Health and Hygiene Related to Cave Conservation

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Although a complete discussion of wilderness medicine or caving-related medical issues is beyond the scope of this book, several broad health categories influence good practices in cave conservation.

- A variety of factors affect caving performance—heat stressors, hydration status, nutrition, and general fitness.
- Hygiene practices help maintain health—human waste disposal, sanitation at camp, and water quality.
- It is important to be aware of several illnesses that may be contracted in cave environments.

Hypothermia

Hypothermia is a common topic in caving literature and is described in first aid and rescue publications. The definition of hypothermia is straightforward. Hypo means “low” and ther mia means “heat.” Many factors can lead to hypothermia or low body heat, but the underlying mechanism is always the same—heat is lost faster than the body can produce it.

Several factors may predispose humans to hypothermia—nutrition, hydration, inactivity, body habitus (lack of body fat), individual variance, alcohol use, and illness.

Hypothermia can be divided into three general categories.

- **Acute hypothermia** occurs suddenly—for example, falling into a stream (sometimes called immersion hypothermia).
- **Subacute hypothermia** occurs over an intermediate period of time (hours)—and would be more common on caving trips and expeditions.
- **Chronic hypothermia** occurs over a longer period of time (days, weeks, or months)—for example, a person living in an unheated room.

Many published lists detail the signs of hypothermia and correlate the symptoms with body temperatures. The accuracy of these lists is often questioned, but the details are not as important as understanding the general trend.

Signs and Symptoms of Hypothermia

- As body temperature falls, shivering begins and coordination decreases.
- Fine movements become more difficult and eventually impossible.
- Walking becomes difficult and ataxia (stumbling) ensues.
- The ability to reason decreases. Decision making becomes difficult and poor judgment ensues.
- As body temperature falls, the victim becomes stuporous (sleepy).
- With progressive decrease in body temperature, shivering ceases and death from irregular heartbeat is not far behind.
It is easy to understand how lack of coordination and poor judgment might impact the cave environment. Hypothermic cavers tend to become clumsy and make bad decisions. Preventing and treating hypothermia is discussed in great detail in other publications. (See sources for additional information at the end of this chapter.) Appropriate clothing, adequate fuel intake (food), proper equipment, detailed planning, and awareness of your own status as well as that of your companions will go a long way toward preventing hypothermic conditions.

**Early Warning—Shivering**

Shivering is the earliest warning sign of hypothermia. It is the body’s first response to falling body temperature. The intense muscle activity of shivering generates heat by increasing heat production up to five times over the rate produced when one is simply sitting (Steinman and Hayward 1995). But heat production is not without a price: calories from food or body stores (fuel sources) are quickly consumed; muscles are quickly fatigued; and fine movements are difficult if not impossible. Don’t ignore shivering hands or chattering teeth.

When you feel cold and before shivering starts, you should begin trying to retain body heat or rewarming by other measures.

- **Put on a hat.** A huge amount of body heat is lost through the head and neck. Up to 70% of total body heat production can be lost through the head when the temperature is -15°C (5°F) (Bowman 1995).

- **Change to dry clothes.** At least put dry clothes next to the skin. Bodies perspire constantly and the moisture is transferred to clothing.  
  - Some fabrics act like evaporative coolers. Cotton absorbs moisture, thus cooling the body by evaporation. Cotton also has high thermal conductivity and allows heat to flow from the body faster.  
  - Nylon absorbs less moisture than cotton, but also retains enough water to cool by evaporation and has poor wicking qualities.  
  - Wool is an excellent insulator, but holds moisture (not as much as cotton, but more than nylon, acrylic, and polypropylene) and becomes much heavier when wet.  
  - Acrylic and polypropylene fabrics absorb minimal water, wick moisture away from skin, and allow body heat to dry garments.  
  - Of all of these, polypropylene has the lowest thermal conductivity and highest insulating value while maintaining a high wicking ability.

- **Eat something.** Simple sugars (for example, candy) will provide the quickest energy. However, over the long term, high fat content or high calorie count foods will serve to refuel and reheat the body more efficiently than other food choices.

