Case Report: Burns
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History

- 3 yo boy, presents to pediatric ED with mother
- Child can be heard crying inside waiting/patient room, has both hands bandaged and wrapped
- According to mother, unwitnessed event but child likely grabbed grates on an old wood burning stove.
- Child immediately screamed out, parents grabbed him, and flushed hands under cool water.
- Wrapped child’s hands in towels and brought to ED
- No other injuries noted
Case cont’d

- PMHx: Had orchidopexy for an undescended testicle at 15 months of age, otherwise healthy.
- Meds: None
- Allergies: Penicillin – Rash
- Immunizations: UTD
- Development: All normal for fine motor, gross motor, and speech
Vitals

- Temp: 36.4
- HR: 154
- RR: 28
- O2: 99% on RA
- BP: 96/52
- Weight: 14.5 kg
- Glucose: Not Done
Physical Exam

- **H+N**: Normal, no obvious burns or singe to oropharynx or nares
- **Cardiac**: N S1S2, no murmurs noted
- **Resp**: AE=AE, no wheeze, no stridor, no obvious increased work of breathing
- **Abdo**: Soft, non tender with N bowel sounds
- **Hands** look as follows......
Hand exam

- CR: 1-2 seconds in all digits
- Radial pulses: N
- Still moving all fingers and wrists
- Mom able to convince child to give a thumbs up
Disposition

- Child’s hands covered in ointment containing lidocaine/tetracaine + vaseline
- Wrapped in gauze, mother advised to change daily with daily application of ointment
- Given follow up appointment with plastics because of location of burn
- Child happy and eating popsicle on way out of the department.
Introduction to Burns

- Relatively common injuries caused by direct or indirect contact with heat, electrical current, radiation, or chemical agents

- With thermal burns, the severity of injury is dependent on length of exposure, the temp, and the intrinsic tissue structure leading to heat conductivity

- Common denominator in burn injuries is protein denaturation and cell death (either by necrosis or apoptosis)
Epidemiology

- In the U.S. there are approx 450,000 medical visits per year related to burns, with 3,500 deaths and 45,000 admissions.

- The majority of burns occur from fire or flame (44%), scalds (33%), contact with hot objects (9%), electricity (4%), or chemical agents (3%)

- More than 1/3 of admissions have >10% TBSA affected. Other admission typically involve severe burns to vital areas such as the hands, face, or feet, or there has been other trauma involved

- Half of patients are between 19 and 44 years of age. Most commonly affected are the upper extremities (44%), lower ext (26%) and H & N (17%)
Pathophysiology

- Unique, dynamic injuries in that there tends to be progression in depth and size occurring AFTER the time of injury.

- Temperatures below 44°C are generally tolerated without injury. However, as temperature rises there is an exponential decrease in the time to injury.

- Traditionally burns are separated into 3 concentric zones: Coagulation, Stasis/Ischemia, and Hyperemia
The cont’d progression of burn injuries is multifactorial and not completely understood at this time.

The initial inflammatory response triggers a cascade that seems to cause further injury.

There is an occlusion of the dermal microcirculation with a combination of red blood cells, neutrophils, and microthrombi that results in reduced perfusion.
Pathophysiology Cont’d

- **Inhalation injury**: Exposure to heat can cause rapid and extensive upper airway edema in burn patients.

- Components of smoke such as incomplete combustion materials (ie CO, cyanide, aldehydes, and oxides) can result in further pulmonary edema and V/Q mismatch.

- Necrosis in the airway leads to de-epithelialization and formation of pseudomembranous casts that cause further airway obstruction.

- Reduced ability to clear secretions causing further exacerbation.
Classification of Burns

Burns are classified by mechanism of injury, depth, extent, and associated injuries and comorbidities.

