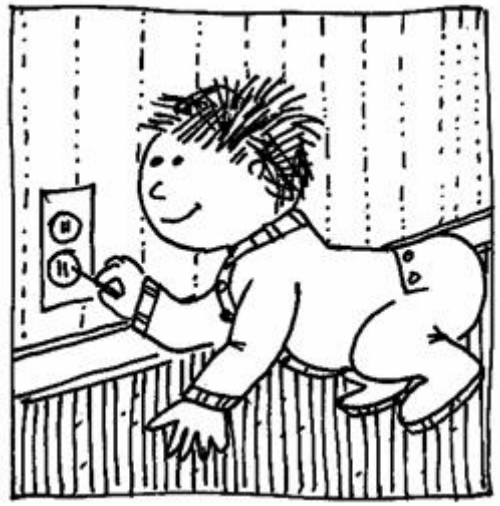


Electrical Burns

新光急診 張志華

Electrical Burns

- Definition
  - Cellular damage due to electrical current
  - High vs. low tension injuries
    - 1,000 Volts dividing line

Electrical Burns - Pathophysiology

- **Joule Effect**:
  - Passage of current through a solid conductor results in conversion of electrical energy to heat

- **Ohm's Law**:
  - $I = V / R$
  - Intensity of the current (amperage) is directly proportional to the potential flow (voltage) and inversely proportional to the resistance

Electrical Burns - Pathophysiology

- **Joule's Law**:
  - $J = 0.24 \cdot I^2 \cdot R \cdot T$
    - J = Heat Production
    - I = Current
    - R = Resistance
    - T = Time

Electrical Burns - Pathophysiology

- Resistance of body tissues
  - Nerves and Blood Vessels
    - Good to excellent conduction
  - Muscle
  - Bone and Skin
    - Resistant to passage of electricity

Electrical Burns - Pathophysiology

- Extent of injury depends on:
  - Type of current (alternating vs direct)
  - Pathway of flow
  - Local tissue resistance
  - Duration of contact

Electrical Burns - Pathophysiology

- Mortality of electrical burns
  - Low-voltage injuries
    - Alter the cardiac cycle
  - High-voltage injuries
    - Cause concomitant tissue damage
    - Survival of contact with voltage greater than 70,000 volts uncommon

Electrical Burns - Acute Care

A - Airway

B - Breathing

C - Circulation

D - Disability

E - Expose the patient

- Look for occult injuries

Electrical Burns - Acute Care

- Airway / Breathing
  - Always examine for airway patency
  - Think of pneumothorax
    - Not uncommon with high-tension injuries
- Circulation
  - ? History of cardiac arrest
  - ECG and ECG monitoring

Electrical Burns - Acute Care

- Circulation
  - Assess peripheral circulation
    - ? Need for escharotomy / fasciotomy
    - May measure muscle compartment pressures
- Disability
  - Neurological status
  - Assess for focal motor and sensory deficits

Electrical Burns - Acute Care

- Skin damage from electrical burns
  - Contact Burns
    - Entry and exit points
  - Arc Burns
    - Current exiting and entering adjacent parts in close proximity
  - Thermal Burns
    - Ignition of clothing

Electrical Burns - Acute Care

- Detailed evaluation
  - Look for other causes of shock
    - Large fluid loss from muscle damage
    - Possibility of associated hemorrhage
      - Vascular injury from associated fractures
      - Chest or abdominal trauma
    - Perforation of intra-abdominal viscus

Electrical Burns - Acute Care

- Detailed evaluation
  - Nervous System
    - Respiratory / extremity paralysis
    - Hemiplegia, aphasia, cerebellar dysfunction, and epilepsy
    - Physiologic spinal cord transection
      - Up to 25% of high voltage injuries

Electrical Burns - Acute Care

- Laboratory - Urinalysis
  - Presence of hemoglobin and myoglobin
    - Lysis of RBC's
    - Destruction of muscle
- Cardiac enzymes
  - Damage to cardiac muscle

Electrical Burns - Acute Care

- Radiology
  - Chest X-Ray
    - Rule of pneumothorax
  - Cervical, thoracic, and lumbar Spine
  - Limbs
    - Fractures and dislocations from tetanic contractions

