BMJ Best Practice

Accidental hypothermia

Straight to the point of care

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Summary

Accidental hypothermia is defined by the unintentional lowering of core body temperature to <95°F (<35°C).

Classified as mild, moderate, or severe according to core temperature. Some experts have suggested a further (more severe) category of profound hypothermia, at a core temperature <75.2°F (<24°C) according to some and <68°F (<20°C) according to others.

Core temperature measured in the lower third of the esophagus correlates well with pulmonary artery temperature and is preferred in patients with a secure airway.

Initial management should focus on stopping further cooling, resuscitation, and supportive care. This includes removing the patient from the cold environment, careful removal of wet or cold clothing, insulation, warming the body, securing the airway, monitoring breathing and circulation, and maintaining circulation using warm intravenous fluids.

Choice of rewarming strategy (passive external, active external, active interna/corel) is based on the patient's core temperature and clinical features; a combination of techniques may be used.

Patients who have sustained a hypothermic cardiac arrest should ideally be rewarmed in a specialist center using extracorporeal life support.

Definition

Accidental hypothermia is characterized by the unintentional lowering of core body temperature to <95°F (<35°C).[1]

A threshold of 96.8°F (36°C) has been adopted in patients with trauma given that hypothermia is associated with higher mortality in this patient group.[2][3]

This topic covers accidental hypothermia in adults.

Epidemiology

Temperature-attributable deaths are much more likely as a result of cold rather than heat exposure.[4] Although traditionally common in regions experiencing severe winters, cases have also been reported in milder climates.[4] [5] [6]

Between 1995 and 2004, an estimated 15,574 of all emergency department visits in the US were hypothermia- or cold-related in nature.[7] On average, around 700 people die annually from accidental hypothermia in the US.[8] From 2003 to 2013, a total of 13,419 deaths were recorded as hypothermia-related and unadjusted annual rates ranged from 0.3 to 0.5 per 100,000 population.[9]

From 2018 to 2020, deaths attributed to hypothermia or excessive cold were typically higher in more rural areas in the US. Higher death rates were noted in males regardless of urbanization level.[10] Of deaths reported between 2003 and 2013 in the US, rates were highest among people ages 65 years or older (mean death rate for males and females were 1.8 and 1.1 per 100,000 of the population, respectively) and males accounted for 67% of deaths.[9] Approximately 10% of deaths were also reported to have alcohol or drug poisoning as a contributing cause.[9]

In the UK, the estimated annual number of hypothermia-related deaths is 300 per year, whereas in Canada, the annual incidence of deaths is 8000.[11]

In Japan - a country with a rapidly aging population - one retrospective review of an accidental hypothermia registry found that hypothermia was more likely to occur indoors and in people ages 65 years or older.[12] [13]

Homeless people are at disproportionately higher risk of hypothermia as a result of cold exposure and substance misuse.[14] [15] [16]

One retrospective cohort study of the International Hypothermia Registry, which included 201 nonconsecutive cases, found that accidental hypothermia was largely identified in young men as a result of mountain accidents.[17]

Etiology

The underlying mechanism of hypothermia is an imbalance between heat production and heat loss.[18] Primary hypothermia is caused by cold exposure, while secondary hypothermia is caused by reduced physiologic reserve as a result of illness or other external causes.[19] [20] Primary hypothermia is more common in homeless or intoxicated people, athletes, and people who get lost outdoors as a result of impaired cognition (e.g., stroke or Parkinson disease).[19] [20] Conditions associated with secondary hypothermia can be grouped into those causing impaired thermoregulation, decreased heat production, or increased heat loss.[18][19]

Impaired thermoregulation[19]

- Central nervous system failure
    - Anorexia nervosa
    - Traumatic brain injury
    - Hypothalamic dysfunction
    - Metabolic failure

    - Neoplasm
    - Parkinson disease
    - Pharmacologic effects (general anesthetics)
    - Stroke (hemorrhagic or ischemic)
    - Toxins
- Peripheral failure
    - Acute spinal cord transection
    - Peripheral neuropathy

Decreased heat production[19]

- Endocrine failure
    - Alcoholic or diabetic ketoacidosis
    - Hypoadrenalism
    - Hypopituitarism
    - Lactic acidosis
- Insufficient fuel
    - Extreme physical exertion
    - Hypoglycemia
    - Malnutrition
- Neuromuscular compromise
    - Extremes of age
    - Impaired shivering
    - Inactivity

Increased heat loss[19]

- Dermatologic illness
    - Burns
    - Induced vasodilation
    - Drugs and toxins
- Iatrogenic
    - Emergency childbirth
    - Cold infusions
    - Heat-stroke treatment
- Other associated clinical states
    - Carcinomatosis
    - Cardiopulmonary disease
    - Major infections
    - Multiple trauma
    - Shock

Pathophysiology

Hypothermia occurs because of a lowering of the core temperature. Core temperature is a reflection of the balance between heat production and heat loss.[18] Heat is produced during the breakdown of high-energy phosphate bonds, and heat is lost through the lungs and skin. Radiation heat loss from the body occurs primarily from infrared emission.[21]

In the initial stages of hypothermia, thermoreceptors situated in the skin and subcutaneous tissues sense the low ambient temperature and cause a regional vasoconstriction. This causes the hypothalamus to stimulate the release of thyroid-stimulating hormone and adrenocorticotropic hormone, leading to stimulation of the thyroid and adrenal glands. The hypothalamus also stimulates heat production by promoting shivering, typically occurring between 93.2°F and 96.8°F (34°C and 36°C). Owing to the effects of prolonged vasoconstriction, acidosis may occur, which may blunt the response to catecholamine production.

Continuous ECG monitoring demonstrates progressive bradycardia. J waves (Osborn waves) may occur at temperatures below 86°F (30°C) and are usually best seen in the lateral precordial leads.[22] Broad QRS complexes, ST elevation or depression, and T wave inversion may also occur as myocardial conduction slows.[11] PR, QT, and QTc intervals are prolonged. Some patients develop atrial fibrillation or junctional rhythms.[23]

Early on, the respiratory center is stimulated, but as time passes, the respiratory rate and tidal volume become depressed. Anatomic and physiologic dead space increases, as does bronchiolar and alveolar edema.[24] The body begins to limit energy-producing functions.

