Chapter 46
Burn Injury

Learning Objectives
- Describe the epidemiology, including the incidence, mortality, morbidity rates, risk factors, and prevention strategies for patients with burn injury
- Describe the anatomy and physiology pertinent to burn injuries
- Describe pathophysiological and systemic complications of burn injury

Learning Objectives (Cont'd)
- Identify and describe types of burn injuries, including thermal, inhalational, chemical, electrical, and radiation exposure
- Describe the epidemiology of chemical burn injury and chemical burn injury to the eye
- Describe the specific anatomy and physiology pertinent to chemical burn injury and chemical burn injury to the eye
Learning Objectives (Cont’d)

• Describe the pathophysiology of chemical burn injury, including types of chemicals, their burning processes, the chemical burn injury to the eye
• Identify and describe depth classifications of chemical burn injury
• Identify and describe the severity of chemical burn injury

Learning Objectives (Cont’d)

• Describe considerations that affect the management and prognosis of patients with chemical burn injury the chemical burn injury to the eye
• Discuss the mechanisms of burn injury and conditions associated with chemical burn injury

Learning Objectives (Cont’d)

• Describe the management of chemical burn injury and chemical burn injury to the eye, including:
   Airway
   Ventilation
   Circulation
   Pharmacological and nonpharmacological treatment
   Transport considerations
   Psychological support communication strategies
Learning Objectives (Cont’d)

- Describe the epidemiology of electrical burn injury
- Describe the specific anatomy and physiology pertinent to electrical burn injury
- Describe the pathophysiology of electrical burn injury

Learning Objectives (Cont’d)

- Identify and describe depth classifications of electrical burn injury
- Identify and describe the severity of electrical burn injury
- Describe considerations that affect the management and prognosis of patients with electrical burn injury

Learning Objectives (Cont’d)

- Discuss the mechanisms of burn injury and conditions associated with electrical burn injury
- Describe the management of electrical burn injury, including airway, ventilation, circulation, pharmacological, and nonpharmacological treatment, transport considerations, psychological support, and communication strategies
Learning Objectives (Cont’d)

- Describe special considerations for the pediatric patient with burn injury
- Identify and describe depth classifications of radiation exposure
- Identify and describe the severity of radiation exposure

Learning Objectives (Cont’d)

- Describe considerations that affect the management and prognosis of patients with radiation exposure
- Discuss mechanisms of burn injury associated with radiation exposure
- Discuss conditions associated with radiation exposure

Learning Objectives (Cont’d)

- Describe the management of radiation exposure, including airway, ventilation, circulation, pharmacological, and nonpharmacological treatment, transport considerations, psychological support, and communication strategies
Introduction

- Each year approximately 1 million people in the United States sustain some type of burn injury
- Men are more likely than women to be burned
- Women are more likely to die from burn or fire-related injuries

Burn Etiologies

- Type frequency in order:
  - Scald or flame related
  - Contact
  - Chemical
  - Electrical
- Two groups represent high-risk burns
  - Infants
  - Elderly

Burn Etiologies (Cont’d)

- Categories
  - Thermal
    - Contact
    - Flame
    - Flash
    - Scald
  - Chemical
    - Acidic or basic
    - Hydrogen concentration
Burn Etiologies (Cont'd)

- Categories
  - Electrical
    - Hidden injuries
    - High voltage
      - $>1000\,\text{V}$
      - Significant cutaneous injury
      - Internal injury
    - Low voltage
      - $<1000\,\text{V}$
  - Radiation

Anatomy and Physiology of the Skin

- Protects from outside invaders
- Helps regulate body temperature
- Maintain body fluid homeostasis

Anatomy and Physiology of the Skin (Cont'd)

- Layers
  - Epidermis
  - Dermis
  - Subcutaneous tissue
Anatomy and Physiology of the Skin (Cont’d)

• Burn zones of injury
  ➢ Coagulation
    • In full-thickness burn, central burn area is devoid of blood flow
    • Tissue not salvageable
    • Necrosis within days

