CASE REPORT

A Case Report of Hypothermia in the Wilderness

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Accidental hypothermia due to environmental exposure is a common condition encountered in the wilderness setting. I report a case of hypothermia that occurred in New Hampshire to a 42-year-old, poorly prepared mountaineer. He presented with ataxia, impaired judgment, oliguria, and slight confusion, suggestive of mild to moderate hypothermia. He was treated in the field using passive and active external rewarming methods and 1 active internal method. The signs, symptoms, and progression of hypothermia are reviewed, and treatment options are discussed, with an emphasis on management of hypothermia in the wilderness setting. Additionally, more complicated treatment modalities are canvassed, as these are of use to rescue teams and expeditions. Current controversies regarding the treatment of hypothermia, resuscitation efforts, and potential complications are also mentioned.

Key words: hypothermia, wilderness, rewarming, afterdrop, climbing, exposure

Case report

A 42-year-old male was descending from a solo “summit” of New Hampshire’s Mount Washington in early February. The temperature was 10°F, and the wind speed was 30 to 80 mph. Just prior to dusk, he staggered into the author’s camp. His jacket was unzipped, and his shirt was untucked. He said he “felt like a bug”; when asked what he meant by this, he became agitated and upset. The patient was an athletic-appearing man of average weight and height. He was not shivering. The skin on his face was erythematous. His lips demonstrated a bluish hue; otherwise, his gross exam was normal.

He was persuaded to enter our tent. After attempting sips of warm water, he vomited twice. He was dressed in a sweater, wool pants, and plastic double mountaineering boots. His outer layer consisted of a down jacket, which was not waterproofed. All of his clothing was damp. He was stripped of his wet clothes, redressed, and placed in a sleeping bag. Water bottles full of warm fluids were placed in the bag around the victim’s thorax. Air-activated heat packs were also applied directly to his thorax, abdomen, and groin. The patient was given warm water by mouth. Within an hour, he began shivering. He did complain of nausea but had no further vomiting. Two hours later, the patient’s lips were no longer blue and,

although shivering, he stated that he “felt better.” He did pass some concentrated urine and was conversant and calm, recalling the entire event.

After recovery, the patient was further interviewed. He cited no past medical problems. He denied consumption of ethanol, medications, or recreational drugs. The patient reported little navigation experience, which apparently led to his wandering off the route in near-whiteout conditions. He became cold and frightened and began running. Losing his balance, he stumbled into a snowdrift, resulting in his clothes becoming damp. He was exposed on the mountain for over 12 hours before finding our camp; over 3 hours of this time was spent in damp clothing.

Discussion

This case represents a common presentation of hypothermia in the wilderness. Accidental or “primary” hypothermia is one of the most commonly encountered emergencies in the wilderness, not only in the winter setting but in any season and in any almost any location. Accidental hypothermia is defined as a body temperature below 35°C with no hypothalamic disease.¹ This can occur any time the victim loses a significant amount of body heat by convection, conduction, evaporation, or radiation.² Prolonged exposure to cold weather is a common cause of heat loss through conduction, particularly

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in situations in which patients are immersed in cold water. Rafters, swimmers, and kayakers are some of the most common sufferers of hypothermia by this means. Wind frequently causes loss of body heat by convection, putting anyone in the wilderness at risk, particularly people who are exposed to high wind for extended periods. Skiers and climbers are prone to this mechanism of hypothermia. This can be exaggerated by damp skin or clothing (particularly slowly drying, highly absorbent cotton fabrics), which efficiently cool the skin surface by evaporation, compounding the cooling effect of wind.

Hypothermia is classified into mild (core temperature of 34°C–36°C), moderate (core temperature of 30°C–33°C), and severe (core temperature less than 30°C) hypothermia.³ If possible, body temperature should be checked, preferably by rectal thermometer, while in the wilderness setting, as this may help classify and guide treatment. A survey of Mountain Rescue Association teams revealed that 73% of them measured body temperature in the field to help direct treatment.⁴ Although these teams predominantly measured oral temperature, which is a less accurate predictor of core body temperature than rectal temperature, this practice, if possible, should be followed.

Given that most outdoor enthusiasts are, at times, exposed to risks of hypothermia, a firm understanding of this disease is essential for wilderness safety. Recognition of the early signs and symptoms of hypothermia, as well as its causes, is essential to developing a treatment plan.