The renal blood flow and glomerular filtration rate decrease as well. Tubular reabsorption decreases as this is an energy-requiring process. As a result, cold-induced natriuresis and diuresis occur.[11]

Hypothermia is also associated with insulin resistance and hyperglycemia. Platelet dysfunction commonly occurs and may lead to a bleeding disorder. Vasoconstriction may lead to tissue hypoxia.[25]

Case history

Case history #1

A 74-year-old man who lives alone was found unconscious in his bed. Although it was the middle of winter, he was only wearing a T-shirt and shorts. The room was unheated and next to his bed were empty beer cans and an empty bottle of lorazepam. Physical examination revealed a core temperature of 87.8°F (31°C), obtained with a low-reading tympanic thermometer.

Case history #2

A 43-year-old climber was visiting Washington state on a climbing expedition. After becoming incapacitated on an exposed mountain face he was rescued after 4 days and airlifted to the nearest emergency department. On arrival, his core temperature was 73.4°F (23°C) and he was unconscious with weak signs of life.

Approach

Suspect hypothermia (core body temperature <95°F [<35°C]) based on the condition the patient is found in and/or the presence of risk factors.

Prehospital assessment

In a prehospital setting, use the four-stage original Swiss system to help estimate the patient's core temperature at the scene (if this isn't already available).[19]

Vital signs can be present even when core temperature is below 75°F (24°C).[44] [45] Stages of hypothermia are based on clinical signs (shivering, vital signs, level of consciousness) that roughly correlate to the patient's core temperature and are used to guide management.[46] However, it is important to note that factors such as trauma, central nervous system failure, and substance misuse and overdose may impair shivering and consciousness, independent of a patient's core temperature.[19]

Consider the revised Swiss system, which may simplify clinical staging in the field, if appropriate; the revised system incorporates risk of cardiac arrest as part of staging.[47]

See Cardiac arrest .

If the patient has been immersed in water, see Drowning .

History

Ask the prehospital team about the condition in which the patient was found. This may provide important clues to the diagnosis; for example, patients who are inappropriately dressed for a cold climate and have spent a long time outdoors or in a cold environment may be hypothermic.

Consider risk factors for hypothermia. These include:[2] [16][19] [27][31][34] [35] [36] [37] [38]

- General anesthetic use
- Trauma
- Drowning
- Extremes of age
- Immobility (e.g., due to illness or injury)
- Substance misuse
- Impaired cognition
- Hypothyroidism
- Stroke
- Parkinson disease
- Homelessness
- Antipsychotic use
- Gram-negative septicemia.

Physical exam including core temperature measurement

Examine and move the patient very carefully while you are assessing them. Keep the patient in a supine position if they have features of moderate or severe hypothermia (e.g., they have stopped shivering or have a reduced level of consciousness) as movement can precipitate ventricular fibrillation, especially if the patient's temperature is <82°F (<28°C).[20] [48]

Check for vital signs (including a carotid pulse) for up to 1 minute.[20] [48] Measure and monitor vital signs as part of ongoing assessment, including: blood pressure; pulse rate; respiratory rate; and oxygen saturations. Be aware that vital signs may be very difficult to detect in a patient with hypothermia, especially in the prehospital setting; a very hypothermic patient may appear dead but still survive with resuscitation.[20][45][48][49] Other causes of cardiac arrest may need to be excluded; cardiac arrest is unlikely to be solely due to hypothermia unless the core temperature is less than 82°F (28°C).[19]

Patients often show signs of confusion or impaired judgment. Additionally, they may be shivering, have increased urinary frequency, and show signs of frostbite on their skin. See Frostbite .

Note that shivering will be absent once the patient's core temperature drops below a certain level; the threshold varies between patients but is typically 82°F to 90°F (28°C to 32°C).[48] However, it is important to be aware that factors such as trauma, central nervous system failure, and substance misuse and overdose may impair shivering and consciousness, independent of a patient's core temperature.

Look for any signs of the underlying cause of hypothermia. For example:[45]

- Self-harm. Consider this particularly if the patient has a reduced level of consciousness or been immersed in water. Check for any signs of drug overdose or alcohol intoxication. See Overview of substance use disorders and overdose .
- Acute illness (e.g., stroke) or injury that has resulted in the patient lying on the ground outdoors for a long period of time.

Clinical signs correlate approximately to the patient's core temperature.[48] However, an individual patient's response to hypothermia may vary considerably; clinical signs can only provide an estimate of core temperature. Urgent critical care support is required for any patient with severe hypothermia.

Core temperature

Do not use a standard clinical thermometer to measure core temperature. This may be inadequate as it will not measure temperatures below 94°F (34.4°C). Conventional mercury thermometers are also not recommended, owing to the risk of breakage and poisoning.

Where feasible (usually in hospital) the 2019 Wilderness Medical Society guidelines and the 2021 European Resuscitation Council guidelines recommend:

- Preferably: an esophageal probe.[20] [48] An esophageal probe correlates well with the temperature of the pulmonary artery and is the preferred method when available.[19] [48] This is usually only possible in critically ill patients as readings must be obtained from the lower third of the esophagus when the airway is secured (i.e., tracheal tube or a supraglottic device with an esophageal channel in place).
- Alternatively: a low-reading tympanic membrane thermistor-based thermometer (where the thermistor touches the tympanic membrane) if the patient is spontaneously breathing.[20] [48]

Bladder catheter temperature sensors can be used in patients who require a urinary catheter, but bladder and rectal temperature lag behind core temperature and are only recommended for stable patients in a hospital setting.[19] [20] Never measure rectal temperature if the patient is in a cold environment. This method requires the patient to be further exposed, which will increase heat loss and potentially worsen hypothermia.

