Cold Weather-related Injuries

Urgent message: Inadequate protection from the cold can put a patient's life and limb at risk. The urgent care clinician must be able to identify symptoms of specific conditions, using the history and awareness of weather conditions to distinguish among the most common.

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Introduction

Winter months provide ample opportunities for recreation such as skiing, sledding, or snowmobiling—and for an array of injuries related to varying degrees of exposure to lower temperatures.

Generally, the extent of such injuries is related to duration of exposure and temperature, with factors such as wet clothing or high wind increasing the risk for more severe injury. The clinician should bear in mind, however, that patients are at risk even when temperatures are above freezing (32° F or 0° C), especially if they lack the proper gear and protection.

This article will review the level and type of injury most likely to present in the urgent care setting. We will concentrate on hypothermia—a dangerous drop in core body temperature—and injuries to body tissue, which can be divided in two categories: those that occur with the freezing of the body tissue (frostbite), and other milder forms that occur without freezing of the body tissue (e.g., frostnip, pernio, and immersion foot or trench foot).

Hypothermia

Hypothermia is defined as a core body temperature below 35° C (95° F). It can be accidental or intentional and can be further classified as:

1. *mild:* 32° to 35° C
2. *moderate:* 28° to 32° C
3. *severe:* <28° C.

Though seen most often in areas where severe winters are more common, hypothermia is also seen in the southern United State.[1] Moderate to severe accidental hypothermia can be lethal in 40% of cases.[2]

Pathophysiology

Body *heat* is generated by cellular metabolism and is lost by skin and lungs; body *temperature* reflects the balance between heat production and heat loss. In response to cold stress, the hypothalamus stimulates

Differential Diagnosis for Hypothermia

- Ischemic or hemorrhagic stroke
- Alcohol toxicity
- Barbiturate overdose
- Hypoglycemia
- Ventricular tachycardia
- Ventricular fibrillation

heat production by shivering and by increasing thyroid and adrenal activity.

Hypothermia causes cellular membrane dysfunction and electrolyte imbalance (namely, hyperkalemia). Crystallization of intracellular and extracellular water leads to cell death.

Clinical presentation

The key to proper diagnosis and treatment of hypothermia is the determination of true core temperature. Practically speaking, this may not be feasible outside of a hospital ED; once initial evaluation utilizing a low-reading oral or rectal thermometer and proper stabilization and initial re-warming are complete, prompt transportation to the nearest hospital is advisable.

In addition to distinctions in core body temperature as mentioned previously, the clinician can gauge the severity of a patient's hypothermia according to certain characteristics of the clinical presentation.

A patient with *mild hypothermia* presents with tachypnea, tachycardia, hyperventilation, ataxia, and/or shivering.

Moderate hypothermia is characterized by:

- proportionate decrease in heart rate, cardiac output
- hypoventilation
- central nervous system depression
- hyporeflexia
- decreased renal blood flow
- decreased shivering
- and, finally, cardiac arrhythmias.

Severe hypothermia can lead to pulmonary edema, oliguria, hypotension, coma, ventricular fibrillation, and asystole.

Children are more prone to hypothermia due to small body mass and limited glycogen storage. In addition, young infants are unable to increase heat by shivering; as such, the clinician should not assume the parents' description of symptoms they've witnessed in children of that age group represents the whole story.

The elderly are also at increased risk for hypothermia due to decreased reserve, chronic illnesses, medications that can affect compensatory response, and possible dementia or isolation.

The clinician should bear in mind that certain medications (e.g., antidepressants, opioids, antipsychotics, ethanol, and general anesthetic agents) can cause hypothermia, either directly or indirectly.

In addition, blood pressure medications (e.g., beta-blockers, alpha-adrenergic agonists) can impair thermoregulation.

Assessment and management

The hypothermic patient should be handled gently; otherwise, arrhythmias may occur.

An airway should be established, and breathing and circulation should be maintained, in patients in respiratory distress or patients with altered mental status who cannot protect their airway.

The patient should be covered with warm, dry blankets.

Any complications should be addressed, and re-warming should be initiated.

Re-warming can be either passive external (for mild hypothermia), or active external, for moderate hypothermia (e.g., warm dry blankets, heating pads, radiant heat, warm baths). The trunk should be re-warmed before the extremities to avoid hypotension.

