Acute Burn Care

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Disclosure

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Objectives

• Discuss the nature and epidemiology of burn injuries
• Discuss emergent/urgent burn evaluation and management
• Discuss follow-up care and referral/transfer
• Discuss management of frostbite injuries
Skin Anatomy

- Epidermis
- Dermis
- Dermal Appendages
- Subcutaneous Tissue
Skin Function

- Protects from infection and injury
- Regulates body temperature
- Prevents loss of body fluids
- Sensory contact with environment
Burn Definition

- Burn: An injury to tissue usually caused by heat but also by abnormal cold, chemicals, poison gas, electricity, or lightning.
Burn Wound Zones

• Zone of Coagulation
  • Dead and stays dead regardless of Rx

• Zone of Stasis
  • Area of vessel contraction
  • Inflamed
  • Ischemic
  • ± viable depending on care

• Zone of Hyperemia
  • Vessel dilatation
  • Capillary permeability
  • Viable with good care and no infection
Burn Depth

- Four categories
  - First Degree
  - Second Degree
  - Third Degree
  - Fourth Degree
First Degree Burn
(Superficial)

- “Sunburn” injury
- Epidermis only
- No scarring
- No disfigurement
Second Degree Burn (Partial-Thickness)

- Entire epidermis and part of dermis
- Pink and blistered
- Most painful
- Heals in 2-3 weeks
  - Dermal Appendages
- Pigmentation changes
- Minimal scarring
- +/- skin grafting
Third Degree Burn (Full-Thickness)

- Entire dermis and epidermis
- White, dry appearance
- Coagulated vessels
- Scarring and disfigurement
- Heals by contracture
- Skin grafting indicated
Fourth Degree Burn (Deep Full-Thickness)

• Burn into underlying structure
• Often charred
• Disfigurement
• Disability
Epidemiology

- Incidence
  - 1.25 Million injuries / year
  - 450,000 patients seek treatment per year
  - 40,000 patients hospitalized annually
  - 3,400 deaths from burn injuries
  - 96.1% overall survival rate
Epidemiology

• Demographics
  • Gender
    • 69% Male
    • 31% Female
  • Ethnicity
    • 59% Caucasian
    • 19% African-American
    • 15% Hispanic
    • 7% Other
Epidemiology

- Injury Types
  - 44% fire/flame
  - 33% scald
  - 9% contact
  - 4% electrical
  - 3% chemical
  - 7% other
Epidemiology

- Location
  - 69% Home
    - Kitchen
  - 9% Occupational
  - 7% Street/Hwy
  - 5% Recreational/Sport
  - 10% Other
Survival

- 96.1% Survival
- Lethal Dose – $50$ (LD$_{50}$)
  - 49% Total Body Surface Area (TBSA) in 1950’s
  - 90 – 95% TBSA today
- 75% of non-survivors perish at the scene
  - Majority are structural fires
High Risk Groups

- Children
  - Heavy and light-for-age groups overrepresented
  - Scald injuries most common
- Elderly
  - Flame injuries most common
  - Pre-existing conditions
High Risk Groups

- Disabled
  - Scalds most common
  - Functional limitations
- Socio-economic status
  - Minority children 3x death rate in house fires
  - Racial differences fade as income increases
High Risk Groups

• Chemical intoxication
  • Risk-taking behavior
  • Impaired responsiveness
  • 40% of house fire deaths
Objectives

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- Discuss management of frostbite injuries
Emergent Management

- Stop the burning process
- Initial resuscitation flows just like trauma
  - Airway
  - Breathing
  - Circulation
  - Disability
  - Exposure
  - Fluids
Airway/Breathing

- Inhalation Injury
  - Not direct thermal injury
    - Except steam
  - Toxic smoke molecules
    - CO, Cyanide, HCl, Phosgene, NH3, Sulfur dioxide, Acrolein, Formaldehyde, Isocyanate
    - Acrylonitriles
    - Synergy of CO and CN. Also CO and H2S
- Asphyxiation
Airway/Breathing