- **Warm up.** Use one of the traditional caver techniques to increase warmth.  
  - Dig out your emergency body-sized plastic bag, crawl in, and put your carbide lamp or candle under the bag to warm up quickly.  
  - Sit shoulder-to-shoulder with two warm cavers for heat transfer.  
  - Skin-to-skin contact inside a sleeping bag is one of the quickest emergency procedures for restoring body temperature.  
  - Two or more bodies clothed in polyester inside a perspiration-wicking bag may warm up even faster.
Hyperthermia

Hyperthermia, or heat stress, is the often forgotten, heat-related illness in caving. The definition is again easily understood from the word itself. Hyper means “high”—thus, hyperthermia is a state of “high heat.”

Many medical and first aid texts make a point of differentiating between heat exhaustion and heat stroke. For our purposes, the distinction is not important. Because of overlap in signs and symptoms, the two conditions cannot be correlated well with different temperatures.

Several factors can contribute to heat-related illnesses—fatigue, lack of sleep, lack of acclimatization, drug use, obesity, sustained exertion, and dehydration.

Symptoms of heat-related illnesses can be easily overlooked.

- Headache
- Confusion
- Drowsiness
- Nausea
- Lack of coordination
- Loss of consciousness—a late symptom
- Cessation of sweating—a very late and ominous sign of hyperthermia

Again, it should be apparent that anything affecting the individual’s ability to reason or function in a coordinated manner will adversely affect the cave environment.

Medical Emergency—Change in Level of Consciousness

With hyperthermia, there is one very important symptom to remember—is there a change in the level of consciousness?

This change can range from confusion to loss of consciousness. If there is an alteration in the level of consciousness, the person has a more severe heat-related illness. This is a true emergency and requires immediate attention (cooling) to prevent permanent brain damage or death.

Rehydrate and Lower Body Temperature

Treatment of heat illness centers on rehydrating the patient and lowering body temperature.

- An efficient way to lower body temperature is to wet the body with water or whatever is available (even urine will do) and then fan the person. (Since this method depends on evaporation, it will be less efficient in the 100% humidity found in many cave environments.)
- Immersion in cool water, previously thought to be contraindicated, is also a very effective cooling method and should be used when other measures fail to lower the body temperature (Dickinson 1995).
- For information on rehydrating a victim, see hydration status below.
- Again, decreased mental alertness is a very serious sign—anything from confusion to unconsciousness should be considered a medical emergency.

Prevention and Acclimatization

Prevention of heat illness requires awareness. Pay attention to signs and symptoms. Consciously monitor yourself and your companions. Plan for heat conditions and give attention to hydration status.

Preparation can help you avoid heat problems. Acclimatization in hot environments may take 7–10 days. However, exercise in a warm environment (1–1.5 hours daily) may help prepare the body for a hot environment. For example, exercising in the warmest, middle part of the day rather than...
in cooler morning or evening hours may facilitate acclimatization to warmer temperatures. Such an exercise program should be undertaken cautiously. Consult your physician before initiating any exercise program.

Hydration Status

Dehydration is an abnormal depletion of body fluids. The state of dehydration can be associated with the temperature-related problems described above, or dehydration can develop without heat-related stressors, as in severe vomiting or diarrhea.

Humans lose about 1.5 liters (1.5 quarts) of water per day through insensible losses—normal fluid loss through breathing or slight perspiration. With heavy exertion in a hot or humid environment, a person can easily lose 1.5 liters or quarts every hour (Hubbard and others 1995). One of the highest recorded sweat losses is about 3.5 liters (3.75 quarts) per hour (Armstrong and others 1986).

Confusion and Stupor

Like heat-associated illnesses, dehydration can cause confusion and lack of coordination. Symptoms of dehydration can accompany and mimic body temperature problems. Confusion and lack of coordination can manifest with hypothermia, hyperthermia, high fever, dehydration, fatigue, medical illness, diabetes, medication effects, and other conditions.

Over-hydration (for lack of a better term) can also cause the same dangerous symptoms. Drinking a lot of water without accompanying salt intake may cause the body’s sodium level to fall to dangerously low levels. In a cave environment, as in any extreme environment, the onset of confusion and the loss of coordination may have severe consequences for the individual, the group, and, consequently, for the cave.

A state of decreased mental awareness is sometimes called stupor which reminds me of stupid. Hence, you get cold, or overheated, or dehydrated … you get stupid. You get stupid … you get dead.

