Treatment of Burn-Injured Patients

Objectives
After reading this article you will be able to:

1. Describe the different types of burns.
2. Describe the Rule of Nines.
3. List the different categories of burns determined by the ABA.
4. Describe the pre-hospital treatment of minor burns.
5. Describe the pre-hospital treatment of major burns.

Treatment of Burn-Injured Patients

The sky's lit up orange as your EMS rig pulls up to the structure fire. You feel the searing heat — even though you've set up 300 feet away. Suddenly, a firefighter emerges from the smoke, half carrying a disheveled man. The man's face is soot smeared. As he comes up to you, you see his arm is severely burned.

Yearly, more than 2.5 million significant burns injuries — caused by heat, electricity, chemicals and radiation — occur in the United States. Some 12,000 of these burn patients die. The pre-hospital provider must often treat burn patients, and, what the provider does greatly impacts their survival. Quick decisions and prompt treatment are important. Below, we'll go over burn injuries and the mechanism of sustaining them. Initial assessment and treatment of burn injuries and associated complications will be emphasized.

Types of Burn Injuries

People can suffer burn injuries in a variety of ways. House fires are a common cause, particularly with children. Thermal burns can be caused by hot fluids like water, oil and antifreeze. Yet, thermal and house-fire burns aren't the only types of burn injuries seen by EMS providers. People can be burned by chemicals, and electrical or radiation sources. While unique in their patterns and associated complications, for most burn injuries the treatment plan is similar — with a few important differences.

Thermal Burns

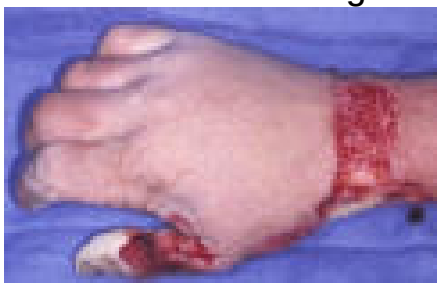
Thermal burns are often caused by

contact or close proximity to fire or heated surfaces or substances. This causes damage to tissues exposed to the heat. Thermal burns are often encountered in house fires. Yet, thermal burn injuries occur in a variety of other ways, as a result of clothing fires caused by careless smokers, for example. Ignited substances such as gasoline, lighter fluid and aerosols can also cause injury.

Thermal burns don't always involve fire or flame. Many times, touching, grabbing or bumping into heated surfaces can cause injury. In the workplace superheated fluids and steam have the potential to cause massive thermal burns. Regardless of the source, thermal burns are created by denaturing the protein of exposed tissue. Burn depth is directly related to heat intensity and exposure duration.

Electrical Burns

Electrical burn injuries are unique. To complete a circuit or ground, electrical currents will always try to take the path of least resistance. If current passes through a human body it will often enter and exit with great force, with the produced friction leaving burn injuries.



Locations of the entrance and exit wounds are important when determining the path electrical current takes. Current will often travel along nerves, arteries and veins rather than through denser tissue. Anything along its path can be damaged. It is also important to determine the source and voltage of the electrical current.

Special care of electrically injured patients is needed. Cardiac rhythm abnormalities are common and can be life-threatening. Also, one shouldn't forget that electrical current can cause massive and intense muscular contractions forceful enough to fracture bones — including the spinal column. Burn damage may not be immediately evident and a high index of suspicion and early management are essential. Amount of current, duration of exposure and the course the current takes through the body are often determining factors in patient outcome.

Chemical Burns

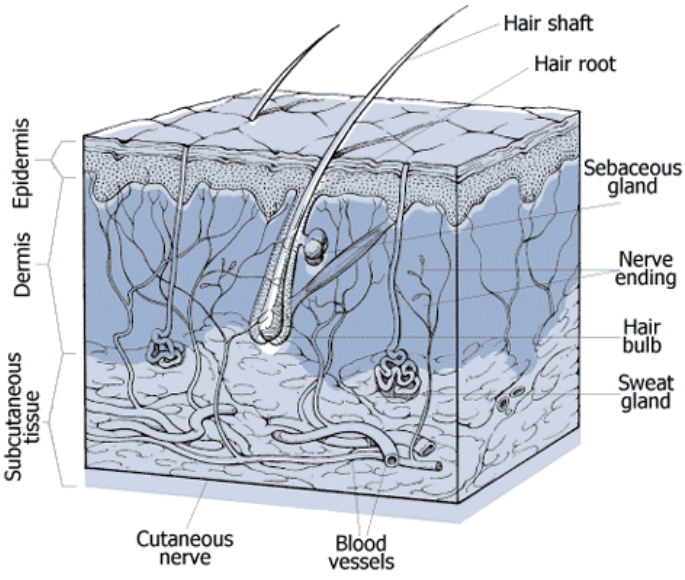
Chemical burns are usually caused by contact with agents that denature tissue. Chemicals may alter tissue's molecular bonds, or may create interactions and produce heat that destroys tissue. Must often, one may think of