- Inhalation injury airway pathology
  - Increased mucous secretion
  - Impaired ciliary clearance
  - Proteinaceous exudate
  - Mucosal sloughing
  - Bleeding
  - Casting, obstruction, ball-valve
  - Increases mortality 20-50%
- ALI/ARDS
Airway/Breathing

• Smoke Inhalation
Inhalation Injury

- Carbon Monoxide (CO) poisoning
  - 200x > affinity for Hgb than O₂
  - SpO₂ abnormally elevated (normal on monitor)
  - Half life
    - Room air: 250 mins
    - 100% FiO₂: 40-60 mins
    - 3 atm HBO: 30 mins
## CO Poisoning

<table>
<thead>
<tr>
<th>COHb Saturation (%)</th>
<th>Symptoms</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-9%</td>
<td>None</td>
</tr>
<tr>
<td>10-20%</td>
<td>Headache, vasodilation</td>
</tr>
<tr>
<td>20-30%</td>
<td>Headache, pulsating temples</td>
</tr>
<tr>
<td>30-40%</td>
<td>Severe Headache, nausea/vomiting, weakened sight, prostration</td>
</tr>
<tr>
<td>40-50%</td>
<td>As above, increased RR and HR, Asphyxiation</td>
</tr>
<tr>
<td>50-60%</td>
<td>As above, Coma, Seizure, Cheyne-Stoke breathing</td>
</tr>
<tr>
<td>&gt; 60%</td>
<td>Coma, Seizure, cardiopulmonary collapse, death</td>
</tr>
</tbody>
</table>
Inhalation Injury

- Cyanide (CN) poisoning
  - Commonly produced by synthetic compounds
  - Binds to cytochrome oxidase
    - Blocks cellular respiration
    - Synergy with CO
  - Effects within seconds of inhalation
  - Persistent acidosis
  - Hydroxycobalaminine (B12 precursor) 5 mg IV x1
Inhalation Injury

- **Diagnosis**
  - History
    - Enclosed environment
    - Escape impeded
    - Loss of consciousness
  - Exam
    - Hoarseness or voice change
    - Barking cough
    - Sooty airways, carbonaceous sputum
    - Burns inside mouth
Inhalation Injury

- Airway management (if indicated)
  - SECURE!!
- Protective vent settings
- Pulmonary toilet
- Inhaled medications
  - Bronchodilators
  - Heparin
  - Acetylcysteine
- Treatment of CO and CN poisoning
  - 100% FiO2
  - HBO treatment
  - Cyanide antidote (hydroxycobalamin)
- Percussive ventilation
- ECMO
Airway/Breathing

• Indications for Intubation
  • Hoarseness, voice change
  • Stridor
  • Large TBSA burn (>50%)
  • Extensive facial burns
  • Burns inside mouth
  • Significant burn edema
  • Signs of obstruction
  • Difficulty swallowing
  • Using accessory muscles
  • Inability to handle secretions
  • Respiratory fatigue
  • Poor oxygenation/ventilation
  • Very large doses of narcotics
  • Impaired level of consciousness, not protecting
  • NOT singed nasal hairs
Emergent Management

- Cool the burned tissue
  - Not ice!
  - 3-5 minutes in cool water
  - Smaller wounds
- Estimate severity of wounds
  - Quantifiable
  - Guides resuscitation
Emergent Management

• “Rule of Nines”
Emergent Management

- Method of Lund and Browder
Burn Shock

- Invariably seen if >33% TBSA
  - Treatment threshold ~20%
  - Age dependent
- Systemic edema possible at 10% TBSA
- Combined shock state
Burn Shock

- Hypovolemia (burn edema)
  - Altered Starling variables
  - Altered capillary permeability
- Decreased cardiac output
  - Preload reduction
  - Decreased contractility
  - Increased afterload
- Later SIRS transition
Fluid Resuscitation