Signs and symptoms

Hypothermic victims may demonstrate early signs that are extremely variable and that are often difficult to evaluate. Certainly, in the context of known cold exposure, hypothermia becomes high on the differential diagnoses when evaluating a victim with mental status changes. Agitation and “flat affect” may be the only signs.¹ In cases of mild hypothermia, confusion, impaired judgment, and dysarthria are the most common central nervous system manifestations. Amnesia may also be present.⁵ The early renal response is a “cold diuresis.” This is due to widespread peripheral vasoconstriction (in an attempt to conserve heat) with afferent renal artery vasodilatation and efferent artery vasoconstriction in an attempt to decrease the perceived “extra fluid volume.”⁵ There is also evidence that a blunted response to anti-diuretic hormone may play a role in this diuresis.⁵ Nausea, vomiting, and a general increase in metabolic rate are all seen at this early stage. Perhaps most importantly, shivering is noted and is relatively effective in very early stages at maintaining normothermia.

As the patient advances to moderate hypothermia, lethargy, hallucinations, and ataxia become more prevalent, with worsening mental status. Shivering is an excellent indicator for screening for early or mild hypothermia. However, the shiver reflex is extinguished as the core body temperature drops below 33°C, so the absence of shivering is a poorly sensitive indicator of moderate or severe hypothermia.³ Hypoventilation begins to occur. At this stage, the renal response changes, presenting as oliguria. Slowing of the metabolic rate occurs, resulting in bradycardia, hypoventilation, and hypotension.⁶ In some cases, psychoses, neuroses, and paradoxical undressing may be seen.⁷ It is at this stage that the patient becomes more susceptible to cardiac dysrhythmias. The classic electrocardiographic finding as the patient progresses toward moderate to severe hypothermia is an “Osbourne” or “J” wave.⁸ Other common signs and symptoms include gastrointestinal problems (nausea, vomiting, and constipation).

Severe hypothermia frequently presents as the progression of moderate hypothermia. A progressive decline in cardiovascular stability occurs, resulting in severe hypotension and dysrhythmias.³ Low cardiac output results in renal hypoperfusion, which ultimately leads to oliguria. Left ventricular function is so poor at this point that left ventricular end diastolic volume rises, leading to pulmonary edema. Eventually, the loss of cerebrovascular function leads to coma and death.

The patient in this case was mildly to moderately hypothermic. Unfortunately, there are no “sentinel findings” that allow the provider to classify which level of hypothermia a victim might be in. Hypothermia represents a progression, a spectrum of deterioration, and compensatory physiologic responses. Commonly, patients will not be easy to classify as mildly, moderately, or severely hypothermic. In such cases, providers are forced to use their best clinical judgment and treat the patient accordingly.

Treatment

Regardless of the severity of hypothermia, all patients should be treated initially with “passive rewarming” methods (Table 1). Patients should be protected from wind to avoid further convective heat loss. Given the difficulty identifying the stage of hypothermia, victims should be moved gently to avoid triggering a cardiac dysrhythmia.¹ Additionally, patients should be kept horizontal and wrapped with dry materials, being sure to insulate the patient from the ground to avoid further conductive heat loss. Foam camping mats are effective for this use. A light and compact tool that aids passive rewarming is an aluminized “space blanket.” When

Table 1. Methods to facilitate passive external rewarming

Remove patient from wind and moisture
Insulate patient from cold surfaces (ground)
Remove wet clothing; replace with dry clothes
Add dry insulating layers
Wrap patient in a reflective “space blanket”
Avoid alcoholic beverages

wrapped around a hypothermic patient, such a blanket can help prevent heat loss from radiation.

The ingestion of warm fluids is helpful, but more important is maintaining a positive relative fluid balance. Dehydration is common, as mild hypothermia causes an initial diuresis. Later, the glomerular filtration rate drops 50% in moderate hypothermia, necessitating fluids to maintain renal function.¹ Fluids by mouth are appropriate, assuming the patient can tolerate them without vomiting. Beverages high in caffeine such as tea or coffee should be avoided, as they cause a diuresis. Ethanol dampens the shiver reflex and should also be avoided. When warm intravenous fluids are available, these should be administered until the patient voids. Ambient-temperature intravenous fluids should be avoided. The detrimental effects of precipitating a more severe state of hypothermia with cooler-than-body-temperature intravenous fluids far outweigh the benefit of maintaining short-term renal function. In most wilderness settings, at least initially, warm oral rehydration is usually the most appropriate and realistic intervention.