- First Degree: Limited to the epidermis, characterized by erythema and pain

- Second Degree/Partial Thickness: Can be further subdivided into superficial and deep. Superficial thickness burns are limited to the papillary dermis while Deep extend to the reticular dermis

- Important to distinguish between the two as Deep partial thickness burns will often will not heal in 2-3 weeks and can lead to scarring and contractures.
Classification of Burns

- **Third Degree:** Also referred to as full thickness burns
  - Appear thick, white, or tan. Also appear dry with possible charred appearance.
  - Non-blanching, and because of nerve destruction are not painful

- **Fourth Degree:** Extend through the skin into muscle and bone.
  - Appear stiff, charred, with visibly thrombosed vessels
1st Degree Burn
2nd Degree Burn
2nd Degree Burns
3rd Degree Burn
4th Degree Burn
Burn Assessment

- Various tools and modalities to assess the depth and healing capacity of burns. In the emergency department however one must use clinical assessment and estimation, which can be unreliable.

- The extent of the burned area or total body surface area (TBSA) burned is also critical in assessment.

- Helps guide the fluid resuscitation management in the patients. Also helps convey criteria for admittance to the hospital/burn ward.

- Only second degree or deeper burns are used when assessing TBSA affected.
Burn Assessment

- A useful tool for assessment of smaller burns or scattered areas of burn is that the area of a patient’s palm and fingers is approximately 1% TBSA.

- For larger burns the “rule of 9’s” is frequently employed.

- The rule of nines should not be used for children as their head is larger and, in proportion, their extremities are smaller than those of adults.

- Finally, burns are classified by severity into minor, moderate, and severe based on the TBSA burned, the percentage of full-thickness injury, and the involvement of specific areas such as the face, hands, feet, or perineum.
Burn Assessment
Burn Assessment

Relative percentages of areas affected by growth

<table>
<thead>
<tr>
<th>Age</th>
<th>Half of head (A)</th>
<th>Half of one thigh (B)</th>
<th>Half of one leg (C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infant</td>
<td>9.5</td>
<td>2.75</td>
<td>2.5</td>
</tr>
<tr>
<td>1 yr</td>
<td>8.5</td>
<td>3.25</td>
<td>2.5</td>
</tr>
<tr>
<td>5 yr</td>
<td>6.5</td>
<td>4</td>
<td>2.75</td>
</tr>
<tr>
<td>10 yr</td>
<td>5.5</td>
<td>4.25</td>
<td>3</td>
</tr>
<tr>
<td>15 yr</td>
<td>4.5</td>
<td>4.25</td>
<td>3.25</td>
</tr>
<tr>
<td>Adult</td>
<td>3.5</td>
<td>4.75</td>
<td>3.5</td>
</tr>
</tbody>
</table>
Burn Assessment

**Minor burn**
15 percent TBSA or less in adults
10 percent TBSA or less in children and older adults
2 percent TBSA or less full-thickness burn in children or adults without cosmetic or functional risk to eyes, ear, face, hands, feet, or perineum

**Moderate burn**
15 to 25 percent TBSA in adults with less than 10 percent full-thickness burn
10 to 20 percent TBSA partial-thickness burn in children under 10 and adults over 40 years of age with less than 10 percent full-thickness burn
10 percent TBSA or less full-thickness burn in children or adults without cosmetic or functional risk to eyes, ears, face, hands, feet, or perineum

**Major burn**
25 percent TBSA or greater
20 percent TBSA or greater in children under 10 and adults over 40 years of age
10 percent TBSA or greater full-thickness burn
All burns involving eyes, ears, face, hands, feet, or perineum that are likely to result in cosmetic or functional impairment
All high-voltage electrical burns
All burn injury complicated by major trauma or inhalation injury
All poor-risk patients with burn injury
Pre-Hospital Management

- First priority is to stop the burning process and prevent further injury.

- Following this, one should assess the airway, cardiac, and peripheral perfusion status.

- Prehospital administration of fluids is warranted in extensive burns if IV access can be established effectively and expeditiously in non-burned skin.

- Ringers Lactate is the fluid of choice as it reduces the chance of developing hyperchloremic acidosis compared to NS. Parkland formula can be used for dosing.

- Burn should be covered with a clean sterile dressing. Minimize hypothermia.
ER Management

- People tend to focus on the burns when patients come in, it is important to look for other injuries and do proper ABC assessment.

