



COLD INJURIES

by Michael Strong

HYPOTHERMIA

Hypothermia is a lowering of the body's internal (core) temperature and is brought about when heat loss outpaces heat production. In wilderness environments, hypothermia commonly results from a combination of inadequate protection from the cold, inadequate food for metabolic fuel (i.e. heat production), and inadequate fluid intake (dehydration). When recreating in conditions conducive to hypothermia (wet, cold, and windy), it is ESSENTIAL to stay well fed and hydrated, and to be equipped with an adequate amount of the right kind of clothing and equipment.

There are several forms of hypothermia, each of which is categorized according to the rate of cooling. In **mountain** hypothermia, core temperature drops over a period of hours. It is the form of hypothermia that backcountry hikers, skiers, climbers, etc. are the most susceptible to. **Immersion** hypothermia can occur relatively quickly – during immersion in cold (68° or less) water for about 30 minutes or longer. **Chronic** hypothermia evolves over a period of days to weeks, commonly occurring in older people who keep their living spaces too cold for comfort and suffer from inadequate nutrition. This article addresses mountain and immersion hypothermia.

Hypothermia and the Brain

The first core organ to exhibit signs of being affected by hypothermia is the BRAIN, which recognizes the smallest of blood temperature changes. During hypothermia:

- *The highest-level brain processes are affected first.* Rational thought, decision-making prowess and judgment are diminished.
- As core temperature continues to drop, *mid-level brain processes are affected*, such as drives and instincts.
- If temperature drop is excessive, *basic life processes* (e.g. respiration, circulation, consciousness) decline.

MOUNTAIN HYPOTHERMIA

Mild Hypothermia - The Body's Initial Response to Cold Stress

Signs and Symptoms

- **Vasoconstriction in the periphery.** Heat loss is too high and blood flow is reduced in the skin and extremities. The person may complain of feeling cold, will be cold to the touch and most likely have goose bumps.
- **Enthusiasm slows and apathy sets in.** The person may become less aware of surroundings, have a hard time keeping up with others, and forget to drink, eat, or take a break.
- **Controllable fine shivering begins,** a sign that the body is experiencing a heat imbalance and is attempting to produce heat.
- **Reduction in ability to perform complex mental tasks** (e.g. count backwards from 100 in increments of 9) begins to set in.
- **Loss of fine motor control,** especially in the hands. Fine motor control is a higher-level cerebral function and will show signs of being compromised early on in the process of T° drop. Lighting a match, zipping up a parka, or tying or untying bootlaces are difficult (due to restricted peripheral blood flow).
- **Inability to perform complex motor functions** (e.g. can't ski without falling), but can still walk and talk.
- **Increased desire to urinate** due to vasoconstriction of blood vessels (called cold diuresis).

Field Treatment for Mild Hypothermia

<u>ACTION</u>	<u>REASON FOR ACTION</u>
1. <i>Remove from the source of cold and protect</i>	<i>Prevent heat loss</i>
All that may be necessary is to seek shelter behind, or underneath a stand of thick trees, behind a large rock, etc. If you cannot get out of the elements, or if the weather is severe, you'll have to put up a shelter.	
2. <i>Remove wet clothing and replace with dry clothing</i>	<i>Prevent heat loss</i>
Take off ALL wet clothing, including base layers and replace with appropriate insulating layers AND protective layers. Put on a hat and a neck warmer to protect the areas of the body where critical heat is easily lost.	
3. <i>Hydrate and maintain blood sugar</i>	<i>Produce heat</i>
Give constant sips of a very sweet drink (e.g. warm Jell-O, Gatorade, etc.). You cannot give too much liquid or too much sugar. An energy bar or gel is also a good idea.	
4. <i>Have the person exercise</i>	<i>Produce heat</i>
Wait about 30 minutes after administering fluids and food. The body needs time to produce energy. Then resume activity (e.g. your hike, backpacking leg, etc.) If in camp, take the person on a brisk walk, preferably uphill for at least 30 minutes.	

