscitation formulas.

<table>
<thead>
<tr>
<th>Formula</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parkland</td>
<td>70 (69.3%)</td>
</tr>
<tr>
<td>Modified for</td>
<td>7</td>
</tr>
<tr>
<td>Colloid</td>
<td>12 (11.9%)</td>
</tr>
<tr>
<td>Galveston</td>
<td>9 (8.9%)</td>
</tr>
<tr>
<td>Brooke</td>
<td>7 (6.9%)</td>
</tr>
<tr>
<td>Warden</td>
<td>6 (5.9%)</td>
</tr>
<tr>
<td>Consensus</td>
<td>5 (5%)</td>
</tr>
<tr>
<td>Slater</td>
<td>2 (2%)</td>
</tr>
<tr>
<td>Hypertonic</td>
<td>1 (1%)</td>
</tr>
</tbody>
</table>

### Table 2 - The various fluids utilized for burn resuscitation.

<table>
<thead>
<tr>
<th>Fluid</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lactated Ringers</td>
<td>92 (91.1%)</td>
</tr>
<tr>
<td>Albumin solution</td>
<td>21 (20.8%)</td>
</tr>
<tr>
<td>Fresh frozen plasma</td>
<td>14 (13.9%)</td>
</tr>
<tr>
<td>LR/NaHCO₃</td>
<td>13 (12.9%)</td>
</tr>
<tr>
<td>Normal saline</td>
<td>5 (5%)</td>
</tr>
<tr>
<td>Hartmann's solution</td>
<td>5</td>
</tr>
<tr>
<td>Hespan</td>
<td>4</td>
</tr>
<tr>
<td>Others (tetrasarch, normosol, HTS/dextran/mannitol, Vit)</td>
<td>5</td>
</tr>
</tbody>
</table>

### Table 3 - Methods used to adjust fluids during burn shock resuscitation.

<table>
<thead>
<tr>
<th>Method</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urine output</td>
<td>94.9%</td>
</tr>
<tr>
<td>Other indicators</td>
<td>22.7%</td>
</tr>
<tr>
<td>CVP</td>
<td>9</td>
</tr>
<tr>
<td>Pa catheter</td>
<td>8</td>
</tr>
<tr>
<td>Base deficit</td>
<td>7</td>
</tr>
<tr>
<td>Lactate</td>
<td>5</td>
</tr>
<tr>
<td>LiDCO</td>
<td>5</td>
</tr>
<tr>
<td>PiCCO</td>
<td>3</td>
</tr>
<tr>
<td>Clinical</td>
<td>3</td>
</tr>
<tr>
<td>Hematocrit</td>
<td>1</td>
</tr>
</tbody>
</table>
Formulas

- **Modified Parkland formula**
  
  *Initial 24 hours*: RL 4 ml/kg/% burn (adults)
  
  *Next 24 hours*: Begin colloid infusion of 5% albumin 0.3–1 ml/kg/% burn/16 per hour

- **Brooke formula**
  
  *Initial 24 hours*: RL solution 1.5 ml/kg/% burn plus colloids 0.5 ml/kg/% burn plus 2000 ml glucose in water
  
  *Next 24 hours*: RL 0.5 ml/kg/% burn, colloids 0.25 ml/kg/% burn and the same amount of glucose in water as in the first 24 hours

- **Modified Brooke**
  
  *Initial 24 hours*: No colloids. RL solution 2 ml/kg/% burn in adults and 3 ml/kg/% burn in children
  
  *Next 24 hours*: Colloids at 0.3–0.5 ml/kg/% burn and no crystalloids are given. Glucose in water is added in the amounts required to maintain good urinary output.

- **Evans formula (1952)**
  
  *First 24 hours*: Crystalloids 1 ml/kg/% burn plus colloids at 1 ml/kg/% burn plus 2000 ml glucose in water
  
  *Next 24 hours*: Crystalloids at 0.5 ml/kg/% burn, colloids at 0.5 ml/kg/% burn and the same amount of glucose in water as in the first 24 hours

- **Formulas developed for children**

- **Shriners Cincinnati**
  
  *Initial 24 hours*:
  
  For older children:
  Lactated Ringer's (RL) solution 4 ml/kg/% burn +1500 ml/m2 total (1/2 of total volume over 8 hours, rest of the total volume during the following 16 hours)

  For younger children:
  4 ml/kg/% burn +1500 ml/m2 total, in the first 8 hours
  RL solution + 50 mEq NaHCO3
  RL solution in the second 8 hours
  5% albumin in LR solution in the third 8 hours
What is fluid creep?

- Tendency to give more fluid than required during burn resuscitation
  - Adults received 2.8ml/kg/%
  - vs
  - 58% exceeded Parkland targets
  - Average volume 6.7 ± 2.8 ml/kg/%
  - > double volume vs controls in 70’s

- Serious complications

Why fluid creep?

- Very large TBSA
- Inaccurate assessment TBSA
- Carelessness
- Opioid creep
- Favouring of crystalloid

Saffle JR. J Burn Care Res 2007
Cancio LC. J Trauma 2004
Dellinger RP. J. Crit Care Med 2004
Holm C. Burns 2004
Burn depth conversion

- Zone of coagulation
- Zone of stasis
- Zone of hyperaemia
- Epidermis
- Dermis

Adequate resuscitation

Zone of coagulation

Inadequate resuscitation

Zone of stasis preserved

Zone of stasis lost
**Burn Depth**

Partial/Dermal/Superficial  
= healing  
= better outcome

Deep/Full thickness  
= surgery  
= morbidity & mortality
Conclusion

• Many strategies
  – Tailor to expertise & setting
  – Colloids have a role
• Titration is key
• Limit fluid volume in large TBSA
• Prevent burn depth conversion & other complications – beware of fluid creep
“Know thyself. Moderation in all things.”

- Aristotle

Thank You