Electrical Burns - Treatment

- Immediate first aid
  - Protect yourself
  - Cardiopulmonary resuscitation
- ECG abnormalities
  - Continued cardiac monitoring
  - Pharmacologic treatment of dysrhythmia

Electrical Burns - Treatment

- Initial evaluation
  - **A**irway / **B**reathing
    - May require respiratory support
  - **C**irculation
    - Maintain intravascular volume
  - **D**isability
    - Associated injuries

Electrical Burns - Treatment

- Fluids
  - Exceeds predicted formulas
  - Chromogens in urine
    - Maintain urine output > 1cc/kg/hr
  - Osmotic diuretic
    - Mannitol
  - Alkalinization
    - Add bicarbonate to fluids

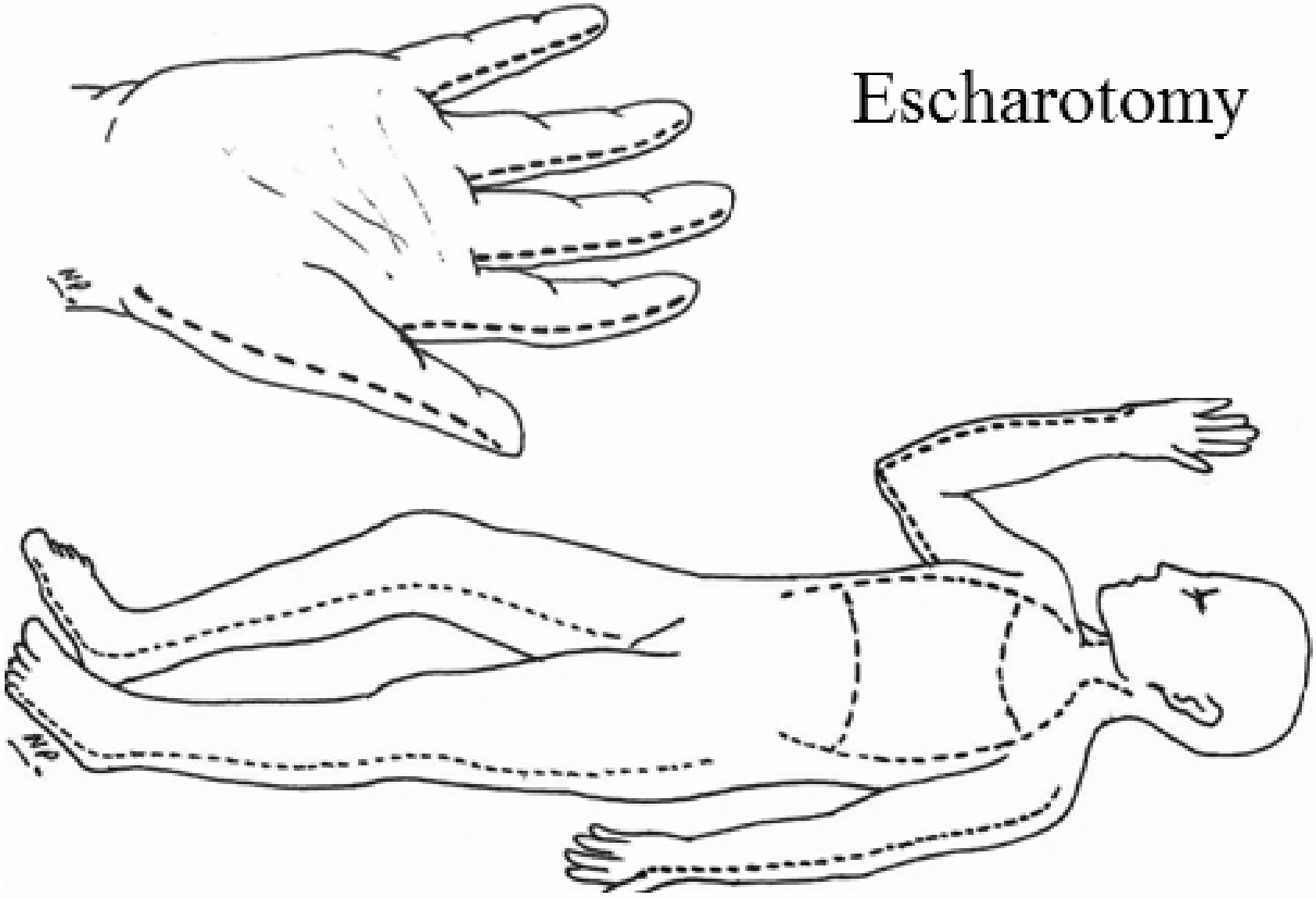
Electrical Burns - Parkland formula

- IV fluid - Lactated Ringer's Solution
- **4** x **BW** in kg x % **TBSA** burn
  - Give 1/2 of that volume in the first 8 hours
  - Give other 1/2 in next 16 hours
- Warning: fluid rate should be gradually reduced throughout the resuscitation to maintain the targeted urine output

Electrical Burns - Treatment

- Wound management
  - Early **escharotomy** and **fasciotomy**
  - Damage around peri-osseous Core
  - Debride obviously necrotic material early
  - Local wound care
    - Silver sulfadiazene vs. sulfamylon
  - Definitive closure frequently requires flap closure
    - Needed to salvage exposed bone

Escharotomy



Electrical Burns - Treatment

- Complete excision vs. cautious debridement
  - Progressive necrosis after the injury
    - Due To Delayed Vascular Occlusion

Electrical Burns - Scalp And Skull

- Common entry site
- Devitalized / exposed bone source of infection
  - Osteomyelitis
  - Epidural abscess
- Approach depends on depth of injury

Electrical Burns - Scalp And Skull

- Partial-thickness bone injury
  - Remove outer table
    - Skin graft acutely
    - Dress until granulation tissue develops
  - Downside
    - Infected diploic cavity - if undue delay before skin grafting
    - Unstable graft with frequent breakdown