• Burn zones of injury
  ➢ Stasis or ischemia
    • Weak blood supply
    • Greatest risk for necrosis if perfusion is untimely
    • >2 hours, full-thickness injury
    • Goal of fluid resuscitation preserving zone of stasis

• Burn zones of injury
  ➢ Hyperemia
    • Outside layer
    • Blanches when touched
    • Salvageable
Anatomy and Physiology of the Skin (Cont'd)

- Burn depth
  - First-degree burn
    - Superficial
  - Second-degree burn
    - Partial-thickness burn
  - Third-degree burn
    - Full thickness
  - Fourth-degree burn
    - Extremely deep

- Second-degree burns
  - Partial thickness
  - Burns with blisters
Anatomy and Physiology of the Skin (Cont’d)

- Burn depth
  - Second-degree burns
  - Partial-thickness leg burn

Anatomy and Physiology of the Skin (Cont’d)

- Burn depth
  - Third-degree burns

Anatomy and Physiology of the Skin (Cont’d)

- Burn depth
  - Fourth-degree, electrical burn
Burn Classification

- Minor
  - Partial thickness, involving <15% of total body surface area in adults, <10% in children and the elderly
  - Full thickness, involving less than 2% total body surface area (TBSA) and not involving an area of function

Burn Classification (Cont’d)

- Moderate
  - Partial thickness, involving 15-25% TBSA in adults or 10-20% in children or the elderly
  - Full thickness, involving 2-10% TBSA, and not involving an area of function such as the face, eyes, hands, feet, or perineum
  - Do not include high-voltage electrical injury
  - Not complicated by inhalation injury or trauma
  - Does not occur in high-risk individuals

Burn Classification (Cont’d)

- Severe (or major)
  - Partial thickness, involving >25% TBSA in adults or >10% TBSA in children <10 years old and adults >50 years old
  - Full thickness, involving >10% TBSA
  - Involve areas of function
  - Caustic chemical burns
  - Result from high-voltage electrical injury
  - Complicated by inhalation injury or trauma
  - Occurs in high-risk individuals
Pathophysiology of Burned Skin

- Overview
  - Size is chief factor for seriousness
  - Body surface area (BSA)
  - Total body surface area burned (TBSAB) referenced
  - Chemical and electrical burns not related to TBSAB
  - Inhalation injury decreases overall survival rate

Pathophysiology of Burned Skin (Cont'd)

- Infection and sepsis
  - Most common cause of death with burns: multiple organ failure
  - Other causes of death
    - Pneumonia
    - Burn shock
    - Pulmonary failure and sepsis
    - Cardiovascular failure

Pathophysiology of Burned Skin (Cont'd)

- Infection and sepsis
  - Sepsis
    - Caused by inflammation and/or infection
    - Organisms responsible
      - Resistant to antibiotics
      - Causes invasive wound infections
      - Spreads through bloodstream to lungs, heart, brain, stomach
Pathophysiology of Burned Skin (Cont'd)

- Infection and sepsis
  - Sepsis
    - Acinetobacter
    - Wound, lungs, blood
    - Difficult to treat

Assessment and Treatment

- ABCs
- Inhalation injuries
  - Airway must be controlled early--signs/symptoms
    - Cough
    - Carbonaceous sputum
    - Soot on tongue
    - Dyspnea
    - Tachypnea
    - Decreased level of consciousness
    - Hoarse voice

Assessment and Treatment (Cont'd)

- Inhalation injuries
  - Risk increases in:
    - Enclosed space exposure to smoke and/or fire
    - Facial burns
    - Chemical gas exposure
    - CO exposure
  - Must gain vein access
    - IV is best route
Assessment and Treatment (Cont'd)

- Thermal injury, must stop burning process
  - Cut burning clothes away after extinguishing them
  - Ensure ABCs
- Administer 100% O₂ and establish IV access as soon as possible
- IV through unburned skin

Assessment and Treatment (Cont'd)