Don’t Count on Thirst

What about thirst? Unfortunately, thirst may be absent. The sensation of thirst is not prominent until the degree of dehydration exceeds the kidney’s ability to deal with the fluid depletion (Hubbard and others 1995). The absence of this early warning often contributes to accidental dehydration. However, voluntary restriction of fluid intake can also contribute to dehydration—for example, if the caver wants to conserve water or decrease urine output. Restricting fluid intake is not a wise choice.

Fluid Intake

Watch your fluid intake—drink enough water. Prevention of dehydration, whether primary or occurring with heat-related disorders, is accomplished by fluid intake.

Because of the absence of thirst, it is important to consume fluids at regular intervals. Endurance athletes often try to consume 250–500 milliliters (8–16 ounces) every 20–30 minutes. This is not practical for caving, but indicates that sometimes you should consider taking in 1–1.5 liters or quarts every hour or so, even when you’re not thirsty.

Much has been written and hypothesized about the type of fluids that can prevent or correct dehydration.

- Alcoholic beverages do not help hydrate—in fact, alcohol causes one to become dehydrated—alcohol causes the kidneys to clear more water by inhibiting the body’s natural antidiuretic hormones. (This is the real
reason you make more trips to the restroom when you’re drinking alcohol.)
• Caffeinated beverages are also a poor choice as they tend to increase urine output.
• Generally, large amounts of water leave the stomach faster than small amounts, but huge gulps can cause discomfort.
• Cold liquids leave the stomach faster than warm ones, but cold fluids may not be available in the cave environment.
• Many commercial sports drinks are available. Sport drink supplements are based on the theory that glucose (or sucrose) promotes stomach emptying; that glucose plus sodium promotes water absorption by the small intestine; that glucose promotes performance; and that sodium is needed to replace salt loses. Research indicates no difference between water and glucose-sodium solutions in terms of absorption or effectiveness in rehydration or effect on performance.
• My personal preference is Gatorade® with a little extra added. To 1 liter (1 quart) of Gatorade, add about 1 liter or quart of water (dilute to half-strength); then add 2 milliliters (1/2 teaspoon) sodium chloride (table salt) and approximately 2 milliliters (1/2 teaspoon) potassium chloride (salt substitute). This combination reduces muscle cramps.
   However, beverages containing potassium (salt substitute) should not be used to treat heatstroke because the body’s potassium may already be elevated.

Nutrition
A well-balanced, nutritionally sound diet is a *sine qua non* of good performance in any physical undertaking. Caving is no exception.

One who is calorically deficient will not have the necessary stamina for prolonged exertion. Therefore, someone on a severely calorie-restricted diet should approach caving with caution.

Persons adhering to a vegetarian diet should pay special attention to the balance of protein they are taking in—it takes special care and effort to maintain proper proportions of different proteins in a vegan diet. This caveat should not be taken as prohibition of vegetarian diets. There is no problem with a properly balanced diet—vegan or otherwise.

Carbohydrate loading, consuming large quantities of complex carbohydrates 12–24 hours before exertion, has been practiced for a long time by endurance runners and other athletes and may be of some benefit.

It may also be wise to add extra salt to food for 1–2 days before heavy exertion, especially if one has been on a sodium-restricted diet. (If sodium restriction was prescribed by a physician or dietitian, definitely consult with them before adding salt.) Muscle cramps are likely to result from inadequate sodium intake before or during heavy exertion. Increasing sodium intake in anticipation of (or in response to) exertion and sweating may help avoid muscle cramps, muscle weakness, and the consequent decrease in coordination that can create new impacts in caves.

Physical Conditioning
Before engaging in any physically exerting activity, one should prepare with a reasonable conditioning program. Generally, 60–90 minutes of aerobic exercise per day for several weeks is a good start. Aerobic exercise raises the heart rate. The exact nature, extent, intensity, and duration is left to the discretion of the reader with the warning that a physician should be consulted before beginning any exercise program—especially if you have chronic or serious medical conditions. Such conditions would include—but are not limited to—heart disease, diabetes, seizure disorders, hypertension, obesity, and thyroid disorders.

Failure to prepare for exertion will result in inevitable decreases in
endurance and coordination, which can easily result in new impacts to cave resources. Decreases in performance abilities will predispose cavers to accidents with the ensuing rescues and the resultant impacts on the cave environment.

