Chapter 23
Burns

Objectives

- Describe incidence, patterns, sources of burn injury
- Describe local and systemic responses to burn injury
- Classify burn depth, extent, severity
- Discuss pathophysiology of signs and symptoms of burn shock
- Outline physical exam of burn patient

Objectives

- Describe field management of burn injury
- Discuss signs and symptoms and management of patients with:
  - Inhalation injury
  - Chemical injury
  - Electrical injury
  - Radiation injury

Scenario,

As you pull up to the scene of a house fire you see firefighters struggling to pull an elderly male out the front door. They frantically shout for you. Your patient is unconscious. You immediately notice soot and burns on his face. His clothing is smoldering, and you note white, leathery, waxy burns on his arms. You can hear the high-pitched stridor as he struggles to breathe, and the acrid smell of his burning flesh fills the air.

Discussion

- What is your first concern as you approach this scene?
- What immediate life threats do you anticipate with this patient?
- What are your priorities of care for this man?
- Why will he need the resources of a burn center?

Burn Injury

- 10,000 deaths/year
- More common in men
- Death rates high in kids and older adults
- Most deaths happen in home
- High incidence in low-income households

Major Sources of Burns

- Interaction between energy (thermal, chemical, electrical, or radiation) and biological matter
- Thermal burns
  - Most common type
  - Flames, scalds, or contact with hot substances
  - Frostbite is a type of thermal injury
- Chemical burns
  - Substances that produce chemical changes in skin with or without heat production

Major Sources of Burns

- Electrical injuries
  - Lightning injuries
  - Direct contact with electrical current
  - Arcing of electricity between two contact points near skin
  - Flash burns if fuel source is ignited

Radiation Injury

- Ionizing and nonionizing radiation
- Burns may result from high level of radiation exposure to a specific area
- Rare

Pathophysiology of Thermal Burn Injury

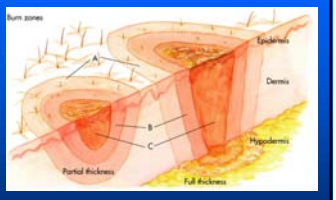
- Tissue destruction depends on:
  - Temperature and duration of exposure
- Ability to resist burn injury depends on:
  - Water content of skin tissue
  - Thickness and pigmentation of skin
  - Insulating substances (e.g., skin oils, hair)
  - Peripheral circulation of skin
    - Affects dissipation of heat

Local Response to Burn Injury

- Burn injury destroys cells or completely disrupts their metabolic functions
  - Cellular death ensues
  - Cellular damage is distributed over a spectrum of injury

Local Response to Burn Injury

- Major burns have three zones of injury
- Appear in bulls-eye pattern:
  - Zone of hyperemia (A)
  - Zone of stasis (B)
  - Zone of coagulation (C)



Systemic Response to Burn Injury

- Hypovolemic shock associated with:
  - Decrease in venous return
    - Decreased cardiac output
    - Increased vascular resistance (except in zone of hyperemia)
  - Renal failure may occur due to:
    - Hemolysis (destruction of RBCs)
    - Rhabdomyolysis (muscle necrosis)

Systemic Response to Burn Injury

- Pulmonary
- Gastrointestinal
- Musculoskeletal
- Neuroendocrine
- Metabolic
- Immune
- Emotional

Classifications of Burn Injury

- Assess and classify as accurately as possible in the prehospital setting
  - Difficult because of progressive nature of injury
  - Amount of tissue damage may not be evident for hours/days after injury

Depth of Burn Injury

- First, second, and third degree (some include fourth degree)
  - First- and second-degree burns are partial-thickness burns
    - Usually heal without surgery
  - Third-degree burns are full-thickness burns
    - Usually require skin grafts

First-Degree Burn

- Painful, red, dry, blanch with pressure
- Superficial layer of epidermal cells is destroyed
- Heals in 2-3 days

Second-Degree Burn

- Superficial partial-thickness
  - Blisters
- Injury extends through epidermis to dermis
  - If no infection, generally heals without scarring

Second-Degree Burn

- Deep partial-thickness
  - Involves basal layer of dermis
  - Sensation in and around wound may be diminished
  - May appear red and wet or white and dry, depending on the degree of vascular injury
  - Major complication is wound infection

Deep Partial-Thickness Burn

Third-Degree Burn

- Full-thickness burn
- Epidermis and dermis destroyed
  - Eschar present
  - Sensation and capillary refill absent
  - Skin grafts needed for timely and proper healing