For the mildly hypothermic patient, passive rewarming is usually appropriate, as these patients have an intact thermoregulatory response. In many of these cases, no more than the aforementioned treatments are required. However, for moderate and severe hypothermia, more aggressive “active” rewarming methods are indicated, as these patients cannot usually mount a thermogenic shiver.⁹ These methods provide direct transfer of heat to the victim’s body, either externally (see Table 2) or internally. Hot water bottles, warm blankets, and air-activated charcoal heat packs should be utilized. These should be placed around the patient’s groin and thorax, as these areas harbor large blood vessels close to the skin surface.⁶

Some experts feel active external rewarming may bring on sudden peripheral dilation, leading to relative hypovolemic shock and possibly precipitating ventricular fibrillation.³ Others argue that vigorous stimulation of the extremities can have similar effects and should be avoided.³ These points are controversial. Several guidelines suggest that the most appropriate intervention is limiting external rewarming to the truncal area, to avoid

Table 2. Methods of administering active external rewarming

Hot water bottles
Placement of patient in a sleeping bag with another person
Chemical heat packs
Exposure to a fire
Forced-air warming blankets
Exposure to warm water
Baths
Electric carbon-fiber warming blankets

peripheral vasodilatation.¹ Others argue that unless the warming is more than “moderate,” peripheral warming poses no such danger.⁶ Giesbrecht⁶ and Vanggaard et al¹⁰ demonstrated that even total immersion of the extremities in warm water does not result in hypotension.

A fire can provide additional heat by radiation and may be helpful. Although uncommonly available during the initial phase of treatment, electric carbon-fiber resistive heating blankets have been shown to provide more than twice the rewarming rate produced by “space blankets” alone, without producing an afterdrop.¹¹ Forced-air rewarming blankets like the well-known Bair-Hugger (Augustine Medical Inc, St Eden Prairie, MN) have been used for years in the hospital setting, but recently, portable versions have also been implemented in the pre-hospital setting. These are obviously not always available, but they have been used by rescue teams and more organized expeditions. Newer rigid versions of the soft forced-air blankets are also being used in the prehospital setting. In addition to their improved durability, these are associated with a higher mean skin temperature than soft forced-air warmers.¹²

Severe hypothermia should initially be treated in the field in the same manner as mild or moderate hypothermia. Rapid but gentle evacuation is critical in these cases, as proper treatment requires more aggressive “active internal rewarming.”¹ Warm intravenous fluids, hemodialysis, warm peritoneal lavage, and warm gastrointestinal irrigation are frequently needed in these cases, but obviously, these options are not available in the field. Warm humidified oxygen is a commonly recommended intervention, either during helicopter or ambulance transport or on arrival to the hospital. The efficacy of this method, however, is questionable.⁶ Transportable warmed esophageal warming tubes are now available. Their expense and size makes them prohibitive in most situations; however, they may be appropriate for more organized rescue or expedition situations.

An additional controversial point is whether or not rewarming in the wilderness setting should be initiated

at all. There is evidence that a hypothermic state may actually be protective for the internal organs that are suffering cellular damage from hypoperfusion.¹³ Bowel and renal perfusion is severely compromised in this relative "low-flow" state, and some feel that a low core body temperature may improve cellular stability and decrease hypoperfusion damage.¹³ However, these hypotheses are still unproved and need further research.

Should cardiopulmonary resuscitation be considered, one must be certain that there is a total lack of palpable pulses. This may be difficult, as vasoconstriction may lead to "thready pulses." Unnecessary chest compressions can rapidly precipitate a dysrhythmia in the cold, irritable myocardium.⁹ Chest compressions are contraindicated in the setting of a frozen thoracic cage.⁹ Once initiated, compressions should be continued, if possible, until the patient is evacuated and body temperature is greater than 32°C, as defibrillation is rarely effective below this temperature.³ Compressions should also be continued as long as a rhythmic contraction pattern is absent. Such chest compressions reduce the risk of pulmonary edema, which can occur as the result of a distended, fibrillating left ventricle.² Basic life support should be continued until at least partial rewarming has been accomplished—hence, the saying "you're not dead until you're warm and dead."

