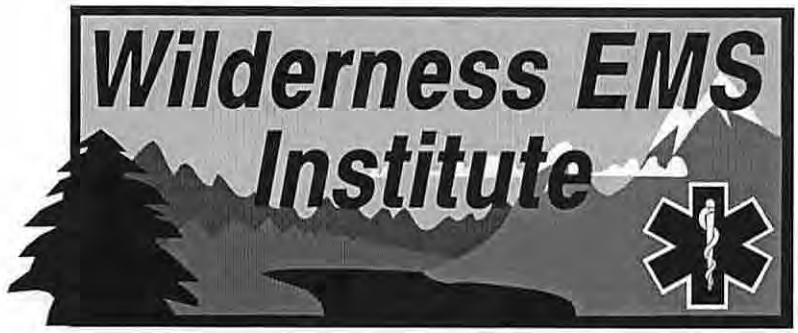
Chapter VIII:

Burns and Lightning



Appalachian Search and Rescue Conference
Center for Emergency Medicine of Western Pennsylvania

Wilderness EMT Textbook

Chapter VIII: Burns and Lightning

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The ASRC-CEM Wilderness Emergency Medical Services Institute

The ASRC-CEM *Wilderness Emergency Medical Services Institute*, previously named the *Wilderness Emergency Medicine Curriculum Development Project*, is devoted to developing curricula for wilderness EMS providers and medical control physicians, and fosters wilderness EMS research. It is a cooperative venture of the Appalachian Search and Rescue Conference and the Center for Emergency Medicine of Western Pennsylvania. The ASRC is a large, tightly-knit wilderness search and rescue organization with eight teams throughout the mid-Appalachian states. The Center for Emergency Medicine is an emergency medicine and prehospital care research and teaching organization. It provides a medical helicopter service, an emergency medicine residency, Emergency Medical Services for the city of Pittsburgh, and conducts a variety of related projects.

The WEMSI Wilderness EMT Curriculum

This chapter is one part of the ASRC-CEM Wilderness Emergency Medical Technician Textbook. In concert with the WEMT Curriculum, the Textbook has been in development since 1986, and took as its starting point a program Dr. Conover developed for the National Association for Search and Rescue in 1980. The Project has also drawn on many other sources in creating this Textbook. These include the Wilderness EMT program of SOLO (Stonehearth Open Learning Opportunities), the WEMT program developed by Wilderness Medical Associates for the National Association for Search and Rescue, and the Winter Emergency Care Course of the National Ski Patrol. The Wilderness Medical Society's educational and research publications provide needed background for the Textbook. The National Association of EMS Physicians has developed and has published clinical guidelines for delayed/prolonged transport; WEMSI protocols are also available as a model.

With textbooks used by its EMT and SAR prerequisites, this Textbook provides all the training material needed to complete the Wilderness Prehospital Emergency Care curriculum established by the Wilderness Medical Society. (Indeed, early drafts of this textbook were a major resource for the WMS curriculum.) We assume that students have the knowledge and skills of an EMT-Basic or EMT-Paramedic. (The curriculum can accommodate both EMTs and paramedics in the same class.) We also assume that students have the knowledge and skills of the Virginia Ground Search and Rescue Field Team Member standards or better. (EMT standards are available from state EMS offices or the U.S. Department of Transportation. The Virginia GSAR standards and GSAR Manual are available from the Virginia Department of Emergency Services, 310 Turner Road, Richmond, VA 23225-6491.) The curriculum is competency-based rather than hours-based, but can be competed in roughly five intensive days. The curriculum also recommends clinical training, for which guidelines are available in the Curriculum.

WEMT Textbook Chapter Development

An outline for each of the twenty sections of the WEMT curriculum was created by a Task Group of five to twenty selected members, but draws on many published sources and consultants. A Task Group Leader guides the Task Group in reviewing and revising the section, and the Project Coordinator supervises all aspects of curriculum development.

When the outline satisfies the Task Group, it goes to our **Editorial Board**. This Board includes officers of the ASRC and Center for Emergency Medicine, our two sponsors. It also includes experts in emergency medicine, search and rescue, and education, and a State EMS director. Once the Lesson Plan is acceptable to the Board, it is released to the public.