- Airway injury and compromise warrants intubation, possibly fiberoptically. If RSI isn’t possible, consider surgical airway

- If IV hasn’t been established then do so. May need central line if peripheral line not possible. Humidified O2 should be done to keep sats high (>92%)

- Full monitors should be in place, and a catheter may be placed in order to monitor U/O
Inhalation Injury

- Smoke inhalation affects 5-35% of burn patients. Presence of inhalation injury more than doubles the mortality rate in adults.

- Traditional methods for assessment of inhalational injury were/are external physical exam, however now it is felt that direct visualization via laryngoscopy (fiberoptic) or bronchoscopy is best.

- Mechanical ventilation helps provide support, can help with secretion control and help in the recruitment of alveoli.

- Aerosolized NAC and Heparin can help with breakdown of thick secretions while suctioning and chest physio augment their removal.
Inhalational Injury

**Table 63-3 Indications for Endotracheal Intubation and Mechanical Ventilation in Burn Patients**

- Upper airway obstruction
- Inability to handle secretions
- Hypoxemia despite 100% O\(_2\)
- Patient obtundation
- Muscle fatigue suggested by a high or low respiratory rate
- Hypoventilation (P\(_{\text{CO}_2}\) > 50 mm Hg and a pH < 7.2)

\(O_2\), oxygen; \(P_{\text{CO}_2}\), partial pressure of carbon dioxide.
Fluid Resuscitation

- Prior to WWII many burn patients died of hypovolemic shock and renal failure. Following combat as well as other fires there began to be fluid regimens.

- The massive amounts of inflammatory mediators lead to increased permeability of the local and systemic vasculature and extravasation of intravascular fluids.

- Patients with small burns can usually be treated with oral fluids (if they can tolerate oral fluids).

- Patients with severe burns require IV fluids in order to prevent shock and increase intravascular volume.
Fluid Resuscitation

- **Parkland Formula**: TBSA x weight (kg) x 4 (ml)
  Gives the amount of fluid to give in 24 hours. First ½ should be given in the first 8 hours while the second ½ should be given over the following 16.

- Other formulas can also be used including “rule of 10”

- This formula states that the estimated burn size (percent of TBSA) is multiplied by 10 to derive the initial fluid rate in milliliters per hour. For every 10 kg above 80 kg, 100 mL is added to this rate.

- These regimens are guidelines and fluids should be adjusted according to tissue/organ perfusion.
# Fluid Resuscitation

<table>
<thead>
<tr>
<th>FORMULA</th>
<th>FIRST 24 HOURS</th>
<th>NEXT 24 HOURS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parkland</td>
<td>LR 4 mL/kg/% burn ½ within first 8 hr</td>
<td>Colloids in amount of 20-60% of plasma volume; glucose in water added to</td>
</tr>
<tr>
<td></td>
<td></td>
<td>maintain urine output 0.5-1.0 mL/kg/hr in adults and 1 mL/kg/hr in children</td>
</tr>
<tr>
<td>Modified</td>
<td>LR(mL) = 4 × kg × % burn in adults</td>
<td>Colloid infusion of 5% albumin at the amount (0.3-1.0)/16 mL/kg/%burn/hr</td>
</tr>
<tr>
<td>Parkland</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Evans</td>
<td>Crystalloids in the amount of 1 mL/kg/% burn, plus</td>
<td>Crystalloids at 0.5 mL/kg/% burn, colloids at 0.5 mL/kg/% burn, and the</td>
</tr>
<tr>
<td></td>
<td>colloids at 1 mL/kg/% burn, plus 2000 mL glucose in water</td>
<td>same amount of glucose in water as first 24 hr</td>
</tr>
<tr>
<td>Brooke</td>
<td>LR 1.5 mL/kg/% burn, plus colloids at 0.5 mL/kg/% burn,</td>
<td>LR 0.5 mL/kg/% burn, colloids at 0.25 mL/kg/% burn, and the same amount of</td>
</tr>
<tr>
<td></td>
<td>plus 2000 mL glucose in water</td>
<td>glucose in water as first 24 hr</td>
</tr>
<tr>
<td>Modified</td>
<td>LR 2 mL/kg/% burn in adults and 3 mL/kg/% burn in children</td>
<td>Colloids 0.3-0.5 mL/kg/% burn, glucose in water to maintain urine output</td>
</tr>
<tr>
<td>Brooke</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Monafo</td>
<td>Solution containing 250 mEq Na, 150 mEq lactate, 100 mEq</td>
<td>Solution titrated with 1/3 NS according to urine output</td>
</tr>
<tr>
<td></td>
<td>Cl; amount adjusted to urine output</td>
<td></td>
</tr>
<tr>
<td>Galveston</td>
<td>LR at 5000 mL/m² TBSA burned plus 2000 mL/m² TBSA, ½</td>
<td>3750 mL/m² TBSA burned plus 1500 mL/m² TBSA</td>
</tr>
<tr>
<td></td>
<td>within 8 hr</td>
<td></td>
</tr>
<tr>
<td>Rule of ten</td>
<td>LR at 10 mL/%burn/hr For every 10 kg above 80 kg, 100 mL</td>
<td>Not applicable</td>
</tr>
<tr>
<td></td>
<td>is added to this hourly rate</td>
<td></td>
</tr>
</tbody>
</table>