Investigations

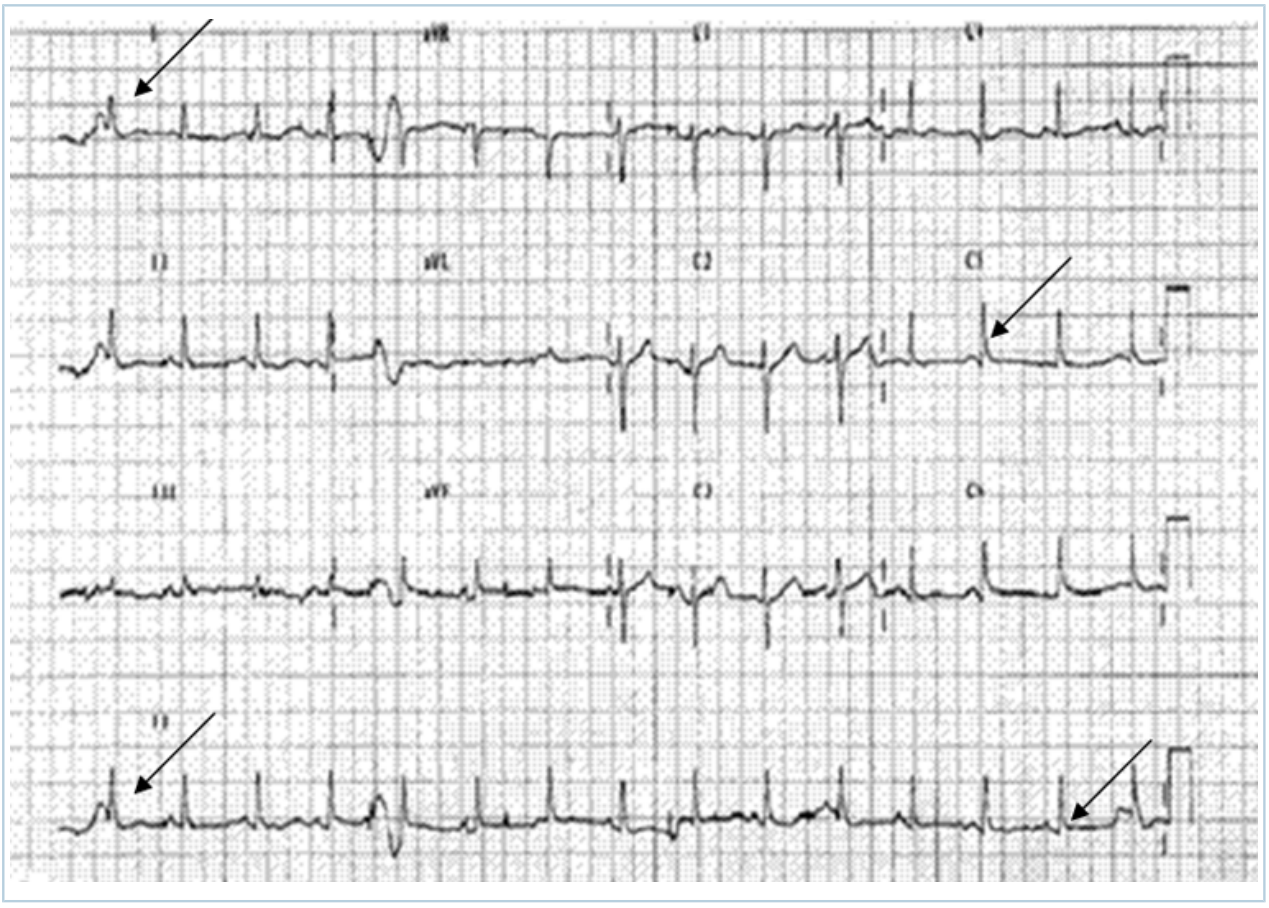
Investigations in the workup of accidental hypothermia are not diagnostic, but do help to guide acute management.

ECG

Continuous ECG monitoring is essential for detecting arrhythmias, which may be fatal. Where possible, ECG monitoring should also be used to detect cardiac arrest.[20] [48]

Arrhythmias can occur at any stage of hypothermia, and also during rewarming. Initially, in mild hypothermia, the ECG may show tachycardia. In more severe cases of hypothermia, the ECG may show progressive sinus bradycardia, atrial or ventricular fibrillation, junctional rhythms, ST segment changes, T-wave inversion, prolongation of the QT interval, and eventually asystole.[11] With the exception of ventricular fibrillation, these changes are likely to improve without treatment as the patient's core temperature increases.[20] [48]

J waves (or Osborn waves) occur in most, but not all, patients.[50] However, they do not correlate well with temperature.[51]



A 12-lead ECG obtained from a hypothermic patient; note, Osborn waves (arrows), which have an extra deflection at the end of the QRS complex

Aydin M, Gursurer M, Bayraktaroglu T, et al. Tex Heart Inst J. 2005;32(1):105

Laboratory tests

Initial investigations should include: arterial blood gas (ABG), blood glucose, and blood chemistries. Further tests are less useful for the acute assessment and management of hypothermia but generally include a complete blood count (CBC) and clotting screen.

- An ABG may show respiratory alkalosis, metabolic acidosis, or a mixed picture. As core temperature decreases, respiration is depressed, resulting in hypoxemia and hypercapnia. A combined respiratory and metabolic acidosis occurs as a result of hypoventilation, retention of carbon dioxide, decreased bicarbonate, impaired hepatic metabolism of organic acid production (owing to impaired hepatic perfusion), and increased lactic acid production. It is important to note that blood pH rises by 0.015 for every 1.8°F (1°C) drop in body temperature. In general, use blood gas results without adjustment for temperature to guide treatment decisions.[52]
- Glucose levels may be normal, high (owing to increased secretion of stress hormones - cortisol, growth hormones, and catecholamines - and reduced insulin secretion, together with increased peripheral resistance to insulin), or low (owing to cold-induced inhibition of hepatic glucose production). Monitor blood glucose even after the patient is normoglycemic because rebound hypoglycemia may develop when normal insulin production resumes. Treat hypoglycemia promptly. Hypoglycemia can stop shivering (because the central control of shivering is dependent on glucose), leading to subsequent heat loss.[53]
- Renal function may be impaired due to dehydration, cold exposure, or rhabdomyolysis.
- Hypokalemia may occur as a result of hypothermia or the associated treatment. Hyperkalemia may occur during rewarming. For a patient in cardiac arrest, hyperkalemia can also indicate that hypoxia preceded hypothermia (e.g., if the patient was found in an avalanche).[48] Initial serum potassium >12 mEq/L (>12 mmol/L) is associated with irreversible death if the patient is in cardiac arrest.[48] Serum potassium is part of the HOPE (Hypothermia Outcome Prediction after ECLS rewarming for hypothermic arrested patients) score for prognostication of successful rewarming.[20] [48]
- A CBC may show elevated hemoglobin and hematocrit, and low platelet and white blood cell counts.
- Prothrombin time and partial thromboplastin time (PTT) tend to be prolonged, although the cause for this is unknown.[54]

Imaging

A chest x-ray is particularly important if patients have an altered level of consciousness. It may show pulmonary edema or infiltrates.