Along with the Task Group Leader, the Editor-in-Chief then produces a Textbook chapter based on the Task Group's outline. Having a single editor provides a coherent, unified style. Basing each chapter on the Task Group's Lesson Plans, as approved by the Editorial Board, ensures accuracy. Each chapter provides glossary entries for any new terms. (New, that is, to a reader with basic EMT and SAR training.) In the complete textbook, these glossary entries will be merged and alphabetized. Each chapter also provides references to support its statements and for further reading. Background material that need not be presented in a class based on the Curriculum appear *in this small, italic font.*

The textbook will be commercially published when completed. All profits will be used to support curriculum development. The textbook will be submitted for publication in 1994. Until then, preliminary versions of the chapters will be printed in this format. These preliminary versions are for use **only** at classes authorized by the Executive Director.

A Course Guide, providing detailed information about Wilderness Emergency Medical Technician training and course scheduling, will also be available in mid-1994; a checklist for recommended in-hospital training is available now. For a price list of available publications, write to: Center for Emergency Medicine, 320 McKee Place, Suite 500, Pittsburgh, PA 15213-4904, or call: (412) 578-3200.

Educational Objectives

1. Describe the immediate care of burns, and address the appropriateness of analgesia for burns in the wilderness.
2. Describe the extended care of sunburn.
3. Describe the extended care of small second and third degree burns in the wilderness, specifically:
   a. cleaning and debriding;
   b. the advantages and disadvantages of applying ointments or creams;
   c. when to drain blisters; and
   d. the role of prophylactic antibiotics in burn care.
4. Describe the causes of "burn shock" and ways to determine the fluid replacement needs for a burn patient.
5. Describe the possible complications of inhalation burns and their management in the wilderness, including:
   a. upper airway burns; and
   b. toxic inhalations.
6. Define "ileus," outline its diagnosis, and describe its impact on the burn patient in the wilderness, especially as regards oral fluid replacement.
7. Identify the need for tetanus immunization for burns.
8. Define the term "escharotomy" and describe two major indications for escharotomy in a burn patient.
9. List three different kinds of lightning strike injury pattern.
10. Identify the common neurological complications of a lightning strike.
11. Identify the pattern of cardiorespiratory arrest following a lightning strike.
12. Identify pertinent facets of burns associated with a lightning strike.
13. Define "vasospasm" and identify its importance in lightning strike victims.
14. Describe the damage that lightning may cause to muscles, and possible consequences.
15. Identify the mechanisms of fractures in lightning strike victims.
16. Explain the importance and effectiveness of cardio-pulmonary resuscitation in lightning strike victims.
17. List several clues that might indicate a lightning strike as the cause of unconsciousness of a patient found in the wilderness, and outline the management of a conscious victim of a lightning strike.
18. Give an explanation of triage for a large group of people struck by lightning.
19. Identify two important points in public education about lightning strikes.

Burns

Immediate Care

Immediate care of burns in the wilderness is no different than on the street:

* Stop the burning by putting out the fire.
* Stop additional heat damage, and provide pain relief, by cooling the area with cold water to the area, unless the area is so large, or the weather so cold,

Notes: *Burns and Lightning*

The immediate management of burns and of victims of lightning are taught as part of EMT and EMT-P classes. However, we believe that the problems, which are relatively common in the wilderness, deserve greater emphasis than given in EMT classes. And, there are particular aspects of extended care for each – possible prolonged coma after a lightning strike but with full neurological recovery, or infection of burns, for example – that are of vital importance to the Wilderness EMT.

that hypothermia or frostbite would develop.

* Cut away nonadherent clothing, and remove rings and other jewelry.

Depending on the situation, you may want to start some analgesia (pain medication) at this point. For most small burns, surprisingly, acetaminophen or ibuprofen should suffice, providing you use cold water and then apply a burn dressing (see below). For larger or particularly painful burns, you can give narcotics. In the city, patients rarely get analgesics until arriving at the Emergency Department. But, when the burn is painful, and the transport time is hours or days, withholding pain medication is cruel, and serves no useful purpose.

Sunburn

Sunburn is caused by the effects of ultraviolet light on the skin.* **Windburn**, occurring in windy, cold conditions, is really a type of sunburn. The wind and cold seem to predispose exposed areas of the skin (especially the face and the back of the hand) to sunburn.

First degree sunburn (reddened skin) is painful, and may interfere with thermal regulation. (Sunburn predisposes to hypothermia and heat illness). Standard treatment includes cool compresses, analgesics (aspirin, acetaminophen, or ibuprofen), and when itching becomes a problem, antihistamines such as diphenhydramine (e.g., Benadryl®). Topical medications are of little benefit, except as the sunburn is healing, at which time scaling and peeling tends to cause severe itching. Keeping the skin moist (with any kind of hand lotion) may help minimize such symptoms. Local anaesthetics are discussed in the chapter on *Wilderness Medical Problems.*

Treat second degree sunburn (i.e., with blistering) as for any other thermal burn. There is some evidence that ibuprofen will help, the earlier the better.[1,2] Steroid creams are useless.[3] Some doctors believe that oral steroids may help in very severe sunburn, but evidence for this is thin.

