VANDERBILT UNIVERSITY MEDICAL CENTER

Category	Clinical Practice
Protocol: Electrical Injury Practice Management Guideline	
Approval Date:	6/4/2020 (CMT)
Review Date:	6/1/2022

Applicable to							
☒ VUH	☒ VCH	☐ DOT	☐ VMG Off-site locations	☐ VMG	☐ VPH	☐ Other	
Team Members Performing							
☐ All faculty & staff	☒ Faculty & staff providing direct patient care or contact	☒ MD	☒ House Staff	☒ APRN/PA	☐ RN	☐ LPN	
☐ Other:							
Content Experts							
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I. Objectives

Describe practice management guidelines for the management of patients with electrical injuries presenting to Vanderbilt University Medical Center (VUMC).

II. Population

All patients evaluated and/or admitted at VUMC after sustaining an electrical injury.

III. Definitions

a. Electrical injuries are different than classical thermal burns due to the deep tissue damage caused by the flow of current through the tissue causing thermal injury and the damage to the vascular endothelium and associated thrombosis. This means that the visible cutaneous injury does not indicate the true size of the tissue injury, which requires larger volumes of resuscitation and the co-efficient used for calculation of initial resuscitations rates is larger. Cardiac injuries (dysrhythmia, myocardial ischemia, decreased ejection fraction, etc.) are not uncommon, and can further complicate resuscitation. These patients also present with a variety of traumatic injuries owing to the current flow including, but not limited to: spine fractures, extremity compartment syndrome, pneumothorax, solid or hollow viscus rupture, etc.
b. Ohm's Law: I=V/R, I=Current, V=Voltage, R=Resistance. The amount of tissue damage is dictated by the current that flows through the tissue. This depends on both the voltage and the resistance. Resistance is difficult to determine, the body is a combination of internal and external resistances (external=wet vs. dry skin, clothing, boots, gloves, etc., internal=bone, blood, muscle, etc.) that continuously change so we use voltage as a surrogate for current.
c. High voltage electrical injury is injury sustained by contact with an energy source of >1000 Volts
d. Common household voltages are 120V for most electrical outlets, ~240V for large appliances (e.g. washer/dryers)
e. Electrocution means death by electricity
f. Contact points are the areas of burn where patient came into contact with objects in the environment, these are not entrance or exit wounds as the current is alternating.

IV. Assessment

Initial assessment of the patient with an electrical injury does not differ from the typical assessment of a combined burn-trauma patient. C-spine precautions should be used.

a. Patients presenting in cardiac arrest should be treated as both a cardiac patient and a trauma patient. ACLS protocols should be instituted while also considering reversible causes of traumatic arrest including hemorrhagic shock and pneumothorax.
b. Fluid resuscitation (balanced crystalloid solution) during the primary survey:
    i. Adult patients should be started at 500ml/hr.
    ii. 6-13-year old patients should be started at 250ml/hr.
    iii. Children under 6 should be started at 125ml/hr.
c. During the secondary survey burn size should be calculated and the fluid rate should be adjusted using the formula:

    (4ml x kg x %TBSA)/16 = the starting fluid rate

d. Complete neurovascular exams of each extremity should be done and documented at time of admission.

V. Diagnosis

Patients presenting with a history of an electrical injury should be treated as a high-voltage injury until the actual voltage is identified. A call to the local electrical company can quickly identify the voltage of the electrical line associated with the injury.

a. Traumatic injuries: A traumagram should be done on all patients with a high-voltage injury. If injuries are identified and the trauma team was not involved at time of evaluation, they will be consulted.
b. Compartment syndrome is a common and limb-threatening risk of electrical injury. Classic signs and symptoms of compartment syndrome (5 Ps: Pain Pallor, Paresthesia, Pulselessness, Paralysis) are unreliable in the setting of electrical injuries, for example, patients may have pain from cutaneous burns or paresthesias from nerve injury. Clinical evaluation is the paramount for diagnosis of compartment syndrome: tight compartments to palpation, pain with flexion/extension, or fixed flexion. Pulselessness and paralysis are late signs of compartment syndrome of any etiology and the diagnosis should come before those signs.
c. Cutaneous burns are diagnosed as in any other mechanism, they should be quantified by both size (% TBSA) and depth.
d. Rhabdomyolysis is diagnosed based on presence of myoglobinuria, elevated CK, and/or elevated serum potassium, and needs to be evaluated on admission and followed to identify resolution or improvement.

