Pediatric Burn Injuries in the Developing World

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Learning objectives

1. Overview of the impact of pediatric burns in the developing world
2. Describe the primary factors contributing to burn prevalence
3. Understand consequences of burns
4. Describe management of burns in the pediatric population
5. Understand barriers to burn care
6. Overview of burn prevention
Major Topics in this Module

- Burn epidemiology
- Burn sequela
- Factors increasing risk of burns
- Burn management
- Barriers to care
- Burn Prevention
Global Epidemiology of Pediatric Burns
Burns: A global burden

• Incidence
  – Global incidence (all ages): 1.1 per 100,000
  – Incidence varies by geographic location, socio-economic status, ethnic group, age and sex
    • 90% of burns occur in LMIC (low & middle income countries)
    • The highest incidence is in southeast Asia

Global distribution of fire-related burns

Sources: Peden, 2002.
Impact of burns on the pediatric population

• Incidence is increasing among pediatric patients
  – Highest in Africa (>96,000 children hospitalized / yr)
  – Children <5 years old are at greatest risk
    • In Ghana, 6.1% prevalence in children 0-5 yo
    • In India, children 0-5 yo account for 50% of all children burns

Impact of burns on the pediatric population

- Incidence can vary greatly by race and ethnicity even within a region:
  - In South Africa, children of African descent have a burn rate of 4.5 per 100,000 compared to 0.3 for white children
  - Disparities in the US:
    - Burn admission rates are 7.7 x higher for African American (AA) than white children
    - AA and Native American children are 2 and 3 times as likely to die in fires than white children

Mortality associated with burns

- 95% of burn deaths occur in LMIC
- Mortality rate among LIC is 11x higher than in HIC
- Children under 5 and the elderly have the highest burn mortality worldwide
  - Fire-related mortality rate in Africa for children under 5 is 32.9 per 100,000
- 6th leading cause of death among 5-14 yo worldwide
- More girls age 5-14 die from burns than TB, HIV/AIDS and malaria combined in Southeast Asia
- Incidence varies dramatically by region and age

What Places Children at Risk?:
Causal and Contributing Factors
Causes of burns

• Causes:
  – Flame burns 57%
  – Scalding 32%
  – Chemical burns 7%
  – Though %s vary by region

Sources: Sowemimo, 1993
Contributing factors: Socio-economics

• Poverty in and of itself is a major risk factor
  – Children from low income homes have 8x greater risk of sustaining burns than those from higher income homes
  – Severity of burns increases with decreasing socioeconomic status (SES)
  – Burn mortality is higher among children from lower SES

Contributing factors: Living conditions

- Children are naturally curious, impulsive and active… increasing risk of burns
- Flammable and caustic substances stored in the home
- Heating with indoor fires
- Cooking practices:
  - 2 billion people worldwide cook with open flames or unsafe traditional stoves
- Flammable clothing

Source: Mock, 2008.
Additional contributing factors linked with living conditions

- Homes made of highly combustable materials
  - Between 2002-2004, 138,000 dwellings were destroyed by fire in South Africa
- Lack of adult supervision
- Overcrowding

Source: Mock, 2008.
Contributing factors: Medical conditions

• Epilepsy
  – Increased risk of a fall
  – Traditional medicine practices, for example the deliberate burning of feet to “rouse the child from…convulsive state”

• Conditions leading to febrile seizures (pneumonia, meningitis gastroenteritis and TB

Child Abuse

- Burns account for 10% of all cases of child abuse
- Majority of victims are < 2 years of age
- Scalding is the most common cause

When to suspect abuse

- Burns to:
  - Perineum
  - Ankles
  - Wrists
  - Palms
  - Soles

- Burns with clean line of demarcation
- Presence of older injuries
- Contradictory accounts of “accident”
- Delays in seeking treatment

Gender violence

• Acid throwing:
  – Most commonly occurs in Cambodia, India, Bangladesh, Afghanistan
  – Majority of acid throwing victims are women
  – Many are under 18
  – Every week >10 females in Bangladesh are victims of acid attacks

• An estimated 4-5 women per day die in bride burings or “kitchen-fires” in India

Burn Sequelae
Consequences of burns

• Disfigurement
• Contractures
  – Lead to severe disability in many cases
• Emotional damage/sequelae
• Delay in reaching developmental milestones and educational development
• Death

