



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

Wilderness EMT Lesson Plan

Part 2: The Wilderness Environment: Hazards, Safety, and Patient Care Implications

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Comments to:

David W. Lindell, M.S., EMT-P, Task Group II Leader <fishmedic@aol.com>
2209 Brookline Rd. Wilmington, DE 19803
(302) 652-0361 (H)

Task Group: Albert Baker, M.D., FCCP; Bruce Bannerman; Keith Conover, M.D., FACEP; Joseph T. Crist; William W. Forgey, M.D.; Peter Hackett, M.D.; Gene Harrison; John C. Hemple; Robert Koester; Richard Kunkle, M.D.; Bruce Randall; William Robinson, M.D.; Noel Sloan, M.D., and Judith Small, M.D.

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Curriculum Coordinator:

Keith Conover, M.D., FACEP 36 Robinhood Road
Pittsburgh, PA 15220 (412) 561-3413 <kconover+pitt.edu>

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 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 1997.

Notes: *The Wilderness Environment*

All students should already have a basic understanding of wilderness travel and survival from experience or other reading. (The book *Search and Rescue Fundamentals* by Cooper, LaValla, and Stoffel is an excellent introduction. The book is available from: Emergency Response Institute, 4537 Foxhall Drive, NE, Olympia, WA 98506; (206) 491-7785.) Thus, no basic survival material is to be presented in the WEMT class.

This session sets the proper tone for the entire WEMT class. The central precept is to teach how to care for patients **in the wilderness**. Stress this idea here, then reinforce it in all sessions. In ASRC-CEM WEMT classes, we reinforce the idea strongly with practical exercises in a wild area (sometimes with heat, cold, wind, rain, or snow).

By reviewing environmental hazards here, the instructor also introduces pertinent medical topics: hypothermia, heat exhaustion, envenomations, altitude illness, and trauma. Protection from the environment is one of the WEMT's few constants. **Everyone** in the field (including the WEMT) is always at risk for becoming a patient. This session helps to establish, at the outset, a wilderness environment theme persisting through the entire WEMT class.

II. The Wilderness Environment: Hazards, Safety, and Patient Care Implications

A. Educational Objectives

1. Define "wilderness," "wilderness EMT," and "wilderness EMS."
2. Discuss the importance of air and oxygen in respect to:
 - a. its presence or absence in the wilderness environment;
 - b. its quality in the wilderness environment; and
 - c. the relationship between available oxygen, barometric pressure, and altitude.
3. List human compensations for altitude exposure and hypoxemia.
4. Discuss the role and importance of sun protection in the wilderness SAR environment.
5. List the types of sun protection and their advantages and disadvantages, citing specific examples of each.
6. Discuss the problems and dangers associated with wind in the wilderness environment.
7. Discuss the windchill effect and its importance to the wilderness EMT.
8. List the hazards associated with each type of precipitation.
9. Describe thunderstorm and lightning hazards to the wilderness EMT.
10. List six good safety rules for when lightning is imminent.
11. Define the term "ground current" as it relates to lightning strikes.
12. Discuss drinking water in the wilderness environment with respects to its:
 - a. presence or absence;
 - b. role in homeostasis;
 - c. quality; and
 - d. use for wound irrigation.
13. List five contaminants of drinking water in the wilderness environment.
14. Describe three methods of purifying (disinfecting) water and the advantages and disadvantages of each.
15. Discuss the role and effects of water in regards to the following:
 - a. drowning;
 - b. thermal conductivity; and

- c. force while moving.
- 16. Summarize the hazards presented by terrain as they relate to the following areas:
 - a. vegetation:
 - (1) physical, and
 - (2) chemical;
 - b. animal:
 - (1) mammalian dangers,
 - (2) reptilian dangers, and
 - (3) dangers from insects and arachnids.
- 17. Discuss the prevention of insect bites and tick attachment.
- 18. Describe the recommended method of tick removal and explain why it is recommended.
- 19. List and explain five man-made hazards that might be found in the wilderness environment.
- 20. Discuss the role of subjective hazards as they relate to the wilderness SAR environment.
- 21. Describe the cave environment.
- 22. List five specific hazards of the cave environment.
- 23. List and differentiate the major components of "the wilderness ambulance."