Fourth-Degree Burn

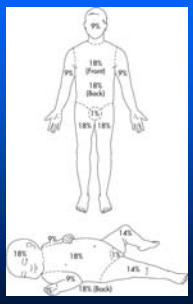
- Included in some burn classifications
- Full-thickness injury that penetrates
  - Subcutaneous tissue
  - Muscle
  - Fascia
  - Periosteum
  - Bone

Extent and Severity of Burn Injury

- Common methods
  - Rule of nines
  - Lund and Browder chart
- American Burn Association (ABA) has devised a categorization of burns to determine severity

Rule of Nines

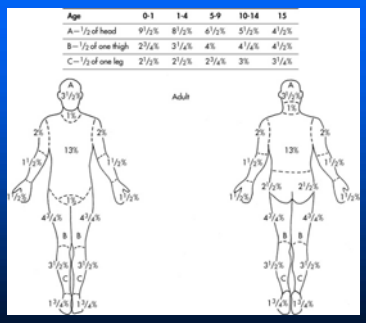
- Divides total body surface area (TBSA) into segments that are multiples of 9%
- Rough estimate of burn size
- Most accurate for adults and children >10 y/o



Lund and Browder Chart

- Accurate method to determine area of burn injury
  - Assigns numbers to each body part
- Used to measure burns in infants and young children
  - Allows for developmental changes in percentages of body surface

Lund and Browder Chart



American Burn Association Categorization

- Classifies burns as major, moderate, and minor
- Considers:
  - Patient's age
  - Medical or surgical problems
  - Burns of:
    - Face and neck
    - Hands and feet
    - Genitalia

Burn Center Referral Criteria

- Burn categorizations used to determine which patients need transport to specialized burn centers
  - American College of Surgeons and American Burn Association have 10 guidelines for burns that usually require burn center referral

Burn Shock

- Shock results from:
  - Edema and accumulation of vascular fluid in the tissues in the area of injury
  - Systemic fluid leak
- Burn shock
  - Emergent phase
  - Fluid shift phase
  - Hypermetabolic phase
  - Resolution phase

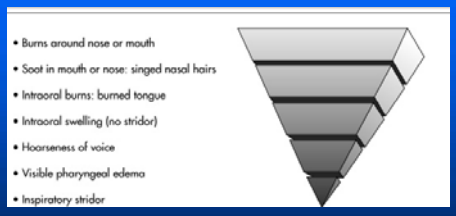
Burn Shock

- Therapy aimed at supporting patient through hypovolemic shock
  - Crystalloid solution (e.g., lactated Ringer's solution) fluid of choice in initial resuscitation
  - Three formulas for calculating fluid replacement volume:
    - Parkland formula
    - Modified Brooke formula
    - Consensus formula

Assessment of the Burn Patient

- Initial assessment
  - Airway
    - Especially patients with inhalation injury
  - Breathing
  - Circulation
  - Neurological status

Probability of Upper Airway Obstruction



History

- Chief complaint (pain, dyspnea)
- Circumstances of injury
  - Enclosed space?
  - Explosive forces involved?
  - Hazardous chemicals involved?
  - Related trauma?
- Source of burning agent (e.g., flame, metal, liquid, chemical)

History

- Significant medical history
- Patient medications (and drugs/alcohol)
- Loss of consciousness at any time
  - Suspect inhalation injury
- Last tetanus immunization

Physical Examination

- Vital signs
  - If severe burns or preexisting cardiac or medical illness, monitor ECG
- Field care and hospital destination determined by:
  - Burn depth
  - Burn size
  - Extent of burned tissue
  - Associated illness or injury

Goals of Prehospital Burn Management

- Preventing further tissue injury
- Maintaining patent airway
- Administering oxygen and ventilatory support
- Fluid resuscitation (per protocol)
- Rapid transport to appropriate medical facility
- Clean technique to minimize patient's exposure to infectious agents
- Psychological and emotional support

Stopping the Burning Process

- Provide scene safety for rescue crew
- Minor first-degree burns
  - Cool the local area with cool water

Stopping the Burning Process

- Severe burns
  - Move patient to area of safety
  - If clothing is in flames or smoldering:
    - Place patient on floor or ground
    - Roll in blanket to smother flames and/or douse with large quantities of cleanest available water
  - Remove clothing while cooling burn so heat is not trapped under smoldering cloth
  - After burn is cooled, cover patient with clean sheet

