

Responding to Victims with Burn Injuries in Disaster Events

**Satellite Conference and Live Webcast
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Produced by the Alabama Department of Public Health
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Faculty

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Burn Definition

- A burn is damage to the skin and mucous membranes



Causes of Burns

- Fires
- Hot water or object
- Electrical
- Chemical
- Radiological

Burn Injuries in the United States?

- Each year, 1.1 million burn injuries require medical attention (American Burn Association, 2002)
 - Approximately 50,000 burn injuries require hospitalization
 - Approximately 20,000 are major burns involving at least 25 percent of the total body surface

Burn Injuries in the United States?

- Each year, 1.1 million burn injuries require medical attention (American Burn Association, 2002)
 - Approximately 4,500 of these people die

Residential Fires Account For 79% of All Fire Deaths in the US

Unintentional Fire and Burn-Related Death Rates
United States, 1995-1998



Source: National Center for Health Statistics, 2000

Burn Data in Alabama

- 1992-1997
 - Residential fires accounted for the largest proportion of deaths
 - Fatality rates were higher for mobile home residents
 - Overall, smoke detectors were present in only 32.5% of the residential fires

Burn Data in Alabama

- 1992-1997
 - The most frequently reported cause of fatal fires was misuse of cigarettes
 - More than half of the victims aged 18 years and older tested positive for alcohol

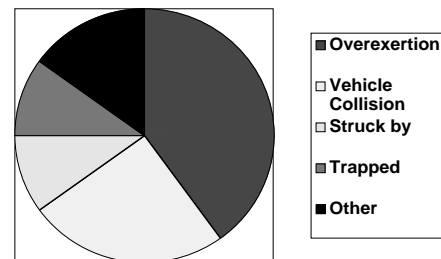
At Risk

- Children
- Elderly
- Poor
- Manufactured or substandard housing
- Rural
- African Americans, native Americans
- Firefighters

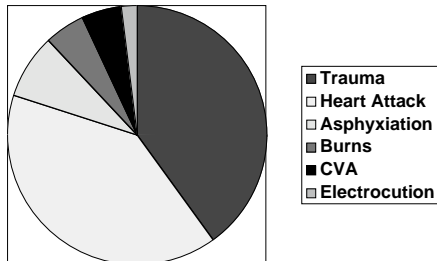
Table 5. Firefighter Fatalities by State and Per 10 Million Population (1990-2000)*

| State | Average 1990-2000 Population | Total Fatalities | Average Fatalities per 10 Million Population by Affiliation | Average Fatalities per 10 Million Population by Incident |
|----------------------|------------------------------|------------------|---|--|
| Alabama | 4,243,844 | 20 | 47.1 | 47.1 |
| Alaska | 588,488 | 2 | 34.0 | 34.0 |
| Arizona | 4,397,930 | 15 | 34.1 | 34.1 |
| Arkansas | 2,512,063 | 14 | 55.7 | 55.7 |
| California | 31,815,835 | 75 | 23.6 | 21.7 |
| Colorado | 3,797,828 | 7 | 18.4 | 52.7 |
| Connecticut | 3,346,341 | 20 | 59.8 | 59.8 |
| Delaware | 724,804 | 3 | 41.4 | 41.4 |
| District of Columbia | 695,250 | 4 | 57.5 | 57.5 |
| Florida | 14,460,152 | 22 | 15.2 | 15.2 |
| Georgia | 7,332,335 | 21 | 28.6 | 28.6 |
| Hawaii | 1,159,883 | 4 | 34.5 | 34.5 |
| Idaho | 1,150,351 | 10 | 86.9 | 69.5 |
| Illinois | 11,924,948 | 32 | 26.8 | 36.9 |
| Indiana | 5,812,322 | 44 | 75.7 | 55.1 |
| Iowa | 2,851,540 | 14 | 49.1 | 49.1 |
| Kansas | 2,582,996 | 14 | 54.2 | 54.2 |

Causes of Fatal Firefighter Injury



Nature of Fatal Injury



The Station Nightclub Fire

- 439 patrons were in the building at the time of the fire, of whom 96 died at the scene
- 100 people ultimately died
- 215 patients were evaluated at area hospitals
 - 64 at one trauma center
 - 151 at 15 other area facilities