CI, chloride; LR, Ringer’s lactate; TBSA, total body surface area; NA, sodium; NS, normal saline.
Fluid Resuscitation

**Special Considerations:**
Children have a larger TBSA relative to weight when compared with adults and therefore have larger fluid requirements.

- Fluid needs often calculated on TBSA rather than weight, using things such as the Galveston Formula.

- **Colloids:** Since leakage of proteins through capillaries lasts 12-24 hours, colloids are not generally recommended in the initial resuscitation unless the burn is very deep.

- ABA guidelines consider the possible addition of colloids AFTER the 12-24 hr mark to decrease fluid requirements.
Local Wound Care

- Burns should be considered contaminated and have gentle cleansing with soap and cool water. Necrotic tissue should be carefully removed as needed (analgesia will most likely be warranted in these scenarios).

- Tetanus booster should be given if patient has not had booster in the last 5 years.

- Ice water should generally be avoided as it has been associated with increased tissue injury and hypothermia.
Local Wound Care

- **Burn Blister Management**: Remains a topic of debate. Some evidence that there is less infection with intact blisters, however tends to be less pain with ruptured blisters.

- With blisters that have already ruptured, any necrotic epidermis should be gently removed while adherent epidermis is left intact. With large or tense blisters, the unruptured blister may be aspirated with a sterile needle.
Burn Dressings

- Purpose is to protect the wound, to reduce pain, to absorb wound exudate, and to reduce evaporative heat loss.

- First degree wounds can generally be managed with topical anesthetics, aloe vera gels, and NSAIDS.

- Second degree wounds can be managed with dressings with the main principle being CLEAN AND GREASY!
Burn Dressings

- **Open:** Appropriate for large, contaminated burns with exudate.
  
  The wound can then be covered by a non-occlusive dressing with daily cleansing and dressing changes.

- **Closed:** Use of occlusive dressings for a moist environment in a wound that has little to mild exudate.
  
  Saran Wrap can be used as it seals in heat, acts as a barrier and also allows you to visualize the wound.
Pain Management

- Burn injuries are among the most painful experienced and pain control should be among the highest priorities for physicians.
- Pain, especially in the emergent phase can be divided into three categories: background, breakthrough, and procedural.
- Pharmacologic agents used to treat burn pain include opioid analgesics, nonopioid analgesics, anxiolytics, and anesthetics. The type of medication used is determined by the severity of pain, the anticipated duration of pain, and intravenous (IV) access.
Pain Management

- Minor burns can be managed with Tylenol and NSAIDS
- In the emergent setting moderate to severe burn pain is generally managed with parenteral opioids titrated to effect.
- Fentanyl (with a short half life) can be used for short breakthrough and procedural pain for things like debridement and dressing changes
- Intravenous infusion of lidocaine (1 mg/kg followed by 40 \(\mu\) g/kg/min infusion) has also been shown to reduce the pain in burn patients.
- In large severe burns or pediatric burns consider sedation and regional nerve blocks
Thank You!!

- References:
  - Rosen’s Guide to Emergency Medicine
  - UpToDate
  - American Burn Association Guidelines