Epidemiology of Burns

- 450,000 persons treated for burn injuries each year
- Half of the 45,000 hospitalizations annually are to the nation’s 125 burn centers
- Average burn center admission is 13% TBSA
- Burns > 40% TBSA now less than 4% of admissions
- Average LOS: 1 – 1.5 days/% TBSA burn
- National mortality: 5%; LD50 70%
Epidemiology of Burns

- 3,500 fire & burn deaths annually
- Majority of fire deaths are residential
- Causes by age group:
  - 0 - 3 yrs: scald
  - 4 - 14 yrs: ignited clothing
  - 15 - 60 yrs: industrial
  - > 60 yrs: household accidents
Cross-section of the Skin

SKIN LAYERS
- Epidermis
- Dermis
- Subcutaneous fat
- Muscle
- Nerve ending
- Hair follicle
- Sweat gland

BURN DEPTHS
- First Degree
- Second Degree
- Partial
- Deep
- Third Degree
## Differential Diagnosis of Depth of Burn

<table>
<thead>
<tr>
<th>Partial-Thickness Burn</th>
<th>Full-Thickness Burn</th>
</tr>
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<tbody>
<tr>
<td><strong>SENSATION</strong></td>
<td></td>
</tr>
<tr>
<td>Normal or increased sensitivity to pain and temperature</td>
<td>Anesthetic to pain and temperature</td>
</tr>
<tr>
<td><strong>BLISTERS</strong></td>
<td></td>
</tr>
<tr>
<td>Large, thick-walled, will usually increase in size</td>
<td>None, or if present, thin-walled and will not increase in size</td>
</tr>
<tr>
<td><strong>COLOR</strong></td>
<td></td>
</tr>
<tr>
<td>Red, will blanch with pressure and refill</td>
<td>White, brown, black or red. If red, will not blanch with pressure</td>
</tr>
<tr>
<td><strong>TEXTURE</strong></td>
<td></td>
</tr>
<tr>
<td>Normal or firm</td>
<td>Firm or leathery</td>
</tr>
</tbody>
</table>
Rule of “Nines”
Modified for Age

Adult

5 years

1 year
**Burn Estimate and Diagram**

**Age vs Area**

**Initial Evaluation**

- Cause of burn: 
- Date of Burn: 
- Time of Burn: 
- Age: 
- Sex: 
- Weight: 
- Date of Admission: 
- Signature: 
- Date: 

<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>
<th>Adult</th>
<th>2°</th>
<th>3°</th>
<th>Total</th>
<th>Donor Areas</th>
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<td>Head</td>
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<td>17</td>
<td>13</td>
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<td>2 1/2</td>
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<tr>
<td>L. Buttock</td>
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<td>2 1/2</td>
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<tr>
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<td>2 1/2</td>
<td>2 1/2</td>
<td>2 1/2</td>
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<td>8</td>
<td>8 1/2</td>
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<td>8</td>
<td>8 1/2</td>
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<td>5 1/2</td>
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<td>6 1/2</td>
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<td>L. Leg</td>
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<td>6 1/2</td>
<td>7</td>
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<td>R. Foot</td>
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<td>3 1/2</td>
<td>3 1/2</td>
<td>3 1/2</td>
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<td>3 1/2</td>
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<td>3 1/2</td>
<td>3 1/2</td>
<td>3 1/2</td>
<td>3 1/2</td>
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</tr>
</tbody>
</table>

**Total**
Emergency Treatment

1. Establish airway
2. Remove clothing
3. Large bore IV’s
4. Estimate extent and depth of burn
5. Calculate fluid requirements
6. Nasogastric suction
7. Foley catheter
8. Tetanus immunization
9. Intravenous sedation
10. Debride and/or cover wound*

*when transferring or in ER, keep wounds warm and in dry sterile dressing
Burn Center Referral Criteria

- Partial thickness burns greater than 10% total body surface area (TBSA)
- Burns that involve the face, hands, feet, genitalia, perineum, or major joints
- Third degree burns in any age group
- Electrical burns, including lightning injury
- Chemical burns
- Inhalation injury
Burn Center Referral Criteria