Image source: Katrine Løfberg
Burn Management 101
# Burn classification

<table>
<thead>
<tr>
<th>Current Nomenclature</th>
<th>Previous Nomenclature</th>
<th>Depth</th>
<th>Clinical Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Superficial thickness</td>
<td>1&lt;sup&gt;st&lt;/sup&gt; degree</td>
<td>Epidermis</td>
<td>Erythema, significant pain, no blisters</td>
</tr>
<tr>
<td>Partial thickness - superficial</td>
<td>2&lt;sup&gt;nd&lt;/sup&gt; degree</td>
<td>Superficial (papillary) dermis</td>
<td>Blisters, clear fluid, and pain</td>
</tr>
<tr>
<td>Partial thickness - deep</td>
<td>2&lt;sup&gt;nd&lt;/sup&gt; degree</td>
<td>Deep (reticular) dermis</td>
<td>Whiter appearance or fixed red staining (no blanching), reduced sensation</td>
</tr>
<tr>
<td>Full thickness</td>
<td>3&lt;sup&gt;rd&lt;/sup&gt; degree</td>
<td>Epidermis, dermis, and complete destruction to subcutaneous fat, and/or muscle and bone, eschar formation</td>
<td>Dry, charred or leathery, thrombosed blood vessels, insensate</td>
</tr>
</tbody>
</table>
Burn classification

Image source: rush.edu
Calculating ‘total burn surface area’ (TBSA)

- Key in assessing severity of burn
- All three depths can be present in same burn wound
- Burn depth can increase with time
- Morbidity and mortality increase with greater burn surface area
  - In developing countries mortality is nearly 100% for burns >40% TBSA
  - In the US, >50% mortality is not reached until TBSA >90%

Image source: www.traumaburn.org
Burns requiring hospitalization

- Greater than 10% total body surface area (TBSA) in children
- Any burn in the very young
- Full thickness burns
- Burns to the face, hands, feet or perineum
- Circumferential burns
- Inhalation injuries

Immediate post-burn care

• Remember your ABCs:
  – Airway
  – Breathing
  – Circulation
• Intubate and mechanically ventilate if you suspect inhalation injury
• Quickly establish IV access (ideally 2 large bore IVs)
• Evaluate for compartment syndrome, particularly with circumfrential burns
Evaluate for inhalation injury

- Can occur without skin burns
- Look for:
  - Singed facial hairs
  - Edema of nose, mouth, pharynx and larynx
  - Carbonaceous sputum
  - Hoarseness
  - Stridor

Image source: Megahed, 2008
Fluid resuscitation

• Fluid is key for:
  – Restoring adequate intravascular volume to prevent hypotension and shock
  – Correcting electrolyte abnormalities
  – Minimize renal insufficiency
• If burns >15%:
  – Massive fluid shifts will likely occur due to systemic inflammatory response syndrome (SIRS)
  – Fluid needs will be greater than anticipated based on appearance of burn alone

Source: Schulman, 2008.
Initial fluid resuscitation for burns >15%

• Parkland formula:
  – 3-4 ml x kg x % total burn surface area (TBSA)
    • ½ in first 8 hours
    • Remaining in next 16 hours
• Galveston Shriner’s formula
  – 5000 mL/m² TBSA burn + 2000 mL/m² body surface area (BSA)

Initial fluid resuscitation, cont.

- Fluid: Lactate Ringer
  - plus 12.5 g 25% albumin per L
  - plus D5W as needed for hypoglycemia
- Remember to monitor glucose levels
  - Glycogen stores of children <5 yo run out quickly
- Inhalation injury increases fluid requirements by 1.1 ml/kg/% TBSA
- Goal of fluid resuscitation → Adequate urine output (>1 ml/kg/hr)

Immediate post-burn wound care

- Tetanus prophylaxis
- Debride all bullae and necrotic tissue
- Cleanse with mild water-based antiseptic (ex: Chlorhexidine)
- Apply thin layer antibiotic cream
- Dress with petroleum gauze and dry gauze
Wound care:

- Goals:
  - Fast healing
  - Prevention of infection
- Daily or twice daily dressing changes
- Daily application topical antibiotic
- Excision and grafting of burn wound within 2-3 days post-injury
  - Decrease in resting energy expenditure
  - Decrease in infection rates

