Course Objectives

Upon completion of this course, the nurse will be able to:

- Discuss safety precautions to prevent electrical or lightning injuries
- Determine the severity of an electric shock or lightning strike
- Determine the type of burns that the victim has sustained
- Have knowledge of emergent, intermediate, and rehabilitative therapy needs of a patient with electrical or lightning injuries
- Perform a cardiac evaluation and monitor a patient with cardiac abnormalities due to electric shock or lightning strike
- Calculate the fluid requirements of a patient with burns due to electrical or lightning injuries
- Have knowledge of the pain management needs of patients with burns and other injuries related to electrical shock and lightning strike injuries
It’s a beautiful day in the park while you’re having a picnic. Dark clouds suddenly appear and you start to hear the sound of approaching thunder. You gather up all of your things because you know that with thunder comes the likelihood and danger of LIGHTNING!

According to NOAA, over the last 20 years there has been an average of 51 lightning strike fatalities in the United States annually; placing it behind floods as the second leading cause of weather related deaths.

What is a “Lightning Strike”? A Lightning Strike is an electric discharge between the atmosphere and an earth bound object. Lightning has a mortality rate of between 10-30% with up to 80% of lightning survivors sustaining long term injuries.

Receiving an electrical shock or being struck by lightning is an unpleasant occurrence that nobody wants to experience. Even with all of the safety precautions that have been put into place, electrical shocks of considerable severity are common and experienced by people all around the world.

Lightning strikes are a totally different category of electrical shocks to the human body. As much as we try to prevent them by installing lightning rods on top of buildings to divert the shock straight to the earth, Mother Nature cannot be tamed according to our desires.

The effects of a lightning strike and an electrical shock on a victim may appear the same, but they require different treatment.

The most important concept for the nurse to understand about electrical shocks is that after a victim sustains a shock, although the victim may at first appear unharmed, internal damage may have occurred that is not immediately apparent. It is imperative that any victim of a moderate to severe electrical shock obtain a medical evaluation to assess any possible damage that may have occurred and receive the necessary medical intervention and care.
There are times when an electrical shock is so strong that the victim cannot separate themselves from the appliance or socket. The body acts like a conductor between the earth and the appliance and the current can flow at high speeds throughout the victim.

**BE AWARE THAT IN EVERY CASE, THE SPEED AT WHICH THE RESCUER ACTS IS EXTREMELY IMPORTANT!** It is vital that the rescuer acts quickly and effectively as it can mean the difference between life and death to shock the victim.

The first thing to do is to try and cut off all power to the household. Touching the person while they’re being shocked is not recommended as you can become part of the circuit and be stuck in the same situation.

If you are unable to cut off power, you need to take some precautionary measures before you touch the person being electrocuted. Wear shoes, preferably made out of non-conductive material such as rubber or plastic. Stand on something dry, like wood or newspapers and then try to separate the victim with an object that is made of wood; like a wooden stick, beam or anything plastic. Touching a person while they are receiving a shock can be fatal for both the rescuer and the victim.

**IN CASE OF HIGH VOLTAGES:**

**DANGER**

When high voltages are involved, you need to inform the power company to shut the power off as high voltage can be instantly fatal. Do not attempt to shut off the power yourself as it can cause an explosion and injure or kill the person.

In the case of a high voltage power wire falling on a car, remain inside the car unless you can smell obvious burning.

Most electrical shock related injuries and electrocutions in the U.S. happen in the occupational sector. Household electrocutions are very low compared to people getting electrical shocks while at work.

**Arc-Flash**

Occupational Safety and Health Administration (OSHA) has found that 80% of all electrical injuries are due to burns caused by an Arc Flash. (IEEE Standards Association, 2006). An Arc Flash is a phenomenon where a flashover of electric current leaves its intended path and travels through the air from one conductor to another, or to ground. The results are often violent and when a human is in close proximity to the arc flash, serious injury and even death can occur. The Arc Flash is common during welding. Welders must protect themselves with personal protective equipment (PPE) such as flame resistance clothing, voltage rated gloves, face shields and full-coverage flash suits.
The Electrical Safety Foundation International (ESFI) is a foundation that gathers information on instances of electrical shock injuries and tries to lessen the likelihood for such accidents occurring in the work place and at home. According to their latest reports, 80% of electricity related injuries can be narrowed down to five main industries:

1) Construction Industry 38%
2) Maintenance & Repair Workers 21%
3) Ground Maintenance Workers 7%
4) Transportation Industry 6%
5) Agricultural Workers 2%

(ESFI, 2010)

Although there has been a considerable decline in the fatalities and injuries caused by electrical shocks in the work place, it is still a genuine threat.

Results of Electrical Shocks

Electrical shocks can result in Burns, Ventricular Fibrillation and Neurological Injuries.

Burns

Although the victim’s body actually conducts the current through itself, it also manages to produce some resistance which results in burns on the skin. Voltages of 500 to 1000 can cause severe internal burns to the victim. Damage to the skin and internal organs is caused by the burning of bodily tissues, which can result in death if not treated immediately.