acids as the offending agent, but alkaline substances can also cause severe burns. Since chemicals will continue to damage tissue until they're removed, removing the agent from the tissue is key. In addition, special consideration must be given to alkaline burns of the eye. These can cause heavy destruction in less than three minutes of contact and can lead to irreversible vision loss. Copious irrigation is essential.

Any liquid chemical needs to be flushed off tissue with a generous amount of water, and dry or powdered chemicals should be brushed off thoroughly, with the area flushed with profuse amounts of fluid. Keep in mind that some chemicals and metals such as lithium, sodium and potassium violently react with water. Therefore, identification and removal of the substance and proper treatment are important. Chemicals can also enter rescuers so proper protection should be used.

Radiation Burns

Radioactive waves emanating from a radiation sources can cause burns. Radioactive materials release alpha and beta particles, and gamma rays. Any radioactive particles or debris remaining on skin can continue to cause damage, so decontamination is important to stop injury and protect the provider.



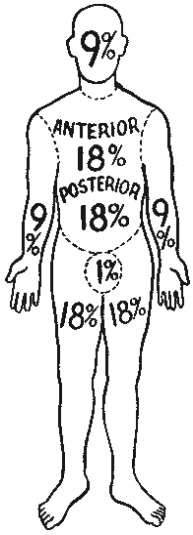
Handling radiation-exposed burn victims requires specialized training and equipment. The tissue damage that occurs is similar to other burns. Again, intensity of the source adds to the tissue damage. It can be reduced by increasing the distance from the source. Duration of exposure also directly impacts the amount of tissue damage. Radiation-producing materials can be extremely dangerous to EMS personnel. OSHA, therefore, has specific requirements for hazardous material recognition for EMS responders. Only thoroughly trained personnel should handle or manage hazardous materials.

Pathophysiology

The skin is an organ covering a large surface area. It has a rich blood supply and is made up of several distinct layers. The outer layer — the

epidermis — covers the dermis, which contains vessels and nerves. Beneath this is the subcutaneous tissue.

The dermis and epidermis are remarkable in function. Humans are protected from the environment by these watertight, efficient tissues. The skin controls body temperature and prevents water loss. It is highly innervated and keeps us in touch with the outside world. But when the skin is damaged by a burn, these functions are disrupted. Damage is quantified by the amount of surface area injured and depth of the damage.



Quantifying the total body surface area (TBSA) burned is commonly done by the Rule of Nines. Another means is to use the palmer aspect of the patient's hand. It represents 1 percent of the TBSA. If, for example, the equivalent of 10 of palm surface areas is needed to cover an injured area, it's a 10 percent of TBSA burn.

Burn depth of is either partial or full thickness. Partial-thickness burns (formerly called first- and second-degree burns) involve the epidermis and portions of the dermis. Full-thickness burns (formerly called third-degree burns) go through the epidermis and dermis and expose or damage muscle, tendons, bone, etc. Partial-thickness burns range from red sunburns to blistering burns. Full-thickness burns show charring and sensory loss.

The American Burn Association (ABA) categorizes burns as minor, moderate or major based on several factors and findings including depth of destruction, TBSA injured, body parts affected, age, pre-existing disease and associated injuries (Table 1).

Table 1: Classifying Burns
The American Burn Association (ABA) categorizes burns as minor, moderate, or major. This is based on depth or tissue destruction, total body surface area (TBSA), body parts affected, pre-existing disease and trauma.
Minor: Burns less than 15 percent TBSA in adults, or less than 10 percent in children or the elderly, with less than 2 percent full-thickness injury. Minor burns do not involve special care areas, including the face, eyes, ears, feet or perineum.