**Personal Hygiene**

Personal hygiene may seem an unusual subject in a book about caving, but it can have great significance. Humans are walking bacterial farms—each body is covered from head to toe with bacteria. Especially high concentrations are found around the mouth and perianal areas. I know some readers are thinking, “Not me!” But no one is exempt from this biological fact.

Each of us sheds millions of skin cells every day. Dust mites that live in carpets and mattresses thrive on tiny flakes of skin and debris. We also shed countless ectoparasites and other microbes that live on our skin and hair. We humans literally leave piles of microscopic matter in our wake. We shed all the time—in the house, in the truck, on the trail, and inside caves.

A simple shower with antibacterial soap may reduce bacteria on a caver’s skin, but you can never completely eliminate the bacteria. Laundering caving clothes, packs, vertical gear, and other equipment between cave trips will decrease the chance of introducing contaminants to a cave or causing cross-contamination between various cave environments.

Many enteric infections—those affecting the gastrointestinal tract—are spread by the simple failure to wash hands. Hand-washing is not practical in a cave. But it is easy to carry a small bottle of disinfecting-gel hand cleaner or a small supply of antimicrobial wipes.

**Human Waste Disposal**

The disposal of human waste is a subject that many people avoid because of the unpleasant connotations. Most of us are accustomed to simply pushing the lever, and flush; it’s gone … out of sight, out of mind. The absence of plumbing or even pit toilets in most caves mandates our consideration of this subject.

In caves with flowing water or those subject to flooding, it has been common practice to dispose of liquid wastes wherever it was convenient on the assumption that it would be diluted and ‘flushed away.” The cavalier implementation of this practice should be reconsidered. Liquid wastes not deposited directly into flowing water may remain for a long time where they are left, thus altering the chemistry of the cave environment, perhaps to the detriment of those organisms that live there.

Wastes deposited into flowing water produce their own problems, apart from the effects on the chemistry of the water and the organisms that may live there—you may be washing or walking in that same water. Furthermore, that water is probably somebody’s drinking water (maybe yours).

Solid wastes in “wet” caves are often, unfortunately, treated the same way. This cavalier attitude has led to the degradation of the environment around many alpine climbing routes.

Microorganisms can move through soil—bacteria can penetrate to about 30 meters (100 feet) in sandy soil and viruses can travel about 90 meters (300 feet) laterally (Backer 1995).

Some sources recommend that feces be spread on rocks in the sun to be desiccated (Backer 1995). The USDA Forest Service recommends that feces be buried 20–30 centimeters (8–12 inches) deep, off trail, and 60 meters (200 feet) from water sources (United States Department of Agriculture-Forest Service 2003; Leave No Trace®, Inc. 2003). Obviously, neither of these options is viable in cave environments.
Every effort should be made to remove solid wastes from caves—no other option exists. This subject has been discussed jokingly as well as in serious debates for a long time. The simplest and most reliable method remains to defecate directly into a zip-closure plastic bag, and double-bag it into another sealable bag for aesthetics and safety. The usefulness of additional bags and desiccating or deodorizing agents (for example, powdered bleach or baking soda) is left to the individual to decide. Some cavers have found that “oven baking bags” are reliable containers. Commercially available dry bags have also been suggested as an outer container for added security. (See burrito bag instructions, page 269; also see human waste, pages 35, 71, and 125.)

**Preventing Cave-Related Infectious and Environmental Diseases**

A complete discussion of cave-related illnesses is beyond the scope of this chapter. For detailed information, check with the Centers for Disease Control and Prevention [<http://www.cdc.gov/>] and other sources listed at the end of this chapter. A few of the illnesses to consider are rabies, histoplasmosis, leptospirosis, and exposure to radon gas.

**Rabies**

*Preexposure prophylaxis* is available for rabies and consists of three simple injections—a relatively painless and relatively safe procedure. Rabies preexposure vaccine is recommended for anyone who will be around large numbers of bats.

If rabies prophylaxis is obtained, it is important to periodically get blood titers checked, booster shots when appropriate, and postexposure vaccine if one’s skin is broken by a bat bite (MMWR 1999).

Although there are reports of persons developing clinical rabies without an obvious bat bite, aerosol transmission of rabies virus has not been conclusively shown to occur (Gibbons 2002). Exposure to rabies can be treated with postexposure prophylaxis.