- Burn injury in patients with pre-existing medical disorders that could complicate management, or prolong recovery, or affect mortality
- Any patients with burns and concomitant trauma (such as fractures) in which the burn injury poses the greatest risk of morbidity or mortality
- Burned children in hospitals without qualified personnel or equipment for the care of children
- Burn injury in patients who will require special social, emotional, or long-term rehabilitative intervention
Parkland Formula

First 24 hours: 4 ml LR/kg/% burn + basal fluids*

– Rate of infusion: 50% in 1st 8 hrs
  25% in 2nd 8 hrs
  25% in 3rd 8 hrs

Second 24 hours: Basal + evaporative losses

→ Basal: 1500 ml / m² / day
→ Evaporative: (25 + % burn) x m² = ml/hr
→ Consider colloid: 0.5 ml FFP / kg / % burn
Parkland Formula

- Example:

- 70 kg male 40 % TBSA
Parkland Formula

- $4 \times 70 \text{ kg} \times 40\% = 11,200 \text{ ml}$

- $11,200 \div 2 = 5,600 \text{ ml}$

- First 8 hours = 700 ml/hr

- Remaining 16 hrs = 350 ml/hr
Burn Shock Resuscitation

Mean Calculated Volume Requirements
(4ml/kg/%burn)

Time Post-burn (hrs)
Monitoring of Resuscitation

- **Vital Signs**
  - BP, Pulse, Respiratory rate, Temperature

- **Urine output**
  - Hourly output, Sp. Gravity, Pigment

- **Invasive methods**
  - CVP, PCWP, Cardiac Output

- **Laboratory tests**
  - Electrolytes & osmolality
  - Hematocrit
  - Albumin
  - Acid-base balance
Indications for Escharotomy

- Cyanosis
- Impaired capillary filling
- Progressive neurological changes
- Loss of palpable or doppler pulses
- Subeschar pressure > 30 mm Hg
Nursing Care in the Operating Room

FREQUENT SITES REQUIRING ESCHAROTOMY OR FASCIOTOMY

Figure 29-18  The locations of commonly used incisions for escharotomy and fasciotomy.
Inhalation Injury

- Responsible for 50% of all burn deaths
- Doubles burn mortality
- Present in 5-30% of all burn admissions
- Associated with increased fluid needs
## Incidence and Mortality of Inhalation Injury as Related to TBSA Burn

<table>
<thead>
<tr>
<th>% TBSA Burn</th>
<th>N</th>
<th>Inhalation</th>
<th>Mortality</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>No Inhalation</td>
</tr>
<tr>
<td>0 - 20</td>
<td>627</td>
<td>2%</td>
<td>1%</td>
</tr>
<tr>
<td>21 - 40</td>
<td>200</td>
<td>11%</td>
<td>2%</td>
</tr>
<tr>
<td>41 - 60</td>
<td>102</td>
<td>20%</td>
<td>18%</td>
</tr>
<tr>
<td>61 - 80</td>
<td>56</td>
<td>32%</td>
<td>24%</td>
</tr>
<tr>
<td>81-100</td>
<td>33</td>
<td>55%</td>
<td>47%</td>
</tr>
</tbody>
</table>
Assessment of Inhalation Injury

- **Predisposing Factors**
  - Closed space
  - Decreased mentation

- **Physical Examination**
  - Facial burns, singed hairs
  - Mucosal edema of nose and mouth
  - Carbonaceous sputum
  - Hoarseness, stridor (laryngeal)
  - Dyspnea, wheezing (small airway)

- **Diagnostic Tests**
  - ABG, CO-Hb
  - Fiberoptic Bronchoscopy
  - Xenon-131 lung scan
  - Chest X-ray
Smoke Inhalation Syndrome
Pathophysiology

- **Acute Functional Anemia**
  - C.O. has 200x greater affinity for Hb
  - Shifts Hb-O₂ curve to LEFT

- **Acute Airway Obstruction**
  - Laryngeal spasm and edema

- **Smoke Poisoning**
  - Compromised surfactant activity
  - Loss of ciliary action
  - Mucosal edema
  - Micro and macro atelectasis
Treatment of Inhalation Injury

- **Airway patency**
  - prophylactic intubation preferred
  - avoid tracheostomy

- **100% Oxygen**
  - half-life of CO-Hb is 30 min (4 hr on room air)