Ventricular Fibrillation

Ventricular Fibrillation can occur when an electrical current passes through a person’s chest. If the current has direct access to the heart, it can cause the muscles in the heart to become uncoordinated and instead of moving in sync as the heart pumps blood, it can cause fibrillation. This is a life threatening arrhythmia and requires immediate defibrillation.
Neurological Effects

The passing of electricity through the heart and lungs has been known to cause nerve damage in shock victims. Repeated or severe electrical shocks can also cause neuropathy. When an electrical current passes through the head, it often causes the victim to lose consciousness.

DID YOU KNOW?

The human body can provide resistance to the flow of electrical current, which is why burns occur on the body. Every person has a different resistance to an electrical current, mainly depending on what type of skin they have. The time of day can also produce a fluctuation in the resistance of the human body to an electrical current. This is mainly because the human body can act differently at different times of the day. The heart rate is usually slower at night compared to during the day.

In dry conditions, the human body can produce resistance of about 100,000 ohms but when wet it reduces to about 1000 ohms. When the body is subjected to high voltages, the human skin breaks down and reduces the resistance to about 500 ohms. (NIOSH, 1998)
Voltage and Current on the Human Skin

The effects of voltage and current on the human skin cannot be determined and is dependent upon a number of factors, including duration, intensity, frequency and history of the electrical stimulus. The temperature and sweat gland activity on the human skin also causes variations in these results.

Clinical Presentation of a Patient with a Lightning or Electrical Injury

The diagnosis of an electrical shock or a lightning strike injury can be a complex process due to the diverse range of clinical signs and symptoms that a victim may suffer following the event. From minor burns to cardiopulmonary arrest, a patient who has suffered an electric shock may exhibit varying symptoms. The nurse should perform a complete head to toe assessment on every shock victim.

Head and Neck

Electrical Injury — For most patients, the head is the contact point for high-voltage injuries. Such patients may exhibit burns, as well as neurological damage which may consequently result in compromised visual acuity and hearing loss. In addition to this, as many as 6% of patients who have suffered a high-voltage injury may develop cataracts following the event.

Lightning Injury — Skull fractures and cervical spine injuries are a common consequence of lightning strikes. In addition, patients may also develop hemorrhage and deafness depending upon the intensity of the injury they have suffered.

Cardiovascular System

Electrical Injury — Cardiac arrest is a common outcome of electrical accidents. In addition to this, patients may also develop arrhythmias and myocardial infarction following an electrical injury.

Lightning Injury — Cardiac arrest is less common in patients who have suffered lightning strikes compared to patients with electrical injuries. However, cardiac injury is common and may result in ECG changes. Patients also commonly exhibit increased blood pressure after a lightning injury, but it usually resolves itself within a few hours, often without the need for treatment.

Skin

Electrical Injury — After cardiac arrest, burns are the most common outcome of electrical injuries, particularly at the points of contact with the source and ground. The total body surface area affected from burns resulting from an electrical injury averages 10-25%.

Points of Entry into the Human Body

There are two main types of shocks that can be sustained by the human body:

Macroshock: This type of current passes through the skin without damaging it. It flows from one point of entry to the other like arm to arm, leg to arm etc. An arm to arm current is considered the most dangerous as it passes directly through the heart as compared to a leg to ground current.

Microshock: This is a type of shock that is produced from within the body. People who have a pacemaker or any other electrical device implanted inside their body, can experience a shock if the device malfunctions.
Hands, skull, and heels are the most common parts to experience the effects of a high-voltage injury.

**Lightning Injury** — Depending upon the location and intensity of the lightning strike, the victim may exhibit one of the following four types of burns or skin changes.

- **Linear** — Linear burns are found on the moist areas of the body, such as under the arms or down the chest.
- **Punctate** — These are cigarette-like burns, ranging from a few millimeters to one centimeter.
- **Feathering** — These are the least painful and seldom result in any significant damage to the skin.
- **Thermal Burns** — These are most commonly observed in patients who are wearing a metal accessory or when the lightning strike results in the ignition of the victim’s clothing.

**Types of Electrical Burns:**

- **Burns Resulting from Severe Electrical Accidents** — These appear as painless, depressed, yellow-gray areas with diminished or no blood supply.
- **Kissing Burn** — Electric current results in the creased flexion area of the extremities (such as the inner elbow). Since the skin of the flexor surfaces contain more moisture as compared to other body parts, electric current often arcs across the flexor crease and results in severe burns and tissue damage. This type of electric burn is known as a “kissing burn”.
- **Electrical Flash Burns** — Superficial partial-thickness burns are known as flash burns.
- **Isolated Thermal Burns** — Result from the burning of clothing.
- **Mouth Burns** — This type is more common in children as it results from sucking or biting on an electrical extension code.

**Extremities**

**Electrical Injury** — High-voltage injuries may result in severe burns on the extremities, especially if they’re also the contact points. Joint areas are likely to experience more severe injury as they have less muscle mass to conduct electricity.

