Types of Burn Injury

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thermal</td>
<td>Flash: Explosions of natural gas, propane, gasoline &amp; other flammable liquids.</td>
</tr>
<tr>
<td></td>
<td>Flame: Intense heat for brief period of time</td>
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<td></td>
<td>Scalds: Caused by hot liquids, water, oil, grease, tar, oil</td>
</tr>
<tr>
<td></td>
<td>Temperature &gt;156 degrees causes immediate tissue injury</td>
</tr>
<tr>
<td></td>
<td>Contact: Hot metal/surfaces, plastics, coals</td>
</tr>
<tr>
<td>Chemical</td>
<td>Caused by strong acids or alkali substances</td>
</tr>
<tr>
<td></td>
<td>Continue to cause damage until agent inactivated</td>
</tr>
<tr>
<td>Electrical</td>
<td>Caused by either AC or DC current</td>
</tr>
<tr>
<td></td>
<td>Current follows path of least resistance and causes injury in areas other than contact/entry site</td>
</tr>
<tr>
<td>Radiological</td>
<td>Caused by alpha, beta, or gamma radiation</td>
</tr>
<tr>
<td>Cold Exposure</td>
<td>Frostbite: localized damage to skin and other tissues due to freezing</td>
</tr>
<tr>
<td></td>
<td>Usually occurs in body parts farthest from heart and those with large exposed areas</td>
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</tbody>
</table>

Scald Burns
- Caused by hot liquids (e.g., water, oil, grease, tar)
- Temperature >156 degrees causes immediate tissue injury
- Accidental: scald injuries have irregular borders associated with splash or drip lines
- Intentional: scald burns more likely to have clear demarcation of injury
- Scalds account for majority of thermal injuries to children
- If history does not correlate with physical findings, call protective services

Chemical Burns
- Classified as either household or industrial agents
- Characterized as: acid, alkaline, organic
- First treatment should be to irrigate skin with enough water to dilute chemical
  - Irrigate acid burns 20 minutes
  - Irrigate alkaline burns 30-45 minutes
- Examples of chemical burn agents:
  - Acid = bathroom cleaners, rust removal products
  - Alkali = household cleansers-oven & drain, bleach
  - Organic = creosote (from tar distillation), gasoline/diesel fuel

Electrical Injury/Burns
- Results from electricity passing through body causing rapid injury to tissues
- Classified as:
  1. High voltage (>1000 volts), low voltage (<1000 volts)
  2. Flash burns secondary to electric arc
- Burns from lightning strike

Electrical Burn Injury
- Primary result is burns
- May cause fractures or dislocations secondary to blunt force trauma or muscle contractions
- High volt injury usually cause internal damage
- Extent of high volt damage cannot be judged by skin examination alone
- Electricity passing through body may injure blood vessels, nerves, and muscles
- High or low volt injury may produce cardiac arrhythmias or arrest

Full-thickness exit wound to armpit post high voltage electrical burn injury
Electrical Injuries

- Damage is dependent on dose, anatomic path, duration of exposure
- Consider:
  - Potential cardiac arrhythmias
  - Seizure activity
  - Potential renal complications associated with:
    - Rhabdomyolysis - rapid breakdown of damaged muscle tissue
    - Breakdown products of damaged muscle cells released into bloodstream
    - Myoglobinuria - protein myoglobin can harm kidneys

Urine from a person with rhabdomyolysis showing characteristic brown discoloration as a result of myoglobinuria

Electrical Injuries

- Wounds typically treated with standard wound care
- Debridement of any charred flesh
- May take a significant amount of time for demarcation to occur

Electrical injury exit site on foot

Radiation Burns

- Damage to skin caused by exposure to radiation energy
- Radiation burns from:
  - UV radiation (sun)
  - X-rays
    - Aka radiodermatitis - associated with prolonged exposure to ionizing radiation
  - High power radio transmitters (body absorbs radio frequency energy and converts to heat)

Ionizing radiation burn: Large red patches of skin on the back and arm from multiple prolonged fluoroscopy procedures

Radiodermatitis (RD)

- A common side effect during radiation therapy
- Various topical agents have been applied
- However, the efficiency of topical agents applied on radiotherapy still uncertain