The Station Nightclub Fire

- 79 patients were admitted
 - 47 to one center
 - 32 to other hospitals



The Station Nightclub Fire - Resources

- Eight patients were transferred from Rhode Island Hospital (RIH) to other Level I trauma centers
- 28 (60%) of the patients admitted to RIH were intubated for inhalation injury

The Station Nightclub Fire - Resources

- For patients admitted to RIH, the extent of the total body surface burn was
 - Less than 20% in 33 patients (70%)
 - 21% to 40% in 12 patients (26%)
 - Greater than 40% in 2 patients (4%)

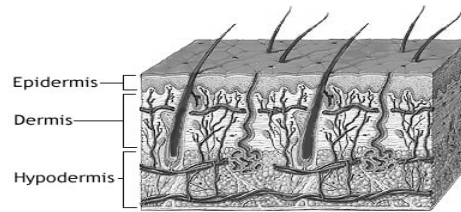
Types of Burns

- Flame
- Scald/steam
- Electrical
- Chemical
- Radiological

Cellular and Tissue Effects

- Damage to the cells and tissue is a function of temperature and time
- Sustained temperatures between 40°C and 44°C cause various enzymes to malfunction
- Higher temperatures cause protein breakdown

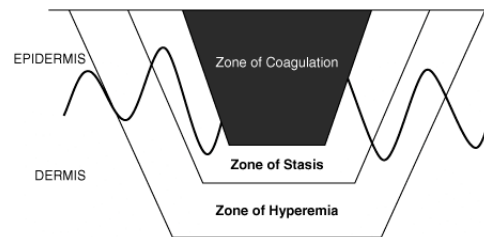
Cellular and Tissue Effects



Pathophysiology of the Burn Wound

- The burn wound is the source of virtually all ill effects seen in the burn patient
- Removal of the burn wound results in much improved patient outcome

Zones of Injury



Source: Feliciano DV, Mattox KL, Moore EE: Trauma, 6th Edition:
<http://www.accesssurgery.com>

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Depth of Burn

- First degree
- Second degree or partial thickness
 - Superficial and deep
- Third degree or full thickness
- Fourth degree

First Degree Burn





Second Degree Burn



Third Degree Burn



Third Degree Burn



Electrical

- Injury dependent on voltage and length of time of contact
- Three mechanisms of injury
 - Tetany, arrhythmia, and specific tissue damage
 - Thermal injury
 - Mechanical injury from falls and violent muscle contraction

Primary Survey

- Airway
 - Can deteriorate abruptly and rapidly
- Breathing
- Circulation
 - BP, Pulse, circumferential burns

Primary Survey

- Disability
 - Neurologic status
- Exposure
 - Pay attention to hypothermia

Secondary Survey

- History
- Circumstances
 - Accidental
 - Suicidal
 - Abuse or assault
- Cause
 - Fire
 - Hot water scalding

Secondary Survey

- Duration of contact with flame or hot water
- Method used to extinguish the fire
- Setting
 - Home
 - Workplace
 - Indoors versus outdoors

Secondary Survey

- Associated trauma
 - Motor vehicle accident
 - Blunt trauma while escaping the fire
 - Explosion
- Associated inhalation

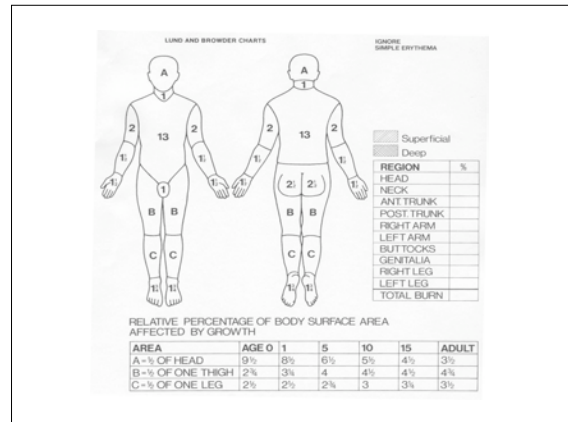
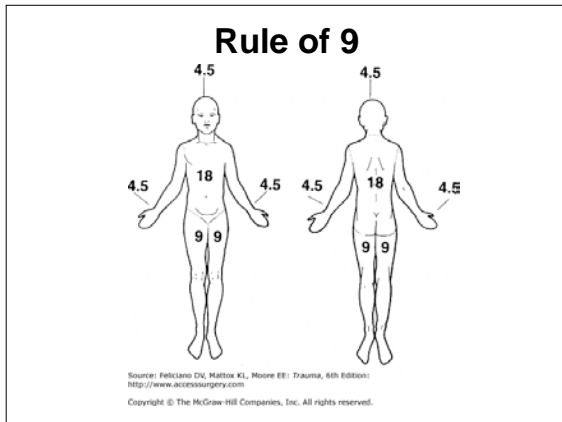
Past Medical History