The issue of performing basic life support in the field is controversial. The risk of inducing cardiac dysrhythmias is significant, as weak pulses may lead to mistaking severe bradycardia for asystole or ventricular arrhythmia.⁸ To help avoid unnecessary chest compressions, the carotid pulse should be palpated for at least 1 full minute before a patient is declared pulseless.⁸ Regardless of body temperature, the American Heart Association recommends initiating cardiopulmonary resuscitation in all pulseless patients.¹⁴ Should intravenous medications or a defibrillator be available, they should be withheld if body temperature is less than 30°C, as medications can accumulate to toxic levels in the hypothermic patient.¹⁴

Additionally, one must be aware of the afterdrop phenomenon, in which the patient's core temperature drops further after warming and removal from the cold, which can precipitate serious dysrhythmias.⁹ The exact mechanism of afterdrop is not known, but it is thought to be related to venous return of cool, peripheral blood to a warmer body core.¹⁵

The management of hypothermia in the wilderness setting is frequently a difficult situation. The stage of hypothermia, appropriate management, and length of therapy are frequently subjective in interpretation. Regardless, an understanding of hypothermia and its causes, presentation, and treatment can be a life-saving

bridge to hospital treatment from the wilderness setting and is essential for anyone traveling in the wilderness.

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References

1. Danzl D. Accidental hypothermia. In: Auerbach PS, ed. *Wilderness Medicine*. St Louis, MO: Mosby Inc; 2001: 135–173.
2. Danzl D, Pozos R. Accidental hypothermia. *N Engl J Med*. 1994;331:1756–1760.
3. Blum F, Veach J. Hypothermia and frostbite. In: Howell JM, Altieri M, Fletcher J, eds. *Emergency Medicine*. Philadelphia, PA: WB Saunders Co; 1998:1574–1579.
4. Hamilton R, Paton B. The diagnosis and treatment of hypothermia by mountain rescue teams: a survey. *Wilderness Environ Med*. 1996;7:28–37.
5. Antretter H, Bonatti J, Danpunt O. Accidental hypothermia. *N Engl J Med*. 1995;332:1033–1034.
6. Giesbrecht G. Prehospital treatment of hypothermia. *Wilderness Environ Med*. 1999;12:24–31.
7. Cohen R, Moelleken B. Disorders due to physical agents. In: Tierney LM, McPhee SJ, Papadakis MA, eds. *Current Medical Diagnosis and Treatment*. New York, NY: Lange Medical Books/McGraw-Hill; 2001:1538–1542.
8. Kulkarni R, Thomas S. Severe accidental hypothermia: the need for prolonged aggressive resuscitative efforts. *Prehosp Emerg Care*. 1999;3:254–258.
9. Bracker M. Environmental and thermal injury. *Clin Sports Med*. 1992;11:419–436.
10. Vanggaard L, Eyolfson D, Xu X, Weseen G, Giesbrecht GG. Immersion of distal arms and legs in warm water (AVA rewarming) effectively rewarms hypothermic humans. *Aviat Space Environ Med*. 1999;70:1081–1088.
11. Greif R, Rajek A, Laciny S, Bastanmehr H, Sessler D. Resistive heating is more effective than metallic-foil insulation in an experimental model of accidental hypothermia: a randomized controlled trial. *Ann Emerg Med*. 2000; 35:337–345.
12. Giesbrecht G, Pachu P, Xu X. Design and evaluation of a portable rigid forced-air warming cover for prehospital transport of cold patients. *Aviat Space Environ Med*. 1998; 69:1200–1203.
13. Tisherman S, Rodrigues A, Safar P. Trauma care in the new millennium. *Surg Clin North Am*. 1999;79:1270–1289.
14. Cummins R, ed. *Advanced Cardiac Life Support*. Dallas, TX: American Heart Association; 1997:11-1–11-3.
15. Nuckton T, Claman D, Goldreich D, Wendt F, Nuckton J. Hypothermia and afterdrop following open water swimming: the Alcatraz/San Francisco Swim Study. *Am J Emerg Med*. 2000;18:703–708.