- With few exceptions, treat with dry dressings
- Do not need to apply water, saline, other irrigants

Assessment and Treatment (Cont'd)

- Complications of prolonged/widespread irrigation
  - Hypothermia
  - Vasoconstriction
  - Metabolic acidosis
  - Coagulopathy
- Hot tar burn
  - Traps heat
  - Must irrigate
Assessment and Treatment (Cont'd)
- Dressings
  - Common kitchen plastic wrap
  - Gel material
  - Avoid use of large gel blankets
- Vasoconstriction
  - Decreases blood supply to zone of ischemia

Estimation of Body Surface Area
- Rule of nines
  - Keep chart available
- Patient's palm

Chemical Burns
- Cutaneous injury
  - Direct contact with dry, liquid, or gaseous chemicals
- Inhalation and lung injury
  - Most common when individuals inhale chemicals in gas form
Chemical Burns (Cont'd)

- Acids
  - Sulfuric
  - Hydrochloric
  - Hydrofluoric
  - Tannic
- Bases
  - Sodium bicarbonate
  - Calcium carbonate
  - Most soaps, other cleaning agents

Chemical Burns (Cont'd)

- Vesicants
  - Mustard gas
  - Lewisite
- Organics
  - Paint stripper
  - Paints
  - Lacquers
  - Cleaning supplies
  - Degreasing and hobby projects

Chemical Burns (Cont'd)

- Pathophysiology
  - Physically destroy proteins integral to cell and tissue support
  - Wreak havoc with intracellular and intercellular communication through ion channels
  - Strong acids
  - Weak acids
Chemical Burns (Cont'd)

- Injury depends on pH and attached ionic chemical
- Acid exposure creates tissue damage through coagulative necrosis
- Bases are lipophilic

Chemical Burns (Cont'd)

- Gaseous form
  - Less likely to cause direct tissue damage
  - Can be absorbed, inhaled systemically
  - When inhaled, can cause severe damage to airways and alveoli of lungs
    - Diffuse inflammatory reaction in lungs
    - Acute lung injury
    - Effect leads to hypoxia

Chemical Burns (Cont'd)

- Vesicants
  - Destroy tissue by disrupting proteins that hold membranes together
  - Widespread blistering of eye and pulmonary tree lining
Chemical Burns (Cont'd)

- Organic solvents
  - Home and industrial
  - Severity depends on concentration, length of contact, BSA involved

Chemical Burns (Cont'd)

- Therapeutic interventions
  - MSDSs have information on toxicity
  - Cutaneous chemical exposure
    - ABCs
    - Remove chemical from skin
    - Protect yourself from becoming exposed

Chemical Burns (Cont'd)

- Therapeutic interventions
  - Cutaneous chemical exposure
    - Solid chemical
      - Remove clothing
      - Brush as much chemical as possible off skin
      - Remain downwind of patient
      - Thorough lavage
      - Assess chemical reactivity with water
      - Skin and hair irrigation for 3-5 minutes
      - Eye irrigation for 5 minutes
      - Oil base chemicals, wash with soap and water
      - Do not neutralize with another chemical
Chemical Burns (Cont'd)

- **Therapeutic interventions**
  - **Cutaneous chemical exposure**
    - Liquid chemical complications
    - Colorless, makes ID of exposed areas difficult
    - Runoff from lavage contaminates surroundings
    - Rapid absorption through skin and contamination of clothing pose risk for prolonged exposure
    - Extensive irrigation or lavage
    - Hazmat units with portable showers used when possible

Chemical Burns (Cont'd)

- **Therapeutic interventions**
  - **Cutaneous chemical exposure**
    - Acid and alkaline exposure
      - Bring pH back to normal
      - Large volume of water
      - Possible hypothermia

Chemical Burns (Cont'd)

- **Therapeutic interventions**
  - **Chemical inhalation**
    - Factors for disbursement
      - Wind and speed direction
      - Chemical weight
      - Containment
Chemical Burns (Cont'd)