- Comorbid conditions
 - Diabetes
 - Immunocompromised
 - Disability and special needs
- AMPLE

Burn Surface Area (BSA) Estimation

- The patient's hand including fingers is approximately 1% of total BSA





Assessment for Perfusion

- Extremity perfusion may be compromised by a circumferential third degree extremity burn
- Respiratory status may be compromised by a circumferential third degree thoracic burn



Special Consideration Pediatrics

- Larger surface area of head
- More susceptible to hypothermia
- Moral support to patient and parents

Special Consideration-Abuse

- History not compatible with injuries
- Delay in seeking care
- Several burns at different stages
- Suspicious family dynamics and reactions

Photo Credit DAVID M. PRESSEL, M.D., PH.D.

Assessment for Smoke Inhalation

- Exposure to smoke in a closed space, cough and shortness of breath
- Physical findings
 - Hoarseness
 - Wheezing
 - Carbonaceous sputum

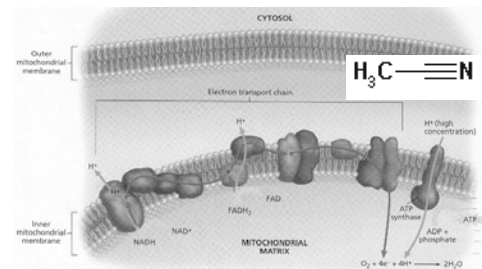
Assessment for Smoke Inhalation

- Physical findings
 - Carbonaceous sputum
 - Facial burns, and singed nasal vibrissae
 - Diagnosis is often established by the use of bronchoscopy
- Coma or altered mental status

Carbon Monoxide - Clinical

- Most common presentation
 - Flu-like illness
- CNS
- CV

Hydrogen Cyanide Mechanism



Hydrogen Cyanide - Clinical

- Clinical
 - CNS
 - CV
 - Bitter almond: only 60% of population can detect it
 - Cherry red skin, fundoscopic exam



Diagnostic Studies

- Carboxyhemoglobin level
- Elevated Lactic acid
- Arterial Blood Gas with a simultaneous Venous Blood Gas
 - O₂ extraction
- Chest radiograph

Special Considerations Ophthalmic Injuries

- Reflex lid closure often protects the eyes during facial burns
- Ophthalmic burns are usually associated with marked facial damage and possible inhalation injury
- Corneal injury is the most common

Resuscitation

- Fluid determined by severity of injury
 - Amount of 2nd and 3rd degree burn
- Lactated ringers
- Initial fluid determined by parkland formula
 - 2-4cc/kg/%TBSA
 - Half is administered over the first 8 hours from the burn

Resuscitation

- DO NOT BOLUS
- Titrate fluid to urine output
 - 30-50cc/hour

Fluid Resuscitation

| FORMULA | CRYSTALLOID | COLLOID VOLUME | FREE WATER |
|-----------------------|--|-----------------------|------------|
| Parkland | 4 ml/kg/%TBSA burn | None | NONE |
| Brooke | 1.5 ml/kg/%TBSA burn | 0.5 mL/kg/% TBSA burn | 2 L |
| Galveston (Pediatric) | 5000 mL/m ² burned + 1500 mL/m ² total | None | None |

Wound Care

- If the patient is to be transferred, cover the burns with sterile, dry, towels or sheets
- Do not soak the burns or wrap with wet towels
 - This may induce hypothermia and worsen outcome