Airway, Oxygen, and Ventilation

- Administer high-concentration humidified (if available) oxygen
- Assist ventilation as needed
- If inhalation injury is suspected, closely observe for signs of impending airway obstruction:
  - Laryngeal edema may be progressive and may make tracheal intubation difficult or impossible
  - Do not delay intubation in these patients

Circulation

- Fluid resuscitation is based on:
  - Severity of injury
  - Vital signs
  - Transport time to hospital
- IV therapy
- If transport is to be delayed or interfacility transport is possible, consider:
  - Analgesics—aggressive pain control
  - NG tube placement
  - Bladder catheterization

Special Considerations

- Facial burns swell rapidly
  - Associated with airway compromise
  - Elevate stretcher at least 30 degrees (if not contraindicated by spinal trauma) to minimize edema
- Avoid pillow if ears are burned

Special Considerations

- Extremity burns
  - Remove jewelry to prevent vascular compromise from edema
  - Assess peripheral pulses frequently
  - Elevate burned limb above patient's heart
- Circumferential burns
  - Threat to patient's life or limb
  - Tourniquet-like effect on extremity or chest

Inhalation Burn Injury

- Epidemiology
- Incidence
- Morbidity/mortality
- Risk factors
- Prevention strategies

Carbon Monoxide Poisoning

- Colorless, odorless, tasteless gas
- Produced by incomplete combustion of carbon fuels
  - Does not physically harm lung tissue
- Affinity for hemoglobin 250x oxygen
  - Small concentrations of CO can cause severe physiological impairments
  - Effects of carbon monoxide poisoning related to blood CO Hgb level
- Treatment

Inhalation Injury above the Glottis

- Upper airway structures susceptible to injury if exposed to high temperatures
  - Signs and symptoms
- Prehospital care

Inhalation Injury below the Glottis

- Mechanisms of direct injury to lung parenchyma are
  - Heat
  - Toxic material inhalation
- Signs and symptoms often delayed
- Prehospital care

Chemical Burn Injury

- Three common types of caustic agents
  - Alkalis (strong bases with a high pH)
    - Hydroxides and carbonates of:
      - Sodium, potassium, ammonium, lithium, barium, calcium
      - Oven cleaners, drain cleaners, fertilizers, heavy industrial cleaners, cement and concrete
  - Strong acids
    - Rust removers
    - Bathroom cleaners
    - Swimming pool acidifiers
  - Organic compounds (chemicals that contain carbon)
    - Wood
    - Coal

Chemical Burn Injury

- Intraoral chemical burns sustained by a boy who ingested bleach

Chemical Burn Injury

- Severity of chemical injury related to:
  - Chemical agent
  - Concentration and volume of chemical
  - Duration of contact

Assessment—Chemical Injury

- Determine:
  - Type of chemical
  - Concentration of chemical
  - Volume of chemical
  - Mechanism of injury
    - Local immersion of body part, injection, splash
  - Time of contamination
  - First aid before EMS arrival
  - Appearance (chemical burns vary in color)
  - Pain

Management

- Scene safety
- Consider protective gear
- Remove all clothing, including shoes
- Brush off powdered chemicals
- Irrigate affected area with copious amounts of water

Chemical Burn Injury to the Eyes

- Causes
- Signs and symptoms
- Management
  - Antidotes or neutralizing agents
  - No agent superior to water for treating most chemical injuries

Use of nasal cannula for eye irrigation

Specific Chemical Injuries

- Petroleum
- Hydrofluoric acid
- Phenol (carbolic acid)
- Ammonia
- Alkali metals

Electrical Burn Injuries

- Epidemiology
- Incidence
- Morbidity/mortality

Types of Electrical Injury

- Tissue damage produced by electrical current depends on
  - Amperage (current flow)
  - Voltage (force)
  - Resistance
  - Type of current
    - Alternating
    - Direct
  - Current pathway
  - Duration of current flow

Types of Electrical Injury

- Direct contact burns
- Arc injuries
- Flame and flash burns

Direct Contact Burn

- Direct contact burn—entry wound (hand)
- Exit wound

Effects of Electrical Injury

- Musculoskeletal
  - Similar to crush injury
  - Myoglobin released from muscle damage
- Cardiovascular
  - Significant dysrhythmias
  - Tachycardia
  - Hypertension
  - Hemolysis releases hemoglobin
  - Blood vessel necrosis