For severe hypothermia, active internal re-warming should be initiated alone or in combination. This includes warm (40° to 42° C) IV crystalloid, warm humidified O2, and irrigation of body cavities with warm crystalloid.

Initial labs should include:

- finger stick blood sugar
- ECG
- BMP
- CBC
- ABGs
- drug screen.

Besides arrhythmias, hypothermia may cause characteristic changes in respiratory rate, pulse rate, QRS prolongation, and elevation of the J point (which produces the characteristic J or Osborn wave; **Figure 1**).[3] The height of the Osborn wave is proportionate to degree of hypothermia.[4]

Remember, a low normal hematocrit is *ab*normal in severe hypothermia because hematocrit increases by 2% for every 1° C drop in temperature.

Also, insulin is ineffective below 30° C.

Hypothermia has neuroprotective effects, so complete recovery of patients with hypothermia and car-

Table 1. Categorizing and Managing Hypothermia

Severity	*Characteristics*	*Action*
Mild	1. Core body temp 32° to 35° C 2. Tachypnea 3. Tachycardia 4. Hyperventilation 5. Ataxia 6. Shivering	Passive, external re-warming
Moderate	1. Core body temp 28° to 32° C 2. Proportionate decrease in heart rate and cardiac output 3. Hypoventilation 4. Central nervous system depression 5. Hyporeflexia 6. Decreased renal blood flow 7. Decreased shivering 8. Cardiac arrhythmias	Active external re-warming: • warm dry blankets • heating pads • radiant heat • warm baths
Severe	1. Core body temp <28° C 2. Pulmonary edema 3. Oliguria 4. Hypotension 5. Coma 6. Ventricular fibrillation 7. Asystole	Active internal re-warming (alone or in combination): • warm (40° to 42° C) IV crystalloid • warm humidified O2 • irrigation of body cavities with warm crystalloid
For all hypothermic patients: • Handle gently to prevent arrhythmias from occurring. • Establish an airway; maintain breathing and circulation. • Be aggressive with fluids. • Cover with warm, dry blankets. • Address complications and re-warm; the trunk should be re-warmed before the extremities to avoid hypotension.		

diac arrest has been well documented.[5] Therefore, under usual circumstances, resuscitative efforts should be continued indefinitely until core temperature reaches 32° to 35° C (93° to 95° F).

Frostbite

When tissue is exposed to subfreezing temperature, ice crystals form both intracellularly and extracellularly, ultimately leading to cell death. Inflammation and ischemia also develop, which leads to further tissue necrosis.

Frostbites can be divided according to their severity in similar fashion to burns:

1. First degree: Central pallor, numbness of skin, surrounded by edema.
2. Second degree: Formation of vesicles with clear or whitish fluid, surrounded by edema and erythema.
3. Third degree: Deeper injury, hemorrhagic vesicles progress to black eschars over few weeks.
4. Fourth degree: Deeper injury extending to muscle and bone.

Risk factors

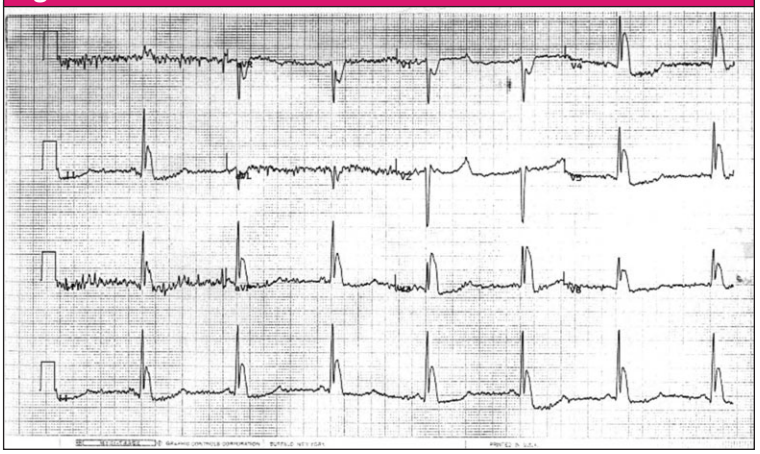
Any factor that increases heat loss or decreases heat production can lead to frostbite. Prime examples would be exposure to extreme cold, windy conditions, or prolonged contact with cold metal or water.[6]

Exhaustion, malnutrition, diabetes, mental illness, alcohol consumption, and tobacco abuse (by virtue of associated peripheral vascular disease) are all factors that increase risk of frostbite.[7]