Ionizing radiation burn: Large red patches of skin on the back and arm from multiple prolonged fluoroscopy procedures

Methods for Preventing/Minimizing Skin Reactions During Radiation Therapy

- Moisturization of irradiated area
- Use of barrier or corticosteroid creams
- Aloe vera and other lanolin-free hydrophilic products often recommended for this purpose
- Objective of treatment for dry desquamation is to lessen patient discomfort by providing moisture to the affected areas
- Treatment of moist desquamation usually involves the use of hydrocolloid dressings to reduce exposure to external pathogens and ultimately to prevent infection

Advice for Patients for Skin Reactions During Radiation Therapy

- Lack of general consensus among radiation therapy centers
- Some common advice given to patients include:
  - Avoid use of metallic-based topical products (eg, zinc oxide creams or deodorants with an aluminum base) - may increase surface dose to skin
  - Avoid alcohol containing products
  - Avoid sun exposure
  - Wear loose-fitting clothing over irradiated area - prevents friction injuries
  - Maintain a clean/dry irradiated area
  - Avoid extreme temperatures
  - Avoid use of starch-based products - increase the risk of infection
- No general accord has been reached across radiation therapy centers about the treatment of radiation skin toxicities
- Additional studies needed
Radiation Recall Dermatitis

- An inflammatory skin reaction that occurs in a previously irradiated body part following drug administration
- Does not appear to be a minimum dose, nor an established radiotherapy dose relationship
- Poorly understood

Frostbite

- Categorized with burns due to similar inflammatory responses and ischemic injuries
- Vasocnstriction and endothelial injury with thrombosis and loss of vascular integrity
- Factors affecting severity:
  - Length of exposure
  - Temperature
  - Humidity
  - Wind chill factor

Classification of Frostbite Injury

- **Superficial** frostbite includes skin and subq
  - Rewarming results in clear blisters
- **Deep** frostbite includes bone, joint and tendon
  - Rewarming results in hemorrhagic blisters
- Favorable prognosis include intact sensation, normal skin color and clear blisters
- Poor prognosis include nonblanching, cyanotic, firm skin and hemorrhagic blisters
- No definitive evidence exists for optimal management of blisters

Thermal Injury Classifications

<table>
<thead>
<tr>
<th>Depth</th>
<th>Classification</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Superficial</td>
<td>1st degree</td>
<td>Epidermal damage</td>
</tr>
<tr>
<td>Partial-Thickness Deep</td>
<td>2nd degree</td>
<td>Epidermis and superficial (papillary) dermis damage Damage extends into the reticular dermis</td>
</tr>
<tr>
<td>Full-Thickness</td>
<td>3rd degree</td>
<td>Complete loss of dermis</td>
</tr>
<tr>
<td></td>
<td>4th degree</td>
<td>Damage to underlying fascia, muscle, bone</td>
</tr>
</tbody>
</table>

First-Degree Superficial Burns

- Characteristics
  - Epidermal damage only
  - Red
  - Dry skin
  - Blanch with pressure
  - Painful (48-72 hours)
  - Peeling skin
  - Examples:
    - Flash injuries
    - Sunburn
- Complete healing 5-10 days without scarring

Second-Degree Burn Superficial Partial-Thickness

- **Characteristics**
  - Extends into superficial (papillary) dermis
  - Usually caused by hot liquids
  - Red, blisters, wet
  - Painful
  - Good blood supply
  - Low risk of infection
  - Heals with minimal scarring 10-14 days
Second-Degree Deep Partial-Thickness Burn

Characteristics
- Extends into deep (reticular) dermis
- Lack of blister formation
- Cause is usually flames
- Dry, white, or charred skin
- Pain is minimal
- High risk for infection
- Re-epithelialization extremely slow, sometimes requiring months
- Scarring can be severe
- May convert to a full-thickness burn
- Skin grafting often preferred for long-term function

Third-Degree Full-Thickness Burns

Characteristics
- Destruction of entire epidermis, dermis
- May extend to muscle, bone, and joint (sometimes referred to as Fourth-Degree burn)
- No residual epidermal cells to repopulate; therefore no re-epithelialization
- Area of wound not closed by secondary intention (contraction) requires skin grafting
- Requires extensive debridement & complex reconstruction of specialized tissues
- Usually results in prolonged disability
- Caused by immersion scalds, flames, and chemical & high-voltage electrical injuries