- Vascular access
  - Large bore IVs
  - CVC for larger burns
  - Through injured tissue
  - SECURED
Fluid Resuscitation

- Restore intravascular volume
  - Hours to days
  - Judicious
  - Support end organ perfusion
  - Avoid compartment syndromes
- Formulas
  - Crystalloid (Parkland, Mod Brooke)
  - Colloid (Evans, Slater)
  - Hypertonic (Warden, Demling)

- NO BOLUS THERAPY!!!
Fluid Resuscitation

Soaker hose analogy
Fluid Resuscitation

• Initial fluid resuscitation rates:
  • 5 years old and younger – LR @ 125 ml/hr
  • 6-14 years old – LR @ 250 ml/hr
  • 15 years and older – LR @ 500 ml/hr
  • Royally messed up – LR @ 750 ml/hr

• Ongoing resuscitation
  • Adults: 2 mL/kg/% TBSA over first 24 hours
  • Children: 3 mL/kg/% TBSA over first 24 hours
  • Rhabdo/Electrical: 4 mL/kg/% TBSA over first 24 hours

• No Bolus therapy!!
Fluid Resuscitation

- Over resuscitation → Compartment Syndrome → Death
Emergent Management

- Foley catheter
- NGT decompression
- Maintain body temp
- Secondary survey
- Trauma evaluation
- Simple, sterile dressings
Emergent Management

- Compartment syndromes
  - The “Five P’s”
  - 30 mmHg or greater
  - Repeated measurement
  - Escharotomy
    - Full-thickness
    - Circumferential
  - Fasciotomy
    - Over-resuscitation
    - Failing resuscitation
    - Electrical injury
Emergent Management

- Escharotomy most common early intervention
Emergent Management

- Special Circumstances
  - High voltage
    - Trauma
    - Compartment syndrome
    - Rhabdomyolysis
    - Cataracts
  - Lightning
    - Cataracts
    - Cardiac monitoring?
Emergent Management

- Special circumstances
  - Chemical Injury
    - Brush off dry chemical
    - Irrigate 30 minutes
    - No acid/base reversal
  - Hydrofluoric acid
    - Topical calcium
    - Systemic calcium
    - Intra-arterial calcium
    - Amputation??
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• Discuss follow-up care and referral/transfer
• Discuss management of frostbite injuries
Referral Criteria

- > 10% TBSA
- Face, hands, feet, genitals, perineum, major joints
- Third degree
- Electrical, including lightning
- Chemical burns
- Inhalation injury
- Pre-existing conditions
- Concomitant trauma
- Pediatrics
- Special social, emotional, rehab needs
Prep for Transfer

- SECURE all lines/tubes
- Dry sterile covering to wounds
- Imaging and labs
- Tetanus booster
- Continuous IV fluids
  - < 5 yo: 125 mL/hr
  - 6-14 yo: 250 mL/hr
  - 15 yo and up: 500 mL/hr
  - Messed up adults: 750 mL/hr
- Air vs. ground
- May admit directly to Burn Center vs ED
Prep for Clinic

- Bacitracin/Adaptic (B&A) dressings
  - Silvadene alters wound appearance, pseudoeschar
  - SSD OK for deep or possibly infected wounds
- Supplies to change daily
- Pain medication
- Tetanus booster
- Call or provide clinic number 612-873-2912
- Seen within a week (usually < 72 hrs)
  - Partial-thickness seen every 7-10 days
  - Indeterminate thickness evaluated for 2-3 weeks
  - Full-thickness scheduled for OR
Acute Burn Care

- Burn wound management
  - Local wound care
  - Skin grafting
  - Excision and closure
  - Advanced reconstruction
    - Tissue flaps
    - Tissue expansion
Burn Dressings

- Bacitracin
- Adaptic
- Mepitel
- Kerlex Gauze
- Stockinette
- Coban
Burn Dressings