Inhalational Injury

- Early intubation
- Mechanical ventilation
- Chest physiotherapy and suctioning
- Carbon monoxide poisoning management
 - 100% Oxygen
 - Hyperbaric oxygen therapy

Inhalational Injury

- Cyanide poisoning management
 - The Lilly Kit
 - Hydroxocobalamin

Escharotomy – Indications

- Used to treat full thickness (third-degree) circumferential burns
- Underlying tissues become constricted due to the eschar's loss of elasticity
 - Leads to impaired circulation distal to the wound

Escharotomy – Indications

- The ability to ventilate a patient may be impaired by a circumferential chest burn

Escharotomy - Description

- H shaped incision



Electrical Burns

- Devastating injury
- Young, working males
- Most frequent cause of amputations on the burn service
- Morbidity, length of stay, and number of operations higher than other burns

Pathophysiology

- Severity
 - Voltage, current, type of current, path of current flow, resistance at point of contact, individual susceptibility
- High voltage vs. low voltage
 - 1000 volts

Pathophysiology

- 99% of all electrical burns are caused by 60 cycle per second commercial alternating current

Mechanism of Injury

- True electrical injury
 - Current flow through tissue
- Arc injury
 - “Flash” type injury
- Flame injury

Clinical Findings

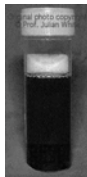


Scene Care

- Shut down the current
- Primary survey
- Spine protection if trauma is suspected

Diagnostic Studies

- CBC and kidney function tests
- Serum creatine kinase and myoglobin
- Urine myoglobin
- EKG
- Radiographs to evaluate for secondary trauma



Acute Care

- Electrocardiographic monitoring
- Resuscitation
- Urine output
 - Myoglobinuria
- Local wound care
- Compartment syndrome

Resuscitation

- Parkland formula not accurate
- 30-50 cc/hour urine output
 - >100cc/hour if muscle damage noted

Myoglobinuria

- Myoglobin released from damaged muscle
- Can precipitate out in renal tubules causing renal failure
- Prevention and treatment requires high index of suspicion
- Treatment: Volume resuscitation, UOP>100cc/hr, mannitol
- NaHCO₃ not proven to be beneficial

Traumatic Injuries

- 15% of electrical burn victims sustain traumatic injuries
- Falls, thrown against objects, compression fractures from tetanic contractions

Compartment Syndrome

- Patients with high voltage electrical injury are prone to developing compartment syndrome within the first 48 hours following injury
- Fasciotomy may be required to prevent further limb damage



Complications

- Renal failure
- Fractures
- Cataracts
- Limb Loss
- Neurologic
 - Paralysis, paresthesias, etc.

Lightning Injury

- 80 fatalities per year
- Direct current blast of 2000 to 2,000,000,000 volts
- Florida and Texas having the most deaths
- Full spectrum of injury
 - Minimal cutaneous burn to full thickness



Chemical Burns

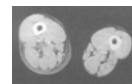
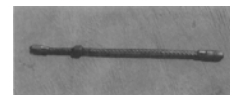
- Due to contact with a chemical caustic agent
- Acid, base or others
- Bad prognostic factors (pH, physical form, duration of contact, amount and others)
- Hydrofluoric acid and its complications

Radiological Burns

- Due to contact or exposure to radiological material or source
- In the absence of a history of a contact with a flame, hot object or liquid, chemical or electrical current
- Delay in onset of clinical findings

Yanango, Peru. Feb 20, 1999

- Iridium source
- Picked up by worker and put in his back pocket
- The patient developed severe radiation burn in his pelvic area



Yanango - Peru May and December, 1999

- He survived with significant disability



Photo 15. Very large second degree burn extended to the upper third of the right thigh. The depth of the defect is significant. The burn is around the entire end of the extremity. The burn edges are well defined, inflamed and are above the surface of the surrounding tissue. They are surrounded by a discolored halo (15 May 1999).

Transfer to Burn Center

- Partial thickness burns >10% TBSA
- Burns involving the face, hands, feet, genitalia, perineum, or major joints
- Third degree burns in any age group
- Electrical burns, including lightning
- Chemical burns
- Inhalation injury

Transfer to Burn Center

- Burns in patients with pre-existing medical problems
- Combination of burns and trauma