B. Wilderness Definitions

- 1. Dictionary definitions of wilderness:
 - a. tract or region uncultivated and uninhabited by human beings
 - b. uninhabited region left in its natural condition
 - c. something likened to a wild region in its bewildering vastness, perilousness, or unchecked profusion
- 2. terms newly defined for this course:
 - a. Wilderness EMT: A specially trained member of a well-organized,

wilderness-oriented, physician-controlled system that provides medical care to patients in backcountry or wilderness situations

- b. Wilderness EMS: A system capable of providing medical care and rescue beyond the means of routine or conventional EMS systems. This may require transport of equipment, personnel, and medications on team member's backs over rugged terrain to the patient, and during evacuation from the site to an entry point into the "normal" EMS system.

C. Air

- 1. patients with trauma or medical problems even more susceptible to wilderness air problems than healthy people
- 2. air possibly inadequate in:
 - a. swiftwater
 - b. avalanches
 - c. mud slides
 - d. natural or manmade pits
 - e. snow caves
 - f. natural caves or mines
 - g. tents with stoves, especially if snow-covered
 - h. cars
- 3. air possibly of inadequate quality:
 - a. too much CO (carbon monoxide) or CO₂ (carbon dioxide; from stoves, catalytic heaters, cars)
 - b. other noxious gases or vapors: volcanic mountains/hot springs may produce poisonous hydrogen sulfide or carbon monoxide; recent incident in South America: nearly-dormant volcano "belched" enough CO₂ to suffocate entire village
 - c. explosive gases:

Effective %O₂	Partial Pressure O₂, mm Hg	Altitude	Physiological Effects of Acute Exposure
21%	160	Sea Level	<ul style="list-style-type: none"> • Normal physiology
17%	130	5,000 feet	<ul style="list-style-type: none"> • Impaired night vision • Increased respiratory rate or depth
14%	110	10,000 feet	<ul style="list-style-type: none"> • Lightheadedness • Dizziness • Headache • Rapid fatigue
12%	90	15,000 feet	<ul style="list-style-type: none"> • Acute Mountain Sickness • Pulmonary edema • Cerebral edema

Table 1: Physiology, Hypoxia, and Altitude

- (1) cave rescue in cave near filling station's leaking underground gasoline tank, or underground gas pipeline
- (2) caver's calcium carbide may become wet and fill cave pack with explosive acetylene gas, ready to explode in caver's face
- (3) decomposition of trash in mines and caves may produce explosive methane
- (4) after explosion, may still be enough gas for second explosion, and may be poisonous gases
- d. particulate matter may fill air, as in dust storm or smoke from forest fire
- e. infectious agents:
 - (1) can get rabies from breathing air in areas with large bat population, especially certain caves; can get histoplasmosis from other caves (both discussed further in *Wilderness Medical Problems*)^{1,2}
- 4. may not have enough O₂ (oxygen)
 - a. in confined space (e.g., crevice rescue), many rescuers may use up available O₂, or simply produce enough CO₂ to pool and displace O₂
 - b. lower barometric pressure decreases amount of O₂ available, via law of partial pressures (EMT-P texts contain a description of law of partial pressures)
 - c. reactions to altitude depend on speed of ascent and degree of acclimatization, cardiovascular fitness, and particular constitution
 - (1) excellent cardiovascular fitness is, unfortunately, not safeguard against altitude illness
 - (2) though high altitudes are not found in East, some Eastern WEMTs may be recreational climbers and need to know about altitude effects
 - (3) air transport increases patient's altitude
 - (4) Table 1 in book (slide also available) summarizes direct effects of sudden exposure to altitude

* normal barometric pressure is 760 mmHg (29.92 inches) at sea level; for practical purposes, barometric pressure decreases .01 inch for every 10 foot increase in elevation

- (5) altitude-related illness might develop after longer exposure to altitude (acute mountain sickness, high altitude cerebral edema, and high altitude pulmonary edema) and acclimatization to altitude covered in *Altitude Illness*
- d. human compensations for altitude or hypoxia:³
- (1) increased respiration (depth, rate, or both): acute adaptation, persists indefinitely
 - (2) increased red cell mass in blood over time; allows more efficient carrying of O₂
 - (3) enzymes in red blood cells increase their O₂ carrying ability; also occurs over time
 - (4) with exercise at altitude, develop increased general cardiovascular fitness
- (1) *dry Canadian air from northwest brings cool, dry weather*
- (2) *warm, moist air from southwest brings precipitation*
- d. *in much of country, summertime weather cycle: for weeks, no new air masses from west; weather is clear each morning, but thunderstorms each afternoon as sun's heat causes moist air to rise*
- e. *tips:*
- (1) *watch for sudden changes in altimeter*
 - (2) *watch for new cloud buildup*
 - (3) *watch for sudden sustained shifts in wind direction*
 - (4) *check weather forecasts*