**Therapeutic interventions**

- **Chemical Inhalation**
  - Treatment
    - Remove exposed patient from environment
    - Remove chemical from patient
    - Secure airway
    - Provide supplemental O₂
    - Assist with ventilation
    - CO₂: move patient to area with low CO₂ concentration
    - Chlorine: significant toxicity on lungs
    - Water lavage and irrigation
    - Airway control
    - Paramedic safety

- **Chemical Eye Burn**
  - Concentration and exposure time
  - Alkalis penetrate more rapidly than acids
  - pH >11.5, irreversible damage
  - Dilute agent
  - Psychological implications, blindness

- **Special considerations**
  - Hydrofluoric acid
    - Concentrations of 2.5% can cause severe hypocalcemia
    - Concentrations of 5% can cause severe burns
  - Continuous burn
  - Hypomagnesemia
  - Hyperkalemia
  - Notify ER
Chemical Burns (Cont'd)

- Therapeutic interventions
  - Special considerations
    - Hydrofluoric acid
      - Physical findings
      - Flush area for 15 minutes
      - Ocular exposure—flush for 20 minutes
      - Do not induce vomiting, administer activated charcoal
      - Hypocalcemia—IV of 10% calcium gluconate solution per medical direction

Chemical Burns (Cont’d)

- Therapeutic interventions
  - Special considerations
    - Hydrogen fluoride
      - When dissolved in water, creates hydrofluoric acid
      - Inhalation injury
      - Do not generally burn skin
      - Pulmonary effects
      - Treat for pulmonary edema and bronchoconstriction

Chemical Burns (Cont’d)

- Therapeutic interventions
  - Special considerations
    - Alkali metals
      - Lithium
      - Sodium
      - Potassium
      - Rubidium
      - Violent exothermic reactions in water
      - Once ignited, difficult to extinguish
      - Treatment
Chemical Burns (Cont'd)

- Therapeutic interventions
  - Special considerations
    - Phenol
      - Flammable aromatic acid
      - Antiseptic and anesthetic properties
      - Possible pediatric overdose through significant skin contact
      - Causes coagulative necrosis

- Therapeutic interventions
  - Special considerations
    - Phenol signs/symptoms
      - Burns are initially red and swollen, later white and opaque
      - Painless or numb
      - Ingestion - abdominal pain, nausea, vomiting, diarrhea
      - Inhalation - respiratory distress, tachycardia, pulmonary edema, hypoxia, cyanosis

- Therapeutic interventions
  - Special considerations
    - Phenol systemic complications
      - Diaphoresis
      - Dysrhythmias
      - Shock
      - Cardiovascular collapse
      - Tachycardia
      - Hypotension
      - Agitation
      - Seizure
      - Coma
Chemical Burns (Cont’d)

- Therapeutic interventions
  - Special considerations
    - Phenol treatment
      - Reduce and stop absorption
      - Wash with polyethylene glycol 400 or polyethylene 300
      - Glycerin and isopropyl alcohol
      - Copious amounts of water
      - Irrigate for 15-20 minutes, continue until no odor
      - Ingestion - do not encourage vomiting, use activated charcoal to block further absorption
    - ABCs
    - Notify ED

Chemical Burns (Cont’d)

- Therapeutic interventions
  - Special considerations
    - Phosphorus
      - Waxy solid that spontaneously ignites
      - Causes thermal and acid burns
      - Garlic odor
      - Treatment aimed at stopping burn and removing residual phosphorus
      - Immerse affected area in water to remove O2

Chemical Burns (Cont’d)

- Therapeutic interventions
  - Special considerations
    - Lime
      - Alkali
      - Combined with water, forms heat
      - Must flood area with large amounts of water to avoid continuing burn
Electrical Impulses

- Associated musculoskeletal trauma common
- Low voltage: <1000 V
- High voltage: >1000 V

Electrical Impulses (Cont’d)

- Flash electrical burn
  - Metal object makes contact with electrically charged fuses
  - Burns to face and hands, eyes

Electrical Impulses (Cont’d)