**Lightning Injury** — Patients who have suffered a lightning strike may exhibit cold, bluish, pulseless extremities, as well as exhibit vasospasm of the extremities. However, the condition usually resolves within a few hours and seldom requires intervention.

**Skeletal System**

Fractures, dislocations of bones, particularly of posterior and anterior shoulders, and soft tissue trauma are common consequences of both electrical and lightning injuries.

**Nervous System**

**Electrical Injury** — A high-voltage injury may result in a diverse range of clinical effects on the central nervous system. Common symptoms include confusion, difficulty with short-term memory, and impaired concentration and focus. In addition to this, victims with head shocks may also have seizures, which usually subside upon treatment and rarely result in long-term disability.

**Lightning Injury** — Most victims who have experienced a lightning strike are further stricken with a unique condition called Keraunoparalysis. This condition is characterized by temporary paralysis which is secondary to the lightning strike. Some other symptoms associated with this condition include cold, blue, pulseless extremities, as well as paresthesia. Hemorrhage, seizures, amnesia, and paraplegia may also be the outcome of severe lightning strikes.
Differential Diagnosis of Electrical Shock Injury Versus Lightning Strike Injury

**Electrical Injuries** — Electrical injuries are self-evident, except under special circumstances which result in no burns, such as in bathtub accidents.

**Lightning Injuries** — Differential diagnosis of lightning strike injuries is more complex, particularly when the affected individual was alone at the time of incident. It may be difficult for a medical professional to identify the etiology of unconsciousness, paralysis, and disorientation, especially when the patient has suffered no burns due to the lightning strike.

Two signs that are a hallmark of lightning injuries:

- **Lichtenberg’s Figure**
- **Damage to the clothes**

**Lichtenberg’s Figure**, also known as “Skin Feathering”, can occur when a victim is electrocuted by high voltage electricity such as a lightning strike.

Management of Patients with Electrical and Lightning Injuries

Providing care to a patient with electrical or lightning injuries poses a unique challenge to most nursing professionals because few injuries are as threatening to the physical and mental health of a patient as are burn injuries.

The treatment plan for a patient with electrical shock or lightning strike injuries can be divided into three phases:

- **The Emergent Phase**
- **The Intermediate Phase**
- **The Rehabilitative Phase**

*The Emergent Phase*

The emergent phase begins immediately after the onset of injury and lasts for a period of 24 hours. During the emergent phase, the nurse should focus on maintaining an adequate airway, breathing, circulation, fluid resuscitation, and providing emotional support to the patient and their family.
First Aid
Patients with electrical shock or lightning strike injuries should be provided with immediate medical attention. Transportation to a hospital or medical center should be arranged immediately, and in the meantime, a health care professional should provide first aid to the affected individual.

First aid for electrical shock and lightning strike injuries includes the following:

- Remove the patient from the source of electric shock.
- Fire on any clothing should be put out by dousing the patient with water or by using a blanket for smothering the flames.
- Use the ABC approach:
  - Airway — Establish and maintain an open airway. In case of vomiting, turn the patient onto one side to keep the airway clear.
  - Breathing — Check breathing. If the patient is not breathing, use an assisted ventilation method (for example, mouth to mouth or a pocket mask) to restore the exchange of gases.
- If patient is conscious, offer them reassurance.

First Aid for Burns

- Remove any accessories, including rings and wristwatch, as well as footwear, if possible.
- If there are burns on extremities, elevate the limbs to prevent fluid loss.
- Avoid handling the body parts with burns unnecessarily.
- Do not splint a burned limb unless it has been fractured or dislocated.
- Apply wet dressings to 20% of the body surface area. The rest should be covered with dry dressings or clean sheets.
- Do not apply any skin formulations, such as creams, ointments, or any other medications.
- If eyelids have suffered burns, cover them with sterile dressings.
- Never use ice to cool off the body as it may result in hypothermia. Use wet dressings to cool the body. Make sure that no more than 20% of the body is cooled off at a time as it may reduce the patient’s body temperature to a dangerously low level.
Recommended Diagnostic Procedures

Cardiac Monitoring after Electrical Shock or Lightning Strike Injuries
Electrical injuries can result in cardiac abnormalities, particularly high-voltage electrical shock injuries and lightning strike injuries that can cause potentially fatal cardiac dysrhythmias. Therefore, cardiac evaluation and monitoring are critical components of the emergent management of patients with electrical shock or lightning strike injuries.

Electrocardiogram — Since both low-voltage and high-voltage injuries may result in a variety of cardiac symptoms, such as arrhythmias, myocardial infarction, and even cardiac arrest, an electrocardiogram (ECG) must be obtained to assess the injury, and the patient should be placed on a cardiac monitor for ongoing cardiac assessment.

Laboratory Tests — The laboratory tests listed in table 1 should be ordered for patients who exhibit cardiac arrhythmias, those with conductive electrical injuries, and patients with entry and exit wounds.

