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CASE REPORT

Successful Field Rewarming of a Patient with Apparent Moderate Hypothermia Using a Hypothermia Wrap and a Chemical Heat Blanket

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Hypothermia is a common problem encountered by search and rescue teams. Although mildly hypothermic patients can be rewarmed in the field and can then self-evacuate, the Wilderness Medical Society hypothermia guidelines suggest that a moderately hypothermic patient in the wilderness requires warming in a medical facility. The Hypothermia Prevention and Management Kit, developed by the US military, consists of a chemical heat blanket (CHB) and a heat-reflective shell. We present a case in which a hypothermia wrap and the CHB from a Hypothermia Prevention and Management Kit were used successfully to rewarm a patient with apparent moderate hypothermia in the field. We are unaware of previous reports of successful field rewarming of a patient with moderate hypothermia. We believe the use of the CHB in conjunction with a hypothermia wrap made field rewarming possible. We recommend that a CHB, along with the components of a hypothermia wrap, be carried by search and rescue teams when a hypothermic patient might be encountered. Although there were no documented core temperatures, we believe this case is consistent with the hypothesis that if a hypothermic patient who is found lying down and shivering is allowed to stand or walk before insulation is applied and before there has been an additional period of 30 min during which the patient continues to shiver, there may be increased afterdrop with deleterious results.

Keywords: resuscitation, search and rescue, accidental hypothermia, afterdrop

Case Report

On a mid-October day in 2017, a healthy 53-y-old woman with no significant medical history was picking mushrooms with friends in the foothills of the Cascade Mountains in Oregon. She became separated from the party at about noon. At 1445, her friends reported her missing. Lane County search and rescue (SAR) was activated. Search teams were in the field throughout the afternoon and night but were unable to locate the missing woman. Temperatures were above freezing with intermittent light rain through the afternoon of the following day.

The next day at 1447, about 24 h after the subject was reported missing, she was found about 1200 m from the trailhead, of which the last 500 m was off trail through densely wooded terrain. She was located by a ground search team using a "sound sweep." She responded to voice by getting to her feet and walking about 3 m (10 ft) toward the searchers. She was animated and excited that she had been found. The search team had her sit on an insulated pad. She was vigorously shivering. She had difficulty holding a cup. Her speech was not slurred. She was alert and oriented to name, location, and date. She was able to describe the events of the previous 24 h, although she remembered clearly what had happened early in the period and was less clear about what had happened in the several hours before she was found by the searchers.

She reported that she had "rolled" her ankle but denied other injuries. She had spent the night huddling under a log where she had covered herself with leaves to stay warm. Her clothes were wet.

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The rescuers gave her high-calorie energy gels, warm drinks, and dry clothes, but not all of her wet clothes could be replaced. She was covered with a sleeping bag. She initially thought she would walk out, but over the next 15 min, she became less alert and was clearly not capable of self-evacuation.

A second ground team, which included two registered nurses and an emergency medical technician, arrived on foot at 1546, about 1 h after the subject was initially found. They described her as being curled up in a depression in the ground, not actively looking around. She had a "flat" affect and was not interacting with the rescuers. Her speech was slurred. She was shivering when the second team arrived but stopped shivering shortly afterward. Her skin was cold to the touch with peripheral cyanosis. Because of the continuing rain, all of her clothing had become wet again.

The patient's wet fleece upper layer, pants, and socks were replaced with dry clothing, including a medium-weight synthetic beanie hat, 2 light synthetic fleece upper layers, long underwear bottoms (Smartwool), and thick socks. She was then placed in a hypothermia wrap, starting with an outer waterproof tarp and a foam pad. The subject was placed on the foam pad and covered with a large chemical heat blanket (CHB) (TechTrade Ready Heat 4 Panel Blanket, Jersey City, NJ) on top of her clothing. This heat blanket contains 4 large chemical heat packs referred to as panels. It is 0.86×1.22 m (34×48 in) and weighs about 0.7 kg (1.5 lb). The CHB failed to heat properly. It was replaced with a second CHB that effectively produced heat. She was then placed in a PrimaLoft synthetic sleeping bag rated to 7°C (45°F) (Marmot Outdoor Equipment, Rohnert Park, CA), and the tarp was wrapped around the entire ensemble. The heat-reflective shell component of the Hypothermia Prevention and Management Kit (HPMK) was not used.