Small Burns

EMT's are taught never to put anything on burns except for cold water or a dry dressing, and this is appropriate for short transport times. The reasons for not applying creams on the street are (1) it makes it harder to clean the burn properly and see what it really looks like, once the patient reaches the Emergency Department, and (2) most over-the-counter burn creams are useless or worse (i.e., don't have antibacterial properties, or may cause allergic reactions).

Small Second Degree Burns: However, for small second degree burns (the size of five palms, which is about 5%, or less), the Emergency Department physician or burn surgeon will generally examine the burn, clean it just a bit, and place silver sulfadiazine (Silvadene®) cream or bacitracin ointment on it. They will tell the patient to reapply the cream or ointment twice a day and come back in 2 or 3 days for a recheck.

Wilderness EMT's should do the same: gently clean the burn of loose blister fragments ("debride") and any foreign material, clean the burn with soapy water, perhaps with some 1% (dilute) povadone-iodine solution, and apply silver sulfadiazine (Silvadene®) cream or bacitracin ointment twice a day. (If you don't have silver sulfadiazine (Silvadene®) or bacitracin, canned non-mentholated shaving cream makes an acceptable substitute.) Ointment or cream serves three purposes:

* it keeps the air away from nerve endings, preventing pain;
* it decreases evaporation; and
* it helps prevent infection.

* Protection from ultraviolet light is discussed in the chapter on *The Wilderness Environment.*

You should leave complete blisters intact, unless they are where they are sure to rupture (e.g., the soles of the feet), or are very large and tightly filled with bloody fluid.* In such cases, prep the blister with an antiseptic such as povadone-iodine (e.g., Betadine®), then drain by a small incision (at the edge of the blister seems to work best) with a sterile scalpel blade or needle. You should then press the blister flat, in the hope that it will stick to the underlying skin and continue to serve as a burn dressing.

Burn surgeons prefer to not give antibiotics to a burn patient unless an actual infection is diagnosed.** And, many people who have not seen healing burns are concerned by the redness around them and convinced that the wound is infected when it is not. Burns generally develop a grayish exudate as they are healing, and get red around the edges. Actual pus in the burn, or redness spreading more than half an inch from the burn, or a positive culture from the wound, would be needed to persuade a burn surgeon that the burn is infected.

Small Third Degree Burns: Small third degree burns (less than 5%) will generally need care in a burn unit for regular debridement, and possibly for skin grafting.

In the wilderness, the care for small third degree burns will be the same as for small second degree burns.

Third-degree burns tend to develop a dense eschar. This is nothing more than dead, burnt skin. Because it is hard, it can compress underlying structures. Burn creams tend to help keep the eschar soft, which also aids in healing. The standard recommendation for third degree burns is to use only water-soluble burn creams such as silver sulfadiazine (Silvadene®), because greasy ointments are too hard to remove. In the wilderness, however, bacitracin or povadone-iodine (e.g., Betadine®) ointments are often available whereas silver sulfadiazine cream is not. If the transport time will be more than a few hours, and you have no silver sulfadiazine, use bacitracin or povadone-iodine ointment. We don't recommend using the "burn cream" from most unit first aid kits, ever.

Large Burns

Burn Shock: The skin is an important organ; it keeps all our water from leaking out. However, when it is burnt, the water **does** leak out! In any patient with a burn more of than 5%, this may cause hypovolemic shock. Another contributor to burn shock is loss of water into the damaged tissue under the burn, which becomes very swollen. First degree burns such as sunburn do not cause loss of fluid through the skin, but a widespread sunburn can cause enough tissue swelling to cause mild shock.

Burn patients typically require more fluid than you might expect, given the extent of the burn. As presented in the Advanced Burn Life Support Course of the American Burn Association, the **"Consensus Burn Formula"** is as follows:

2-4 cc of Ringer's Lactate
x Body Wt. (kg)
x Total Body Surface Area burn
for the first 24 hours:
give half in the first 8 hours, then
half over the next 16 hours.

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* rationale: bloody blisters, whether from burns or friction, are thought to contain inflammatory compounds that continue damaging the skin unless drained

** Their reasoning is that they want to save the antibiotics for when they are really needed, so the patient gets infected with easy-to-kill bugs, rather than ones that are resistant to the antibiotic the patient is already on. This is very different from orthopedic surgeons, who feel strongly that antibiotics should be given to any patient with an open fracture, preferably a half hour prior to the fracture.