Laboratory Tests Recommended for Patients with Electrical Injuries

<table>
<thead>
<tr>
<th>Test</th>
<th>Rationale/Indication</th>
</tr>
</thead>
<tbody>
<tr>
<td>CBC</td>
<td>All patients with injuries beyond minor burns</td>
</tr>
<tr>
<td>Electrolytes</td>
<td>All patients with injuries beyond minor burns</td>
</tr>
<tr>
<td>BUN and creatinine</td>
<td>All patients with injuries beyond minor burns</td>
</tr>
<tr>
<td>Creatine Kinase</td>
<td>Any patient with suspected muscle damage</td>
</tr>
<tr>
<td>Urinalysis</td>
<td>To detect myoglobinuria and muscle damage</td>
</tr>
<tr>
<td>Liver function tests</td>
<td>When intra-abdominal injury is suspected</td>
</tr>
<tr>
<td>Coagulation profile</td>
<td>When patient requires a surgical procedure or when an intra-abdominal injury is suspected</td>
</tr>
<tr>
<td>Blood types and cross match</td>
<td>When patient requires a surgical procedure</td>
</tr>
</tbody>
</table>
Radiology — The following radiological procedures should be conducted in patients with electrical shock or lightning strike injuries:

- **CT Scan of Head** — This is done to identify any intracranial abnormalities and is particularly indicated in patients with electrical injury associated with a fall or those who present with loss of consciousness. A CT scan of the spinal cord may also be required if a spinal injury is suspected.

- **Plain Radiographs** — For patients who complain of pain and restricted motion, a plain radiograph of the affected areas should be ordered.

**Other Tests** — When smoke inhalation is suspected, a chest x-ray along with an arterial blood gas (ABG) should be obtained.

**Fluid Resuscitation**

Fluid resuscitation is an important aspect of providing emergent care to a patient with electrical shock or lightning strike injuries. Once first aid has been provided to the patient, the nurse should administer the following interventions:

- Insert a large bore catheter to administer IV fluids as ordered
- Calculate Total Body Surface Area (TBSA) affected
- Calculate the fluid needs of the patient using one of the fluid resuscitation formulas given below

Since electrical injuries can cause massive fluid shifts from intracellular to extracellular spaces along with extensive tissue damage and acidosis, the nurse should monitor the patient’s hemodynamics constantly and administer fluids as ordered.

**KEEP IN MIND**

**Fluid Resuscitation Guidelines**

- Initial fluid resuscitation should aim for a urine output of greater than 0.5ml per kg per hour, and preferably 1ml per kg per hour, if the patient is exhibiting signs of myoglobinuria.
- While the burns caused by lightning injuries are generally superficial, patients with electrical injuries may have an extensive fluid deficit. Therefore, increase fluid replacement 2 to 3 times depending on the TBSA involved.
- Hematuria or dark urine is indicative of the need of more aggressive fluid therapy to prevent further damage. In such cases, use fluids along with bicarbonate at 1 to 2 mEq per kg.
- Mannitol can be used to promote osmotic diuresis.
**Fluid Resuscitation Formulas**

There are two formulas that are widely used for calculating the fluid needs of a burn patient — the Parkland Formula and the Consensus Formula.

**The Parkland Formula** — *Ringer’s Lactate 4ml X body weight in kg X % TBSA*

The Parkland formula involves administration of large amounts of fluids in the first 24 hours to prevent acidosis and hypovolemic shock. After this, the amount of fluid is titrated based on the urine output of the patient. Generally, the goal is to maintain a fluid administration rate between 30 and 50ml per hour after the first 24 hours.

In order to use this formula, it is important that a nurse knows how to calculate the total body surface area affected. Generally, the Rule of 9’s is used to calculate TBSA.

**The Rule of 9’s**

According to the Rule of 9’s, (Figure 1) the body is divided into several anatomical regions, each of which represents 9% of the total body area. In case only a small part of an anatomical region has suffered burns, the nurse should calculate TBSA by assessing how many times their outstretched palm (1%) covers the area (University of Washington).

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**EXAMPLE**

A patient receives burns of his arms, chest, back, and head. He weighs 180 pounds. Using the Parkland and Consensus formula, determine how much fluid should be administered within the first 8 hours if the patient suffered injury at 0600 hours?

To determine the amount of fluid to be administered using the Parkland formula, use the following steps:

1. Calculate the TBSA %
   
   Arms (9% each) = 18%, Chest = 18%, Back = 18%, Head = 9%
   
   TBSA (%) = 18 + 18 + 18 + 9
   
   TBSA (%) = 63%

2. Convert the patient’s weight from pounds to kilograms.
   
   1 kg = 2.2 lbs.; therefore, 180 pounds ÷ 2.2 = 81.8 ≈ 82 pounds

3. Insert values in the Parkland formula.
   
   4 ml X 82 X 63 = 20,664 ml in 24 hours

4. Since according to the Parkland formula, half of the amount is infused within the first 8 hours of injury, the patient will receive 10,332 ml from 0600 to 1400 hours.