Effects of Electrical Injury

- External burns
- Respiratory injury
  - Ventilation impaired
- Neurological injuries
  - Respiratory center depression
  - Brain tissue injury
- Myoglobin release and renal involvement

Assessment and Management

- Scene safety for rescuers or bystanders
- If patient is in contact with electrical source, consult appropriate personnel before touching patient
  - Once scene is safe, patient care can begin

Initial Assessment

- Proceed as for all other trauma patients
- Immobilize cervical spine
- If apnea, provide assisted ventilation:
  - Intubation because apnea may persist for lengthy periods
- For breathing patient, maintain a patent airway and support with supplemental high-concentration oxygen

Initial Assessment

- If patient is in cardiac arrest, resuscitation efforts should be implemented according to protocol

History

- History
  - Chief complaint (e.g., injury, disorientation)
  - Source, voltage, and amperage of electrical injury
  - Duration of contact
  - Level of consciousness before and after injury
  - Past significant medical history

Physical Examination

- Search for:
  - Entrance and exit wounds
  - Trauma caused by tetany or a fall
- Remove all clothing and jewelry
- Assess and document distal pulses, motor function, and sensation in all extremities
- Cover wounds with sterile dressings
- Manage associated trauma appropriately
- Monitor ECG

Management

- Early fluid resuscitation is critical
- Establish two large-bore IV lines in extremity without entry or exit wounds
  - Fluid of choice is LR or NS
  - Flow rate determined by patient's clinical status

Lightning Injury

- 70 deaths/year
- DC of 200,000 amps
- Potential of 100 million volts
- Injury by direct strike or side flash
- Cardiac arrest possible

Lightning Injury

- Pathway of damage often over rather than through skin
  - Lightning burns are linear, feathery, and punctate (pinpoint)
  - Classified as minor, moderate, or severe

Assessment and Management

- Scene safety
- Prevent injury from subsequent lightning strikes
- Airway and ventilatory support
- Basic and advanced life support
- Patient immobilization
- Fluid resuscitation to prevent hypovolemia and renal failure
- Pharmacological therapy (per protocol)
- Wound care
- Rapid transport to appropriate hospital

Radiation Exposure

- Industrial radiography is source
- Rarely requires emergency care
- Scene safety is a priority

Radioactive Particles

- Alpha particles
  - Skin will stop
  - Dangerous if ingested or inhaled
- Beta particles
  - Penetrate subcutaneous tissue
  - Full PPE, including SCBA, needed
- Gamma rays and x-rays
  - Most dangerous
  - Lead shields needed

Radiation Exposure

- Nonionizing radiation
  - Not usually considered dangerous
  - Radio waves and microwaves
- Ionizing radiation
  - Nuclear weapons
  - Reactors
  - Radioactive material
  - X-ray machines
  - Threat to rescue personnel

Measurements of Radiation

- Roentgens
- RAD (radiation absorbed dose)
- REM (roentgen equivalent man)
- Radiation doses

Emergency Response to Radiation Accidents

- Approach with caution
- Do not enter scene until it is secured
  - Rescue personnel, emergency vehicles, and command post positioned 200-300 ft upwind of site
  - Should not eat, drink, or smoke at accident site or in any rescue vehicle

Emergency Response to Radiation Accidents

- Contact appropriate local authorities
- Wear suitable protective clothing
- Dose meters should be available for all rescue personnel

Personal Protection from Radiation

- Factors
  - Time
  - Distance
  - Shielding
  - Quantity

Emergency Care for Victims of Radiation Accidents

- Patients who have been irradiated are not radioactive
  - Follow protocol for removing radioactive material from a patient's clothing, skin, or open wounds
  - Treat patients in normal fashion
  - Move patient away from radiation source
  - Do not delay lifesaving care for patient transfer or decontamination
  - IV fluid replacement should be initiated if indicated using strict aseptic technique

Radiation Decontamination

- Radiation emergencies may be defined as:
  - Clean
    - Patient exposed but not contaminated
  - Dirty
    - Patient contaminated
    - Only properly trained personnel should attempt to decontaminate radiation victims
  - Patients who are transported should be isolated from the environment
  - Transport all patient's effects with patient

Conclusion

Understanding the consequences of burn injuries and appropriate prehospital management can reduce morbidity and mortality in this complex patient group.

Questions?