- Physical examination
  - High-voltage electrical injuries
    - Explosive damage to tissues
    - Muscle damage
    - Cardiac injury
    - Skeletal muscle injury
Electrical Impulses (Cont’d)

- Physical examination
  - High-voltage electrical injuries
    - Skeletal trauma
      - Long bones can fracture under stress of massive skeletal muscle contraction caused by energy passing through the body
    - Vertebral column fracture
    - Throw injuries
    - Full spinal immobilization
    - Splint suspected long bone fractures

Electrical Impulses (Cont’d)

- Physical examination
  - High-voltage electrical injuries
    - Blood vessel and nerve damage
      - Critical arteries damaged
      - Insufficient distal arterial flow
      - Coagulate blood flow within vessels
      - CNS and PNS at risk for injury
      - Spinal cord injury
      - Peripheral nerve damage
      - Neuralgia

Electrical Impulses (Cont’d)

- Therapeutic interventions
  - Ensure own safety
  - Assess scene
  - Turn off power source regardless of MOI
  - ABCs
  - Assume spinal trauma, full spinal immobilization
  - Immobilize suspected long-bone injuries
  - IV fluids at 1000 mL/hr in adults per medical direction
  - Cutaneous and thermal burns–dry dressings
Electrical Injuries

- Lightning injuries
  - Same as high-injury voltage treatment
  - If outside, rapidly stabilize, immobilize, and move to safer venue
  - Scene safety

Electrical Injuries (Cont'd)

- Lightning injuries
  - Warning signs of lightning strike
    - Tingling sensation in hair or skin
    - Buildup of static electricity
    - Unusual odors
    - Assume lightning position
Electrical Injuries (Cont’d)

- Lightning injuries
  - Mechanisms causing lightning injuries
    - Electrical current
    - Secondary blunt trauma
  - Ferning or Lichtenberg flowers
    - Burn patterns from lightning

- Other injuries
  - Tympanic membrane rupture
  - Hearing loss
  - Amnesia
  - Confusion
  - Seizures
  - Pulmonary contusions
  - Hemorrhages
  - Edema

Pediatric Burn Injuries

- Most common
  - Scalds
  - Contact burns
  - Flame or fire

- Epidemiology and demographics
Pediatric Burn Injuries (Cont’d)

- Skin anatomy
  - Dermis thinner than adults
  - Partial thickness in adult is full thickness for child

Pediatric Burn Injuries (Cont’d)

- Physical examination and estimating burn injury size in children
  - Disproportionate BSA of head and extremities
  - Separate burn assessment diagram used
  - Lund-Browder chart
  - More fluid is not better, can cause congestive heart failure
  - Abdominal compartment syndrome
Burn Shock

- Relative hypovolemic shock
- Distributive shock
- Comparable to septic shock

Burn Shock (Cont’d)

- Capillary leak
  - Thermal injury to capillaries and larger vessels
  - Destruction or red blood cells, contributes to anemia
- Universal loss of fluid
  - Gaps between cells that comprise capillary walls

Burn Shock (Cont’d)

- Cytokine release
  - Cause capillaries to open, leak plasma into surrounding tissue
  - Causes plasma to collect in third space, interstitium
  - Fluid shift causes burn wound edema
  - Eyes, brain, bowel engorged
  - Myocardial depressant factor
Therapeutic interventions for burn shock:
- Burn resuscitation
  - Capillary leak begins to resolve
  - Interstitial fluid shifts
  - Volume returned to vascular tree

Consensus formula
- Total volume administered divided by 2
- Result administered over first 8 hours
- Infants—maintenance fluid with dextrose
Burn Shock (Cont’d)

- Therapeutic interventions for burn shock:
  - Burn resuscitation
    - Fluid resuscitation in pediatric patients
    - Children have stiff and noncompliant left ventricles
  - Burn unit resuscitation
    - Tailor fluid based on:
      - Hourly urine output
      - Serum base deficit
      - Serum lactate level