To calculate the fluid needs of the patient using the Consensus formula, use the first and second step as for the Parkland formula, and then insert values into the equation:

2 ml X 82 X 63 = 10,332 ml

4 ml X 82 X 63 = 20,664 ml

On the high end (4 ml), the amount infused over 24 hours is found to be 20,664 ml, of which half (10,332 ml) will be administered from 0600 to 1400 hours.

On the low end (2 ml), the amount infused over 24 hours is found to be 10,332 ml, of which half (5,166 ml) will be administered from 0600 to 1400 hours.
The Consensus Formula — Ringer’s Lactate or another balanced saline solution 2ml-4ml X body weight in kg X % TBSA. The amount of fluid thus calculated is administered over a period of 24 hours. In the first 8 hours, half of the fluid is infused, while the remaining is infused over the next 16 hours.

**Psychological Care of an Electrical Injury Patient**

Although most clinical interventions are focused on meeting a patient’s physiological needs during the emergent phase of treatment, it is important for a nurse to remember that this is a time of extreme crisis for the patient as well as their family. Therefore, a nurse should offer emotional support to the patient, if he/she is conscious, and their family, by helping them understand the treatment process and keeping them as comfortable as possible. Some patients may also require support from a clergy member.

Guidelines for Further Management:

1. Children and adults who have suffered low-voltage electrical injuries can be discharged from the emergency room if they show no ECG abnormalities, have no history of loss of consciousness, or any other reason for hospital admission, such as a fracture or soft-tissue injury.

2. Patients who have a history of loss of consciousness after sustaining the injury or who have developed cardiac dysrhythmias should be admitted for telemetry monitoring.

**The Intermediate Phase**

The intermediate phase begins 48 to 72 hours after sustaining the injury. Unlike the emergent phase, in which the focus of care is to eliminate fluid deficits, in the intermediate phase the patient is likely to exhibit changes in capillary permeability and increased urinary output.

Patients who have compromised renal or cardiac function may show symptoms of congestive heart failure due to the aggressive fluid therapy provided during the Emergent Phase. Therefore, the nurse should determine the patient’s fluid status by assessing central venous pressure (CVP) when ordered by the physician. While CVP varies, the general range is 5 to 12 mm H₂O. High CVP values indicate volume overload, while low values indicate fluid deficits.

In addition to this, there are a number of other complications that may arise during the intermediate phase of treatment, such as anemia, paralytic ileus, ulcers, acute respiratory failure, and local and generalized infections. Of all these, infections are the biggest threat to a patient with electrical and lightning injuries.
### Organisms Causing Invasive Burn Wound Infection (Church D, 2006)

<table>
<thead>
<tr>
<th>Group</th>
<th>Species</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gram-positive organisms</strong></td>
<td><em>Staphylococcus aureus</em></td>
</tr>
<tr>
<td></td>
<td>Methicillin-resistant <em>S. aureus</em> (MRSA)</td>
</tr>
<tr>
<td></td>
<td>Coagulase-negative <em>staphylococci</em></td>
</tr>
<tr>
<td></td>
<td><em>Enterococcus</em> sp.</td>
</tr>
<tr>
<td></td>
<td>Vancomycin-resistant <em>enterococci</em></td>
</tr>
<tr>
<td><strong>Gram-negative organisms</strong></td>
<td><em>Pseudomonas aeruginosa</em></td>
</tr>
<tr>
<td></td>
<td><em>Escherichia coli</em></td>
</tr>
<tr>
<td></td>
<td><em>Klebsiella pneumonia</em></td>
</tr>
<tr>
<td></td>
<td><em>Serratia marcescens</em></td>
</tr>
<tr>
<td></td>
<td><em>Enterobacter</em> spp.</td>
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<tr>
<td></td>
<td><em>Proteus</em> spp.</td>
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<tr>
<td></td>
<td><em>Acinetobacter</em> spp.</td>
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<tr>
<td></td>
<td><em>Bacteroides</em> spp.</td>
</tr>
<tr>
<td><strong>Fungi</strong></td>
<td><em>Candida</em> spp.</td>
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<tr>
<td></td>
<td><em>Aspergillus</em> spp.</td>
</tr>
<tr>
<td></td>
<td><em>Fusarium</em> spp.</td>
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<tr>
<td></td>
<td><em>Alternaria</em> spp.</td>
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<tr>
<td></td>
<td><em>Rhizopus</em> spp.</td>
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<tr>
<td></td>
<td><em>Mucor</em> spp.</td>
</tr>
<tr>
<td><strong>Viruses</strong></td>
<td><em>Herpes simplex virus</em></td>
</tr>
<tr>
<td></td>
<td><em>Cytomegalovirus</em></td>
</tr>
<tr>
<td></td>
<td><em>Varicella-zoster virus</em></td>
</tr>
</tbody>
</table>

**Wound Debridement**

Debridement should be used to remove eschar and other cellular debris from the wound bed. This can be done by gently washing the burned tissue away with water and mild soap, or alternatively, enzyme debridement can be used for burns that are not affecting more than 10% of the TBSA. The physician can also opt for surgical debridement for extensive burns.

