Management of Burn Trauma

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Objectives:

• Compare tissue involvement and physiologic consequences for first-degree, second-degree and third-degree burn injuries
• State how the ‘rule of nines’ is used to estimate the percentage of total body surface area (TBSA) affected by a burn injury
• Describe principles used for optimal early care of the burn victim
• Review criteria used to refer burn victims to a regional burn center
Management of Burn Trauma: Initial Evaluation

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Goals and Objectives

• Complete an initial evaluation of burn trauma
• Determine inhalation injury involvement
• Determine size and depth of burn injury
• Review burn shock resuscitation physiology
• Calculate and initiate burn shock resuscitation
• Refer and prepare burn injured patient to the U of U Burn Center or verified Regional Burn Center
Burn Injury

- Burn injuries rank amongst the top 15 leading burdens of disease globally
- National Fire and Burn Deaths average 3,400 annually
- Hospitalizations Related to Burn Injury: 40,000, including 30,000 at burn centers
- Survival Rate: 96.1%
- Burn injuries include: Cold injury, Flame, Chemical, Scald, and Electrical

Sources: National Electric Injury Surveillance System-All Injury Project (NEISS-AIP); National Emergency Department Survey (HCUP-NEDS) (2010 Data); National Ambulatory Medical Care Survey.


Source: American Burn Association National Burn Repository (2012 report)
Initial Evaluation

• STOP THE BURNING!
  – Airway
    • Early Identification of Inhalation Injury and early intubation.
  – Breathing
  – Circulation
    • Early Initiation of Burn Shock Resuscitation
    • Establish access even through burn
  – Disability
  – Environment/Exposure
    • Burn injured patients are more likely to develop hypothermia, keep them wrapped in warm blankets and warm fluids
Initial Evaluation

• Airway

• Evidence of possible Inhalation Injury
  – Carbonaceous sputum
  – Singed facial hair
  – Facial Burns/Facial Edema
  – Mechanism of injury (enclosed space)
  – Pediatric airway
Depth of Burn

- **First Degree**
  - Superficial, epidermis involved only, no blisters.

- **Second Degree (Partial Thickness)**
  - Injury through epidermis to varying degrees of the dermis (superficial vs. deep 2nd degree).

- **Third Degree (Full Thickness)**
  - Epidermis, dermis into subcutaneous fat involved.

- **Fourth Degree**
  - All layers of skin and subcutaneous fat into muscle, tendon and bone.
Burn Depth

First Degree

Second Degree

Third Degree
Burn Size Estimate:
Total Body Surface Area

- Adult
  - Body surface area roughly equivalent to mass
  - Rule of “NINES”
- Pediatric
  - Body surface area is larger than mass, hence Rule of “NINES” does not apply exactly
  - Palm of child =1% TBSA
  - Head = 18% of TBSA
- Threshold for Burn Shock Resuscitation= 15% TBSA
Review Burn Shock physiology

>20% TBSA Burn Injury

Local and systemic release of inflammatory and vasoactive mediators

Disrupted capillary integrity and edema

Intravascular hypovolemia and hemoconcentration peaking between 12-16h post-burn injury

Reduced cardiac output and eventually MOF

Overall goal in the first 24hrs is to replete the intravascular deficit.
Burn Shock Resuscitation

• In 1978, Baxter retrospectively reviewed 954 adult and pediatric resuscitations
  – Most patients' total crystalloid fluid requirements ranged from 3.7 to 4.3 ml/kg/%TBSA burn. (Parkland/Baxter formula 4ml/kg/%TBSA burn)

• Lactated Ringer’s
  – Relatively hypotonic (134 mEq of NaCl)
  – Does not interfere with indirect measures of hypoperfusion such as base deficit or lactate as continuous normal saline infusion.
## Burn Shock Resuscitation Formulas