Fourth-Degree Full-Thickness Burns

Characteristics
- Complete destruction of epidermis, dermis, and subcutaneous tissue
- Involvement of underlying fascia, muscle, bone, or other structures
- White, dry, leathery with absence of pain
- High risk for infection
- Caused by: immersion scalds, flame burns, chemical & high-voltage electrical injuries
- No residual epidermal cells to repopulate; therefore no re-epithelialization

Treatment Full-Thickness Burns
- Areas not closed by wound contraction will require skin grafting
- Often requires extensive excisional debridement
- Grafting frequent
- Often results in prolonged disability
- Functional limitations frequent

Burn Geographic Zones of Injury

Zone of Coagulation
- Area of greatest heat transfer & damage
- Irreversible tissue loss
- Devitalized necrotic tissue

Burn Geographic Zone of Stasis
- Adjacent to zone of coagulation
- Tissue severely metabolically compromised
- Poor blood flow (stasis)
- Tissue potentially salvageable
- May convert to complete tissue loss if prolonged hypotension, infection, or edema
Farthest from the point of direct thermal insult
Injury to the tissues is minimal

Burn Geographic Zones
Zone of Hyperemia

- The American Burn Association has used these parameters to establish guidelines for the classification of burn severity
  - (1) extent, depth, and location of burn injury
  - (2) age of patient (older considered >50 years)
  - (3) etiologic agents involved
  - (4) presence of inhalation injury
  - (5) coexisting injuries or preexisting illnesses

American Burn Association Severity Classification

<table>
<thead>
<tr>
<th>Minor</th>
<th>Moderate</th>
<th>Major</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adult &lt;10% TBSA</td>
<td>Adult 10%-20% TBSA</td>
<td>Adult &gt;20% TBSA</td>
</tr>
<tr>
<td>Young or old &lt;5% TBSA</td>
<td>Young or old 5%-10% TBSA</td>
<td>Young or old &gt;10% TBSA</td>
</tr>
<tr>
<td>&lt;2% full-thickness burn</td>
<td>2%-5% full-thickness burn</td>
<td>&gt;5% full-thickness burn</td>
</tr>
<tr>
<td>High voltage injury</td>
<td>High voltage burn</td>
<td></td>
</tr>
<tr>
<td>Possible inhalation injury</td>
<td>Known inhalation injury</td>
<td></td>
</tr>
<tr>
<td>Circumferential burn</td>
<td>Significant burn to face, joints, hands, or feet</td>
<td></td>
</tr>
<tr>
<td>Other health problems</td>
<td>Associated injuries</td>
<td></td>
</tr>
</tbody>
</table>

1% TBSA = size of patient’s palm and fingers

Total Body Surface Area (TBSA) Component for Determining Severity of Wound

<table>
<thead>
<tr>
<th>Component</th>
<th>TBSA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Head</td>
<td>9%</td>
</tr>
<tr>
<td>Each arm</td>
<td>9%</td>
</tr>
<tr>
<td>Anterior torso</td>
<td>18%</td>
</tr>
<tr>
<td>Posterior torso</td>
<td>18%</td>
</tr>
<tr>
<td>Each leg</td>
<td>18%</td>
</tr>
<tr>
<td>Genitals/perineum</td>
<td>1%</td>
</tr>
<tr>
<td>Entire foot</td>
<td>2.5%</td>
</tr>
</tbody>
</table>

Palm of hand ~ 1% TBSA
Perineum ~ 1% TBSA

Infants/Children TBSA

- Calculation different due to size of head proportionally larger than adults
- Lund-Browder formula instead of Rule of Nines
- For children over age of one
  - For each year above one - add 0.5% to each leg and subtract 1% for the head
  - This formula should be used until the adult rule of nines values are reached.
Major Burns
Should be Referred to Burn Center
1. Partial-thickness burns >10% TBSA
2. Involve face, hands, feet, genitalia, perineum, or major joints
3. Third-degree burns in any age group
4. Electrical burns, including lightning injury
5. Chemical burns
6. Inhalation injury
7. Preexisting medical conditions that could complicate management, prolong recovery, or affect mortality
8. Burns and concomitant trauma (such as fractures) in which burn injury poses greatest risk of morbidity or mortality
9. Burned children in hospitals without qualified personnel or equipment for care of children
10. Patients who require special social, emotional, or rehabilitative intervention

