Acute And perioperative care of the burn-injured patient

Anesthesiology, V 122, No 2

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- Pathophysiology
- Initial evaluation and management
- Anesthetic management
Pathophysiology

- Massive tissue destruction
- Cytokine-mediated inflammatory response
- Intravascular volume loss

- Two distinct phase described in 1942:
  Burn-shock phase
  Hypermetabolic phase
- Burn shock phase

48 hours or more
Continued loss of plasma into burned injury
Edema formation, increased SVR
Impaired tissue and organ perfusion
Hypermetabolic phase

After 48 to 72 hours after burn injury
Increased oxygen consumption, CO2 production, and protein wasting
Increased cardiac output and decreased SVR
Pathophysiologic Changes in the Early Phase (24-48 hrs) of Burn Injury

**Heart & Circulation**
- Tachycardia
- ↓ Cardiac index
- ↓ Stroke volume
- Normal or low blood pressure
- ↓ SvO₂
- ↑ PVR and SVR
- ↑ Hematocrit
- CVP variable
- Metabolic acidosis
- Echocardiogram/ultrasound:
  - Small chambers
  - Decreased contractility

**Brain**
- Altered mental status
- ? Cerebral edema
- ↑ Pain response
- ↑ ADH

**Lungs – Inhalation Injury**
- Pulmonary edema
- Bronchospasm, bronchorrhea
- Acute respiratory distress syndrome

**Adrenal gland**
- ↑ Aldosterone
- ↑ Cortisol

**Kidney-Bladder**
- Myoglobinuria
- Oliguria
- Urine fractional Na⁺<1%

**Circumferential burn**
- Compartment syndrome of chest, abdomen and/or limbs depending on site of circumferential burn

**Skin**
- Non-blanching burned skin
- Mottled clammy non-burned skin
- Fluid loss through burned skin
- Generalized edema in >25% body burn

**Altered pharmacological responses**
Pathophysiological Changes During Hypermetabolic/hyperdynamic Phase of Burn (> 48 hrs)

Heart & Circulation
- Tachycardia
- ↑ Cardiac index
- Subclinical myocardial dysfunction
- Echocardiogram
  - Altered contractility
- ↑ SvO₂
- ↓ SVR

Lungs – Inhalation Injury
- Pulmonary edema
- Bronchospasm, bronchorrhea
- Acute respiratory distress syndrome
- Pneumonia

Liver
- Altered metabolic function
- Altered drug clearance
- Fatty liver
- ↑ Live blood flow
- ↑ Gluconeogenesis
- ↓ Coagulation factors
- Albuminemia

Kidney
- ↑ Glomerular filtration rate
- ↓ Tubular function

Bone marrow
- ↓ Hematopoiesis
- Anemia
- Immunoparesis
- Osteoporosis

Brain
- Altered mental status
- ↑ Cerebral edema
- ↑ Pain response

Systemic inflammatory response
- High energy expenditure (↑O₂ consumption & ↑CO₂ production)
- Muscle catabolism
- Insulin resistance - hyperglycemia
- Persistence of generalized edema with >25% body burn

Altered pharmacological responses
Initial evaluation and management

- Airway assessment
- Laryngeal injury
- Inhalation injury
- Fluid resuscitation and I/O
- TBSA
- Flame burn or electrical burn
Airway assessment

Presence of airway injury
Signs of airway obstruction
Preexisting airway abnormality

It is safer to intubate the patient early than risk a difficult intubation after airway swelling has occurred.
Laryngeal injury

Early recognition of laryngeal injury and consultation with a laryngologist
For anesthesiologist, it is important to make laryngeal examination when intubation
Inhalation injury

1) Direct injury to face and upper airway
2) Chemical injury to the trachea, bronchi, and alveolar due to inhalation of the toxic products
3) Impairment of oxygen transporter process due to inhalation of CO

Upper airway edema usually resolves in 3 to 6 days
Fluid resuscitation and I/O

<table>
<thead>
<tr>
<th></th>
<th>LR</th>
<th>4 ml/kg/%TBSA Burn</th>
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</thead>
<tbody>
<tr>
<td>Parkland</td>
<td>LR</td>
<td>1.5 ml/kg/%TBSA burn</td>
</tr>
<tr>
<td>Brooke</td>
<td>LR</td>
<td>0.5 ml/kg/%TBSA burn</td>
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<td>Colloid</td>
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</table>

For example for g., For 70-kg person with 60% burn:

- Parkland formula: \(4 \times 70 \times 60 = 16,800\) ml of LR/24 h;
- Brooke formula: \(1.5 \times 70 \times 60 = 6,300\) ml of LR/24 h;
  \(0.5 \times 70 \times 60 = 2,100\) ml colloid/24 h.

For either formula, half of total volume is administered over the first 8 h. Infusion rates should always be adjusted up or down based on physiological responses.

LR = lactated Ringer’s; TBSA = total body surface area.