Infections

• Wounds are initially sterile but quickly colonize with endogenous then exogenous microbes
• Indicators of infection:
  – Wound discoloration or hemorrhage
  – Cellulitis
  – Fever and WBC are not reliable signs of infection

Infections

- Most common causes:
  - Pseudomonas aeruginosa
  - Staphylococcus aureus
- Resistance is increasing worldwide
  - In one Indian tertiary hospital, 16% of patients had multidrug-resistant strains of pseudomonas
  - 61% of pseudomonal infections in a level 1 trauma center in Tehran, Iran, were resistant to *imipenem* (one of the most effective treatments for pseudomonas)

Populations most at risk for infections

• Children
• Immunocompromised patients
  – HIV+
  – Burns >30% TBSA
• Patients with diabetes
• Malnourished patients

Sources: Rafla, 2011.
Dressings

- Topical antibiotic:
  - Silver nitrate
    - Cheap
    - Does not penetrate eschar
    - Depletes electrolytes
  - Silver sulfadiazine
    - Some penetration of eschar
    - Risk of neutropenia
  - Mafenide acetate
    - Penetrates eschar
    - Risk of developing acidosis

Nutrition

• Burns lead to increased metabolic demands and energy requirements
  – For burns >40%, resting metabolic rate increases up to 200%
  – Primarily protein catabolism
    • Protein requirement increased to 2.0 g/kg/day
• Many children in LMIC countries will present to the hospital already malnourished
• Without adequate nutrition wound healing will not occur

Nutrition

• Goal: Loss of less than 10% of preinjury weight
  – Patients should be weighed daily
• Enteral feeds are superior to parenteral
  – Feed child orally if possible
  – Otherwise place nasogastric feeding tube

Contracture prevention and treatment

• Contractures cause significant disability, especially when they develop over joints
• Splinting is critical
• Surgical contracture release can improve mobility


Image source: Katrine Løfberg
Obstacles to treatment

• Lack of facilities for:
  – Initial treatment
  – Reconstruction
  – Rehabilitation
Lack of medical resources

• Hospitals:
  – There are few burn centers in developing world
    • Most are in large cities and inaccessible to the majority of the population
    • Many lack the basic medical supplies needed to treat burns
  – Few medical staff are trained in burn care
Barriers to Care

- Family
  - Inability to afford taking time off from work
  - Lack of funds for transport
  - Other children in need of supervision and limited family resources
Burn Prevention

- Interventions need to be tailored to and suitable for region taking into account social, cultural, political and economic milieu of a country
- Educational campaigns
- Safer cooking
- Hot water heaters
- Fire retardant clothing
Preventing the preventable:

• Building capacity for and increasing access to burn treatment is important, BUT burns are preventable injuries! Therefore, prevention is essential.

• Legislation and interventions that have helped reduce risk of burns in high-income countries:
  – Promoting smoke detectors and interior sprinklers
  – Setting hot water heater thermostat to 120° F (48° C) or lower
  – Increased safety requirements for household appliances
  – Availability of flame retardant clothing

Preventing the preventable: Low-resource settings

- Educational campaigns:
  - Recognizing burn hazards:
    - Children playing around open flames
    - Unattended hot liquids
    - Unattended kerosene heaters
  - School burn prevention programs such as the one offered in rural Malawi by the Africa Burn Relief Program (www.africaburnrelief.org)
  - Community education programs such as the one conducted by Schwebel et al., in South Africa focused on safe use of kerosene in the home
Preventing the preventable: Low-resource settings

• Hazard reduction and environmental modification:
  – Stable, raised cooking surfaces
  – Use of playpens or barriers to separate cooking area from play areas
  – Safe storage of fuel in well-marked, child-proof containers

Summary

• Burns account for a significant proportion of pediatric morbidity and mortality worldwide, particularly in LICs
• Majority of burns are due to fire or scalding, often related to cooking practices
• Initial evaluation should always include an assessment for child abuse
• Appropriate burn care, in a tertiary hospital if needed, can dramatically decrease deaths and lifelong disabilities
Summary continued

• Lack of medical resources and financial strain on families are primary obstacles to treatment

• Ultimately, the key to decreasing morbidity and mortality associated with burns is prevention via…
  – Educational campaigns
  – Legislative changes
  – Hazard reduction and environmental modification
References


References

References


References


References

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References


Credits

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