After debridement, a topical antibiotic and dressing should be applied to the wound. Some commonly used topical antibiotic formulations include:

- Sulfadiazine
- Mafenide Acetate
- Silver Nitrate

Each of these topical antibiotics has unique benefits. For example, silver nitrate has the ability to retard the growth of different bacteria. Mafenide acetate is particularly useful against gram-negative bacteria, especially *Pseudomonas* spp.
Topical Burn Care

Burn wounds heal best in moist environments that facilitate re-epithelialization and prevent dehydration. Such an environment can be created by applying a topical antibiotic cream or occlusive dressing. When selecting a topical antibiotic, it is important to choose the one that promotes healing, prevents wound infection, and offers pain relief. Since there are very few agents that exhibit all three properties, it may become necessary to use a combination formulation. In addition to this, the antimicrobial spectrum of the topical antibiotic should also be kept under consideration.

For superficial burns, lipid containing topical formulations should be used, such as Aloe Vera, honey, or an antibiotic ointment. There is evidence that the lipid component of these formulations helps prevent drying of the wound and facilitates tissue repair.

Patients who develop no further complications progress to the next stage of the treatment; the Rehabilitative Phase. Other patients, who develop cellulitis or an infection, should be referred to a burn center.

Patients who meet one or more of the following criteria should be referred to a specialized burn center:

- Patients with burns and concomitant trauma, such as fractures, in which the injury poses a high risk of morbidity and mortality
- Burns in children
- Burns in patients who require special emotional or rehabilitative care
- Burns in patients with a preexisting medical condition that may complicate the treatment process
- Burns that involve face, limbs, genitalia, or major joints
- Burns that affect more than 10% of the total body surface area
- Full thickness (third degree) burns in patients of any age

Pain Relief in Patients with Burns due to Electrical Shock and Lightning Strike Injuries

Burns are classified on the basis of their thickness and surface area; however, pain resulting from burns does not always correlate to the severity of injury. Therefore, it is important for a nurse to assess the pain experienced by the patient correctly and administer appropriate pain-relieving medicines accordingly.
Pharmacological Methods of Pain Control

During the first 48 hours, decreased blood supply to body organs, including the liver and kidneys, may result in decreased clearance of medications, increasing its serum levels and the risk of side effects. Conversely, some patients get into a hypermetabolic state after 48 hours of the burn injury, and therefore may require larger doses of a pain killer. Also, patients with kidney and liver damage should be prescribed a pain-relieving medicine cautiously as impaired hepatic or renal function may increase the serum levels of the drug, contributing to its side effects.

For burn patients, doses vary widely between individuals and can vary with the same individual over time.

The following analgesics are commonly used to offer pain relief to patients with electrical shock or lightning strike injuries:

1. Opioids — Available in a range of potencies, methods of administration, and duration of actions, opioids are the cornerstone of burn pain control. While opioids offer the unique benefit of reduced risk of post-traumatic stress disorder, their use is associated with a number of side effects, including respiratory depression, and therefore, should be used cautiously. Patients are likely to develop tolerance to opioids with prolonged use; therefore it is necessary to switch the drug being used with another opioid to restore analgesia in the patient.

Some opioids that are commonly used for pain relief include:
Fentanyl — A rapid onset, short acting opiate, fentanyl is a very potent pain killer. It can be administered by a variety of routes and is particularly suitable for short painful procedures, such as change of burn dressings.

Morphine — Offering rapid control of pain on intravenous administration, morphine is suitable for use during the emergent phase of treatment. Morphine is also available in oral form, however, to achieve adequate analgesia, higher doses must be used.

Oxycodone — Oxycodone’s similar efficacy is that of morphine, however, the side effects of hallucinations and histamine-induced itching are less frequent with oxycodone.

2. Simple Analgesics

Acetaminophen — Acetaminophen is a weak analgesic, however, when used in combination with opioids, it offers a synergistic effect. With an excellent risk profile and few contraindications, acetaminophen can be used safely in patients with concomitant medical conditions.

NSAIDs — While NSAIDs offer similar effects as that of acetaminophen, they cannot be used for long-term in burn patients because of their kidney function impairment potential. Therefore, the use of NSAIDs is restricted to young patients with burns affecting a small area of the body (<10% TBSA). Because of their gastrointestinal side effects, NSAIDs should always be administered with adequate ulcer prophylaxis, and should not be used in patients with extensive burns because of their anti-platelet effect.

3. Miscellaneous Drugs

Gabapentin — The use of gabapentin along with morphine in acute burn patients can result in a reduction of morphine requirements.

Ketamine — Ketamine, which is used as an anesthetic, can help induce a stage of dissociative anesthesia, which means that the patient may appear awake, but is detached from their surroundings, and is therefore, less likely to feel the burn pain. The benefit of using ketamine over other anesthetics is that unlike other anesthetics, it does not result in reduced heart rate and blood pressure. Apart from this, ketamine has remained effective in reducing the opiate consumption by approximately 30% in post-operative surgical settings and therefore, can prove to be of great value in patients who have responded poorly to opiates (Visser E, 2006).