2. Sun

- a. sun may melt snow and make slopes prone to avalanche; by midmorning or early afternoon, travel hazardous on many snowy slopes⁵
- b. bright sunlight or reflections off water, snow, or sand require protective eyewear to reduce total visible light and ultraviolet light to safe levels
 - (1) ultraviolet (UV), with lesser contribution from infrared, causes snowblindness (UV "sunburn" of cornea)
 - (2) most sunglass manufacturers careful to point out that their sunglasses block 98%, 99%, or 100% of UV light
 - (3) UV light also thought to cause cataracts: opacities in lens of eye
 - (4) four types of sunglasse lens material
 - (a) Acrylic
 - i) inexpensive
 - ii) melts in the heat
 - iii) scratches easily
 - iv) breaks easily
 - (b) CR-39 plastic

D. Weather

1. Weather patterns^{*4}

- a. *weather patterns vary from area to area; must know your local patterns*
- b. *general principles:*
 - (1) *sudden changes in barometric pressure (e.g., sudden changes in altimeter readings): sudden changes in weather*
 - (2) *high pressure areas: dry, clearing weather*
 - (3) *low pressure areas: lingering/heavy precipitation*
 - (4) *cold fronts: vertical; sudden, severe changes in weather; severe storms*
 - (5) *warm fronts: gradually lowering skies and drizzle or other precipitation, but rarely severe storms.*
- c. *in most of U.S., weather comes from west*

* material in small italics not required in classes nor found in educational objectives; may be used for optional lecture or left to students to read

- i) more expensive
- ii) fairly strong against impact
- (c) Polycarbonate plastic
 - i) scratches easily
 - ii) often has anti-scratch coating
 - iii) very strong against impact
 - iv) Bollé manufactures polycarbonate sunglass lenses; subsidiary (Yarrow) can provide prescription polycarbonate lenses
- (d) Glass
 - i) very strong when totally unscratched
 - ii) fractures easily once scratched
 - iii) doesn't scratch as easily as plastic
- (5) color choice for sunglasses is subjective
 - (a) pick color that gives similar color spectrum compared with "normal" and personally pleasing
 - (b) no good evidence that "blue-blocking" sunglasses give superior protection or improved vision as claimed
- (6) mirror coatings
 - (a) reflect some infrared (heat)
 - (b) scratch easily
 - (c) also reflect light onto nose and cause increased sunburn there (can be blocked by leather or plastic nose guard)
- (7) side guards important for protection against solar keratitis (snowblindness); can improvise from duct tape, if necessary*
- c. sun's effect on skin particularly dangerous at higher altitudes: less atmosphere to protect against sun
 - (1) UV light frequency ranges
 - (a) UVB
 - i) responsible for sunburns and suntans
 - ii) produced by most tanning lamps
 - (b) UVA
 - i) causes little sunburn or tanning
 - ii) known to damage skin and lens of eye (cataracts)^{6,7}
 - (2) UVB light flux increases about 4% for every thousand feet of elevation
 - (a) sunburn progressively more of a problem with altitude
 - (b) clouds absorb only about 30% of UVB, so a cloudy day little protection against sunburn, especially at altitude
 - (3) those taking certain medications may develop photodermatitis from UVA
 - (a) photodermatitis slightly different from sunburn, but differences not important
 - (b) wilderness medical kit drugs can cause photodermatitis:
 - i) non-steroidal antiinflammatory drugs (ibuprofen)
 - ii) tetracycline/doxycycline
 - (4) wind known to increase susceptibility to sunburn; "windburn" really sunburn from both wind and ultraviolet (even on cloudy days)
- d. best treatment is prevention: physical or chemical
 - (1) physical: clothing
 - (a) hats
 - (b) sunglasses with side shields
 - (c) clothing covering all extremities
 - (d) thin clothing may offer little protection against sun, especially when wet; plain white Hanesß brand T-

* more on eye protection in Dr. Donner's section on eye protection in the proceedings of the 1990 meeting of Wilderness Medical Society