The burn formula is just a guideline. The best way to assess for adequate fluid replacement in a burn patient is by the urine output; it should stay above 50cc/hr for an adult, or 1cc/kg/hr for a child or infant. Other signs to indicate adequate fluid replacement include a clear mental status, and elimination of all signs of shock.

During the first 24 hours after a burn, the capillaries leak protein, so there is no point in giving colloids. (See the chapter on *Wilderness Trauma* for more on colloids and other types of intravenous fluids.) After the first 24 hours, though, colloids such as dextran or albumin make excellent resuscitation fluids.

Note you may need to give patients with inhalation injury, electric burns such as lightning, myoglobinuria, or hemoglobinuria even more fluid than prescribed by the burn formula. (Myoglobinuria and hemoglobinuria are discussed in the chapter on *Wilderness Trauma.*)

Inhalation Injury: Upper Airway burns are the major cause of immediate death after burns. Clues to an upper airway burn include singed nasal hairs, cough producing sooty sputum, shortness of breath, or hoarseness. Your major imperative is to protect the airway; you may need to perform early endotracheal intubation or create a surgical cricothyroid membrane airway.

Toxic Inhalation may be a problem from forest fires, fires inside tents or snow caves, or other wilderness burns. A patient may sustain a toxic inhalation with or without burns. Clues to toxic inhalation include respiratory distress, wheezing, and cough. Symptoms of toxic inhalation may be delayed many hours after the fire, so watch the patient carefully for 24 hours. Depending on the exact presentation, your treatment may include:

* oxygen to help counteract direct toxic effects of cyanide, carbon monoxide, and other poisons;
* adrenergic agents such as albuterol to counteract bronchospasm (see the chapter on *Wilderness Medical Problems* for management of bronchospasm); or
* early intubation and positive pressure ventilation for Adult Respiratory Distress Syndrome (discussed in the chapter on *Wilderness Trauma*).

Ileus: After any trauma, it is common for the intestines to go "on strike." When a patient has an ileus (the most common grammatical way to use the term), the contents of the stomach and intestines stay where they are, rather than moving gradually from the beginning to the end, as is the usual case. The coordinated peristaltic movements of the GI tract stop, or are replaced by ineffective spasms.

You cannot feed a patient with an ileus. If you give the patient something to eat or drink, it will sit in the patient's stomach until he or she vomits. Even if you don't let the patient eat, gas created by normal bacterial action on the contents of the GI tract tends to cause bloating and vomiting. The standard treatment for those with an ileus, therefore, is to place an NG tube to allow gas and stomach secretions to drain out without making the patient vomit.

Clues to a patient with an ileus include:

* the patient is not hungry;
* bowel sounds are absent or markedly decreased; and
* the patient is not having bowel movements and is not passing gas per rectum*.

Patients with more than 25% burns will, 2/3 of the time, develop an ileus. So, if you have a wilderness burn patient, and no IV fluids, should you give oral fluids? This is a difficult question. Fluids to prevent burn shock are a vital part of the management of a large burn. More than anything else, fluid resuscitation prevents early burn death. Probably the best answer is to give

* farted.

small sips of an oral rehydration fluid (see the chapter on *Heat-Related Disorders* about oral rehydration fluids). Slow down or stop if the patient vomits, or complains of feeling bloated, especially if the patient has signs of an ileus. If the patient shows signs that the ileus is gone (passing gas, hungry, increasing bowel sounds), increase the oral fluids once more.

Tetanus: Burns are considered high-risk wounds as far as tetanus, even though they are not punctures. Any team member with a significant second or third degree wilderness burn, and who has not had a recent (less than 5 years) tetanus immunization should leave the field within 1-2 days for a tetanus immunization.

Escharotomy: In large third degree burns, the eschar may become so hard that, if it extends all the way around a limb, it may constrict and cut off circulation. In such a case, or if eschar constriction around the chest interferes with respiration, the eschar must be cut. An escharotomy involves making cuts through the eschar in a linear pattern along the limbs and along the sides of the chest. This is an advanced technique generally taught only to those who have gone beyond EMT-Paramedic training (e.g., flight nurses).[4]

Those with severe burns may develop myoglobinuria, which is discussed in the chapter on *Wilderness Trauma.*

Lightning

Lightning has, for centuries, been known as one of nature's most massive displays of power. Seen by primitive peoples as carriers of the gods' displeasure, this massive destructive force is a common hazard for those travelling the exposed ridges and summits of the mountains, even the lower Appalachian peaks. (Prevention of lightning injuries is discussed in the chapter on *The Wilderness Environment.*)

Lightning may strike and injure a person in any of the following ways:

* a direct strike on the head or a metal object such as a pack frame;
* an indirect or "splash" injury as the lightning splashes off a nearby object, e.g., a tree or rock spire;
* a "step potential" injury, when the ground current travels up one leg and down the other;
* a ground current injury, in which the victim is in a shallow shelter cave and the current arcs across, or
* a direct blast injury from the force of the thermal expansion caused by the lightning bolt, or by objects flung through the air by the strike's force.