Electrical Burns - Scalp And Skull

- Full thickness bone injury
  - Coverage obtained with flap closure
    1. Excise cranial bone
       - Carries associated risks of cranial procedure
    2. Flap closure over exposed bone
       - Assume devitalized bone is “bone graft”
       - Assume bone is not osteomyelitic **- delay in procedure can result in bone colonization**

Electrical Burns - Extremities

- Commonly involved in electrical burns
  - Often grasp source with hand
  - Lower extremity often exit point
- Periosseous tissues can harbor areas of myonecrosis
  - Often more proximal than the cutaneous component

Electrical Burns - Long Term Complications

- Central Nervous System
  - Late onset of paraplegia or quadriplegia
  - Problems with gait / balance
  - Difficulties with speech
  - Seizures
  - Personality changes
- Commonly associated with entrance or exit wounds of the skull

Electrical Burns - Long Term Complications

- Eyes
  - Increased risk of cataract development
    - Onset up to one year later
- Skeletal
  - Contractures
  - Bone cysts
  - Heterotopic bone formation
    - Cause - forced passive mobilization

Electrical Burns - Lightening Injuries

- Mechanism
  - Direct strike
  - Side flash
    - Flow of current between person and nearby object struck by lightening
  - Current often travels over surface of the body
    - Not through

Electrical Burns - Lightening Injuries

- Management
  - Primary survey
  - Assess injury
    - History (other trauma, cardiac arrest)
    - Physical Exam (Include Thorough Neurologic Exam)
  - Maintain airway
  - Cardiac monitoring
    - ECG on admission
    - Continuous cardiac monitor for 24 hours

Electrical Burns - Lightening Injuries

- Management
  - Resuscitation
    - Increased fluid requirements due to underlying muscle damage
    - Foley catheter
    - Analyze urine for myoglobin
  - Maintenance of peripheral circulation
    - Frequent monitoring
    - Decompress with escharotomy or fasciotomy

