Thermal Injuries

Manika Bhandari, Malika Bhola, Rucha Desai, Dhruvika Joshi, Abir Shamim
Life Science 4M03
INTRODUCTION
Anatomy of the skin

- The skin has three anatomical layers
  - Epidermis
  - Dermis
  - Subcutaneous tissue

- When the skin is damaged, the epidermal cells regenerate from cells deep within the dermal appendages

http://www.hopkinsmedicine.org/healthlibrary/conditions/dermatology/burns_85.P01146/

(Lloyd, 2012)
What is a burn and how does it occur?

- The International Society of Burn Injuries:
  - An injury to the skin or other organic tissue that is primarily caused by thermal or other acute trauma

- Some or all cells in skin and other tissues destroyed by:
  - Hot liquids (scalds)
  - Hot solids (contact burns)
  - Flames (flame burns)

(Anandani, 2010)
Epidemiology
Burns: A Global Burden

- Fourth most common type of trauma worldwide
- 265,000 deaths occur each year
- 96% of fatal deaths in LMIC
- Highest incidence in southeast Asia
Global distribution of fire-related burns

(Peden, 2002)
RISK FACTORS
## Table 2 - Relative impact of risk factors on burn injury incidence

<table>
<thead>
<tr>
<th>Risk factor</th>
<th>HICs</th>
<th>LMICs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poverty</td>
<td>+++</td>
<td>+++ More prevalent</td>
</tr>
<tr>
<td>Education</td>
<td>++</td>
<td>± High immolation rate associated with higher education</td>
</tr>
<tr>
<td>Ethnicity</td>
<td>–</td>
<td>Association of ethnicity to poverty, low education, and certain cultural habits is the major factor of higher risks</td>
</tr>
<tr>
<td>Family patterns</td>
<td>+</td>
<td>±</td>
</tr>
<tr>
<td>Type of residence</td>
<td>+++</td>
<td>+++ More prevalent</td>
</tr>
</tbody>
</table>

Invariably, components of low socio-economic status are associated with higher burn injury risk. (+++) High impact, (++) moderate impact, (+) low impact, (±) equivocal impact, (–) no impact.

(Bishara, 2009)
PATHOPHYSIOLOGY
Forms of Response

The body responds to a burn injury in two ways:

1. Local Response (tissue damage)
2. Systemic Response (organ systems affected)

(DeSanti, 2005)
Local Response: Three Zones of a Burn

Jackson’s Thermal Wound Theory

- **Zone of Coagulation**
  - Central
  - Max/irreversible damage
  - Coagulation of constituent proteins
- **Zone of Stasis:**
  - Decreased tissue perfusion (flow of blood)
  - Tissue here can be salvaged
- **Zone of Hyperemia**
  - Peripheral area of the burn
  - Increased flow of blood
  - Decreased cell injury
  - Generally recovers

Systemic Response

- Activated once the burn reaches 30% of total body surface area
- Inflammation and cytokine release initiated; peaks 5 to 7 days after
- Acute/Resuscitative Phase (48 hrs)
- Hypermetabolic Phase (>48 hrs)

(Cakir, 2004)
<table>
<thead>
<tr>
<th>Type</th>
<th>Response</th>
</tr>
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</table>
| Cardiovascular | ● ↓ blood flow to tissues and organs  
● ↑ capillary permeability (fluid and protein loss), internal temperature, water permeability, blood flow to tissues/organs  
● Edema formation |
| Pulmonary     | ● Lung inflammation  
● Respiratory difficulties from inhaling smoke  
● Bronchial obstruction and airway resistance  
● Altered capillary permeability |
| Renal         | ● ↓renal blood flow, GFR  
● ↑ levels of stress hormones  
● Acute renal failure → mortality |
| Gastrointestinal | ● ↓nutrient absorption, DNA synthesis in small intestine  
● ↑ ulcer incidence, gastric secretions |
| Immune        | ● Immunosuppressed state and release pro-inflammatory factors  
● Microbial invasion in damaged skin  
● ↓ lines of defense, phagocytic activity, T-cell functioning  
● ↑ neutrophil accumulation increases, macrophage hyperactivity, reactive nitrogen intermediates  
● Susceptibility to sepsis  
● Multiple organ failure |

Types of Burns

RADIATION BURNS

ELECTRICAL BURNS

THERMAL BURNS

CHEMICAL BURNS

http://www.clipartpanda.com/categories/sunburn-clipart
http://www.clipartpanda.com/categories/electr shock-clipart
http://www.123rf.com/photo_10560214_illustration-of-a-kid-b siling-water.html