Moderate: Mixed partial-and full-thickness burns of 15 to 25 percent TBSA in adolescents and young adults, 10 to 20 percent in children under age 10 and adults over 40. Full-thickness burns less than 10 percent TBSA not involving special care areas.
Major: All burn injuries totaling more than 25 percent TBSA in adolescents and young adults. Burns involving more than 20 percent TBSA in children under 10 and adults over 40. Full-thickness burns of 10 percent of greater. All burns involving the hands, feet, face, eyes, ears or perineum that are likely to result in either functional or cosmetic impairment. All inhalation injuries, high-voltage electrical injuries or burns complicated by fractures or other trauma. Burns that occur in high-risk patients such as infants, the elderly and patients with diabetes, heart disease, renal disorders or other health problems.

Other Symptoms and Associated Injuries

The delicate tissue of the eyes and mucous membranes of the airway can be easily damaged if exposed to heat, fumes, chemicals, electricity or radiation. The nose, mouth, throat and lungs, for example, can be damaged if the victim breathes while at close proximity to a heat source. Tissue sloughing and swelling may ensue, including the airway.

Breathing while in a burning environment can damage the respiratory process, particularly if carbon monoxide (CO) or cyanide levels are sufficiently high. Half of the 12,000 burn-related deaths annually involve CO poisoning. CO has a greater affinity for hemoglobin than oxygen and can easily occupy all binding sites, leading to poor oxygen delivery and death. CO poisoning is best treated in the field by removing the patient from the toxic environment and administering high-flow oxygen.

Cyanide (CN) acts at the cellular level, disrupting all cellular function and leading to rapid loss of vital signs. Treatment includes remove from the toxic environment, administering oxygen and use of an antidote kit.

Another area adversely affected when large amounts of tissue are burned is the renal system. Due to the body's clearing of the by-product of burnt tissue, the kidneys can be overwhelmed by myoglobin. This is often complicated by the hypovolemic state created by massive fluid loss, causing concentrations of toxins in the kidney that can be damaging. Adequate hydration and good urine output are essential to reducing the risks of renal damage or failure.

Initial Assessment and Treatment

When responding to a burn victim gather as much information as possible. First, determine if a situation exists that may injure rescuers or is continuing to injure victims. Assess how long the patient was exposed to the offending agent or heat and the intensity of that exposure. Determine if the patient inhaled any of the heat or chemical. In addition, was there a fall or other trauma? Is there a suspicion of blast injuries?

After locating the patient, extinguish any burning or smoldering clothes, or remove contaminated garments once in a safe environment. Make sure the patient is adequately decontaminated before delivering him/her to the medical team.

As always, assessing the ABCs is a priority. Don't be distracted or overwhelmed by a burn's appearance. Often, a burn doesn't initially kill a person, but associated injuries can be life-threatening. After securing the airway and establishing adequate breathing, circulation and end-organ perfusion, move to the secondary survey. Look for associated injuries such as fractures, open wounds, and entrance and exit wounds. Check pulse, movement and sensation. Initiate moving the patient as soon as possible to the proper facility. Air transport to a burn center should be seriously considered if the situation warrants. Still, if faced with burn-associated injuries that are immediately life-threatening, the EMS provider may decide to transport to the nearest appropriate facility.

Airway

Is the patient keeping his/her airway open and handling secretions adequately? Inhalation injuries may present initially or over time. Look for burns near or in the nasal or oral passages. Singed facial hair and carbonaceous sputum are often telltale signs of significant inhalation and airway injury. In addition, airway swelling may create a problem. Advanced airway techniques may be needed if the usual management skills don't effectively keep the airway open.

Nasal or oral tubes may be necessary if jaw thrust doesn't open the airway. A low threshold for intubation should be maintained. Early — but careful — endotracheal tube placement may eliminate the need for later surgical airway procedures. Don't forget to protect the C-spine if trauma is associated with the burn injury. This is particularly important when dealing with electrical burns or blast injuries.

Breathing

Assure adequate respiration in both quality rate and volume, and support

breathing with supplemental high-flow oxygen. This is critical if the patient has suffered and inhalation injury or has been exposed to toxic fumes such as CO. If necessary, support ventilation with positive pressure ventilation.

Circulation

Evaluate and treat hypotension aggressively. Remember, since a burn damages skin function, fluid loss can be massive. Keep evaluating patients for other sources of volume loss or causes of hypovolemia. Tachycardia, anxiety, poor capillary perfusion and blood pressure changes should be aggressively treated by volume replacement, PASG or both, if applicable under regional protocol. Fluid replacement for volume loss due to burns is easily calculated using the Parkland formula or a variation (Table 2).

