



Hypothermia

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Hypothermia Objectives

Upon completion of this self-study module, you should be able to:

- To identify the aspects of the history and physical exam that raise suspicion for hypothermia and cold injury
- To describe the treatment of the patient with hypothermia or cold injury

People with environmental exposure to cold temperatures may present with a variety of signs and symptoms of hypothermia and other cold injury. Hypothermia is defined as a core body temperature $< 35^{\circ}\text{C}$. Cold injuries include frostbite and trench foot. As the ED sometimes functions as the safety net for the community, people without the resources or ability to protect themselves from exposure to cold temperatures will often present (or be brought) to the ED for treatment. Patients suffering from hypothermia and cold injury range from outdoor adventurers to intoxicated individuals, the undomiciled, the mentally or physically ill, the elderly, children, and the poor.

This module will discuss only hypothermia caused by the unintentional exposure to cold temperatures (primary hypothermia), not that caused by other disease processes (secondary hypothermia) or therapeutic hypothermia.

Classic Presentation

History

Hypothermia: Often environmental exposure is obvious, but atypical cases, such as wet indoor patients, are more subtle. Patients with altered mentation may not be able to communicate a history of cold exposure. Bystanders may report a change in personality, paradoxical undressing, rocking, dysarthria, ataxia, or frank confusion.

Frostbite: Cold injury produces damage to exposed extremities, often made worse by poor circulation to the extremity because of constrictive clothing or hypothermia which reduces blood flow to the periphery. Patients first experience pain in the affected areas, then numbness, and may have mistaken the disappearance of pain for improvement.

Trench foot: Lower extremities with prolonged exposure to wet and cold conditions develop tissue damage, often presenting as paresthesias, pain, or numbness.

Physical Exam

Hypothermia: Exam findings do not strictly correlate to temperature, but signs often cluster as hypothermia progresses from mild (32-35°C) to moderate (28-32°C) to severe (< 28°C).

Degree of Hypothermia			
Degree of Hypothermia	Mild (32-35°C)	Moderate (28-32°C)	Severe (<28°C)
Vital Signs	Tachypnea Tachycardia without hemodynamic instability	Bradycardia Bradypnea	Bradycardia Hypotension Pulselessness Bradypnea/apnea
Muscular	Shivering	Cessation of shivering	Rigidity

Respiratory	Hyperventilation	Hypoventilation	Pulmonary edema
Cardiac		Arrhythmias, decreased cardiac output	Ventricular fibrillation, severely decreased cardiac output
Neurologic	Dysarthria, ataxia, amnesia, altered judgment, apathy, fine and gross motor impairment: “Mumbles, grumbles, stumbles, fumbles, tumbles”	Paradoxical undressing, Decreased responsiveness, Hyporeflexia, Dilated and sluggish pupils, Dysarthria ataxia	Coma/unresponsiveness Areflexia Fixed pupils
Urine output	Polyuria (cold diuresis)		Oliguria

Frostbite: Tissues appear pale and firm, with poor capillary refill and sensation. Severe frostbite appears purple due to blood sludging.

Trench foot: Skin may appear red and swollen at first, progressing to blisters and bullae and finally hemorrhage in the skin and deeper tissues.

Initial Actions and Primary Survey

- Minimize jerky movement of the severely hypothermic patient as movement or exercise may precipitate ventricular fibrillation
- Stabilize airway: endotracheal intubation if needed for airway protection in the unresponsive patient
- Stabilize breathing: administer warm humidified O₂, endotracheal intubation for respiratory failure
- Stabilize circulation: monitor, ECG, intravenous access, warm IV fluids
- Remove cold wet clothing, dry patient, cover with warm dry coverings or warming blanket (bear hugger). Initiate active rewarming measures.
- Look for signs of accompanying cold injury, trauma, or underlying illness (secondary hypothermia)

Diagnostic Testing

The best method for measuring and monitoring core body temperature is a low-reading temperature probe in the esophagus or rectum. Rectal temperature probes (not thermometers) should be inserted five inches into the rectum; lodging the probe in feces will give a falsely low reading. Rectal temperature also lags behind true core temperature during rewarming.

Laboratory testing may reveal hemoconcentration, hypo/hyperkalemia, hypo/hyperglycemia, or abnormal coagulation. Tests that warm blood to 37°C may give false positive or false negative results, e.g. arterial blood gas, coagulation studies.

A plain chest film may reveal pulmonary edema.