Burn Considerations
- Partial-thickness burns heal on their own unless something causes them to convert to full-thickness
- Infection can cause partial-thickness to become full-thickness
- Airway integrity primary concern
- Inhalation damage from by-products of combustion and smoke significant cause of mortality
- Most immediate burn deaths from hypoxia due to carbon monoxide from fire displacing oxygen on hemoglobin of RBCs

Burn Management
Divided into Three Phases
1. Emergent or Resuscitative Phase
2. Acute Phase (after emergent phase and until wounds are closed)
3. Rehabilitative Phase to restore function

Emergent or Resuscitative Phase
- Medical Assessment
  - Assess for presence of inhalation injury/secure airway
  - Assess size of burn (TBSA) using the "Rule of Nines"
  - Assess and classify burn depth
  - Begin fluid resuscitation (Parkland Burn Formula)
  - Maintain body temperature (prevent hypothermia)
  - Achieve cardiopulmonary stability
  - Establish adequate tissue perfusion and monitor for compartment syndrome
  - Escharotomies may be necessary to prevent tissue, muscle, and nerve death
  - Debridement of necrotic, dirty, or infected wounds

Parkland Burn Formula
- Calculates approximate IV Ringer’s lactate needed for first 24 hours
- 4 mL x body weight x %TBSA
- ½ first 8 hours, second ½ in next 16 hours
- In general, monitor and modify according to urine output and vital signs

Burn Interventions Full-Thickness
- Proper cleansing
- Infection of most concern after airway issues
- Topical antibiotics
  - Silver sulfadiazine
  - Mafenide acetate
  - Neomycin, polymyxin, and bacitracin ointment
  - Mupirocin ointment
  - Acetic acid solution
  - Dakin’s solution
  - Silver dressings

Excerpted from Guidelines for the Operations of Burn Units (pp. 55-62), Resources for Optimal Care of the Injured Patient: A National Action Plan, Committee on Trauma, American College of Surgeons.
**Burn Interventions**

- **Bandages**
  - Protect from infection
  - Reduce body, head, and water vapor loss
  - Patient more comfortable
  - Absorbs drainage from wounds
  - Assists with positioning for functional healing of limbs/digits

**Elevation of Limbs**

- Person with a serious burn injury goes into shock, which causes swelling
- Badly burned skin becomes stiff and resists swelling, leading to increased pressure inside limbs, fingers, or toes that create ischemia to tissues
- Keeping injured limb raised reduces pressure to help prevent edema-induced ischemia

**Surgical Management in Burns**

- **Escharotomy**
  - Surgical cuts in burned tissue allows area to expand; decrease the pressure build up from edema
  - Pressure build up from swelling can cause necrosis due to lack of blood flow

- **Fasciotomy**
  - Indicated for compartment syndrome

**Surgical Management in Burn Care Skin Grafting**

- Full- and partial-thickness burns
- Excision or debridement of burned skin followed by grafting reduces number of days in hospital and usually improves function and appearance of burned areas

**Advanced Topical Interventions for Burns**

- Skin grafts
- Flaps
- Tissue engineered products
- See Topical Management Section

**Exercise**

- As burned skin heals, skin around wound contracts (shrinks) toward center of wound as scar tissue forms in wounded area
- Joints must be regularly exercised to prevent scar tissue induced contractures
- Contractures often have to be released surgically
- Exercising burned limbs can be painful, but increases flexibility and reduces long-term complications
- Rehabilitation begun early and continuing throughout healing process ensures greatest flexibility and return to highest level of function
Pressure Garments

- Hypertrophic scarring above level of burn/skin
- Not fully understood
- Keeping pressure on the scar as it forms helps reduce the amount of hypertrophic scarring

Splinting of Joints

Burn References

- American Burn Association: http://www.ameriburn.org/BurnUnitReferral.pdf
- burnsurgery.org