



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

Wilderness EMT Lesson Plan

Part 8: Burns and Lightning

Version 3.02 August 12, 1994

Comments to:

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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 curriculum 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 Lesson Plan is one part of the ASRC-CEM Wilderness Emergency Medical Technician Curriculum. In concert with a textbook, the Curriculum 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 other sources. These include the Wilderness EMT program offered by 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 Curriculum. The National Association of EMS Physicians has published clinical guidelines for delayed/prolonged transport that apply to WEMTs.

With its prerequisites, this Curriculum complies with the Wilderness Prehospital Emergency Care curriculum established by the Wilderness Medical Society. 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.) The other prerequisite is certification to the Virginia Ground Search and Rescue Field Team

Member standards or equivalent. EMT standards are available from state EMS offices or the U.S. Department of Transportation. The Virginia GSAR standards 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 completed in roughly five intensive days. The curriculum also provides a checklist of recommended clinical training.

WEMT Lesson Plan 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 actively supervises all aspects of curriculum development. Each Task Group provides references to support its statements and for further reading, and a glossary.

They also have been refined through seven pilot classes, several which have been held under the auspices of the Virginia Department of Emergency Services and Division of Emergency Medical Services. These agencies played a major part in development of the curriculum.

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, experts in emergency medicine, search and rescue, and education, and a State EMS director. Once it is acceptable to the Board, we release the Lesson Plan to the public.

Because we expect many good suggestions from the public, we are publishing these Lesson Plans, in a sense, as "drafts." We will distribute these individual Lesson Plans as widely as possible. After all Lesson Plans have had a year of public review, we will review and revise as appropriate, then issue a single comprehensive curriculum. We will continue to review and revise the curriculum regularly.

We actively solicit suggestions from anyone reading this. Please send your comments to the Task Group Leader as listed on the title page.

We are writing a textbook based on the material in the lesson plans. The Project Coordinator is the Editor-in-Chief, and works closely with Task Groups to consolidate and revise the material into a comprehensive textbook. All who have contributed to the curriculum will be acknowledged as contributors. The textbook will be submitted for publication in 1994.

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 a possible prolonged coma after a lightning strike but with full neurological recovery, or infection of burns, for example a that are of vital importance to the Wilderness EMT.

VIII. Burns and Lightning**A. 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.

B. Burns**1. Immediate Care**

- a. immediate care of burns in wilderness same as on street:
 - (1) stop burning/put out fire
 - (2) stop additional heat damage/provide pain relief: cold water to area

- (unless area large, or weather cold: danger of hypothermia or frostbite)
- (3) cut away nonadherent clothing; remove rings and jewelry
- b. may start analgesia (pain medication)
- (1) for most small burns: acetaminophen or ibuprofen PO along with cold water to burn usually enough; then apply burn dressing
 - (2) larger or painful burns: may give narcotics
 - (3) narcotics not given "on street" for burns, but OK to give in wilderness
2. **Sunburn**
- a. caused by ultraviolet light*
 - b. **Windburn**
 - (1) type of sunburn
 - (2) wind and cold predispose to sunburn
 - c. First degree sunburn (reddened skin)
 - (1) painful
 - (2) may interfere with thermal regulation (predisposes to hypothermia and heat illness)
 - (3) standard treatment:
 - (a) cool compresses
 - (b) analgesics (aspirin, acetaminophen, or ibuprofen)
 - (c) when itching a problem: antihistamines such as diphenhydramine (e.g., Benadryl®)
 - (d) topical medications do little, except when peeling: hand lotion decreases itching (local anaesthetics discussed in *Wilderness Medical Problems*)
 - d. second degree sunburn (blistering):
 - (1) treat as any other thermal burn
 - (2) ibuprofen helps, the earlier the better^{1,2}
- (3) steroid creams are useless³
 - (4) some believe oral steroids help very severe sunburn, but evidence is thin
3. **Small Burns**
- a. EMTs taught "never put anything on burns except cold water or dry dressing"; appropriate for short transport times because:
 - (1) harder to clean and evaluate burn once patient reaches ED
 - (2) most over-the-counter burn creams useless or worse (no antibacterial properties, or cause allergic reactions)
 - b. **Small Second Degree Burns**
 - (1) if size of five palms (>5%), ED physician or burn surgeon will:
 - (a) examine, clean, apply silver sulfadiazine cream or bacitracin ointment
 - (b) tell patient to apply cream or ointment twice a day and come back in 2-3 days for recheck
 - (2) Wilderness EMTs do same:
 - (a) gently remove loose blister fragments ("debride") and foreign material
 - (b) clean with soapy water, perhaps with 1% (dilute) povidone-iodine solution
 - (c) apply silver sulfadiazine cream or bacitracin ointment twice a day (if no silver sulfadiazine or bacitracin, canned non-mentholated shaving cream acceptable substitute)
 - (d) ointment/cream:
 - i) keeps air from nerve endings, preventing pain
 - ii) decreases evaporation
 - iii) prevents infection
 - (3) leave complete blisters intact, unless sure to rupture (e.g., soles of feet), or

* Protection from ultraviolet discussed in *The Wilderness Environment*.