ECG may show

- J (Osborne) waves in moderate-severe cases
- prolonged intervals (PR, QRS, QT)
- arrhythmias (atrial or ventricular)

Here is an ECG with Osborne waves in the precordial leads: note the positive deflections at the junction between the QRS and the ST segment.

Frostbite and trench foot are diagnosed by history and physical exam.

Treatment

All wet clothing should be removed and the patient's skin should be dried. The invasiveness of rewarming methods correlates to the severity of the hypothermia, but rapid rewarming is the goal for all patients.

Rewarming Techniques		
Severity of hypothermia	Methods of rewarming	Examples

Mild	Passive external rewarming	Blankets (remove cold wet clothes first) Oral hydration with sugared drinks
Moderate	Passive external rewarming + Active external rewarming	Electric or forced warm air blankets + often add noninvasive internal: warm intravenous fluids, warm humidified oxygen
Severe	Active internal rewarming	warm intravenous fluids, warm humidified oxygen, warm bladder and gastric, or sometimes thoracic or peritoneal lavage (rarely done anymore) central arteriovenous or venovenous rewarming, cardiopulmonary bypass, dialysis

Most arrhythmias: Provide supportive therapy, not anti-arrhythmics. Cardiac pacing and atropine are often ineffective for bradycardia.

Ventricular fibrillation: Perform CPR and defibrillation per ACLS protocols, except that antiarrhythmics and repeat defibrillation should be deferred until the patient is warmed to above 30°C. Administer bretylium if available. Note that lidocaine is ineffective for hypothermia-induced dysrhythmias.

Resuscitate patients in cardiac arrest while rewarming to a core temperature of 32°C before terminating resuscitation efforts, unless the patient's chest is frozen or there is ice filling the airway.

Complications of rewarming

The patient's temperature may decrease during rewarming (called afterdrop) as peripheral vessels dilate and increase return of cool blood from extremities to the core. Rewarming shock (hypotension) may occur as rewarming causes vasodilatation. Rewarming can also drop pH, electrolyte imbalances, and coagulopathy.

Frostbite: Immediately immerse the affected area in warm water (37-39°C). Remove constricting clothing and jewelry. Consult surgical services for exploration and debridement, though amputation is usually delayed until the gangrenous tissue has clearly demarcated, a process often taking months. Treatment includes ibuprofen as an anti-inflammatory agent, tetanus toxoid, elevation of the affected area, and narcotic analgesia. A potential new therapy is the administration of tissue plasminogen activator to improve perfusion and decrease the incidence of amputation. Observe for the development of compartment syndrome in severe cases. Hypothermia should be treated first before frostbite.

Trench foot: Keep feet warm, clean, and dry. Elevate the extremity.

Disposition

Patients who have suffered from hypothermia and cold injuries must have a warm place to go, and not be discharged back to the cold environment.

Moderate to severe hypothermia often requires care in a monitored or intensive care setting for:

- close monitoring of core temperature
- cardiopulmonary support
- correction of electrolyte and pH imbalances
- care for comatose or altered patients
- observation for the development of DIC, rhabdomyolysis, pancreatitis, seizures, and other complications

Pearls and Pitfalls

- Always check a patient's core temperature in any patient with signs or symptoms consistent with hypothermia.
- Rapid active rewarming minimizes morbidity and mortality.
- Provide aggressive rewarming and resuscitation efforts to patients in cardiac arrest due to hypothermia; they often regain full neurologic recovery.
- Always look for and treat associated injuries and underlying illness.

References

1. G Giesbrecht, et al, Hypothermia, Frostbite, and other Cold Injuries: Prevention, Survival, Rescue, and Treatment, Second Edition, 2006, The Mountaineers.
2. "Hypothermia," 112; IV-136-IV-138, Circulation, Nov 2005.
3. "State of Alaska Cold Injuries Guidelines: Alaska Multi-level 2003 Version," Department of Health and Social Services, Division of Public Health, Section of Community Health and EMS, <http://www.chems.alaska.gov> (<http://www.chems.alaska.gov/>).
4. M Laniewicz, et al, "Rapid Endovascular Warming for Profound Hypothermia," Annals of Emergency Medicine, Vol 51 No 2, Feb 2008.
5. K Bruen, et al, "Reduction of the Incidence of Amputation in Frostbite Injury with Thrombolytic Therapy," Archives of Surgery, Vol 142, Jun 2007.