- shirt has sun protection factor (SPF) of only 5*
- (2) chemical: sunscreens
 - (a) for wilderness, sunscreens with SPF > 15 recommended; waterproof sunscreens needed for wilderness
 - (b) "clear sunscreens" selectively absorb ultraviolet light; older sunscreens block UVB; newer sunscreens also block some UVA
 - i) most common blocker used to be PABA (para-aminobenzoic acid); those sensitive to sulfa drugs should avoid (use PABA-free sunscreen, e.g., benzophenone- or cinnamate-based)
 - ii) reapply sunscreen if washed, abraded, or perspired off
 - iii) some dermatologists believe PABA is absorbed into the outer layers of skin, particularly after bath or shower; others disagree
 - (c) simple sun blocking agents (opaque white zinc oxide or titanium dioxide glacier cream) provide absolute protection but bizarre appearance
 - (3) many useless sunburn "protectors":
 - (a) oral PABA useless
 - (b) commercial "bronzers": make skin darker; cause no harm, but no protection against sunburn
 - (c) commercial "tanning accelerators" do nothing⁶
 - e. equipment also affected by sun
 - (1) materials like nylon degraded by continuous exposure to sun, particularly at altitude
 - (2) sun may heat equipment to point of failure if exposed for long period
 - f. sunscreens may make clothing and equipment deteriorate; sunscreen on hardware collects dirt causing premature wear and possibly jamming

3. Wind

- a. noise: may make it hard for rope team and litter team to hear each other
- b. deadfall from trees: also look up when picking place to set litter down
- c. windborne particles: eye injury (especially around helicopters)
- d. **wind chill temperature:** calculated temperature; expresses chilling effect of the current temperature and wind **on exposed flesh**, in terms of equivalent temperature without wind; wind also increases evaporation from wet clothing/flesh⁸

4. Heat and Cold

- a. WEMT Curriculum assumes that students have SAR background and need no explanation about dealing with heat and cold, e.g., dangers of cotton, need for warm-when-wet clothing
- b. those without SAR background should read book such as *Search and Rescue Fundamentals* by Cooper, LaValla, and Stoffel, available from Emergency Response Institute, 4537 Foxhall Drive, NE, Olympia, WA 98506; (206) 491-7785
- c. medical consequences of exposure to heat and cold covered in *Thermal Regulation, Heat-Related Disorders, and Cold-Related Disorders*
- d. medications affected by light or extremes of temperature; however, many common emergency drugs safe after frozen and thawed^{9,10,11} (list provided in *Pharmacology*)

* sun protection factor (SPF) is minimum dose of ultraviolet light to provide skin erythema with sunscreen, divided by the minimum erythema dose without sunscreen; thus, with SPF of 2, can stay in sun 2 hours and get same burn as from 1 hour with no sunscreen

5. Precipitation

- a. snow, rain, sleet, and hail may:
- (1) make footing hazardous for the litter team
 - (2) decrease visibility
 - (3) increase need for litter belay
 - (4) increase risk of flooding
 - (5) predispose patient/litter team to hypothermia
- b. hail: associated with large thunderstorms; sometimes as large as 1.5 lb. (0.7 kg); have killed people¹²
- c. snow: avalanches, even in Appalachians (small avalanche can wreak havoc on litter team in of ravine)

6. Thunderstorms and Lightning

- a. severe hazards especially on exposed, rocky ridges; thunderstorms part of summertime afternoon shower cycle, or associated with cold front
- b. lightning injuries: 250 injured and 150 killed each year¹³
- c. distance of lightning, in miles, estimated by seconds from flash to thunderclap divided by 5
- d. lightning likely to strike person:
- (1) in open fields, on open water, or where person is highest object
 - (2) standing next to single protruding object in middle of clearing (i.e., lone tree)
 - (3) near large metal objects such as Stokes litter
- e. danger from lightning small but significant, but for patient in steel basket on end of wet rope on exposed cliff, danger immediate
- f. some places likely to have large ground current arc during lightning strike: shallow depression such as small shelter cave (deep caves safe except near entrance)
- g. when lightning imminent:
- (1) avoid open water

- (2) avoid open ground
- (3) avoid tall objects
- (4) avoid being the highest point
- (5) avoid sheltering in moist areas and depressions
- (6) span as small a distance as possible
- (7) insulate yourself from the ground
- (8) divest yourself of any metal objects
- (9) if on a face, tie in with horizontal lines, as for a traverse, to avoid vertical current flows
- (10) if a strike is imminent, as indicated by St. Elmo's fire, or hair "standing on end," get away from a metal litter, and crouch down to present as small a target as possible¹⁴