B. Moderate Hypothermia

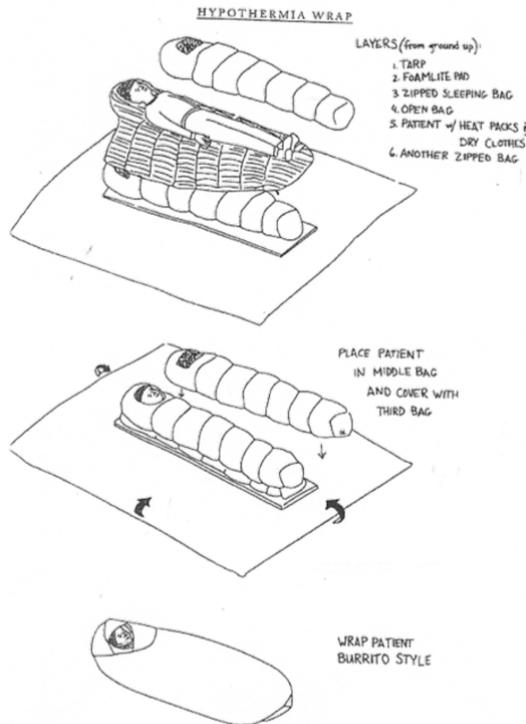
Signs and Symptoms

- **Uncontrollable shivering** starts at about 95°F and produces a reasonable amount of heat.
- **Decline of mental status continues.** Hypothermia has now progressed to the point where mid-level brain functions such as instincts and drives are affected. Watch for the **UMBLES**: The person may STUMBLE, TUMBLE, MUMBLE, FUMBLE, AND GRUMBLE, which show a change in motor coordination and level of consciousness. The person may be belligerent, depressed, and have an "I don't care" attitude. Person may be unaware of being cold and may have amnesia.
- **Ataxia** (the inability to walk in a straight line) becomes evident.
- **Speech is slurred** as facial muscles become impaired.

Field Treatment for Moderate Hypothermia

<u>ACTION</u>	<u>REASON FOR ACTION</u>
1. <i>Remove from the source of cold and protect</i>	<i>Prevent heat loss</i>
Same as for mild hypothermia with the exception that this person will need a protected environment – cabin, tent, snow cave, hypothermia wrap (see below).	
2. <i>Remove wet clothing and replace with dry clothing</i>	<i>Prevent heat loss</i>
Same as for mild hypothermia.	
3. <i>Hydrate and maintain blood sugar</i>	<i>Produce heat</i>
Same as for mild hypothermia, with the following considerations: As core temperature drops, patients have a harder time digesting solid foods. It's more important to give hot, sweet fluids.	
4. <i>Add external heat via an external heat source</i>	<i>Produce heat</i>

The person is too cold to generate adequate heat via exercise. Place them in a **hypothermia wrap**. The goal is to protect the surround the patient with at least 4" of insulation on all sides and to eliminate all forms of heat loss. Use multiple sleeping bags if you have them. Place several sleeping pads underneath the patient to eliminate conductive heat loss. Wrap hot water bottles in insulation to reduce the possibility of burning the patient, and place them in this order: palms of hands, soles of feet, chest area, armpits and groin. Wrap the person in a 'space blanket' to reduce radiant heat loss, and finish with a vapor barrier (e.g. tent fly, sheet of plastic, etc.) The end result is a patient wrapped 'burrito-style', with the only openings at the mouth and nose.



It may take awhile for the person to warm up (the body will rewarm at the rate of about 3.5°F/hr.). Upon recovery, the person will likely be very tired and will need three to four hours of rest. Do not engage in vigorous exercise (e.g. continue your backpacking trip) immediately after the re-warming process is successfully completed.

NOTE: Shivering produces a lot of heat and is a natural response to cold stress. A vigorously shivering individual should warm up effectively in a heated, protected environment (e.g. cabin, car, etc.). Wrap the person in a blanket and give warm, sweet drinks.

Assessing Hypothermia

Mild to Moderate – Core T° above 90° - Conscious, shivering, able to walk, talk, eat and drink, alert. Can rewarm on own.

Severe – Core T° below 90° - Semi-conscious or unconscious, no shivering, unable to rewarm on own.

C. Severe Hypothermia

Signs and Symptoms

- Shivering stops (this person has run out of fuel), the person has difficulty speaking and cannot walk, has exposed skin that is blue and puffy, and demonstrates incoherent/irrational behavior, such as 'paradoxical undressing'.
- The person may be able to maintain posture and an appearance of awareness.
- As T° drops into the mid-to-low 80's, muscles become rigid, the person lapses into a semi-conscious state, pulse and respiration rate decrease, and pupils dilate. By the time the body T° reaches 80° the person is unconscious, heartbeat and respiration is erratic and the pulse may not be palpable. The person eventually lapses into cardiac and respiratory failure.

Field Treatment For Severe Hypothermia

- **FIRST AND FOREMOST** - handle this patient gently! The heart is extremely excitable during severe hypothermia and all but the gentlest handling can induce cardiac arrest (ventricular fibrillation).
- Reduce heat loss AND add heat – place person in a HYPOTHERMIA WRAP and add hot water bottles. Provide food and fluids ONLY if the person is conscious and able to swallow without the possibility of aspiration.

- Prevent **AFTERDROP** (a quick drop in core temperature). Afterdrop occurs when cold, metabolically stagnant blood circulates back to the core, rapidly dropping core temperature and potentially shocking the heart. NEVER place a severely hypothermic patient into a tub of warm/hot water in an attempt to increase core temperature. And NEVER let a severely hypothermic person walk around! Keep movement to a minimum.
- DO NOT administer CPR. A heartbeat will be hard to detect. You could do more damage than good. Rescue breathing only!