Young children, the elderly, women, and African-Americans are at higher risk for frostbite.[8]

As noted earlier, the clinician should also be cog-

Figure 1.



nizant of the fact that exposure to cold weather is not the only causative factor for frostbite; e.g., accidental frostbite has been reported after prolonged application of ice packs without a buffer between skin and the ice pack in musculoskeletal injuries.[9]

Clinical presentation

Hands, feet, and face are the most frequently affected sites of frostbite.[10] Depending on the depth of the injury at the time of evaluation, the patient may present with symptoms ranging from just pallor and numbness to blood-filled blisters, eschars, and tissue necrosis.

Treatment

The role of the urgent care provider as described here is assumed to be at the pre-hospital level, either at the site of the injury or at an outpatient establishment.

First and foremost, the patient should be removed from the cold place, given dry, warm clothes, and covered with warm, dry blankets.

If there is a chance of refreezing, do not re-warm frostbite, as this worsens tissue injury.

Handle the frostbitten area with care; pad or splint extremities.

Do not unroof small blisters; maintain aseptic technique; avoid occlusive dressings and only use non-adherent gauze.

Large bullae that interfere with movements can be drained and bandaged.

Advise the patient to avoid using frostbitten extremities, and to never rub or massage frostbitten areas.

Passive external re-warming can be initiated by placing the extremity in warm water or using body heat, by placing hands in the axillae.

Tetanus prophylaxis is indicated if the patient is not up to date.[11]

Topical antibiotics are not indicated, but parenteral antibiotics should be given in case of infection. Prophylactic antibiotics

are controversial, but are indicated at the first symptoms of infection and should cover *Pseudomonas*, *Strep* and *Staph*.

The presence of hypothermia should be considered.

Complications

Infection and gangrene formation with amputation are the short-term complications of frostbite. Long-term complications include paresthesias and decreased sensation of the frostbitten areas.

Early surgical consultation is recommended, as frostbite may require long-term wound care.

Prevention

The most commonly suggested ways to avoid frostbite include:

1. limiting the time of exposure to cold weather
2. dressing in layers
3. covering face, eyes, ears and hands
4. wearing warm, waterproof boots
5. avoiding tobacco and alcohol
6. maintaining adequate fluid intake
7. refraining from applying emollients to exposed skin.[12]

In addition, when a trip to the wilderness is planned, adequate preparation should be made. Proper supplies should be gathered, and immediate family should be notified of the planned duration and anticipated route for the trip.

Other Cold-weather Injuries

In addition to the urgent or emergent conditions described previously, there are several relatively common, less-severe injuries that nonetheless require assessment (even if only to rule out the more serious frostbite). These include:

Frostnip

The term "frostnip" refers to a milder form of cold-related injury to the tissue. There is no deep tissue freezing involved, nor permanent damage present; the main characteristic is reversible blanching of the skin, typically on the earlobes, cheeks, nose, fingers, and toes.

Frostnip can develop several hours after exposure to extreme cold. The primary complaint is likely to be local paresthesias that resolve quickly with re-warming.

Pernio or chilblain

This is a common type of cold weather-related injury, again without tissue freezing. Toes, fingers, ears, and

nose are the most often affected parts.

The affected areas are itchy, painful, edematous, and red or purple. In some cases, blisters or small ulcers may also form.

Pernio usually last for several days and heals completely after several weeks.

Trench foot

First described during World War I, trench foot is caused by prolonged immersion in cold water or mud (hence its alternate name, "immersion foot"), causing alternating arterial vasospasm and vasodilatation. Tight boots exacerbate the condition.

Initially, the feet become cold and anesthetic. After 24 to 48 hours, hyperemia follows and feet become red-hot with a burning sensation, and are edematous and painful. Often, hemorrhagic bullae and ulcers are formed.

Following this, the post-hyperemic phase occurs after two to six weeks. The limbs become cyanotic and sensitive to cold. Cellulitis, lymphangitis, and gangrene may develop.

Better knowledge about the condition, improved foot hygiene, better boot design, and keeping feet dry has almost eliminated the condition among our troops. The homeless, on the other hand, are still susceptible.

Referral Criteria

The extent of the injuries, the overall patient condition, and the capabilities of the urgent care center and its providers will determine the necessity for and timing of referral to the ED. ■

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