Lightning strikes typically cause the following problems.

Neurological: A strike usually produces **coma** and other neurological deficits, such as lower extremity paralysis, and often including amnesia for the lightning strike and surrounding events.

Cardiopulmonary arrest: Lightning strikes cause **asystole**; ventricular fibrillation is usually a late consequence of hypoxia from **respiratory paralysis.** (Thus, artificial respiration is an important part of resuscitation from a lightning strike.)

Burns: High-voltage electrical injury causes dendritic skin burns (in a branching pattern), sometimes with severe entrance and exit burns. Lightning causes burns deep within the muscles and along nerves and blood vessels. The extent may not be apparent from what you see on the skin surface.

Vasospasm: Lightning strikes are known to cause vasospasm leading to pulseless extremities, even though the heart may be beating properly, and even though there is no compartment syndrome. (Compartment syndrome is severe swelling in a muscular compartment, pressing on blood vessels and nerves. Compartment syndrome is discussed in the chapter on *Wilderness Trauma.*)

Muscle Damage: A lightning strike may cause enough direct muscle damage to lead to myoglo-

binuria, or enough red blood cell damage to cause hemoglobinuria, which may then cause kidney damage. (Myoglobinuria and hemoglobinuria are discussed in the chapter on *Wilderness Trauma.*)

Fractures: After a lightning strike, fractures may come from muscle spasms or from the blast effect of the strike. Treat each strike victim as a trauma patient. Assume cervical spine injury (unless the patient is alert and meets the other criteria set out in the chapter on *Wilderness Surgical Problems*).

Ruptured Eardrums: Like any blast injury, a lightning strike's thunderclap may burst a person's eardrums.*

A particularly important point about lightning strikes is that the patient may have **respiratory paralysis, unconsciousness, and vasospasm with undetectable pulses; despite which, prolonged artificial respiration may allow the patient to recover with no neurological deficit.** Coma may last for days or weeks, but some patients will still make a full recovery. Each lightning strike victim needs immediate ABC's, with careful attention to protecting the C-spine. Almost all trauma patients and many cardiac patients with cardiac arrest will die even if you apply CPR. Lightning strike victims, on the other hand, offer you an excellent chance to save a life through basic life support.

If you find a patient in or near a thunderstorm, with coma, dendritic burns, or ruptured eardrums, you should start vigorous resuscitation, for the patient may be a lightning victim.

Anyone you find confused near a lightning strike might be a victim of the strike. You should check for pulses (remember the possibility of vasospasm) and check the BP. Perform a regular trauma exam; if you have an otoscope, check for tympanic (eardrum) perforations. Although such patients are generally stable, and recover without incident, evacuation is in order, with cardiac monitoring if available.

If you must triage a group of people who have been hit by lightning, the rule should be "**resuscitate the dead,**" because those showing some signs of life are likely on the way to recovery.

As a WEMT, you can play an important role in educating members of search and rescue teams and the outdoor public. You can teach the "resuscitate the dead" triage principle for lightning strikes. You can also emphasize that, unlike those still attached to a high-tension line, lightning strike victims are **not** electrically charged in any significant way, and it is safe to begin immediate CPR.[4,5]

Glossary

Culture: A culture is a sample from a suspected infection that is placed on a medium (e.g., agar in a Petri dish) that supports the growth of the suspected microbe; the medium is checked in about 2 days for growth of the microbe.

Debride: To trim away dead tissue.

Dendritic: In a branching pattern.

Eschar: A hard, leathery material that forms in third degree burns.

Escharotomy: Cutting into the dense eschar that results from a third-degree burn. This is done to prevent constriction of an extremity and to allow circulation to continue unimpeded, or to release tension around the chest causing difficulty breathing.

Exudate: A thick, yellow, white, or gray material that exudes from inflamed tissues. For example, most second degree burns develop an exudate.

Ileus: When the bowels stop working. This is common after surgery or trauma.

Vasospasm: Spasm (constriction) of the blood vessels, as from a lightning strike.

* Ruptured eardrums are discussed in the chapter on *Wilderness Medical Problems.*

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