If the patient has been immersed in water, it may show inhaled foreign bodies, such as false teeth or debris from the water, which will need to be removed. See Foreign body aspiration .

Investigations to consider

Serum creatinine kinase and myoglobin levels should be checked for rhabdomyolysis if the patient may have been lying on the ground outdoors for a long time and they have not been immersed in water. See Rhabdomyolysis .

If vital signs are undetectable, use ultrasound and end-tidal CO_2, where possible, to confirm cardiac arrest.[20] [48]

History and exam

Key diagnostic factors

cold exposure and body temperature <95°F (<35°C) (common)

- Those inappropriately dressed for a cold climate and outside for a considerable amount of time may be hypothermic, as assessed by measurement of a body temperature <95°F (<35°C).[27]

impaired mental status (common)

- Confusion, apathy, and impaired judgment. Typically seen in people with moderate hypothermia (core temperature of 82°F to 90°F [28°C to 32°C]).
- See Evaluation of altered mental status .

shivering (common)

- Patient may be shivering, or there may be a history of shivering.
- Note that shivering will be absent once the patient's core temperature drops below a certain level; the threshold varies between patients but is typically 82°F to 90°F (28°C to 32°C).[48] May also be absent in patients with hypoglycemia.

frostbite (common)

- Occurs when the skin and subcutaneous tissue freeze, causing cellular damage.
- See Frostbite .

Other diagnostic factors

tachypnea, tachycardia, hypertension (common)

- Usually seen in people with mild hypothermia (core temperature of 90°F to 95°F to [32°C to 35°C]). Note that tachycardia may progress to bradycardia, even in mild hypothermia.

respiratory depression, bradycardia, hypotension (common)

- Usually seen in people with moderate hypothermia (core temperature of 82°F to 90°F [28°C to 32°C]). However, note that tachycardia may progress to bradycardia, even in mild hypothermia.

coma and apnea (common)

- Usually seen in people with severe hypothermia (core temperature of <82°F [<28°C]). Some patients may have weak signs of life at temperatures <82°F (<28°C).
- Beware of diagnosing death in a patient with hypothermia, even when the patient has fixed pupils or early signs of rigor mortis; signs of life may be minimal if the patient has severe hypothermia.[49]

cold-induced diuresis (common)

- Occurs with progression of hypothermia as the kidney loses its ability to concentrate urine.[11]

Risk factors

Strong

trauma

- The incidence of hypothermia in patients admitted to hospital with major trauma is estimated to be around 13%.[26] The trauma 'triad of death' - a combination of hypothermia, acidosis, and coagulopathy - is known to significantly impact chances of survival in patients with severe injuries.[2] [3]

drowning

- Hypothermia may be a sign of prolonged exposure to water.[27] Case reports of drowning patients surviving prolonged submersion in icy water and cardiac arrest are rare, and typically involve small children.[28] In the majority of cases, hypothermia carries a poor prognosis.[29]
- See Drowning .

general anesthetic use

- Evidence suggests that during general anesthesia, especially after anesthetic induction, there is an internal redistribution of heat from the core to the peripheral compartment resulting in a linear drop in body temperature (i.e., 0.9°F to 1.8°F [0.5°C-1.0°C] per hour). Although unclear, it appears that this phase may last as long as there is a difference between energy metabolic production and heat loss. Long surgical procedures may also be associated with low body temperature.[30] [31]
- Active prewarming of patients for at least 30 minutes before general anesthesia is recommended to prevent hypothermia and reduce shivering.[32] [33]

substance misuse

- Alcohol causes vasodilation, impairs judgment, and causes somnolence and a subjective feeling of warmth, so that measures to prevent hypothermia are not taken. Other drugs such as cannabis impair judgment and restrict shivering, thereby limiting the ability to respond appropriately to cold temperatures. Substance misuse is common among homeless hypothermic patients and is an important risk factor for death.[14] [15][16]

impaired cognition

- Patients with impaired cognition (e.g., Alzheimer disease, Parkinson disease, stroke) may be at increased risk. If the ability to judge temperature is impaired, patients may dress inappropriately for weather conditions. Getting lost or even stranded is a frequent occurrence and, as a result, patients are at a high risk for hypothermia.

hypothyroidism

- Decompensated hypothermia may present with hypothermia, depressed vital signs, and altered mental status.[34]

stroke

- Stroke may impair thermoregulation as a result of central nervous system failure.[19]

Parkinson disease

- Parkinson disease may impair thermoregulation as a result of central nervous system failure.[19]

homelessness

- A well-established risk factor for accidental hypothermia. Hypothermia associated with homelessness is a significant risk factor for hypothermia-related death.[16]

extremes of age

- Older adults are at particular risk, most commonly due to acute medical illness, which may interfere with the body's ability to regulate temperature.[13] [35]
- Children have a larger body surface area relative to body size compared with adults. Relative to the rest of their body, the head is large and therefore dissipates heat rapidly.[36] Newborns are particularly at risk as they lack an effective mechanism for heat production.

gram-negative septicemia

- Release of bacterial toxins can cause peripheral vasodilation, impairing the ability to preserve heat by vasoconstriction, thereby increasing the risk of hypothermia.

immobility

- Patients who are immobile (e.g., due to illness or injury) are at increased risk of hypothermia.[37]

Weak

use of certain drugs

- Although rare, hypothermia may be a life-threatening adverse effect of antipsychotics. One systematic review found that hypothermia was reported most commonly with olanzapine, haloperidol, and risperidone.[38] Although the mechanism is unclear, it is hypothesized that antipsychotic-induced hypothermia may be due to peripheral vasoconstriction inhibition and central thermoregulation failure.[38] [39]
- Hypothermia may also manifest secondary to overdose with opioids, tricyclic antidepressants, phenothiazines, barbiturates, benzodiazepines, and sedatives/hypnotics.[40] [41]
- Hypothermia has been reported with metformin overdose as a result of systemic vasodilation secondary to acidemia.[35] [42] [43]