<table>
<thead>
<tr>
<th>Year</th>
<th>Formula Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1942</td>
<td>Harkins formula</td>
<td>Any patient with at least a 10% burn: administer 1,000cc plasma for each 10% total surface area burn over first 24 hrs.</td>
</tr>
</tbody>
</table>
| 1947 | Body weight burn budget | First 24 hrs: 1-4 L LR + 1200ml 0.5NS + 7.5% body weight colloid + 1.5-5L D5W.  
For second 24 hrs: same formulation except change colloid to 2.5% body weight |
| 1952 | Evan’s formula        | First 24 hrs: NS at 1ml/kg/%burn + colloids at 1ml/kg/%burn + plus 2000ml glucose in water.  
Second 24 hrs: one-half the first 24 hrs crystalloid and colloid req + the same amount of glucose in water as in the first 24h. |
| 1953 | Brooke formula        | First 24 hrs: LR at 1.5 ml/kg/% TBSA burn + colloid at 0.5 ml/ kg/% TBSA burn.  
Second 24 hrs: Switch to D5W 2000 ml. |
| 1979 | Modified brooke       | First 24 hrs: LR at 2 ml/kg/% TBSA burn, one half in the first 8 hours and half in the remaining 16 hours.  
Second 24 hrs: colloid at 0.3 to 0.5 ml/kg/% TBSA burn + D5W to maintain urine output. |
| 1984 | Monafo formula        | First 24 hrs: Saline with 250 mEqNa + 150 mEq lactate + 100 mEqCl. Rate adjusted per urine output.  
Second 24 hours: one third of isotonic salt administered orally. |
Parkland Formula

• Burn Shock resuscitation calculation=

\[ 4 \text{ ml} \times \text{WT (kg)} \times \% \text{TBSA} \]

*Half given in first 8hrs and Half given over next 16hrs*

Example: 90 kg man with a 56% TBSA burn.

= \[ 4 \text{ml} \times 90 \text{ kg} \times 56 \% \text{TBSA} \]

= 20,160 ml

= 20.16 L Total Fluid resuscitation in 24hrs
Burn Shock Resuscitation

Goals
• Restore intravascular volume
• Maintain organ perfusion
• Restore electrolyte losses

Endpoints
• 0.5-1ml/kg/hr. of UOP
• CVP or PAOP
• Resolution of base deficit, Lactate
National and International opinion on the current state of burn shock fluid resuscitation

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 7</td>
<td></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 (tetrastarch, normosol, plasmalyte, Ringers acetate, HTS/dextran/mannitol, Vit C)</td>
<td></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>LiDCCO</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>

Table 4 – Responses to questions addressing the adequacy of resuscitation formulas.

<table>
<thead>
<tr>
<th>Question</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>87% feel formula works well</td>
<td></td>
</tr>
<tr>
<td>Amount of fluid provided during resuscitation</td>
<td></td>
</tr>
<tr>
<td>Just right</td>
<td>70%</td>
</tr>
<tr>
<td>Too much fluid</td>
<td>24%</td>
</tr>
<tr>
<td>Too little fluid</td>
<td>7%</td>
</tr>
<tr>
<td>Fluid provided compared to formula</td>
<td></td>
</tr>
<tr>
<td>Above formula</td>
<td>55%</td>
</tr>
<tr>
<td>Below formula</td>
<td>12%</td>
</tr>
<tr>
<td>At formula</td>
<td>33%</td>
</tr>
</tbody>
</table>

American Burn Association
Referral Criteria

1. Partial thickness (2nd degree) burns greater than 10% total body surface area (TBSA)
2. Burns that Involve the face, hands, feet, genitalia, perineum or major joints.
3. Full thickness (3rd degree) burns any age group
4. Electrical burns, including lightning injury
5. Chemical burns
6. Inhalation injury
7. Burn injury in patients with preexisting comorbidities
8. Burn injury with concomitant Trauma
9. Pediatric burns in hospitals without qualified personnel or equipment for the care of children
10. Burn injury with patients who require special social, emotional, or rehabilitative intervention (i.e. Non-accidental burn injury of children)

Excerpted from Guidelines for the Operation of Burn Centers (pp. 79-86), Resources for Optimal Care of the Injured Patient 2006, Committee on Trauma, American College of Surgeons. www.ameriburn.org
Preparation and Referral to the Burn Center

• Call your regional burn center for referral based on ABA consensus referral criteria.
• All burn injuries should remain intact with dry sterile dressing applied.
• Keep all patients wrapped in warm blankets.
• Place Foley catheter to monitor UOP
• If patients meet criteria for referral to a burn center please arrange transport early. Early appropriate care can positively impact outcomes.
Burn Care Resources

• Referral to University of Utah Burn Center
  – Healthcare.utah.edu/burn center/
  – Inpatient, outpatient

• Burn Disaster Website
  – Crisisstandardsofcare.utah.edu

• American Burn Association
  – www.ameriburn.org
  – List of verified burn centers
  – Advanced Burn Life Support (ABLS)
University of Utah Burn Center
Questions

“State of Grace”
References