A third ground team then arrived with a Stokes wheeled litter. The subject, inside the hypothermia wrap, was placed in the litter. The evacuation began at 1636, a little less than 2 h after the subject was found. The rescuers and subject reached the trailhead in just under 1 h by 1730, a little less than 3 h after the subject was found. By this time, the subject had been in the hypothermia wrap for about 1.5 h. Toward the end of the evacuation, she became alert and her speech was no longer slurred.

At 1736, the subject was placed in a ground ambulance for transport to the hospital, still in the hypothermia wrap. After about a half hour, she complained of feeling hot. The wrap was undone, and the CHB was removed.

On arrival in the emergency department at 1852, the patient was alert with clear speech. Vital signs were heart rate 100 beats·min^{-1}, respiratory rate 18 breaths·min^{-1}, blood pressure 108/63 mm Hg, "temporal artery" temperature 36.9°C, and oxygen saturation 98% on room air. Her height was 1.63 m (5 ft 4 in). Her weight was 62.6 kg (138 lb). Body mass index was 23.7 kg·m^{-2}. Comprehensive metabolic panel was essentially normal, although serum sodium was slightly low at 133 mmol·L^{-1}, potassium was slightly low at 3.3 mmol·L^{-1}, and bicarbonate was low at 18 mmol·L^{-1}. Complete blood count showed mild leukocytosis (11.3×10^9 cells·L^{-1}). At 2025, one of the rescuers saw the patient in the emergency department and reported that she appeared to have completely recovered. The patient left the emergency department before being discharged or admitted to the hospital. On further follow-up by e-mail in January 2018, she reported no sequelae.

Discussion

WHAT WAS THE LEVEL OF HYPOTHERMIA WHEN THE PATIENT WAS FIRST FOUND?

We believe that when first found, the patient was mildly hypothermic. Her mental status was normal, and she was shivering. According to the Wilderness Medial Society guidelines for field staging of hypothermia, patients who have a normal mental status and are shivering are either cold stressed (not hypothermic—core temperature >35°C) or mildly hypothermic (core temperature 35−32°C).[1] These 2 levels of hypothermia are distinguished by the patient's ability to "care for self." The description of the patient as sitting or lying and confused about the events of the previous few hours suggests that she was not able to care for herself. This indicates that she was hypothermic rather than cold stressed.

WHY DID THE PATIENT'S MENTAL STATUS WORSEN IN THE FIRST HOUR AFTER BEING FOUND?

We believe that the patient's core temperature decreased to the moderately hypothermic range (core temperature 32−28°C) after she was found. She was initially given energy gels, warm drinks, and extra dry clothes and was covered with a sleeping bag. Despite these interventions, her mental status became abnormal. She stopped interacting with the rescuers, developed slurred speech, and stopped shivering. Patients with an abnormal mental status who are conscious are likely to be moderately hypothermic. They may or may not be shivering.[1] The loss of shivering indicates either that the core temperature cooled further or that the patient did not have adequate energy to maintain shivering. It is also possible that she had rallied when found then relapsed from exhaustion or relief at having been rescued. The patient's subsequent

improvement with rewarming measures makes it unlikely that her mental status was due to these possibilities or to other etiologies of altered mental status, such as hypoglycemia or infection. Hypoglycemia is unlikely because her mental status worsened after she received nourishment. Later follow-up revealed no signs of infection.

A decrease in core temperature was likely caused by the patient's clothes, including the extra dry layers, becoming wet. Wet clothing increases the rate of heat loss by a factor of 5 compared to dry clothing.[2] In addition, the brief physical activity of walking likely worsened the drop in core temperature. Standing or walking can worsen afterdrop, which is the continuing drop in core temperature after removal from a cold environment.[3] The mechanism is thought to be vasodilation in the legs, causing increased blood flow through cold tissue with return of cooled blood to the central circulation. Once the peripheral circulation is vasodilated, increased blood flow through cold tissue will persist, even if the patient is again still and horizontal.[1] A patient who might be hypothermic and who is found lying down should generally not be allowed to stand or walk until insulation has been applied and shivering supported for 30 minutes.[1] This may seem overly cautious, but there is a risk of clinical deterioration due to increased afterdrop from peripheral vasodilation, especially if the patient has a core temperature near the lower end of mild hypothermia.[1] Afterdrops of as much as 5 to 6°C have been reported in hypothermic patients.[1]

CAN A MODERATELY HYPOTHERMIC PATIENT BE REWARMED SUCCESSFULLY IN THE FIELD?