(John Hopkins Medicine, 2007)
Classification of Burns

First Degree
- Epidermis (outer layer)
- Dry and red
- Eg. sunburn

Second Degree
- Epidermis and dermis layers
- Red, blistered and swollen
- Eg. Burn from scalding hot water

Third Degree
- Fully penetrate the epidermis and dermis layers and subcutaneous
- White or charred
- No sensations of pain - nerves destroyed
- Eg. flame burn from a fire

http://www.burninjuryfirm.com/burn-injury-classification/

(John Hopkins Medicine, 2007)
ASSESSMENT AND DIAGNOSIS
Assessment

- Conduct a thorough patient evaluation

Primary Survey

- A = airway
- B = breathing
- C = circulation
- D = disability
- E = exposure
- F = fluid resuscitation

Secondary Survey

- Head-to-Toe examination
- Size, depth and circumference
- Tetanus shot for more than first degree burn

(Alharbi et al, 2012)
Assessment

Rule of Nines

- Adult: 15% surface area burn
- Children: 10% surface area burn
- Any burn in very young, elderly are at higher risk

(Lloyd et al., 2012) (WHO, 2007)
Referral to Burn Centers

A patient needs to be admitted to a specialized burn centre if:

- Partial thickness burns greater than 10% TBSA
- Electrical burns, including lightning injury.
- Inhalation injury.
- Burn injury in a patient with preexisting medical disorders.

(Alharbi et al, 2012)
MANAGEMENT

Objective: Rapid Healing, Pain Control, Return to Full Function, Aesthetics
Initial Management of Burns

(Lloyd et al., 2012)

(WHO, 2007)
Initial Management of Burns

Superficial Burn

- Topical non steroidal anti-inflammatory drugs and aloe vera reduce pain
- Lotion, honey, aloe vera or antibiotic ointment

(Lloyd, 2012)
Partial Thickness Burn

- Topical antimicrobial agent
  - Alternate occlusive dressing
  - Silver sulfadiazine (Ag-SD)

http://www.webmd.com/drugs/2/drug-13530/silver-sulfadiazine-topical/details
Long Term Management of Burns

- Scars undergo maturation
- Facial burns
- Infections
- Skin graft
  - Depth and thickness of burn

(Enoch, Roshan & Shah, 2009)
(Lloyd et al., 2012)
(WHO, 2007)
Pediatric Burn Management

- Burns scars do not expand and keep pace with child growth
  - Lead to contractures
  - Early surgical release of contracture recommended

- Burn prevention focused on children
  - Scalding
  - Flame related injuries

Table 1. Burn Prevention in Children

<table>
<thead>
<tr>
<th>Safety Measure</th>
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<tbody>
<tr>
<td>Always test bathwater³</td>
</tr>
<tr>
<td>Check household smoke alarms regularly⁴</td>
</tr>
<tr>
<td>Cook on the back burners of the stove when children are present³</td>
</tr>
<tr>
<td>Do not leave a child unattended in the bathtub or near water faucets³</td>
</tr>
<tr>
<td>Do not leave a child unattended near a fireplace⁹</td>
</tr>
<tr>
<td>Keep matches, firecrackers, gasoline, and other explosives out of reach of children³</td>
</tr>
<tr>
<td>Never hold a child when working with or around hot objects³</td>
</tr>
<tr>
<td>Set household water heaters to less than 120°F (48.9°C)³</td>
</tr>
<tr>
<td>Supervise children carefully while an exercise treadmill is in use³</td>
</tr>
</tbody>
</table>

*Information from references 3, 8, and 9.*

(Lloyd et al., 2012)
(PO, 2007)
PREVENTION
Conclusion

Prevention is a primary means for reducing burn related deaths and disabilities.

http://technotes.alconox.com/detergents/liquinox/cleaners-water-labs-w-heavy-metals/

http://www.asbestosandfiresafety.com/asbestos-gallery.html

http://www.uberizmo.com/2015/05/novartis-robotic-pills-diabetes/
References


Questions

What absorptive dressing is most frequently used to deal with partial thickness burns?

1. Silver nitrate
2. Iodine solution
3. Silver sulfadiazine
4. Mafenide acetate
5. Cerium nitrate

Which of these are not a zone of burn, as described by Jackson’s Wound Theory?

A. Zone of Coagulation
B. Zone of Inflammation
C. Zone of Stasis
D. Zone of Hypoemia
E. Zone of Hyperemia

i. A, C, D
ii. A, C, E
iii. A, B
iv. B, D
v. C