E. Water

1. WEMT should be able to estimate drinking water amounts for team
 - a. individual daily requirement: range from few to many liters
 - b. thirst primarily indicator of **hypernatremia** (increase in salt level in blood) rather than fluid deficit (may occur with greater water than salt loss, as with profuse sweating); therefore must educate team members: urge adequate drinking¹⁵
 - c. if suspect dehydration, ask member to urinate and judge the state of hydration by amount and color of urine
2. water quality (drinking, wound irrigation)
 - a. contaminants in water:
 - (1) bacteria:
 - (a) enteropathogenic bacteria (cause gastroenteritis), e.g., *Salmonella*, *Shigella*, *Campylobacter*, certain types of *E. coli*
 - (b) wound pathogens: *Staphylococcus*, *Streptococcus*, *Pseudomonas*, *Clostridium tetani*

- (2) viruses:
 - (a) that cause diarrhea: *Norwalk agent, rotaviruses*
 - (b) *Hepatitis A*, one of the non-A, non-B hepatitis viruses
- (3) mineral and heavy metal contaminants: pesticides, mine residue, industrial waste
- (4) microscopic parasites: tapeworm, *Giardia lamblia*
- (5) gross organic material, dirt
- b. different requirements for drinking vs. wound irrigation
 - (1) drinking water: remove or kill organisms that cause disease when ingested
 - (2) irrigation water:
 - (a) kill spores of bacteria that cause wound infections
 - (b) spores more resistant to killing than other bacteria and viruses
 - (c) however: irrigating grossly-contaminated wound with water containing few spores will reduce bacterial count and do more good than harm
- c. water purification and disinfection methods:
 - (1) **Filtering**
 - (a) strain out large-size particles with coffee filters, cheesecloth, or clean shirt-tail; especially effective if water first "floculated" with pinch of alum
 - (b) micropore filters (Katadyn™; First Need™; Mountain Safety Research "Water Works Total Filtration System" filters):*
 - i) remove organisms, but not viruses (hepatitis, diarrhea)
 - ii) will produce water suitable for "sterile" irrigation, because viruses unlikely to cause infection when used for irrigation
 - iii) larger-pore filters designed solely to remove *Giardia* will not provide water suitable for irrigation
 - (2) **Boiling:**
 - (a) kills most pathogenic organisms
 - (b) some bacterial spores resist boiling
 - (c) at sea level, boiling 10 minutes kills most spores that cause wound infections
 - (d) virtually all enteric pathogens (cause disease if swallowed) killed by bringing water to a boil (at sea level): time to bring to boil also working toward disinfection
 - (3) **Halogens (iodine or chlorine tablets, crystals, or solutions):**
 - (a) disinfect based on:
 - i) concentration of halogen
 - ii) duration of contact
 - iii) temperature of water
 - (b) iodine:
 - i) superior to chlorine (kills more pathogens)
 - ii) iodine-containing tablets still U.S. Army choice for field disinfection
 - iii) effective against almost all enteric pathogens when used as directed
 - iv) true iodine allergy very rare
 - v) ill effects from occasional use iodine-purified water exceptionally rare
 - vi) strong iodine taste objectionable to some
 - vii) some systems use chemicals or absorbents to remove the iodine after disinfecting period

* size of pores in First Need™ filter larger than Katadyn™, but design seems to trap all bacteria in tests

- (4) new filter system: uses iodine-containing resin
 - (a) organisms exposed to very high iodine concentration passing through filter, but no iodine escapes filter
 - (b) appears effective against all pathogens
 - (c) probably best to let water sit for 15 minutes after filtering to let iodine attached to pathogens finish killing them
 - (d) two manufacturers; * most attractive for SAR use is PUR Scout; combines 1-micron filter to remove larger elements such as Giardia cysts with iodine resin to kill bacteria and viruses; weighs twelve ounces, fits in a pack's side pocket; optional add-on charcoal filter removes organic contaminants (pesticides, herbicides)
- (5) for routine drinking water disinfection in wilderness or disaster, we recommend
 - (a) an iodine-resin filter with a charcoal filter such as the PUR Scout
 - (b) iodine, either tablets or another method such as crystals; if water very cloudy, flocculate first (with pinch of alum) and filter through filter paper**
- (6) for wound irrigation, we recommend: water from a filter such as Katadyn™ or PUR Scout; if don't have filter, use iodine-treated water
- (7) can use povidone-iodine (e.g., Betadine) solution to disinfect water: 8 drops per liter of water for half an hour; use more or longer contact time if very cold or if very dirty water
- (8) question often arises in WEMT classes:
 - (a) if prolonged transport, and grossly contaminated wound, and only irrigant available is urine, should you use it?
 - (b) tentative answer is to use only male urine (female urine has higher bacterial count)
 - (c) should anyone actually use this technique, we expect careful follow-up and paper presented at annual meeting of Wilderness Medical Society
- (9) if in disaster setting, and need to disinfect large amounts of water:
 - (a) chlorine bleach (e.g., Clorox™ bleach): is solution of sodium hypochlorite (Clorox™ is 5.25%), which releases chlorine
 - (b) amount depends on condition of water: more cloudy = more organic material to "soak up" chlorine = add more bleach
 - (c) cold water: need more chlorine
 - (d) time: very important; if can leave water for several hours, can use lower levels of chlorine
 - (e) simple rule (fairly reliable for all situations): 2 drops of 5% bleach*** per liter (quart) of water overnight; same as 4cc of 5% bleach (Clorox™) for every 40 liters=10 gallons****