Benzodiazepines — Various anxiolytics, including benzodiazepines, are used as adjunct analgesics in patients with burns due to an electrical shock or lightning strike injury. These, when used in conjunction with an opiate, can help reduce the required dose of the opioid drug and produce analgesia. However, benzodiazepines should be used with great caution as they are prone to cause respiratory depression.
Nutrition is one of the most overlooked aspects of the management of a patient with electrical or lightning injuries. Since the metabolic response of the body due to burns caused by an electrical or lightning injury is characterized by hypermetabolism, increased protein catabolism, and weight loss, it is imperative that special attention be paid to fulfilling the nutritional requirements of the patient in order to prevent malnutrition.

The need for adequate nutrition particularly increases when a patient has burns affecting 30% or more of his TBSA, as the extent of injury is directly proportional to changes in metabolism. There are studies that suggest that malnutrition may interfere with wound healing and delaying the closure of open burn wounds (Rowan MP, 2015).

Various research studies suggest the following nutritional recommendations for patients with burns due to electrical shock or lightning strike injuries:

**Route of Feeding**
Aggressive fluid therapy in the resuscitation phase may result in generalized edema which may lead to paralytic ileus; therefore, while the gastric route is the preferred route, care should be taken to avoid gastrointestinal complications. Early enteral feeding within 6 to 12 hours of the injury is associated with significant advantages, including:

- Reduction in the hypermetabolic response of the body to the injury
- Increased immunoglobulin production
- Reduction of stress ulcers
- Reduced risk of malnutrition and energy deficit (Rousseau A, 2013)

*Parenteral nutrition* is indicated in cases where enteral feeding is contraindicated or has resulted in poor response from the patient. However, patients receiving parenteral nutrition should be closely monitored for abnormal increase or decrease in blood glucose levels as well as fulfillment of the daily energy requirements. Overfeeding should also be avoided as this may also result in fatty liver infiltration and increased infectious morbidity.

**Psychosocial Care**

Electrical shock and lightning strike injuries are traumatic experiences that not only affect a patient’s physical health, but also place huge stress on their psychological status. While recent advancements in the treatments and medications available to care for these patients have helped reduce the mortality and morbidity rates, it has led to an increased number of patients who are required to make mental alterations and become adjusted to their altered physical appearance after the injury. *As a result, the survivors of electrical shock and lightning strike injuries can suffer various psychological effects, particularly depression, anxiety, and post-traumatic stress disorder.*

Different patients may exhibit different signs of psychological stress at different stages of the treatment process. Broadly speaking, we can divide the psychological symptoms and treatments required into four stages as presented in the following table.
### Phases of Recovery with Expected Psychological Symptoms and their Recommended Treatments (Dalal PK, 2010)

<table>
<thead>
<tr>
<th>Treatment Phase</th>
<th>Expected Symptoms</th>
<th>Recommended Treatments</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Admission</strong></td>
<td>Anxiety, terror</td>
<td>Anti-anxiety and pain-relieving medicines</td>
</tr>
<tr>
<td></td>
<td>Pain</td>
<td>Psychological support:</td>
</tr>
<tr>
<td></td>
<td>Sadness, grief</td>
<td>- Reassurance</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Normalization</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Relaxation techniques</td>
</tr>
<tr>
<td></td>
<td>Pain</td>
<td>Anti-anxiety and pain-relieving medications</td>
</tr>
<tr>
<td></td>
<td>Sadness, grief</td>
<td>Continued psychological support</td>
</tr>
<tr>
<td></td>
<td>Anxiety, terror</td>
<td>Medication for managing acute stress disorder</td>
</tr>
<tr>
<td></td>
<td>Acute stress disorder</td>
<td></td>
</tr>
<tr>
<td><strong>Critical Care Phase</strong></td>
<td>Pain</td>
<td>Anti-anxiety and pain-relieving medications</td>
</tr>
<tr>
<td></td>
<td>Sadness, grief</td>
<td>Continued psychological support</td>
</tr>
<tr>
<td></td>
<td>Anxiety, terror</td>
<td>Medication for managing acute stress disorder</td>
</tr>
<tr>
<td></td>
<td>Acute stress disorder</td>
<td></td>
</tr>
<tr>
<td><strong>In-Hospital Recovery</strong></td>
<td>Increased pain with anxiety</td>
<td>Analgesics</td>
</tr>
<tr>
<td></td>
<td>Anger, frustration</td>
<td>Pharmacological treatment of depression and anxiety</td>
</tr>
<tr>
<td></td>
<td>Depressive episodes</td>
<td>Psychotherapy (cognitive-behavioral and family therapy)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Rehabilitation</strong></td>
<td>Adjustment difficulties</td>
<td>Psychotherapy (cognitive-behavioral and family therapy)</td>
</tr>
<tr>
<td></td>
<td>Post-traumatic stress disorder</td>
<td>Pharmacological therapy for post-traumatic stress disorder</td>
</tr>
<tr>
<td></td>
<td>Anxiety</td>
<td>Anxiolytics and anti-depressants</td>
</tr>
<tr>
<td></td>
<td>Depression</td>
<td></td>
</tr>
</tbody>
</table>