Tests

1st test to order

Test	Result
core temperature measurement • Do not use a standard clinical thermometer to measure core temperature. This may be inadequate as it will not measure temperatures below 94°F (34.4°C). Conventional mercury thermometers are also not recommended, owing to the risk of breakage and poisoning. Where feasible (usually in hospital), an esophageal probe is preferred as it correlates well with the temperature of the pulmonary artery.[19] [20] [51] This is usually only possible in critically ill patients as readings must be obtained from the lower third of the esophagus when the airway is secured (i.e., tracheal tube or a supraglottic device with an esophageal channel in place). • Alternatively, a low-reading tympanic membrane thermistor-based thermometer (where the thermistor touches the tympanic membrane) can be used if the patient is spontaneously breathing.[20] [48] • Bladder catheter temperature sensors can be used in patients who require a urinary catheter, but bladder and rectal temperature lag behind core temperature and are only recommended for stable patients in a hospital setting.[19] [20] Never measure rectal temperature if the patient is in a cold environment because this method requires the patient to be further exposed, which will increase heat loss and potentially worsen hypothermia.	**<95°F (<35°C)**
12-lead ECG • Continuous ECG monitoring is essential for detecting arrhythmias, which may be fatal. Where possible, ECG monitoring should also be used to detect cardiac arrest.[20] [48] • Arrhythmias can occur at any stage of hypothermia, and also during rewarming. • Initially, in mild hypothermia, the ECG may show tachycardia. In more severe cases of hypothermia, the ECG may show progressive sinus bradycardia, atrial or ventricular fibrillation, junctional rhythms, ST segment changes, T-wave inversion, prolongation of the QT interval, and eventually asystole.[11] With the exception of ventricular fibrillation, these changes are likely to improve without treatment as the patient's core temperature increases.[20] [48] • J waves (or Osborn waves) occur in most, but not all, patients.[50] However, they do not correlate well with temperature.[51]	**sinus bradycardia; atrial fibrillation; J wave or Osborn wave; ST elevation or depression; T wave inversion; prolonged PR, QT, and QTc interval; broad QRS complexes**
CBC • Hemoglobin and hematocrit may be elevated due to hemoconcentration. Platelets and WBCs are abnormally low due to sequestration in the spleen.	**elevated hemoglobin and hematocrit, low WBC and platelet counts**
serum electrolytes • Renal function may be impaired due to dehydration, cold exposure, or rhabdomyolysis. Hypokalemia may occur as a result of hypothermia or the associated treatment. Hyperkalemia may occur during rewarming. • For a patient in cardiac arrest, hyperkalemia can also indicate that hypoxia preceded hypothermia (e.g., if the patient was found in an	**hypokalemia, hyperkalemia**

Test	Result
avalanche).[48] Initial serum potassium >12 mEq/L (>12 mmol/L) is associated with irreversible death if the patient is in cardiac arrest.[48] Serum potassium is part of the HOPE (Hypothermia Outcome Prediction after ECLS rewarming for hypothermic arrested patients) score for prognostication of successful rewarming.[20] [48]	
blood glucose • Glucose levels may be normal, high (owing to increased secretion of stress hormones - cortisol, growth hormones, and catecholamines - and reduced insulin secretion, together with increased peripheral resistance to insulin), or low (owing to cold-induced inhibition of hepatic glucose production). Monitor blood glucose even after the patient is normoglycemic because rebound hypoglycemia may develop when normal insulin production resumes. Treat hypoglycemia promptly. Hypoglycemia can stop shivering (because the central control of shivering is dependent on glucose), leading to subsequent heat loss.[53]	**may be elevated, often normal, sometimes low**
ABG • May show respiratory alkalosis, metabolic acidosis, or a mixed picture. As core temperature decreases, respiration is depressed, resulting in hypoxemia and hypercapnia. A combined respiratory and metabolic acidosis occurs as a result of hypoventilation, retention of carbon dioxide, decreased bicarbonate, impaired hepatic metabolism of organic acid production (owing to impaired hepatic perfusion), and increased lactic acid production. It is important to note that blood pH rises by 0.015 for every 1.8°F (1°C) drop in body temperature. In general, use blood gas results without adjustment for temperature to guide treatment decisions.[52]	**respiratory alkalosis, metabolic acidosis, or mixture of both; respiratory acidosis is suggested by pH <7.35 and carbon dioxide partial pressure >40 mmHg; metabolic acidosis is suggested by pH <7.35, bicarbonate ≤24 mEq/L, and a normal partial pressure of carbon dioxide, although it may be low with compensation; PaO_2 may be low with severe hypothermia, and/or if there are pulmonary infiltrates or edema**
clotting screen • Prothrombin time (PT) and PTT are prolonged due to inhibition of enzymatic activity in both the intrinsic and the extrinsic coagulation cascade. The cause of coagulopathy is unknown.[54]	**elevated PT and PTT**
chest x-ray • Particularly important if the patient has an altered level of consciousness. • May show pulmonary edema or infiltrates. • If the patient has been immersed in water, it may show inhaled foreign bodies, such as false teeth or debris from the water, which will need to be removed. See Foreign body aspiration .	**may be normal or may show pulmonary infiltrates and/or edema**

Other tests to consider

Test	Result
serum creatinine kinase • Should be checked for rhabdomyolysis if the patient may have been lying on the ground outdoors for a long time and they have not been immersed in water. See Rhabdomyolysis .	**>5 times the upper limit of normal indicates rhabdomyolysis**
myoglobin levels • Should be checked for rhabdomyolysis if the patient may have been lying on the ground outdoors for a long time and they have not been immersed in water. See Rhabdomyolysis .	**increased levels in blood and/or urine is an indicator of rhabdomyolysis**
end-tidal CO_2 • Used to detect cardiac arrest, where possible, in the absence of vital signs.[20] [48] See Cardiac arrest .	**low or absent in cardiac arrest**
ultrasound • Used to detect cardiac arrest, where possible, in the absence of vital signs.[20] [48] See Cardiac arrest .	**ventricular fibrillation#or absence of cardiac activity in cardiac arrest**