- large and tightly filled with bloody fluid; * to drain:
- (a) prep with antiseptic (e.g., povidone-iodine) then drain by small incision at edge of blister with sterile scalpel blade or needle
 - (b) press blister flat; may stick to underlying skin and serve as burn dressing
- (4) infections:
- (a) burn surgeons don't give antibiotics unless actual infection diagnosed
 - i) save antibiotics for when really needed; thus patient gets infected with easy-to-kill bugs, rather than ones resistant to antibiotic
 - ii) different from orthopedic surgeons: give antibiotics for any open fracture, preferably half-hour prior to fracture
 - (b) many see redness around healing burns; believe wound infected when not
 - i) healing burns generally develop grayish exudate, and red around edges
 - ii) to persuade a burn surgeon that burn is infected: actual pus in burn; redness spreading more than half an inch from burn; or a positive culture from wound
- c. **Small Third Degree Burns**
- (1) third degree burns >5% need admission to burn unit for regular debridement; possibly skin grafting
 - (2) in wilderness, care for small third degree burns same as small second degree burns
 - (3) third-degree burns develop dense eschar: dead, burnt skin
 - (a) because hard, can compress underlying structures
 - (b) burn creams/ointments:
 - i) keep eschar soft which aids in healing
 - ii) try to use water-soluble burn creams such as silver sulfadiazine (greasy ointments harder to remove)
 - iii) in wilderness, often only bacitracin or povidone-iodine ointments available; use them if transport time more than few hours
 - iv) don't use "burn cream" from unit first aid kits
4. **Large Burns**
- a. **Burn Shock**
- (1) skin important: keeps water from leaking out; when skin burnt, **does** let water leak out!
 - (a) in patient with burn >5%, may cause hypovolemic shock
 - (b) loss of water into damaged tissue under burn, which becomes very swollen, also adds to shock
 - (c) first degree burns do not cause loss of fluid through skin; but widespread first degree burn (sunburn) can cause enough tissue swelling to cause mild shock
 - (2) burn patients require more fluid than might expect, given extent of burn; "**Consensus Burn Formula**" presented in Advanced Burn Life Support Course of American Burn Association:

**2-4 cc of Ringer's Lactate
x Body Wt. (kg)**

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

x Total Body Surface Area burn for first 24 hours: give half in first 8 hours, then half over next 16 hours.

- (3) burn formula is just a guideline
 - (a) best way to assess fluid replacement in burn patient is by urine output: should stay >50cc/hr for adult; >1cc/kg/hr for child or infant
 - (b) other signs of adequate fluid replacement: clear mental status, elimination of all signs of shock
- (4) during first 24 hours after burn, capillaries leak protein, so no point in giving colloids (colloids and other IV fluids discussed in *Wilderness Trauma*); after first 24 hours, colloids (dextran, albumin) excellent resuscitation fluids
- (5) patients with inhalation injury, electric burns (lightning), myoglobinuria, or hemoglobinuria need even more fluid than per burn formula (note that myoglobinuria/hemoglobinuria discussed in *Wilderness Trauma*)

b. Inhalation Injury

- (1) **upper airway** burns
 - (a) major cause of immediate death after burns
 - (b) clues to upper airway burn: singed nasal hairs, coughing sooty sputum, shortness of breath, hoarseness
 - (c) major imperative is to protect airway: may need early endotracheal intubation or surgical cricothyroid membrane airway
- (2) **toxic inhalation**
 - (a) may be from forest fires, fires in tents or snow caves
 - (b) may be with or without burns
 - (c) clues: respiratory distress, wheezing, cough
 - (d) symptoms may be delayed so watch carefully for 24 hours
 - (e) treatment:
 - i) oxygen: counteract toxic effects of cyanide, carbon monoxide, other poisons
 - ii) adrenergic agents (albuterol): counteract bronchospasm (management of bronchospasm discussed in *Wilderness Medical Problems*)
 - iii) early intubation and positive pressure ventilation if Adult Respiratory Distress Syndrome (ARDS; discussed in *Wilderness Trauma*)

c. Ileus

- (1) after trauma, common for intestines to go "on strike"; when patient has an ileus (most common grammatical way to use term), contents of stomach and intestines stay where they are, rather than moving from beginning to end, as is normal: coordinated peristaltic movements of GI tract stop, or replaced by ineffective spasms
- (2) cannot feed patient with ileus: food will sit in patient's stomach until vomits
- (3) even if patient doesn't eat, gas from normal bacterial action on contents of GI tract causes bloating and vomiting
- (4) standard treatment is to place NG tube: allows gas and stomach secretions to drain out without making patient vomit
- (5) clues to ileus:
 - (a) not hungry
 - (b) bowel sounds absent/markedly decreased
- (6) patients with >25% burns will, 2/3 of time, develop an ileus; but, fluids to prevent burn shock are vital part of management of a large burn; fluid resuscitation prevents early burn death; if no IV fluids:
 - (a) give small sips of oral rehydration fluid (discussed in *Heat-Related Disorders*)