Exposure may be a bite (but since bats are usually small, the bite usually is not noticed) or contamination of an open wound or mucous membrane by bat saliva or nerve tissue (brain matter). Consequently, postexposure rabies prophylaxis should be considered when direct contact between a human and a bat has occurred—unless the exposed person can be absolutely certain a bite, scratch, or mucous membrane exposure did not occur.

*Postexposure prophylaxis* consists of an injection of immune globulin (antibodies) and a series of five vaccination shots (MMWR, 1999). Appropriate postexposure prophylaxis is widely available in the U.S., but some other countries use different vaccines and regimens.

Caution should be exercised if seeking postexposure prophylaxis overseas. The most current information is readily available from the Centers for Disease Control and Prevention [<http://www.cdc.gov/>]. Unfortunately, *rabies encephalitis* (rabies virus infection of the brain) is a zero-tolerance disease—essentially anyone who develops the clinical syndrome of rabies will die.

**Histoplasmosis**

There is no prevention for *histoplasmosis* other than avoiding dust contaminated with bat guano or using a HEPA filter respirator. Interestingly, it appears that this fungus grows in soil contaminated with bat or bird guano but not in the guano itself.

Histoplasmosis is fairly common in the eastern United States, especially in the Mississippi and Ohio River areas. Many persons living in these areas...
already have some antibodies to histoplasmosis. Persons residing outside these endemic areas (those areas where the fungus is common) may be more susceptible to infection or prone to more severe disease, but this is only a generalization.

**Leptospirosis**

*Leptospirosis* is an infection caused by a corkscrew-shaped bacterium carried in the urine of some animals (including bats) and it can infect humans when they wade in water contaminated by animal urine. This infectious disease is easily treated with antibiotics (such as doxycycline).

**Radon**

The presence of radon gas in caves and its clinical significance for humans is still a matter of some debate. Radon gas is a *carcinogen* (a substance that causes cancer) but it appears to work synergistically with smoking. Exposure to radon gas in the home, where the exposure is long-term and continuous, appears to be a greater risk than the relatively short-term exposure one might encounter on a caving trip, even a multi-day expedition.

**Other Illnesses**

Other infectious diseases which have been discussed in relation to caving include hantavirus, blastomycosis, coccidioidomycosis, and plague. For additional details about these illnesses, refer to the sources for additional information at the end of this chapter.

- *Hantavirus* can cause hantavirus pulmonary syndrome, but epidemiological factors (that is, where the deer mice live) make it an unlikely risk for cavers.
- *Blastomycosis* is a fungal infection found in the southeastern U.S. and is sometimes spread by digging in contaminated soil. Using respirators when digging to find cave passages may be helpful.
- *Coccidioidomycosis* is a fungal infection found in the southwestern U.S. (also called Valley Fever or San Joaquin Fever).
- *Bubonic Plague* is endemic though uncommon in southwestern parts of the country and is caused by the bite of an infected flea.

**Disclaimer**

Every situation and every individual is different and must be evaluated on its own.

No treatment should be started or carried out based solely on this or any other protocol.

No medication, treatment, or medical device should be administered or applied without complete training in, and a thorough understanding of the uses, limitations, and possible complications of said treatment or device.

The opinions expressed herein are solely those of the author and do not represent the views, opinions, treatment protocols, or standards of any other individual, group of individuals, medical group or organization, hospital, other organization, the NSS, or any section thereof or any of its other internal organizations.
Cited References


Centers for Disease Control and Prevention (CDC). Internet <http://www.cdc.gov/>. Accessed 2003 Feb 5. [The Centers for Disease Control and Prevention (CDC) is recognized as the lead federal agency for protecting the health and safety of people at home and abroad, and providing credible information to enhance health decisions.]


Additional Reading


Sources for Additional Information

Medical Section of the National Speleological Society
Web: <http://www.caves.org/section/medical/>

Centers for Disease Control and Prevention (CDC)
1600 Clifton Rd NE
Atlanta GA 30333
Phone: 404-639-3311
Travelers' Information Hotline Phone: 877-394-8747
Web: <http://www.cdc.gov/travel/>
International Association for Medical Assistance to Travelers (IAMAT)
417 Center St
Lewiston NY 14092
Phone: 716.754.4883
Web: <http://www.cybermall.co.nz/NZ/IAMAT/>

The Wilderness Medical Society
3595 East Fountain Blvd Suite A1
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Web: <http://www.wms.org/>