A urinary catheter provides a means of following U/O (0.5 – 1 ml/Kg/HR)
## TBSA
### Rule of nine

<table>
<thead>
<tr>
<th>Area</th>
<th>Birth-1 yr.</th>
<th>1-4 yrs.</th>
<th>5-9 yrs.</th>
<th>10-14 yrs.</th>
<th>15 yrs.</th>
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</tbody>
</table>

**Only 2° and 3° burns are included in the total TBSA burn percent**
- Flame burn or electrical burn

  Electrical burn
  → Life-threatening arrhythmias
  → Bone experiences the highest heat accumulation
  → U/O: 2ml/Kg/HR
Anesthetic Management

- Preoperative assessment
- Airway management
- Vascular access
- Ventilator management
- Monitoring
- Intrahospital patient transporter
- Muscle relaxants and anesthetic agents
- Opioids and pain management
- Ketamine
- Regional anesthesia
- Blood loss and volume
- Temperature
- Postoperative care
Blood loss and volume
- Shed blood cannot be efficiently collected in a suction canister.
- Estimate blood loss: 2.6%-3.4% of blood volume for every 1% TBSA
- The use of colloid can help limit the amount of fluid needed.
- Mortality is decreased by previous and more aggressive administration of FFP with massive bleeding.
## Preoperative assessment

<table>
<thead>
<tr>
<th>Age of patient</th>
<th>Elapsed time from injury</th>
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</thead>
<tbody>
<tr>
<td>Extent of burn injury (total body surface area, depth, and location)</td>
<td>Associated injuries</td>
</tr>
<tr>
<td>Mechanism of injury</td>
<td>Presence of infection</td>
</tr>
<tr>
<td>Inhalational injury and/or lung dysfunction</td>
<td>Coexisting diseases</td>
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<tr>
<td>Airway patency</td>
<td>Immune dysfunction</td>
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<tr>
<td>Hematologic issues</td>
<td>Altered drug responses</td>
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<tr>
<td>Adequacy of resuscitation</td>
<td>Magnitude of surgical plan</td>
</tr>
<tr>
<td>Presence of organ dysfunction</td>
<td>Difficult vascular access</td>
</tr>
<tr>
<td>Gastric stasis</td>
<td>Altered mental states</td>
</tr>
</tbody>
</table>
- Airway management
  - Preexisting airway abnormality
  - Current airway injury
  - Signs of glottic obstruction
  - Mouth opening
  - Dressing and NG may make difficult mask ventilation
  - Infection/sepsis, intestinal edema, and opioids may slow gastric empty, which increased the risk of aspiration pneumonia
  - Securing the ETT (cuffed ETT, tie)
- Vascular access
  Technical challenge (edema)
  Infection (Debridement)
  Ultrasound guide
  Intraosseous cannulation
Ventilator management
TV: less than 6ml/Kg
Plateau pressure: less than 30 cmH2O
Rate: higher than normal due to hypermetabolic state and increased CO2 production

Plan to extubation:
Cuff leak test
Laryngoscope
• Monitoring
  Surgical staples to fix equipment
  Pulse oximetry: ear, nose, or tongue
  Blood pressure cuff: sterile and better care of the injured site
  Neuromuscular function monitoring
Intrahospital patient transporter

- Patients requiring mechanical ventilation during transport requires at least two anesthesia personnel or an anesthesia personnel and a respiratory therapist
- Sedation, analgesia, muscle relaxants
Muscle relaxants and anesthetic agents
Succinylcholine: result in hyperkalemia
NDMRs: increased dose
Rocuronium used in RSI: 1.2-1.5 mg/Kg, 90 seconds
normal patients: 0.9-1.0 mg/Kg, 60 seconds
Volatile anesthetic dose: no influence for outcome
# Opioids and pain management

Keep infusion narcotics intraoperatively

<table>
<thead>
<tr>
<th>Stage of Injury</th>
<th>Background Anxiety</th>
<th>Background Pain</th>
<th>Procedural Anxiety</th>
<th>Procedural Pain</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acute burn ventilated</td>
<td>#1 Midazolam infusion</td>
<td>Morphine infusion</td>
<td>Midazolam boluses</td>
<td>Morphine boluses</td>
</tr>
<tr>
<td></td>
<td>#2 Dexmedetomidine infusion</td>
<td>Morphine infusion</td>
<td>Dexmedetomidine higher infusion rate</td>
<td>Morphine boluses</td>
</tr>
<tr>
<td></td>
<td>#3 Antipsychotics</td>
<td>Morphine infusion</td>
<td>Haloperidol (very slow) boluses</td>
<td>Morphine boluses</td>
</tr>
<tr>
<td>Acute burn not ventilated</td>
<td>#4 Propofol infusion (&lt;48h)</td>
<td>Morphine infusion</td>
<td>Propofol boluses</td>
<td>Morphine boluses</td>
</tr>
<tr>
<td></td>
<td>Dexmedetomidine IV or scheduled lorazepam IV or PO</td>
<td>Morphine IV or PO</td>
<td>Lorazepam IV/PO</td>
<td>Morphine IV/PO or Ketamine IV</td>
</tr>
<tr>
<td>Chronic acute burn</td>
<td>Scheduled lorazepam or antipsychotics (PO)</td>
<td>Scheduled morphine or methadone</td>
<td>Lorazepam or antipsychotics (PO)</td>
<td>Morphine PO or oxycodone</td>
</tr>
</tbody>
</table>
Ketamine

Advantages: hemodynamics stability
preserving airway patency
decreasing airway resistance
treatment of opioid-induced tolerance

Disadvantages: exert inflammatory effects
hypotension
Regional anesthesia
Potential benefit in patients with burn injury intraoperatively
Improve postoperative analgesia

Central neuraxial techniques (SA/EA): no reports suggesting that epidural abscess are more common in burn patients

Peripheral neuraxial techniques (TAP): very useful to provide analgesia
Temperature
Very important!
Maintain at 27C to 38C in OR, depending on the age and severity of the burn
Postoperative care
Whether to extubate in OR
Safe transport to ICU and appropriate monitor
Postoperative pain
Thanks for your attention!