* Water Technologies Corporation, 14405 21st Ave. N., Suite 120, Plymouth, MN 55447, (800) 637-1244, (612) 473-1625; and PUR, a Division of Recovery Engineering, Inc., 2229 Edgewood Avenue South; Minneapolis, MN 55426; (800) 845-7873; PUR products are available by mail from a variety of providers, including Travel Medicine, Inc., 351 Pleasant St., Suite 312, Northampton, MA 01060, (800) 872-8633

** can reportedly get similar effect from a pinch of the fine white ash from a campfire

*** or 10 drops of 1% bleach

- (f) if need to use water right away, double the bleach and leave for an hour^{16*}
3. other water considerations:
- near-drowning: treatment same in the city and in wilderness; swiftwater and low-head dams significant hazards, especially team with rescue gear, or for patients strapped into litter
 - thermal conductivity of water much higher than air (wet clothes suck out heat faster than dry); cotton and down lose virtually all insulation value when wet
 - strength of current in rain-swollen creek easy to underestimate
 - water makes radios fail, especially when immersed; water also absorbs radio energy; range of VHF-FM radios decreases markedly in downpour

F. Terrain

1. Gravity

- people slipping or falling, or things falling on people, common causes of wilderness injury
- patient strapped into Stokes, or litter team members hanging onto litter, not at liberty to move away from falling objects, so protection essential (helmets and packs for litter team, helmet and face shield for patient)

2. Plant hazards

- twig in eye:** eye protection essential for night operations

- deadfalls:** must wear helmets when attached to the litter or otherwise unable to dodge falling limbs

c. sticks/logs:

- may injure legs/feet of litter bearers: limited ability to chose path or see their feet
- also common injury to those running through woods lost

- Thorns:** may cause serious lacerations, especially with evacuation through brambles

- Generalized allergy:** hay fever; no more need be said

- Skin irritation** (discussed in *Wilderness Medical Problems*):

- direct irritation (e.g., stinging nettles)
- skin allergy (poison ivy and other plants)

- Animal hazards** (animal bites discussed in *Wilderness Surgical Problems*):

a. Mammals

(1) Rabid animals

- unusually friendly or bizarre behavior of wild mammal suspicious for rabies
- rabies discussed further in *Wilderness Medical Problems*

(2) Bears

- bears vastly overrated as hazard
- black bears (only kind in the East) generally dangerous only if cornered, wounded, or protecting young
- brown and cinnamon bears merely different colored black bears

**** one drop= 0.05cc; 4 liters=1 gallon (roughly)

* information on water purification methods based on information presented by Howard Backer, M.D., at the Eighth Annual Scientific Meeting of the Wilderness Medical Society, September 1992; proceedings available from: Wilderness Medical Society, P.O. Box 2463, Indianapolis, IN 46206, (415) 663-9107