- Ventilatory support as needed

- **No steroids or prophylactic antibiotics**
Topical Antibacterial Therapy

- Silver Sulfadiazine
- Sulfamylon
- Silver Nitrate
Silver Sulfadiazine

- **Mode of action:** silver ion and sulfa
- **Biochemical changes:** none reported
- **Advantages:** painless
- **Disadvantages:** moderate penetration
- **Contraindications:** G-6-PD deficiency, newborns, pregnancy
Sulfamylon (5%)

- **Mode of action:** unknown

- **Biochemical changes:**
  - carbonic anhydrase inhibition

- **Advantages:**
  - active penetration
  - no resistance

- **Disadvantages:**
  - pain
  - metabolic acidosis
Silver Nitrate (0.5%)

- **Mode of action:** Silver ion

- **Biochemical changes:** hyponatremia, methemoglobinemia

- **Advantages:** painless, no resistance

- **Disadvantages:** poor penetration, staining, more nursing care
Other

- Bacitracin
- Neosporin
- Triple Ointment
Natural Course of the Burn Wound

Injury

Inadequate Perfusion

Demarcation

Separation of Dead Tissue

Regeneration of Connective Tissue and Vasculature

Epithelialization (2nd degree burn)

Granulation Tissue (3rd degree burn)
Management of Partial Thickness Wounds

- Debridement
- Topical Antimicrobials
- Non-adherent or Biological Dressings
- Spontaneous Re-epithelialization
- Reassess for Hypertrophic Scar
Early Burn Wound Excision

- **Advantages:**
  - Rapid wound closure
  - Prevent infection
  - Reduce hospitalization
  - Early mobilization and rehabilitation

- **Disadvantages:**
  - Major blood loss
  - Risk of technical failure
  - Need for surgical expertise
Clinical strategies for closing different-sized deep partial- and full-thickness burn injuries

**Small (<20% BSA*)**
- Excise burn
- Cover with autograft

**Medium (20%-35% BSA)**
- Excise burn
- Cover with available autograft

**Large (35%-70% BSA)**
- Excise burn
- Cover remainder of wound with artificial skin or allograft
  - For artificial skin, remove Silastic epidermis and cover with autograft as available (before Silastic has been in place for 50 days)

**Massive (>70% BSA)**
- Replace allograft with autograft when donor sites have regenerated (at approximately 14 days after injury)

For allograft, immunosuppress with antithymocyte globulin (Atgam) until donor sites have regenerated sufficiently to close all but 20% BSA; replace with autograft as available
Complications of Burns

- **Septic**
  - Invasive burn wound sepsis
  - Suppurative thrombophlebitis
  - Pneumonia

- **Gastrointestinal**
  - Ileus
  - Curling’s ulcer
Electrical Injury

- **True** (direct)
  - Entry and exit wounds
  - Damage to all deep tissues
  - Depth and extend usually underestimated

- **Arc**
  - Electric current leaps from conductor to skin
  - Temp of arc approx. 2500°C
  - Arcing of 1” per 20,000 volts

- **Flash**
  - Similar to thermal burns
Initial Management of Electrical Injuries

- **Airway**
- **Fluid replacement**
  - Fluid requirements may be underestimated
  - Maintain urine output above 1.0 ml/kg/hr
  - Follow EKG for transient arrhythmias
- **Wound Care**
  - Watch for vascular compromise
  - Early debridement in multiple stages
  - Bleeding precautions
Chemical Burns

- **Acid burns**
  - Eg. inorganic acids
  - Causes coagulation necrosis.
  - Treatment:
    - Remove clothing
    - Copious irrigation with water if liquid
      (brush away if powder)

- **Alkali Burns**
  - Eg. NaOH, lime, or ammonia
  - Treatment: same principles as for acids
  - Burns deeper due to fat saponification
LA_{50} for Burn Injuries: 1940-2003

Shriners Hospitals for Children • Shriners Burns Hospital • Cincinnati, Ohio

Percent TBSA Burn Associated with a 50% Mortality

- 1940: Penicillin
- 1950: Broad spectrum antibiotics
- 1960: Refinement of fluid therapy
- 1970: Specialized Burn Care Centers
- 1980: Aggressive nutrition
- 1993: Aggressive excision
- 2003: Permanent Skin Substitutes