- Distributive shock
- Cytokines
- Fluid shift

- Therapeutic interventions
  - Burn resuscitation
    - Fluid resuscitation in pediatric patients
    - Burn unit resuscitation
Inhalation Injury

- Description and definition
  - Smoke inhalation
  - Thermal injury to airways
  - Mortality rate is 30%
  - Cellular hypoxia, eventual death

Inhalation Injury (Cont’d)

- Airway anatomy
  - Upper airway
    - Respiratory tract above glottis
    - Injury affects:
      - Vocal cords
      - Larynx
      - Trachea
      - Bronchi
      - Bronchioles
      - Alveoli
    - Injury most often from direct thermal injury

Inhalation Injury (Cont’d)

- Airway anatomy
  - Lower airway
    - Particles inhaled damage cellular lining of respiratory tract
    - Widespread sloughing of airway lining
    - With mucus, debris blocks lower airway, forms concretions difficult to expectorate
    - Lung segment collapse behind obstruction
    - CO inhalation injury
Inhalation Injury (Cont’d)

- Chemicals
  - CO
  - Cyanide
    - Produced in fires involving nitrogen-containing polymers
    - Toxicity from inhibition of cellular oxygenation
    - Disables respiratory chain of mitochondria

Inhalation Injury (Cont’d)

- Chemicals
  - Hydrogen chloride
    - Produced by combustion of polyvinyl chloride
    - Severe damage to respiratory tree and pulmonary edema
  - Aldehydes
    - Chemicals/byproducts of wood and kerosene combustion
    - Irritability and edema of respiratory tract

Inhalation Injury (Cont’d)

- History and physical examination
  - Time important
    - Unrecognized injury, airway edema develops rapidly
    - Fatal closure of trachea, bronchi
    - Environment found
    - Visual examination
    - Listen with stethoscope
Inhalation Injury (Cont’d)

- Differential diagnosis
  - Asthma
  - Emphysema
  - Congestive heart failure with pulmonary edema
  - All may exacerbate with burn or smoke inhalation injury

- Therapeutic interventions
  - ABCs
  - High-flow O₂ immediately
  - ET intubation—“one chance” attempt

Radiation Exposure and Injuries

- Etiology
  - Everyday life exposure
  - Dirty bombs
  - “Radioactive materials” vehicles
- Rare cause of burn injury
- Types of radioactive particles
Radiation Exposure and Injuries (Cont'd)
- Types of radioactive particles
  - Alpha
  - Beta
  - Gamma

Radiation Exposure and Injuries (Cont'd)
- Therapeutic intervention: acute care for the radiation-exposed patient
  - Rest, fluids, antiemetic medications
  - Decontamination
  - Dirty even

Radiation Exposure and Injuries (Cont'd)
- Personal protection from radiation exposure
  - Decrease exposure time
  - Increase distance from source
  - Use shielding devices
  - Limit aggregate quantity
Analgesia for Burn Patients

- Pain reception, analgesia
  - Pain sensation from tissue injury with activation of nociceptive pain fibers
  - Once stimulated, pain impulse travels by nerve fibers to spinal cord, reaching brain
  - Narcotics most commonly used for acute burn
  - Pain difficult to control
  - Larger burns with capillary leak syndrome

Analgesia for Burn Patients (Cont’d)

- Administration of analgesics
  - IV route
  - If cannot use IV route, intramuscular or subcutaneous routes
  - Per medical control, 5 mg morphine

Indication for Transport, Transfer to Burn Center

- Criteria
  - Partial thickness >10% TBSA
  - Face, hands, feet, genitalia, perineum, major joints
  - Third-degree burns
  - Electrical burns
  - Chemical burns
  - Inhalation injury
  - Preexisting medical disorders
  - Children
  - Special social, emotional, long-term rehabilitation
Care in Burn Center

- Initial care
  - Patient reassessed
  - Indicators of adequate resuscitation assessed

Care in Burn Center (Cont'd)