Differentials

Condition	Differentiating signs / symptoms	Differentiating tests
Sepsis	• Patients may present with fever and rigors. However, a lowered temperature is possible (particularly in very young patients and older adult patients) and the presentations may be indistinguishable.	• Blood and urine cultures and tracheal aspirate with Gram stain analysis may show a pathogen. WBC may be elevated.
Hypothyroidism	• Cases that mimic hypothermia most commonly result from longstanding hypothyroidism. Typical symptoms include cold intolerance, fatigue, weight gain, constipation, a deep voice, coarse hair, and dry skin. • Severe hypothyroidism may result in myxedema coma. Myxedema refers to nonpitting edema of skin and soft tissue. An associated change in level of consciousness (not necessarily coma) is present. • Concurrent infection or noncompliance with thyroid replacement medications may precipitate myxedema coma in a patient with hypothyroidism.	• Thyroid function tests show a high thyroid-stimulating hormone and low free thyroxine/triiodothyronine (T4/T3).
Hypoglycemia	• Common presenting symptoms include nausea, confusion, tremor, sweating, palpitations, or hunger. • Patients may present with a lowered temperature as hypoglycemia can impair the body's ability to retain heat through shivering.	• Serum glucose <50 mg/dL (<2.8 mmol/L).
Substance misuse and overdose	• Substance misuse (e.g., with cannabis) may impair judgment and restrict shivering, thereby limiting the ability to respond appropriately to cold temperatures.	• Drug screen will be positive for substances taken.

Condition	Differentiating signs / symptoms	Differentiating tests
	• Signs and symptoms depend on the substance taken.	
Alcohol intoxication	• Usually presents with altered mental state alone. Alcohol causes vasodilation, impairs judgment, and causes somnolence and a subjective feeling of warmth. Measures to prevent hypothermia may not be taken and therefore patients may present with lowered temperatures.	• Serum alcohol level will be positive.

Criteria

Clinical staging for accidental hypothermia: the original Swiss system[46][47]

- Stage 1
  - Estimated core temperature of 90°F to 95°F (32°C to 35°C).
  - Clear consciousness with shivering.
- Stage 2
  - Estimated core temperature of <90°F to 82°F (<32°C to 28°C).
  - Impaired consciousness without shivering.
- Stage 3
  - Estimated core temperature of <82°F to 75°F (<28°C to 24°C).
  - Unconsciousness.
  - ECG: ventricular fibrillation or asystole.
- Stage 4
  - Estimated core temperature classically 75°F to 57°F? (24°C to 13.7°C?).
  - Apparent death; vital signs absent.
  - ECG: asystole.
- Stage 5*
  - Estimated core temperature of <57°F? or <48°F? (<13.7°C? or <9°C?).
  - Death due to irreversible hypothermia.

*NB: Hypothermia V (HT V) was later removed from subsequent revisions of the Swiss classification system due to uncertain cutoff temperatures based on historic survival records.[47]

Clinical staging for accidental hypothermia: the revised Swiss system[47]

The revised Swiss system uses risk of cardiac arrest in order to stage accidental hypothermia, rather than core temperature.[47] It also incorporates the AVPU scale (alert, verbal, pain, unresponsive) to assess a

patient's level of responsiveness instead of using shivering as a stage-defining sign. The revised Swiss system has been designed to simplify clinical staging in the field.

- Stage 1
  - "Alert" from AVPU.
  - Risk of hypothermic cardiac arrest: low.
- Stage 2
  - "Verbal" from AVPU.
  - Risk of hypothermic cardiac arrest: moderate.
- Stage 3
  - "Painful" or "Unconscious" from AVPU.
  - Vital signs present.
  - Risk of hypothermic cardiac arrest: high.
- Stage 4
  - "Unconscious" from AVPU.
  - No detectable vital signs.
  - Hypothermic cardiac arrest.

The Wilderness Medical Society: accidental hypothermia classification[48]

- Mild
  - Estimated core temperature of 95°F to 90°F (35°C to 32°C).
  - Normal mental status, shivering, but not functioning normally and unable to care for self.
- Moderate
  - Estimated core temperature of 90°F to 82°F (32°C to 28°C).
  - Abnormal mental status with shivering, or abnormal status without shivering, but conscious.
- Severe/profound
  - Estimate core temperature of <82°F (<28°C).
  - Unconscious.

Approach

Initial management involves assessing and managing the patient's airway, breathing, and circulation, and preventing further heat loss.[45][55] Get urgent support from the critical care team for any patient with severe hypothermia.

Be aware that vital signs may be very difficult to detect in a patient with hypothermia, especially in the prehospital setting; a very hypothermic patient may appear dead but still survive with resuscitation.[20][45] [48][49] Do not declare a patient dead prior to full resuscitative measures and aggressive rewarming, unless in the case of nonsurvivable traumatic injury or rigor mortis.[45]

Supportive measures depend on the patient's clinical status and severity of hypothermia, and include:[20][45] [48] [55]

- Removal of wet and cold clothing and insulation (e.g., with a warm blanket)
- Advanced airway management
- Heated humidified oxygen and warm intravenous fluids, particularly once rewarming has been started
- Management of cardiac arrhythmias (with the exception of ventricular fibrillation [VF], these are likely to improve without treatment as the patient's core temperature increases)
- Management of hypoglycemia
- Monitoring of core temperature and hemodynamic status during rewarming.

Choice of rewarming strategy (passive external, active external, active internal/core) is based on the patient's core temperature and clinical features; a combination of techniques may be used.

Hypothermia in the prehospital setting

The prehospital management of the hypothermic patient should be focused on:[20][45][48] [55]

- prevention of further drops in body temperature (i.e., carefully removing the patient from the cold environment, and removal of any wet or cold clothes),
- stabilization of the patient following basic life support (BLS) and advanced cardiovascular life support (ACLS) protocols,
- maintenance of the patient in a supine position if they have features of moderate or severe hypothermia (e.g., they have stopped shivering or have a reduced level of consciousness),
- insulation of the patient and stabilization of the core temperature by starting rewarming measures (as long as there is adequate monitoring in place to detect any arrhythmias caused by rewarming), and
- transfer of the patient to an appropriate center for rewarming; where available, this should be to an extracorporeal life support (ECLS) center for patients with hemodynamic instability or severe hypothermia and patients in cardiac arrest or at imminent risk of cardiac arrest.