- (d) only polar or grizzly bear reported to stalk humans
 - (e) climbing tree adequate defense against older grizzly, but grizzly cubs and black bears climb trees
 - (f) bear attacks maybe based on dominance behavior; submissive behavior (playing dead) can be effective deterrent
 - (g) further reading for interested students: Stephen Herrero's book¹⁷
 - (3) **Feral dogs**
 - (a) if person bitten by feral dog, leave wound open, treat with antibiotics
 - (b) depending on location of bite, consider evacuation for immediate rabies immunization, or at least arrange for evaluation for rabies immunization on return to civilization
 - (4) **Feral pigs**
 - (a) in southeast, feral pigs known to grow to 300 pounds
 - (b) sometimes will attack humans
 - (5) **Deer**
 - (a) in national parks where protected from hunting, deer beg for hand-outs
 - (b) unlike well-known (and overrated) danger of bears, few know that razor-sharp deer hooves can disembowel person
 - (6) **Others**
 - (a) skunks with spray
 - (b) porcupines with spines
 - (c) refer students to any American encyclopedia for further reading
 - b. **Reptiles**
 - (1) snakebite greatest concern if not greatest danger in many areas
 - (2) discussed in *Bites and Stings*
 - c. **Insects and Arachnids**
 - (1) *Hymenoptera (bees and wasps) cause more deaths (from anaphylaxis, discussed in Wilderness Medical Problems) than all other animal hazards combined*
 - (2) *Hymenoptera stings, and spider and insect bites, covered in Bites and Stings*
- 4. Preventing Insect Bites and Tick Attachment:**
- a. insect bites range from itchy annoyance to serious infections; some envenomations causing tissue loss; prevention:
 - (1) garments forming physical barrier (e.g., tucking pants into socks)
 - (2) most widely used repellents contain DEET
 - (a) convenient for areas of body not conveniently covered by clothing (face, neck, hands)
 - (b) DEET available in concentrations as high as 90%; however, DEET absorbed through skin, has toxic effects on central nervous system; reports of seizures caused by DEET¹⁸
 - (c) therefore, new repellents available:
 - i) lower percentage of DEET in special vehicle (extends time DEET stays on skin)
 - ii) lower percentage of DEET with a synergist to maintain effectiveness; R-326 is common synergist
 - (3) black flies:
 - (a) DEET effective against mosquitoes and ticks, but not biting black flies (common in North in late summer)
 - (b) "Old Woodsman's Fly Dope":
 - i) tarry, smelly, staining
 - ii) preparation of natural resins
 - iii) widely available in biting black fly areas
 - iv) repels both black flies and humans
 - (c) R-11 effective against black flies, but recently replaced by R-326; little publicly known about R-326, but

EPA tested and found to be safe and effective

- (d) best all-around repellent: commercial products with low to intermediate DEET, either long-lasting formula or with R-326 for black flies, e.g., Sawyer DEET-PLUS®* 19

- (4) new tick and mosquito repellent: permethrin

- (a) generally applied to clothing
 (b) combined with long-acting DEET or DEET with synergists, provides a very good protection against bites^{20*}

- (5) Avon *Skin-So-Soft* (commercial concentrated bath oil):

- (a) widely touted as best repellent for black flies and mosquitoes
 (b) no good controlled studies comparing to other repellents.
 (c) safety for continued widespread use on skin undetermined
 (d) reputed to wear off quickly²⁰

5. Removing ticks

- a. ticks transmit Lyme disease and Rocky Mountain Spotted Fever; if found, should remove immediately
 b. to remove: grasp head close to mouth parts with forceps (tweezers) and pull gently; tick's jaws fatigue and loosen
 c. jerking may decapitate tick, leaving head embedded in the skin cause infection; if happens, remove retained mouth parts with needle or tip of #11 scalpel blade

- d. using hot object, crushing tick, or covering the tick with petrolatum may cause tick to vomit into skin and blood vessels, making disease; avoid

- e. clean and dress bite wound with antibiotic ointment^{21,22,23}

6. Manmade hazards:

- a. searching unsafe structures (buildings, mines)

- b. electrical lines:

- (1) in aircraft crashes
 (2) in catastrophic disasters
 (3) may droop low enough to encounter WEMTs handheld radio antenna or backpack frame
 (4) electric fences in rural search areas

- c. Chemical hazards:

- (1) forest spraying with insecticides
 (2) field fertilizers
 (3) toxic waste dumps
 (4) mine tailings

- d. Military aircraft crash sites:

- (1) weapons
 (2) armed ejection seats
 (3) possibly radioactive materials

- e. Crime:

- (1) booby traps around stills or marijuana fields
 (2) assault by those protecting stills or marijuana fields

7. subjective hazards

- a. lack of knowledge regarding:

- (1) wilderness environment
 (2) nature and scope of the tasks at hand

* R-326: "Repellent #326"; chemically Di-N-propyl isocinchromeronate; also known as MGK-326, for McLaughlin-Gromley-King, Minneapolis firm that makes almost all insect repellent ingredients

* Sawyer Products, Box 188, Safety Harbor, FL 34695; (813) 725-1177; DEET-Plus lotion or spray is \$3.49 for 2 oz.