Table 2: Parkland Formula for Calculating Fluid Replacement in Burn Injuries

$\frac{4cc \times wt.\ In\ kg \times TBSA\ percent\ burn}{2}$	=	cc in first eight hours, then remainder in next 16 hours		
Example: 100 kg man with burns on 40 percent of body				
$\frac{4cc \times 100\ kg \times 40\ percent\ burn}{2}$	=	$\frac{16000}{2}$	=	8000cc in eight hours (or 1000cc per hour for eight hours)

While rapidly transporting a patient to a medical facility, constant assessment and reassessment of associated and life-threatening injuries are appropriate. Burned surface areas need to be protected from contamination and fluid loss. Frequently, a sterile dry dressing is all that's necessary. Still, sterile burn sheets and sterile saline for irrigation may be needed.

Patients exposed to high temperatures or flame may be hot. Cooling down tissue with room temperature, saline-soaked dressings or burn sheets may prevent further damage and offer some pain relief. But avoid ice or cold irrigation fluids, and don't place home remedies or creams on a burn. They can often hold heat in and interfere with later cleaning. Commercially available burn gels, water soluble and impregnated into flexible pads, are applied directly to a wound to protect and cool. Use of these products varies from region to region. Still, they are gaining in acceptance across the United States.

Pain Control

Burns that affect the layers of tissue will also damage nerves in the area. That's why full-thickness burns are painless. But most burn injuries in the real world aren't purely full-thickness and painless. Most likely, various

degrees of painful partial-thickness burns surround the full-thickness burn area. Therefore, pain management is important. The horrible pain associated with burns can greatly affect a patient's stability. Once life-threatening injuries, including internal and head injuries, are excluded, pain can be managed. Sedate in a patient is most humane. Field use of narcotics for burns is up to local medical control. Options for pain control vary from service to service, but may include morphine, valium or nitrous oxide.

Treatment of Minor Burns

Pre-hospital treatment of minor burns should include steps to protect against contamination and fluid loss. Anything done in the field, though, shouldn't interfere with evaluation and treatment in hospital. Therefore, sterile and lightly wrapped dressings should be applied. Don't open blisters or remove skin. And, if the burned meets ABA criteria as a minor burn, it doesn't involve special care areas such as the face, eyes, hands, feet or perineum. Continually assess and control ABCs, give high-flow oxygen and assess associated injuries.

Treatment of Major Burns

Major burns are potentially life or limb threatening. The decision on which hospital or burn center to use must be made quickly. Don't hesitate to discuss the patient's condition with on a line medical direction when available, and use aero medical transport when appropriate. Examine the means of injury and be suspicious of airway involvement. Often, patients will require intubation and ventilation on high-flow oxygen.

Control the ABCs and maintain a high index of suspicion for other life-threatening injuries. IV access and fluid replacement are important. Cover all burn areas with sterile dressings and keep distal portions of extremities accessible for continued evaluation. Don't neglect to remove all partially burned clothes. Cover the burn with a sterile burn sheet.

Complications and Considerations

Remember, with airway burns or inhalation injuries, the patience of the airway may change. The airway, appearing relatively unaffected, may become more compromised over time. Maintain a low threshold for definitive airway management.

IV access may prove a difficult task when dealing with massive burns. Try not to start IVs in the burn area or distal to the burn area. Consider external jugular access if the neck is not involved. The patient may require cut down. With children, intraosseous infusion may be necessary.

When the chest or extremities are circumferentially burned, the burned tissue may constrict the area. With an extremity, it becomes a limb-threatening injury due to swelling and decreased blood flow. Rapid transport to a medical facility is necessary so that an incision can be made through to burnt tissue. Remember, swelling will occur with burn injuries and care must be taken to avoid any item that constricts.

Summary

Thermal, electrical, chemical and radiation sources can cause burns and damage tissues. In addition, associated injuries can be life or limb threatening. This means careful evaluation of the injury mechanism is essential, and special care must be taken if the patient was in a confined space facing heat or chemical or toxic fumes.

Remember that electrical injuries follow the current's path and can involve deep structures and organs. Therefore, the heart and brain's electrical activity can be adversely affected. Initial assessment and constant re-evaluation is essential, as these injuries will often worsen with time.

When dealing with burns, fluid hydration and pain control are important. Since the skin is damaged, care must be taken to protect against contamination and fluid loss. Sterile non-constricting dressings and burn sheets are most adequate, and newer water-soluble gels may be considered if approved by medical direction. Finally, remember that careful review of the classification and quantification of burn injuries will be helpful in burn management.

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