Objectives

- Describe the pathophysiology that occurs with electric injuries
- Discuss specialized assessment techniques utilized when caring for a patient with an electric injury
- Outline the principles of management for the patient with an electric injury
Electric Injury: The Grand Masquerader

- Small surface injuries may be associated with devastating internal injuries
- 1,000 deaths per year
- Often work-related
- Significant public health & economic impact
Types of Electric Injury

- High voltage – 1,000 volts or greater
- Low voltage

Mechanisms
- Current
- Arc
- Flash
- Ignition of clothing
Body becomes part of the electric current

Injury extent determined by
- Strength of current
- Duration of contact

**Ohm's Law**

Current \( (I) \) is
- Directly proportional to Voltage \( (V) \)
- Inversely proportional to resistance \( (R) \)

\[ I = \frac{V}{R} \]
Tissue Injury

Extent of injury dependent upon

- Type of current
- Pathway of flow
- Local tissue resistance
- Duration of contact

- Current flow is related to cross-sectional area of the involved body part
Once resistance is overcome, current flows through underlying tissue.

Body acts as a volume conductor.

Current flows throughout the involved body part.
- Bone has high resistance
- Current flows along bone surface
- Generated heat damages adjacent muscle
- Deep muscle injury may occur when superficial muscle appears normal
Indicators of High-Voltage Electric Injury

- Loss of consciousness
- Paralysis or mummified extremity
- Loss of peripheral pulse
- Flexor surface burns (antecubital, axillary, inguinal, popliteal)
- Myoglobinuria
- Serum CK above 1,000 IU
- Cardiac &/or pulmonary arrest at scene
Measured in amperes (A)

- **Alternating (AC)** by reversal of electron flow every half cycle
  - Most commercial applications
  - More dangerous (tetany, death from cardiac fibrillation, respiratory muscle paralysis)

- **Direct (DC)**
  - Lightning
  - Car batteries
  - Medical devices
Types of Injury Based on Mechanism

Alternating Current

- Electricity flows back and forth from power source to anatomic contact point of patient
- Contact sites, but no true entrance / exit sites

Direct Current

- Travels in one direction
- Entrance & exits sites may be seen
Types of Injury Based on Mechanism

Arcing

Ionization of air particles between two conductors

- Heat can reach 4,000 °C
- Can vaporize metal
- Causes clothing to ignite, resulting in flame burns
- Form of explosion dissipates excess energy
- May result in associated blunt trauma
Types of Injury Based on Mechanism

Flash

- Result from power source or ignition of clothing or surroundings
- Flame burn can occur without underlying tissue injury
Risk is 1 in 280,000

Kills 80 – 100 people in US annually

Associated with 30% mortality

70% of survivors suffer serious complications

Direct current
Characteristics
- Not associated with deep burns
- Cardiac & neurological damage
- Presentation varies widely

Injury results from
- Direct strike
- Side flash (current discharges through the air from object to victim)
- Side flashes most common type of injury
- Immediate myocardial depolarization
- Respiratory paralysis
Secondary Survey

- Head to toe exam
- Remove clothing & jewelry
- Identify contact points
- Estimate extent of surface burn
- Perform a detailed neurological exam
- Document changes over time
- Assess for orthopedic injuries, occult internal injuries, evidence of compartment syndrome
Resuscitation

- 2 large bore IV lines
- Initiate LR fluid therapy
  - Calculate surface burns
  - Initial estimate of fluid requirements based on surface burns
- ↑ UOP to 75 – 100 cc/hr if hemochromogens present
- Indwelling urinary catheter required
12 lead ECG

Cardiac monitoring for dysrhythmias or ectopy
Circumferential cutaneous burns or electric contact site:

- Assess skin color, capillary refill and peripheral pulses hourly

Remove all jewelry

Surgical intervention for vascular compromise
Muscle Compartment Syndrome

- ↑ pressure in compartment, due to edema causes ↓ blood flow to muscle
- When pressure exceeds capillary pressure, muscle damage occurs
- Symptoms include
  - Severe pain with flexion or extension of the muscles within the compartment
  - Numbness or tingling in a hand or foot
  - Decreased or absent pulses
Surgical Intervention for Vascular Compromise

- **Escharotomy**: if compromise is related to circumferential cutaneous burn

- **Fasciotomy**
  - Needed in face of subfascial edema
  - Muscle compartment pressure elevation
Upper Limb

- Protect the ulnar nerve
- Incise the skin and subcutaneous tissue and open underlying fascia
- Carpal tunnel release may be necessary
- Consult with burn center physician before proceeding
Lower Limb

- All 4 compartments susceptible, as muscle enclosed between bones & tight intermuscular septum
Electric Burns in Pediatric Patients

Characteristics

- Low voltage most common
- Generally occur in households
  - Faulty insulation
  - Electrical appliances
  - Frayed electric cords
  - Insertion of metal objects into socket

Wound Care

- Usually a minimal cutaneous injury
- Oral commissure burns may result in delayed bleeding
Electric injuries frequently seen in emergency settings

Often associated with blunt trauma

Necessitate prompt initiation of fluid resuscitation with high UOP to clear hemochromogens

Assess peripheral circulation

Assess cardiac status