**The Rehabilitative Phase**

The Rehabilitative Phase begins when the burns are almost healed and the required wound care is manageable by the patient or family/caregiver, and ends when the patient has achieved an optimal level of health and wellbeing. The focus of care during the Rehabilitative Phase is to help the patient return to the pre-injury stage. If this goal is impossible due to extensive injury, the focus is on helping the patient adjust to the lifestyle the injury has imposed.

At the time of discharge, the following rehabilitative interventions should be administered by a nursing professional:

- **Wound Care** — The nurse should educate the patient and their family member/caregiver on how to perform the wound care ordered by the physician and instruct them on the signs and symptoms of infection and complications that should be reported to the physician immediately.

- **Education** — In addition to wound care, the patient and their family/caregiver should be provided comprehensive information regarding pain management, nutrition, prevention of complications, particularly infections, and rehabilitative exercises.

- **Follow up Care** — Generally, most patients discharged from a burn center are required to visit a burn clinic after discharge for continued evaluation of the status of the burn. In severe cases, the planning of reconstructive surgery may be required.

- **Referral** — For patients with a severe burn injury, or those who cannot manage to care for themselves, Home Health nursing care may be ordered by the physician. The hospital discharge planner can assist with setting up home health care services for the patient.
The following ‘Home Care Checklist’ provides a comprehensive list of home care instructions that should be provided by a nursing professional to the patient and/or their caregiver.

**Home Care Checklist for a Patient with Burns due to an Electrical Shock or Lightning Strike Injury**

<table>
<thead>
<tr>
<th>At the completion of the home care instructions, the patient or their caregiver should be able to:</th>
<th>Patient</th>
<th>Caregiver</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mental Health</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Identify strategies to promote the patient’s mental health. Some of the possible strategies include:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Remember that getting adjusted to a new lifestyle takes time.</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>2. Resume previous activities gradually.</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>3. Be aware of your own feelings and fears and discuss them with others.</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>4. Expect frustrations and depression about changes in physical appearance.</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Wound Care Instructions</td>
<td></td>
<td></td>
</tr>
<tr>
<td>The patient should be aware of the following wound care and sun protection precautions:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Wear sun block to protect the burned skin from the sun.</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>2. Do not try to scratch and remove blisters as this may cause further trauma to the skin.</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>3. Lubricate the skin with a mild lotion or any other skin formulation prescribed by the doctor.</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>4. Use only mild soap and water on burned areas.</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Exercise</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Explain the following guidelines regarding exercise and physical activity:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Try to perform your personal tasks on your own.</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>2. Adhere to the exercise regime provided by the doctor.</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Nutrition</td>
<td></td>
<td></td>
</tr>
<tr>
<td>The following nutrition guidelines should be provided by the nurse:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Eat a diet high in protein and calories.</td>
<td>✓</td>
<td></td>
</tr>
</tbody>
</table>
2. Drink adequate volume of fluids to prevent constipation caused by pain-relieving medicines.

<table>
<thead>
<tr>
<th>Pain Management</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Describe the following instructions for managing pain:</strong></td>
</tr>
<tr>
<td>1. Since many painkillers may cause drowsiness, avoid situations that require alertness, such as driving or operating machinery.</td>
</tr>
<tr>
<td>2. Take pain-relieving medicines as prescribed by the physician.</td>
</tr>
<tr>
<td>3. Try non-pharmacological means of pain management, such as relaxation and distraction to relieve pain.</td>
</tr>
</tbody>
</table>

**CONCLUSION**

The nurse plays an integral part in providing care to a patient who has suffered an electrical shock or lightning strike, and it can be a challenging process that requires expertise and experience. Nursing professionals should be aware of the complex needs of these patients in order to be able to provide them with appropriate care and achieve optimal outcomes.

It is important that the nurse remains attentive and vigilant during all stages of the treatment plan in order to reduce the risk of morbidity and mortality. In addition to this, knowing how to calculate the fluid requirements of a patient with burns due to electrical shock or lightning strike injuries is also important, as inadequate fluid resuscitation therapy can lead to a number of complications, including increased length of stay, risk of infections, or even death, due to extensive fluid deficit and subsequent organ damage.

As the *Emergent Phase* of treatment focuses on fluid resuscitation and cardiac monitoring, the *Intermediate Phase* focuses on pain management and wound care. The two are important aspects of the treatment process as they affect the patient’s comfort, as well as their ability to get back to their home and their pre-injury lifestyle as quickly as possible.

Once the desired outcomes are achieved and the patient is ready to go home, the nurse should provide support and guidance on the importance that the patient follows-up with their physician in order to remain on the path to attaining a healthy and active lifestyle.
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