H11: Electrical Injuries

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Introduction

Electrical injuries are typically categorized as either high voltage (>1000 volts), low voltage (<1000 volts) or lightning injuries. High voltage injuries typically involve subcutaneous fat, muscle and even bones. Current flow, arcs, or flames from the ignition of nearby material may cause injuries. Voltage, amperage, type of current (AC vs DC), path of current flow and duration of contact all play a role in the severity of the injuries.

Low voltage injuries present with similar patterns but typically have a lesser degree of injury.

Lightning strikes can conduct millions of volts of electricity very rapidly yet often result in lesser physical injury than high voltage contact. Lightning frequently results in cardiorespiratory arrest for which prompt CPR/defibrillation is often successful.

Essentials

PARAMEDIC SAFETY IS CRITICAL: DO NOT APPROACH ELECTRICAL SOURCES OR DOWNED POWER LINES UNTIL QUALIFIED PERSONNEL HAVE DEEMED THE SCENE SAFE.

- Reverse triage victims of a lightning strike: patients in cardiac or respiratory arrest should be treated first.
- Cardiac arrest is the most immediate threat in both high and low voltage electrical injuries. Follow standard cardiac arrest guidelines.
- Secondary trauma from falls after electrical shock is common.
- Continuous cardiac monitoring is indicated, if available.

Additional Treatment Information

- External burn size is a poor indicator of the extent of internal injuries
- Fluid resuscitation needs are often higher for electrical injuries than for thermal burns
- High voltage electrical injury patients are at risk for developing rhabdomyolysis. Early fluid resuscitation can limit the associated renal damage. Rhabdomyolysis may also lead to hyperkalemia.

General Information

- Lightning produces incredibly high voltage and amperage over a very short duration of contact with the patient. Current, in a lightning strike, tends to flow around the outside of the body, and as a result internal electrical injuries are rare. The most common injuries sustained in a lightning strike are "flashover burns," which happen when the direct current heats the skin and vaporizes any moisture on the victim's skin. These burns are typically superficial, and rarely require fluid resuscitation.
- Lightning does not need to directly strike the victim to cause injuries. It is common for entire groups of people standing near a lightning strike to be injured. In cases of triaging multiple patients, initial efforts should be focused on those in cardiac or respiratory arrest. Spontaneously breathing patients following a lightning strike have a high likelihood of survival without further intervention. Those in cardiac or respiratory arrest are likely to have good outcomes with prompt resuscitation.
- The extent of injury caused by electrocution is dependent on the following factors:
    1. The type and amount of current (AC vs DC, voltage and amperage)
    2. The route the current follows through the body
    3. The duration of contact with the energy source
- The most immediate life threat is a cardiac dysrhythmia. Usually ventricular tachycardia or ventricular fibrillation. Cardiac arrest following electrocution is generally a result of electrical disruption rather than damage or burns to the myocardium itself. Early, aggressive resuscitation efforts are often successful in restoring cardiac output as these patients are general younger and healthier.

- Electrical arcing can generate temperatures in excess of 2,500° C. External burns are most often seen at the site of entry and exit and rarely provide an accurate representation of internal injury. Even small entry/exit wounds can be associated with significant internal tissue damage.
- The internal effects of high voltage electrocution can be grave. Muscle tissue, connective tissue, bones, blood vessels, nerves and organs in the path are all at risk for serious thermal injury. Muscle damage can lead to rhabdomyolosis as muscle cells rupture, spilling myoglobin and potassium into systemic circulation. Bones may be directly damaged or even fractured by violent sustained muscle contractions. Intravascular coagulation may occur as the current passes through major vessels. This occasionally results in secondary thrombotic events.
- Fluid resuscitation needs in electrical injuries are often higher than for isolated thermal injuries. Fluid volume calculations based on body surface area (BSA) burned are not accurate for electrical burns. An initial normal saline bolus of 5ml/kg followed by 100ml/hour is appropriate for normotensive patients in the pre-hospital setting. Extended care and inter-facility goals should titrate fluid to achieve a urine output of 0.5-1ml/kg/hour.

Interventions

First Responder

- Ensure scene safe from live electrical power
- Consider spinal motion restriction
- If in cardiac arrest: begin compressions and follow appropriate guidelines for resuscitation.
  - → N02: Adult Cardiac Arrest
  - → M06: Pediatric Cardiac Arrest
- Supplemental oxygen as required
  - → A07: Oxygen and Medication Administration
- Flush and decontaminate affected area with sterile saline
  - → PR05: Patient Decontamination
- Do not cool burns longer than 1-2 minutes, including decontamination time
- Dress injuries as required
- Identify type of current and duration of contact

Emergency Medical Responder – All FR interventions, plus:

- Rapid transport
- Consider analgesia
  - → E08: Pain Management
  - Nitrous oxide

Primary Care Paramedic – All FR and EMR interventions, plus:

- Obtain vascular access.
  - → D03: Vascular Access
- Fluid resuscitation: for high voltage injuries (>1000 Volts), initial bolus of 5 ml/kg followed by 100 ml/hour

Advanced Care Paramedic – All FR, EMR, and PCP interventions, plus:

- Consider analgesia:
  - KetAMINE
  - FentaNYL
- Treat known or suspected hyperkalemia
  - → E03: Hyperkalemia

Evidence Based Practice

Electrocution / Electrical Burns

Lightning

References

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