Patients are at risk of imminent cardiac arrest if they have any of the following:[20]

- Core temperature <86°F (<30°C), or <89.6°F (<32°C) if the patient is frail with multiple comorbidities
- Ventricular arrhythmia
- Systolic blood pressure <90 mmHg.

If an ECLS center cannot be reached within 6 hours, non-ECLS rewarming should be started in a peripheral hospital.[20]

It is important to be gentle during patient transport as cardiac excitability makes the patient's heart susceptible to arrhythmias.[48]

Exercise is not recommended as a rewarming strategy (unless core temperature is above 95°F [35°C]) due to the risk of fatal arrhythmias secondary to peripheral vasodilation.[56] Exercise can also cause cool blood to return to the central circulation.[56]

Cardiac arrest

Cardiopulmonary resuscitation (CPR) should be initiated promptly and without interruption in patients where vital signs cannot be detected after 1 minute and in patients with a nonperfusing rhythm (including VF, ventricular tachycardia [VT], and asystole).[20] [48] Where possible, ECG monitoring, end-tidal CO_2, and ultrasound should also be used to detect cardiac arrest.[20] [48]

Be aware that vital signs may be very difficult to detect in a patient with hypothermia, especially in the prehospital setting; a very hypothermic patient may appear dead but still survive with resuscitation.[20] [45][48][49] Do not declare a patient dead prior to full resuscitative measures and aggressive rewarming, unless in the case of nonsurvivable traumatic injury or rigor mortis.[45]

The American Heart Association (AHA) recommends providing standard BLS and ACLS treatment for patients with accidental hypothermia, combined with the appropriate rewarming techniques in line with the patient's clinical status.[45] In some cases, patients may be unresponsive to cardiovascular drugs, pacemaker stimulation, and defibrillation, although there is an absence of robust data to support this; defibrillation should still therefore be attempted for VF and VT.[45] If defibrillation fails to restore a normal heart rhythm after a single shock, continue adhering to standard BLS and ACLS protocol; there is uncertain evidence regarding the effectiveness of deferring defibrillation until a target core temperature is achieved.[45]

Vasoactive drugs should generally be avoided until patients have been rewarmed to at least 86°F (30°C).[48] This is because drug metabolism and protein binding are both affected in hypothermia so drugs that are administered in patients with very low core temperatures may reach toxic levels with rewarming. However, the AHA advises that epinephrine (adrenaline) administration is reasonable in cardiac arrest as part of the ACLS algorithm.[45]

For a patient in cardiac arrest, hyperkalemia can indicate that hypoxia preceded hypothermia (e.g., if the patient was found in an avalanche).[19] Severe hyperkalemia and very low initial core temperatures may predict unsuccessful resuscitation efforts; serum potassium is part of the HOPE (Hypothermia Outcome Prediction after ECLS rewarming for hypothermic arrested patients) score for prognostication of successful rewarming.[20][45][48] The Wilderness Medical Society states an initial serum potassium >12 mEq/L (>12 mmol/L) is associated with irreversible death if the patient is in cardiac arrest.[48]

See Cardiac arrest .

Airway

If the patient cannot maintain or protect the airway, it should be secured with an advanced airway (e.g., tracheal tube or supraglottic airway device). Advanced airway placement should be attempted only by those with appropriate training and experience.[20] [45] Patients with an advanced airway should be ventilated at half the standard normothermic rate.[48]

Advanced airways should allow passage of a gastric tube: this allows placement of an esophageal temperature probe as well as decompression of the stomach.[48] An esophageal probe is the preferred method of core temperature measurement in patients with hypothermia as it correlates well with the temperature of the pulmonary artery.[19] [20] [48]

It is important to note that endotracheal intubation may cause VF in severe hypothermia. However, this risk is small and the benefits of intubation when indicated outweigh the risk of VF.[19] [48]

Placement of an endotracheal tube may be more difficult in cold environments due to hypothermia-induced trismus.[19] [48] If laryngoscopy is not possible, fiber-optic intubation or cricothyroidotomy can help facilitate placement of an endotracheal tube, but it may be preferable to consider a supraglottic airway device until the patient is moved to a warm environment.[48]

Breathing

Patients with hypothermia can receive heated humidified oxygen therapy, regardless of their oxygen saturations.[48] This reduces heat loss through respiration, but is not effective as a rewarming method on its own; it should be used as an adjunct to other rewarming techniques.

Circulation

In moderate and severe hypothermia, circulating blood volume is reduced due to vasoconstriction.[48] Circulatory access via a peripheral intravenous catheter is the preferred method, though this may be difficult to achieve in hypothermic patients because of cold-induced peripheral vasoconstriction.[48] If not immediately possible, intraosseous access should be established instead.

Patients should be infused (intravenously or intraosseously) with normal saline, warmed to 104°F to 107.6°F (40°C to 42°C).[48] Warmed intravenous fluids help to prevent heat loss but do not actively rewarm the patient. Infusing warmed intravenous fluid also offers the additional advantage of improved absorption of administered drugs. Lactated Ringer solution should be avoided as the liver will not be able to metabolize lactate in hypothermia.[48]

It is important that patients are carefully monitored for signs of fluid overload and volume depletion. It is likely that large volumes of fluid will be required because vasodilation during rewarming causes expansion of the intravascular space and subsequent hypotension.[19] [48] Warmed intravenous fluids should ideally be administered via boluses, guided by vital signs (heart rate and blood pressure) as opposed to continuous infusion, as this will help avoid issues with fluid cooling or lines freezing.[19] [48]

Vasoactive drugs are generally avoided when managing hypotension in a patient with significant hypothermia, unless the hypotension is due to other causes (e.g., sepsis) or in highly specialist scenarios (e.g., if the patient is undergoing ECLS).[20] Always seek urgent advice from the critical care team before giving vasoactive drugs. If indicated, vasoactive drugs should be withheld until the patient's core temperature is at least ≥86°F (≥30°C).[48] However, the AHA advises that epinephrine administration is reasonable in cardiac arrest as part of the ACLS algorithm.[45]

All arrhythmias apart from VF (particularly atrial arrhythmias) are likely to improve without treatment as the patient's core temperature increases.[19] [20] [48] However, if the patient has bradycardia and hypotension that is disproportionate to their hypothermia, consider transcutaneous pacing.[48] See Overview of dysrhythmias (cardiac) .