VI. Interventions

a. Recommended labs:

i. Standard burn admission labs (CBC, BMP)
ii. Creatine Kinase (CK)
iii. BMP q6hr to evaluate potassium and Creatinine trends in patients with high voltage electrical injuries. Troponins have not been shown to be informative in the management of electrical injury patients.
iv. UA to evaluate for myoglobinuria

b. Tests:

i. EKG. Cardiac arrhythmias are commonly noted after electrical injury, they are more common after high-voltage injury than low-voltage.
ii. Q1hr neurovascular checks with elevation for extremities with contact points that do not require immediate fasciotomy
iii. Traumagram for all patients with a high-voltage mechanism

VII. Treatments

a. Resuscitation
   i. Patients should be resuscitated per the burn resuscitation protocol using [(4ml x kg x %TBSA)/16] as the starting fluid rate
   ii. Urine output goals depend on the presence of myoglobinuria. If absent, UOP goal is 30ml/hr. If present, UOP goal is 75-100cc/hr until myoglobinuria clears.
b. Monitoring
   i. All patients with a high-voltage mechanism require cardiac monitoring for 24 hrs post-injury
   ii. All patients with chest pain, an abnormal EKG, or a loss of consciousness require cardiac monitoring for 24 hrs post-injury
c. Medications
   i. Multimodal pain control per burn center practice including Gabapentin, PRN Oxycodone, and scheduled Tylenol. Avoid NSAIDs in these patients given the risk of AKI and need for operative intervention.
   ii. Diuretics are NOT indicated for the treatment of rhabdomyolysis

d. Operative Interventions
    i. Fasciotomy is indicated emergently for patients with compartment syndrome
    ii. Excision of full thickness cutaneous burn is indicated per burn center per usual practice. Caution should be used when considering grafting at first excision as these wounds typically have progressive necrosis for days to weeks after injury, likely due to the microvascular injury caused by the electrical current.
    iii. Amputations: Patients with high-voltage electrical injuries have higher rates of amputation compared to other burn injury mechanisms. If an amputation is determined to be necessary by the burn surgery attending, a second opinion from either a burn, ortho, or plastic hand surgeons will be sought prior to proceeding with amputation.

VIII. Disposition

a) The following patients should be admitted to the BICU:
    i. Patients with high-voltage electrical injury mechanism
    ii. Any patient with additional critical care needs
    iii. Any patient requiring resuscitation (cutaneous burns, myoglobinuria)
    iv. Any patient requiring cardiac monitoring
    v. Any patient requiring q1hr neurovascular checks
b) The following patients should be admitted to the burn stepdown unit:
    i. Low-voltage electrical injuries requiring admission for wound care, pain control, or therapy evaluation and treatment
c) The following patients can be discharged from the ED:
    i. Low-voltage injury mechanism without EKG changes, without history of loss of consciousness, and not meeting standard admission criteria

IX. Other considerations

a. Ocular sequelae: Cataracts can occur in up to 8% of electrical injury patients. Prior to discharge from the hospital, patients who are receiving workman's compensation benefits should be evaluated for baseline cataract status.

b. Other long-tern sequelae: Varied and non-specific neuropsychiatric sequalae have been described. Without intentional screening for these issues, they can be easily missed.
    i. Psychological: A social work (SW) consult is mandatory on these patients. SW will perform their standard screening and make recommendations for a formal psychiatry consult as needed.

ii. Neurological, Central: Cognitive deficits may be missed during the index hospital stay. Cognitive evaluations are required for these patients prior to discharge. If a deficit is noted, appropriate follow-up should be scheduled.

iii. Neurological, Peripheral: A complete neurological exam should be performed and documented at time of admission and prior to discharge.