A mildly hypothermic patient who is not injured can be rewarmed in the field if given shelter, insulation, and caloric intake to support shivering. Under most conditions shivering is the most effective endogenous source of heat to raise core temperature.[4] We are not aware of previous cases in which a moderately hypothermic patient was successfully rewarmed in the field. In addition to shelter, insulation, and calories, a moderately hypothermic patient requires an external source of heat to rewarm. Most heat sources available in the field provide insufficient heat to rewarm a moderately hypothermic patient. In many cases, the primary benefit of using field heat sources is to prevent further cooling. The current report likely represents a case of successful rewarming in the field from moderate hypothermia to a nonhypothermic state (cold-stressed or normothermic). Although not verified by core temperature measurements, the clinical estimation of levels of hypothermia supports this conclusion.

HOW WAS THIS APPARENTLY MODERATELY HYPOTHERMIC PATIENT REWARMED IN THE FIELD?

The US military developed the HPMK, which is now commercially available in the civilian market, to prevent hypothermia associated with trauma. The HPMK has 2 components: a CHB (Ready-Heat) and a heat-reflective shell. The US military now mandates the use of an HPMK to prevent trauma-associated hypothermia for all litter-evacuated casualties.[5] This recommendation was based on a study using a human torso model, which found less heat loss using an HPMK when compared to other methods of heat conservation, including the Ready-Heat CHB alone and a forced air method (3M Bair Hugger, St. Paul, MN).[6] A civilian study compared a CHB with other active methods of heat conservation, such as warmed intravenous fluids, during transport of trauma patients. Patients gained heat with CHB and lost heat with other methods, although the differences were small.[7]

HOW CAN THE HPMK BEST BE USED IN CIVILIAN SAR?

A practical method in the civilian SAR setting is to use the CHB without the heat-reflective shell and to construct a hypothermia wrap. The HPMK weighs 1.6 kg (3.5 lb), while the 4-panel CHB, without the heat-reflective shell, weighs about 0.7 kg (1.5 lb). Lane County SAR teams routinely carry materials that can be used to construct a hypothermia wrap. An improvised hypothermia wrap that includes a sleeping bag that provides insulation is likely to be more effective than a system using only the heat-reflective shell. In the current case, a CHB with a hypothermia wrap effectively rewarmed the patient in the field.

The CHB should not be placed in direct contact with the skin. A barrier, such as a towel or a base layer of clothing, should be placed to prevent burns. CHBs have a limited shelf life, typically several years. Sometimes a CHB will fail to produce heat, even before the end of the 5-y shelf life claimed by the manufacturer. The CHB is activated by exposure to oxygen. Once activated, it will not produce heat again. A hole in the packaging, which can occur if the plastic outer layer is creased, will cause the affected panel to heat. If this is not noticed, the heat pack can be carried into the field and 1 or more panels will fail to heat. In addition, the CHB will not work when wet. The first CHB that was placed in this case had a premature failure. Of the 4 panels, 3 produced no heat and the fourth produced a very limited amount.

LIMITATIONS

There were no temperature measurements before the time the patient arrived at the hospital. SAR teams in the United States do not routinely carry thermometers. The diagnosis and treatment of hypothermia in the field is based primarily on clinical presentation. At the hospital, the measured temperature was not a core temperature and was determined by a very unreliable method (temporal artery thermometer). The patient was shivering much of the time during the rescue. It is possible, although unlikely, that she would have rewarmed without the CHB.

Conclusion

This case report describes a patient with apparent moderate hypothermia who was effectively rewarmed in a field setting. We are not aware of previous cases in which a moderately hypothermic patient was rewarmed successfully using only field-rewarming methods. We believe the use of the CHB in conjunction with a hypothermia wrap made field rewarming possible. We recommend that a CHB, along with the components of a hypothermia wrap, be carried by SAR teams when a hypothermic subject might be encountered. Although there were no documented core temperatures, we believe this case is consistent with the hypothesis of possible increased afterdrop with deleterious results if a hypothermic patient who is found lying down and shivering is allowed to stand or walk before insulation is applied and before there has been an additional period of 30 min during which the patient continues to shiver.

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