IMMERSION HYPOTHERMIA

The main reason that acute hypothermia is more traumatic than accidental hypothermia is that water conducts heat away from the body approximately 25 times faster than air at the same temperature. When water temperature falls below 68°, immersion hypothermia occurs in about 30 minutes if a person is not wearing protective clothing. The body's response to cold water immersion is as follows:

- **1ST MINUTE** - The initial reaction is a gasp reflex. As the cold reaches the skin, the peripheries vasoconstrict. Warm blood is forced into the core, which acts as an insulating barrier. The main goal during the first minute is to KEEP FROM DROWNING.
- **10 MINUTES** - You now have 10 minutes to get out of the water before your muscles and nerves become ineffective. After this you will no longer be able to tread water and unless you're wearing a pfd, you will be incapable of keeping yourself afloat.
- **1 HOUR** - If you are wearing a pfd and your head stays above water, you will remain conscious for about an hour (individual differences in clothing, energy stores and body build dictate just how long). When your core T° reaches 86°, you'll lose consciousness.
- **2 HOURS** - You can still be successfully rescued if you are found in about 2 hours. Hypothermic cardiac arrest occurs when core T° is below 82.4° - and this can take as long as an hour to occur after slipping into unconsciousness.

If you pull someone out of the water with severe hypothermia do not let the patient walk (see severe hypothermia above).

PREVENTING HYPOTHERMIA

Unlike the paddler who falls overboard into cold water, accidental hypothermia can rarely be attributed to a single factor. As with many outdoor accidents, it's the accumulation of many small errors (or in this case, small heat losses) that lead to eventual misfortune. In extreme environments, it's the small things that matter most and one's habits of safe behavior are usually the best defense against mishap. Taking that few extra sips of water, eating a handful of trail mix, putting on raingear in time and hiking at a comfortable pace may be all that's necessary to keep hypothermia at bay.

To prevent hypothermia:

- Wear the appropriate clothing for the conditions. For the paddler this means a wetsuit or drysuit when water temperatures warrant their use. For backcountry travelers, this means proper base, insulating and protective layers.
- Use clothing properly. Put protective gear on in time; take off layers to prevent overheating and put them back on in time to prevent chilling.
- Drink water! Eat adequate food, especially carbohydrates.
- Maintain a pace that prevents overexertion. Take sufficient rest breaks.
- Watch for hypothermia in others so that if it occurs, you can treat it early or prevent it from happening at all.

TRENCH FOOT

Trench foot (also called immersion foot) is a localized cold injury caused by prolonged exposure of the feet to wet conditions above freezing, usually in temperatures between 30°F and 40°F. If the feet are wet all the time, trench foot can occur in relatively warm (e.g. 60°F) temperatures.

How Does Trench Foot Occur?

When the feet get wet, and conditions are cool, the body constricts the peripheral blood vessels in order to prevent excessive heat loss. Extended exposure (i.e. approximately 12 hours) to cold, wet conditions is necessary to produce trench foot. If vasoconstriction lasts long enough, tissues in the foot are robbed of nutrients and toxins begin to build up. **If circulation is continuously impaired for SIX HOURS or longer, there can be permanent damage to the tissue** (caused by prolonged deprivation of oxygen-called hypoxia). If circulation is not restored within 24 hours, the person may have permanent damage. The area is sensitive to cold and prone to future cold injury.

Signs and Symptoms

- Feet initially are pale and wrinkled. As the extremity rewarms, color may return, the feet may become red, hot to the touch, perhaps tingly, itchy, and sweaty. The most obvious reaction is pain that can be difficult to ease (narcotics have little effect).
- Blisters will likely develop. Eventually, the effected tissue dies and sloughs off.

Treatment

- Keep the feet clean, dry, and warm. Elevate the foot to reduce swelling. DO NOT immerse in warm water (too painful).
- Keep the patient warm to promote generous blood flow to the feet.
- Do not permit the person to walk. Unlike frostbite, where (in many cases) walking on a frozen foot results in minimal or no damage to tissues, trench foot patients can do considerable damage to the tissues by walking.
- Administer antihistamines (many re-warming symptoms are caused by histamine release).
- The recovery period can be long (weeks) and nerve damage may be permanent.

Prevention

- Keep the feet dry! This may take a lot of work if your feet are continuously exposed to a wet environment. Adequate footwear and plenty of changes of dry socks are critical in wet conditions.
- Change into dry socks at least once a day. Never sleep with wet socks on.
- Avoid tight socks or footwear that can constrict circulation.
- Air your feet out whenever possible. Massage your feet to stimulate circulation.
- Check your feet often. Your feet do not have to be immersed in standing water to contract trench foot. Excessive sweating is also cause for concern. Foot powder with aluminum hydroxide can reduce sweating.

Resources

Giesbrecht, Gordon, G. & Wilkerson, J. *Hypothermia, Frostbite and Cold Injuries*. The Mountaineers.

Schimelpfenig and Lindsey, *Wilderness First Aid*. National Outdoor Leadership School, Ch. 9.

Tilton, Buck. *Backcountry First Aid and Extended Care*, 4th Ed. Globe Pequot Press.

Weinberg, Andrew D. *Hypothermia Prevention, Recognition and Treatment*. <http://www.hypothermia.org/weinberg.htm>