- Additional care
  - Wound care
    - Hypermetabolic state
    - Debridement
    - Bio burden

Care in Burn Center (Cont'd)

- Additional care
  - Nutrition
    - Burns >15% TBS - need exogenous proteins, carbohydrates, fats
    - Burns >20% TBSA - feeding tube
    - Rebuild structure of injured skin
    - Aid in incorporation of grafted skin over burn area
Care in Burn Center (Cont’d)

- Additional care
  - Surgical care of burn patient
    - Involve full thickness of dermis
  - Invasive wound infection
  - Cover wound with elemental silver product
  - Larger burns cause immunosuppression, infectious complications
  - Hygiene important—patient isolated, good barrier protection
  - Skin grafting
  - Early excision and grafting—2 to 3 days

Psychosocial Issues and Burn Injuries

- Nightmares, depression
- Acclimating to home, work, school
- Long-term problems
  - Debilitating scar contraction, possible plastic surgery
  - Acclimating to warm and cold environments
  - Burn itch

Burn Prevention

- Scald injury to infants
- Electrical injury in persons not involved in maintenance of utilities
- Burns related to improper use of petroleum accelerants
- Burns related to flammable clothing
Chapter Summary

- Approximately 1 million people are burned each year in the United States
- Majority of burn patients are male
- High-risk groups for sustaining burn injuries include:
  - Infants (10% of all patients), the elderly (14%),
  - and those in high-risk occupations

Chapter Summary (Cont’d)

- Burns are categorized by cause, size (BSA involved), and depth
- Major categories of burns are thermal, chemical, radiation, and electrical
- BSA is approximated by using the rule of nines or the Lund-Browder chart;
  approximating the size of the burn is critical

Chapter Summary (Cont’d)

- Depth is categorized as superficial thickness (first degree), partial thickness (second degree), or full thickness (third degree)
- Skin is the largest organ in the body, is quite complex, exists in layers, and correlates with depth of burn injury
  - Skin is responsible for, among other functions, controlling body temperature, preventing invasion of infectious organisms, and maintaining water balance
Burns partial or full thickness have three zones of injury:
- Zone of coagulation, necrosis (innermost)
- Zone of ischemia (middle, outer zone)
- Zone of hyperemia (outermost zone)

Superficial burns:
- Painful, nonblistered, best represented by the common sunburn

Partial-thickness burns:
- Pink, moist appearing, quite painful, blistered, have intact blood supply

Full-thickness burns:
- Grayish-white appearance, insensate, have lost the blood supply

Inhalation injury (commonly called smoke inhalation)
- Alone, significant inhalation injury results in a 30% mortality rate
- Signs include cough (productive, nonproductive), tachypnea, hypoxemia
Chapter Summary (Cont’d)

- Symptoms of inhalation injury include dyspnea, air hunger, and fatigue
- Treatment of inhalation injury includes high-flow oxygen and intubation if necessary
- Early intubation is the key to preventing early, devastating loss of airway

Chapter Summary (Cont’d)

- Treatment of the cutaneous component of burn injury involves:
  - Dry, clean, sterile dressings, IV fluid resuscitation for burns larger than 15% TBSA, and pain control
  - With the exception of tar, asphalt, or chemical burns, lavage/irrigation of burns should not be used
  - Lavage will result in hypothermia, which substantially increases morbidity in burn patients

Chapter Summary (Cont’d)

- Cutaneous exposure to chemicals causes varying burn depth, primarily from two factors: pH of the chemical and length of exposure time
- Chemicals are broadly categorized as either acidic (pH less than 7) or alkaline (pH greater than 7)
- Basic understanding of chemistry is essential for treating chemical burns
Chapter Summary (Cont’d)

- Chemical, tar burns are rare exceptions to the "no irrigation" rule in burn care
  - Chemicals should be diluted to prevent ongoing burn injury
  - Tar and asphalt burns should be cooled with water to prevent ongoing, deep burn injury when trapped heat is contained beneath a blanket of molten material.