** available from Travel Medicine, Inc., 351 Pleasant St., Suite 312, Northampton, MA 01060, (800) 872-8633

- b. overconfidence:
 - (1) bane of many otherwise excellent outdoorspeople
 - (2) for EMT, common overconfidence error is application of "street" EMS concepts in wilderness
 - (3) particularly common: underestimating time and difficulty of wilderness evacuation by factor of 5 to 10
- c. poor judgment: allowing mission goals (e.g., reaching the patient, finishing the evac) to cause personal danger, injury or death
- d. fear:
 - (1) fear healthy and may prevent unreasonable risks, but
 - (2) panic may lead to rash and unreasonable behaviors resulting in serious injury/death
- e. lack of will to survive may ultimately lead to death²⁴
- c. sometimes waterfall **is** the main passage, and must go up or down the waterfall
- 5. cold
 - a. average temperature for mid-Appalachian caves is 50-54°F (10-12°C)
 - b. cold surface runoff may make cave water colder
 - c. wet clothes and direct contact with cold rock make hypothermia common
- 6. confusing
 - a. many passages look alike
 - b. many caves 3-D mazes
- 7. long: most caves short (e.g., PA caves mostly < 1 mile long), but in KY, VA, WV, > 10-30 miles²⁵

G.Caves

- 1. **completely** dark: must carry three sources of light
- 2. vertical
 - a. some have vertical shafts, at entrance or anywhere
 - b. up to 200' deep in most cave-bearing areas
- 3. tight
 - a. sometimes must take off helmet or coveralls to get through
 - b. sometimes, cannot get through no matter what (even though patient managed somehow)
- 4. wet
 - a. water formed most caves, often still present
 - b. often, sticky/slippery mud, or stream, or water-filled crawlway, or waterfall
- 8. bats
 - a. may be rabid, or infected with other diseases
 - b. keep physical contact with bats to minimum, for the bat's sake as well as yours
 - c. avoid bat and bird droppings: may carry contagious diseases
- 9. Quoting from a direct contribution from the Eastern Region, National Cave Rescue Commission: "Caves are not the place for the uninitiated. If you think that you might have to respond to a cave rescue as a WEMT, get the proper training: a Cave Rescue Orientation class from the Eastern Region, National Cave Rescue Commission. Emergency phone number for Eastern Region, National Cave Rescue Commission: 1-804-674-2400 (Virginia Emergency Operations Center). NCRC national number: 1-800-851-3051."

H. The Wilderness "Ambulance"

1. useful to compare "street" EMT's ambulance to analogous equipment used by the Wilderness EMT, for example, tires equivalent to litter team members' booted feet
 - a. blistered feet or slippery shoes on a rescue team be just as hazardous as bald tires on an ambulance
 - b. training in good foot care, and proper personal equipment, including boots, essential parts of wilderness "ambulance"
 - c. need for **personal** equipment as well as team equipment: for instance, a five-mile hike in not-broken-in "team" boots would make rescuers into casualties
2. ambulance headlights equivalent to rescuers' headlamps; night-time wilderness rescuers trying to carry (and care for) a patient using hand-held flashlights worse off than EMTs in an ambulance with no headlights and no interior lighting
3. analogies can be carried to extremes, but useful starting place for looking at SAR team's equipment needs

Glossary

- Alum:** A chemical sometimes used as an aid in wilderness water disinfection.
- Cataracts:** Opacities in the lens of the eye.
- CO₂:** Carbon dioxide.
- CO:** Carbon monoxide.
- Flux:** The "amount" of light or other electromagnetic radiation.
- O₂:** Oxygen.
- PABA:** Para-AminoBenzoic Acid; a sunscreen.
- Photodermatitis:** A rash, similar to sunburn, caused by exposure to the sun's ultraviolet "A" light after taking certain medications.
- Wilderness:** A tract or region uncultivated and uninhabited by human beings; an uninhabited region left in its natural condition; something likened to a wild region in its bewildering vastness, perilousness, or unchecked profusion.

Wilderness EMS: A system capable of providing medical care and rescue beyond the means of routine or conventional EMS systems. This may require transport of equipment, personnel, and medications on team member's backs over rugged terrain to the patient, and during evacuation from the site to an entry point into the "normal" EMS system.

Wilderness EMT: A specially trained member of a well-organized, wilderness-oriented, physician-controlled system that provides medical care to patients in backcountry or wilderness situations.

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