Acticoat & Acticoat Flex

Mepitel

Mepilex Ag Transfer

Mepilex Ag
Epithelialization

- Partial thickness wounds
  - epidermal appendages
    - sweat ducts
    - hair follicles
- Full thickness wounds
  - Epithelial migration
    - 1 mm/day
  - Contraction
    - Quarter-sized wounds
  - Surgery
Contraction vs. Contracture

- Fibroblasts convert to myofibroblasts
- surrounding skin pulled inward
- open wounds shrink closed
- advantage
  - sensate skin
- disadvantage
  - contracture
Skin Grafting

- Burn wound is excised
- +/- temporary coverage
- Donor skin harvested
- Graft applied to burn wound
- Ironclad postop dressing
Skin Grafting

- Sheet graft vs. meshed graft
Skin Grafting

- Large burns
  - Multiple OR trips
    - Early excision
    - Donor sites
  - Temporary coverage
    - Porcine xenograft
    - Human allograft
    - Integra
- Early postoperative period
  - Secure dressing
  - Immobilization
  - 5-7 day dressing change
Recovery/Healing

• Average stay ~7 days
• Large burns may stay months
• Multidisciplinary team
  • Physical therapy
  • Occupational therapy
  • Nutritionist
  • Trauma psychology
  • Chaplaincy
  • Pharmacy
  • Speech Pathology
  • Residents
  • Physician assistants
  • Nursing
  • And more…
Suspected Abuse Cases

- History, exam don’t match
- Stereotypical exam findings
  - Dip line
  - Flexor, plantar sparing
  - Absent splash marks
  - Perineal, genital, buttock
  - Other injuries
- Increasing elder abuse
- Transfer via EMS
  - Even minor burns
- Child maltreatment team, CPS evaluations
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• Discuss the nature and epidemiology of burn injuries
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Frostbite/Frostnip

- Average of ~25 severe frostbite admissions per year (many more minor cases)
- Incidence increased dramatically approaching 0°F
Frostnip

- Pain
- Pallor
- Numbness
  - Completely reversible with warming
  - No resulting tissue loss
Frostbite

- Mechanism of injury
  1. Direct freezing of the tissues
  2. Reperfusion injury, thrombosis
Frostbite

- Initially may present:
  - Hard
  - Cold
  - White
  - Numb
  - Clumsy
Frostbite

- Following thawing
  - Mottled
  - Dark or bright red
  - Can be extremely painful

- Blistering
  - Appear over hours to days
  - Character will change after 12-24 hours
Frostbite Classification

1\textsuperscript{st} Degree
- Hyperemia/edema
- Non-blistered

2\textsuperscript{nd} Degree
- Large clear blisters
- Partial thickness skin necrosis

3\textsuperscript{rd} Degree
- Hemorrhagic blisters -> dark eschar
- Full-thickness & subcutaneous skin loss

4\textsuperscript{th} Degree
- Full-thickness skin necrosis involving bone, tendon or muscle
Frostbite Management

- Do not begin rewarming in the field
  - Unless ability to keep thawed is certain
- Rapid rewarming
  - 40°C for 30-45 min.
- Mechanical protection
- Update tetanus
- Analgesia
Frostbite Management

- Thrombolytics if indicated
- Scheduled Ibuprofen & Neurontin
- Wound care
  - Blisters
  - Aloe Vera/Dermaide
  - Bed for the first 24-72 hours
- PT, OT, Nutrition
- Manage withdrawal, chem dep
Thrombolytics

- No perfusion after warming
- Positive bone scan
- Alteplase IV
  - 0.15 mg/kg load
  - 0.15 mg/kg/hr for six hours
- Lovenox x 7 days
- Repeat bone scan at 24 hours
Frostbite Management

- Local wound care during demarcation
- Long demarcation period
  - “Frostbite in January, amputate in June”
- Skin grafting and/or amputation if indicated
- Prosthetic management
  - Preop prosthetist consultation
- Chronic pain management
- OT/PT
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Advanced Burn Life Support (ABLS)

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Questions??

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