Chapter Summary (Cont’d)

- Inhalation of chemicals can cause serious lung injury; inhalation remains a significant threat to those involved in the initial incident and those responding to the incident
- Other manners of exposure to chemicals include absorption, ingestion, and injection

Chapter Summary (Cont’d)

- Electrical injuries may occur in the home, as part of occupational hazards, and in recreation
- Most common cause of immediate death with electrical injury is ventricular fibrillation
- Electrical injuries are categorized as either high or low voltage
  - Energy of less than 1000 V low voltage and energy greater than 1000 V high voltage
Chapter Summary (Cont’d)

- Example of low-voltage is household current; example of high voltage is lightning.
- Low-voltage and high-voltage injuries:
  - Low-voltage injuries cause flash burns and minor muscle/cutaneous injury from direct contact.
  - High-voltage injuries cause devastating muscle, bone, and nerve injury.

Chapter Summary (Cont’d)

- High-voltage injuries are treated with:
  - Spinal, long bone immobilization, and aggressive fluid resuscitation.
- Pediatric burn injuries are common.

Chapter Summary (Cont’d)

- Dermal portion of skin of children is much thinner than adults.
  - At increased risk for deep burn injury.
- Fluid resuscitation in children must be undertaken with caution.
Burn shock is a unique form of shock, distributive shock. Hallmark is capillary leak. Intravascular loss of fluid in the form of plasma, leaked through capillaries, into third space. Burn shock is treated with fluid resuscitation in a staged manner. Administration is then slowed as fluid moves back into intravascular space. Fluid resuscitation for burn injury is undertaken with balanced salt solution. More fluid in burns is not necessarily better. Formula used for adult burn resuscitation is consensus formula; it calls for 2-4 mL/kg/TBSAB of IV fluid given over the first 24 hours after burn injury.
Chapter Summary (Cont’d)

- Rarely will a significant amount of fluid be given in the prehospital setting
- Paramedics should understand that an IV rate of more than 250 mL/hr is rarely needed
- Radiation-associated burn injuries are rare but pose an exceptional danger to both patient and provider

Chapter Summary (Cont’d)

- Three types of radioactive particles: alpha, beta, gamma
- Gamma radiation is the most dangerous
- All types of radioactive particles exist in communities paramedics serve

Chapter Summary (Cont’d)

- Treatment of radiation exposure focuses on principles of decreased exposure time, removal from source, and decontamination
  - For all types of radiation, aggregate quantity should be limited
- Pain is a significant problem with all types of burn injury; controlling pain is an important step in care of the burn patient
Chapter Summary (Cont’d)

- Preferred route of administration in the acutely injured burn patient is IV
  - Subcutaneous and intramuscular routes can be used but are less effective because of poor perfusion of these tissues

Chapter Summary (Cont’d)

- The following types of burns should be referred to a qualified burn center for care:
  - Partial-thickness burns of more than 10% TBSA
  - Burns involving hands, feet, genitalia, face, perineum, or major joints
  - Third-degree burns in any age group
  - Electrical burns, including lightning injury
  - Chemical burns
  - Inhalation injury (with or without burns)
  - Burns with associated trauma of any type

Chapter Summary (Cont’d)

- The following types of burns should be referred to a qualified burn center for care:
  - Burns in patients with special social, emotional, and long-term rehabilitative needs
  - Burns in children if the current institution lacks qualified personnel and equipment necessary to care for children
  - Care at a burn center is a continuation of care begun in the prehospital setting
Chapter Summary (Cont’d)

- Goal in treatment of the burn patient is to restore function, at all levels, to as close to the preburn injury state as possible.

Chapter Summary (Cont’d)

- Surgical care of burn wounds includes:
  - Simple wound care with debridement
  - Surgical excision of wounds with skin grafting
  - Reconstructive surgery to restore the normal contour of the body
  - Function of motion
  - Improve cosmetics

Chapter Summary (Cont’d)

- Prevention, goals of ABA, burn centers
  - Overwhelming majority of burn injuries are preventable
Questions?