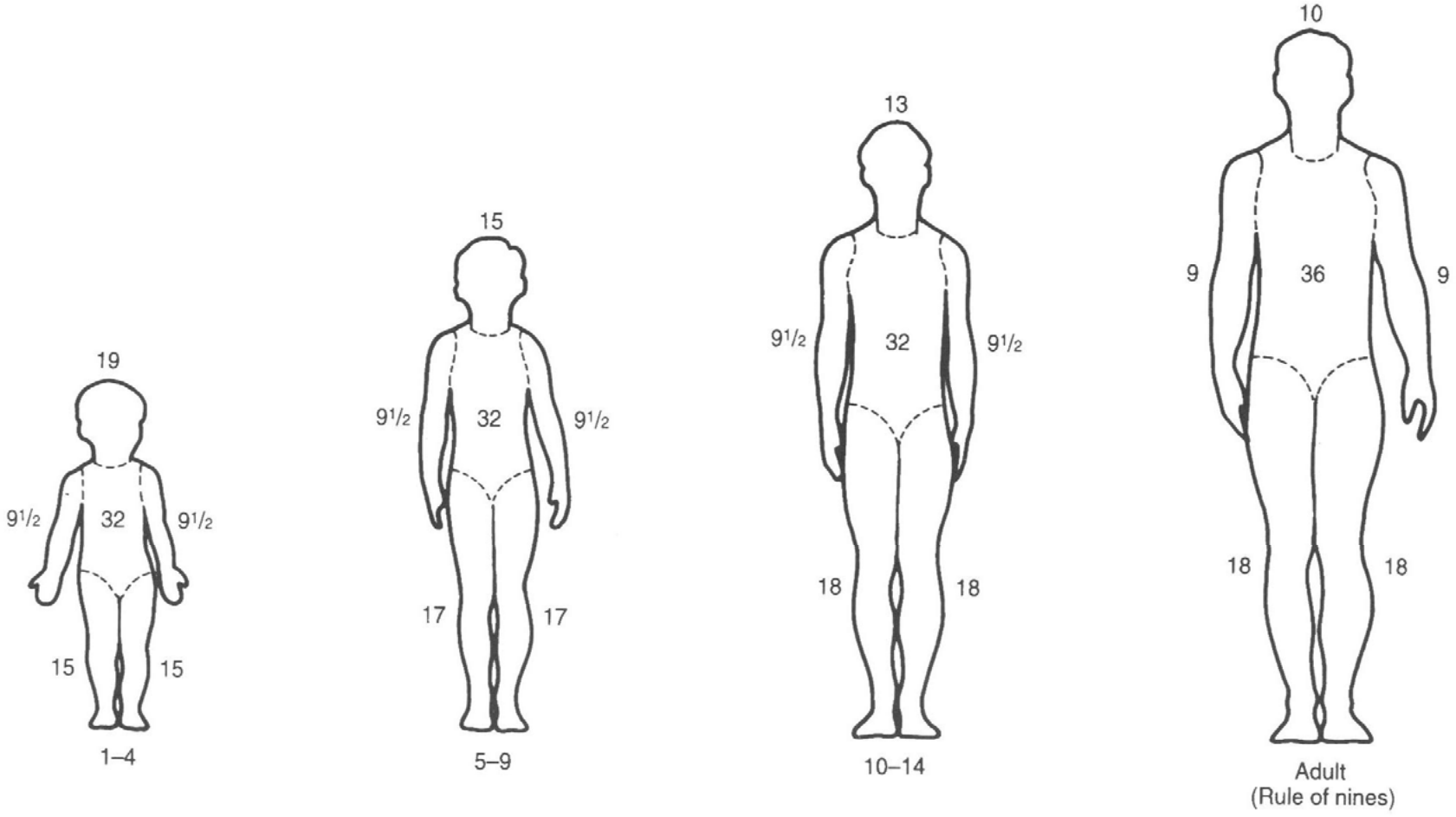
Electrical Burns - Pediatric Patient

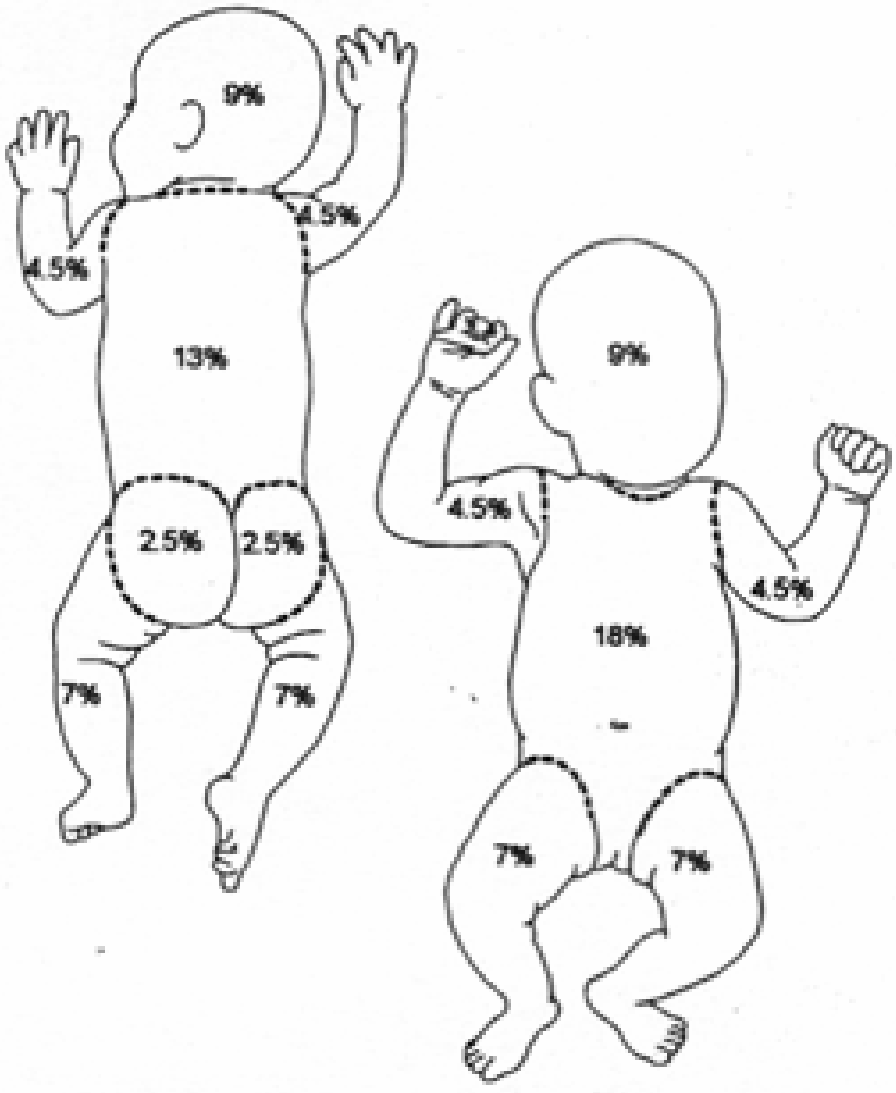
- Low voltage common
  - Usually minimal cutaneous injury
  - No muscle damage
- Injuries to oral commissure
  - Look worse than they really are
  - No immediate debridement
  - Watch for delayed bleed with eschar separation

Pediatric Burns

- Scald burns most common under age 3 years
- Flame burns more commonly seen over 3 years
- Always be Aware of child abuse
- Large surface area
  - Increased fluid requirements
  - Affects temperature regulation
- Thin dermal layer results in increased tissue destruction

Pediatric Burns - Circulation

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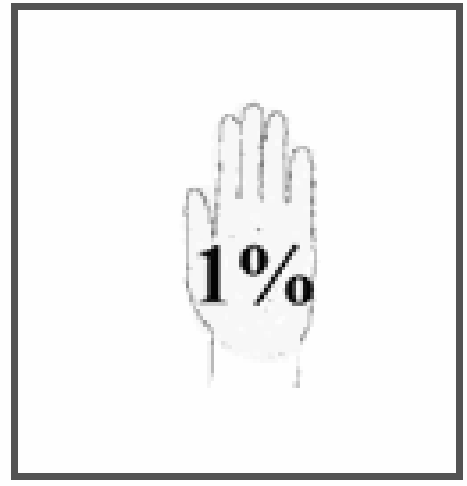
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