- (b) slow down or stop if patient vomits, or feels bloated, especially if has ileus
- (c) if ileus gone (passing gas, hungry, increasing bowel sounds), increase oral fluids
- d. **Tetanus**
 - (1) burns are high-risk for tetanus, even though not punctures
 - (2) any team member with significant second or third degree wilderness burn, and no recent (< 5 years) tetanus immunization should leave field within 1-2 days for a tetanus immunization
- e. **Escharotomy**
 - (1) third degree burn eschar may, if all around limb, constrict and cut off circulation
 - (2) eschar around chest may interfere with breathing
 - (3) escharotomy: linear cuts through eschar along limbs and sides of chest (advanced technique taught only to flight nurses and similar)⁴
- f. severe burns may cause myoglobinuria (discussed in *Wilderness Trauma*)
- e. direct blast: from thermal expansion caused by lightning bolt; or from objects flung through air by strike's force
- 3. lightning strikes may cause following problems
 - a. **neurological: coma** or neuro deficits such as lower extremity paralysis; often amnesia for lightning strike and surrounding events
 - b. **cardiopulmonary arrest: asystole**; ventricular fibrillation usually late consequence of hypoxia from **respiratory paralysis** (thus, artificial respiration important part of resuscitation)
 - c. **burns**:
 - (1) high-voltage electrical skin injury: dendritic burns (branching pattern); sometimes severe entrance and exit burns
 - (2) burns deep within muscles and along nerves and blood vessels; extent may not be apparent from surface appearance
 - d. **vasospasm**: vasospasm leading to pulseless extremities, even though heart may be beating properly and no compartment syndrome (compartment syndrome: severe swelling in muscular compartment, pressing on blood vessels and nerves; discussed in *Wilderness Trauma*)
 - e. **muscle damage**: may cause enough direct muscle damage to lead to myoglobinuria, or enough red blood cell damage to cause hemoglobinuria, which may then cause kidney damage (discussed in *Wilderness Trauma*)
 - f. **fractures**: from muscle spasms or blast effect; treat as trauma patient; assume cervical spine injury (unless patient alert and meets other criteria set out in *Wilderness Surgical Problems*)
 - g. **ruptured eardrums**: thunderclap may burst eardrums*

C. Lightning

1. common hazard on exposed ridges and summits of mountains, even lower Appalachian peaks (prevention discussed in *Wilderness Environment*)
2. may strike and injure:
 - a. direct: on head or metal object such as a pack frame
 - b. indirect ("splash"): from nearby object, e.g., tree or rock spire
 - c. "step potential": ground current up one leg and down the other
 - d. ground current: in shallow shelter cave and current arcs across
4. **patient may have respiratory paralysis, unconsciousness, and vasospasm with**

undetectable pulses; despite which, prolonged artificial respiration may allow patient to recover with no neurological deficit

- a. coma may last for days or weeks, but some patients still make full recovery
 - b. victims need immediate ABCs, with careful attention to C-spine
 - c. almost all trauma patients and many cardiac patients with cardiac arrest die even with CPR; many lightning strike victims survive and do well if basic CPR started
5. patient in or near thunderstorm, with coma, dendritic burns, or ruptured eardrums, needs start vigorous resuscitation: may be lightning victim
 6. anyone confused near lightning strike might be victim of strike:
 - a. check for pulses (remember possibility of vasospasm)
 - b. check BP
 - c. regular trauma exam
 - d. if otoscope available, check for tympanic (eardrum) perforations
 - e. patients generally stable; recover without incident; still, evacuate, with cardiac monitoring if available
 7. If must triage a group hit by lightning, rule is **“resuscitate the dead”**: those showing some signs of life are likely on way to recovery
 8. WEMT can play an important role in educating members of SAR teams and outdoor public:

- a. “resuscitate the dead” triage principle for lightning strikes
- b. unlike those still attached to a high-tension line, lightning strike victims **not** electrically charged and **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 growth of suspected microbe; medium is checked in about 2 days for growth of 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 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 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 bowels stop working. This is common after surgery or trauma.

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

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* ruptured eardrums discussed in *Wilderness Medical Problems*