Dextrose

Treat hypoglycemic patients with dextrose.[48] Hypoglycemia can stop shivering (because the central control of shivering is dependent on glucose), leading to subsequent heat loss.[53] Where blood glucose testing is not available and hypothermic patients present with an altered level of consciousness, empiric dextrose should still be initiated.[48] See Nondiabetic hypoglycemia .

Monitor blood glucose even after the patient is normoglycemic as rebound hypoglycemia may develop when normal insulin production resumes.

Insulin should not initially be started in patients with hyperglycemia as high blood glucose has not been shown to be detrimental in patients with hypothermia.[48] Monitor blood glucose and seek expert advice if: hyperglycemia is worsening; there is associated ketosis; hyperglycemia persists after successful rewarming; or the patient has type 1 diabetes.

Rewarming

The optimal rewarming method depends on the severity of hypothermia and the patient's clinical condition. If the patient has:[19] [20][45][48][49]

- Mild hypothermia (core temperature 90°F to 95°F [32°C to 35°C]), start passive external rewarming methods initially. Active external rewarming methods should be used if there is an insufficient response to passive methods and are useful in both shivering and nonshivering patients. Mild hypothermia can be managed in a prehospital setting; patients do not require transfer to hospital provided they are uninjured, alert, and shivering.
- Moderate or severe hypothermia (core temperature ≤90°F [≤32°C]), use external (active and passive) and internal rewarming methods. Get urgent support from the critical care team for any patient with severe hypothermia.
- Severe hypothermia (core temperature ≤86°F [≤30°C]) and cardiac arrest, extracorporeal rewarming is the preferred method as it allows for rapid rewarming. Patients with severe hypothermia, hemodynamic instability, or witnessed out-of-hospital cardiac arrest and those at risk of imminent cardiac arrest should be transferred to centers capable of providing ECLS. Patients are at imminent risk of cardiac arrest if they have any of the following: core temperature <86°F (<30°C), or <89.6°F (<32°C) if the patient is frail with multiple comorbidities; ventricular arrhythmia; systolic blood pressure <90 mmHg.

Patients with severe trauma should be treated aggressively with active rewarming, regardless of the severity of their hypothermia; hypothermia is associated with higher mortality among trauma patients.[3] [26] [48]

It is critical that patients with moderate or severe hypothermia have their core temperature and hemodynamic status continuously monitored during rewarming.[48] Heat redistribution within the body can cause a continued fall in core temperature after removing the patient from a cold environment (also known as afterdrop). Avoid hyperthermia during and after rewarming.[19]

Monitor potassium: hypokalemia may occur as a result of hypothermia or the associated treatment and hyperkalemia may occur during rewarming. Serum potassium is part of the HOPE (Hypothermia Outcome Prediction after ECLS rewarming for hypothermic arrested patients) score for prognostication of successful rewarming; severe hyperkalemia may predict unsuccessful resuscitation efforts.[20][45][48]

External rewarming methods

External rewarming methods may be passive or active.[19]

Passive methods involve reducing further evaporative heat loss through removal of wet clothing and insulating the patient (e.g., with warm blankets and dry clothes).[45][48][55] Patients may be given high-calorie food and warm sweet drinks if alert and able to safely consume food and fluids orally; these do not rewarm the patient but will supply energy for shivering.[19] [55] Active movement (e.g., standing, walking) should also be encouraged if possible in patients with mild hypothermia and shivering who have had adequate time to rewarm.[19] [48]

Active external rewarming may involve using electric heat pads or blankets, hot water bottles, chemical heat pads, or forced air warming.[48]

Internal rewarming methods

Active internal (also known as active core) rewarming, used alone or in combination with active external rewarming, is the most aggressive strategy and is indicated in moderate to severe hypothermia. Active internal rewarming methods include: lavage with warmed normal saline, ECLS, veno-venous rewarming, continuous renal replacement therapy (CRRT), and hemodialysis.[19]

ECLS rewarming provides sufficient circulation and oxygenation while the core body temperature is increased at a rewarming rate of 39.2°F to 50°F (4°C to 10°C) per hour.[19] Patients with severe hypothermia, hemodynamic instability, or witnessed out-of-hospital cardiac arrest and those at risk of imminent cardiac arrest should be transferred to centers capable of providing ECLS.[20] [48]

If the patient is in cardiac arrest, ECLS rewarming is the preferred method of active internal rewarming.[20][45][48] For patients with hemodynamic instability, ECLS rewarming should be considered as it may provide some benefit.[48] Evidence suggests that ECLS rewarming offers a better survival outcome than other treatment modalities.[19] [57] [58] Preferably, ECLS rewarming should be performed with extracorporeal membrane oxygenation (ECMO) over cardiopulmonary bypass (CPB).[48]

ECLS requires heparinization, undesirable in the hypothermic patient and in patients with severe trauma who are already at increased risk of coagulopathy.[2] [20][59] Low- and no-anticoagulation protocols are being investigated in adults at high bleeding risk.[60]

Other methods of active internal rewarming (lavage, veno-venous rewarming, CRRT, and hemodialysis) are less effective and may only be recommended where ECLS rewarming is unavailable.[19]

Irrigation with normal saline (lavage) can be peritoneal, thoracic, gastric, bladder, or colonic, warmed to 104°F to 107.6°F (40°C to 42°C).[19] [48]

Continuous veno-venous hemofiltration (CVVH), a type of CRRT, may be considered in patients with hyperkalemia (e.g., due to rewarming or rhabdomyolysis) or acidosis.[61]

Treatment algorithm overview

Please note that formulations/routes and doses may differ between drug names and brands, drug formularies, or locations. Treatment recommendations are specific to patient groups: see disclaimer

Acute (summary)		
mild hypothermia: >90°F to 95°F (>32°C to 35°C)		
	1st	passive external rewarming
	adjunct	supportive care
	adjunct	heated humidified oxygen
inadequate response to passive external rewarming	adjunct	active external rewarming
	adjunct	warmed intravenous fluids
moderate or severe hypothermia not in cardiac arrest: ≤90°F (≤32°C)		
	1st	supportive care
	plus	passive external rewarming
	plus	warmed intravenous fluids
	plus	active external rewarming
	plus	active internal rewarming
	plus	heated humidified oxygen
	adjunct	hemofiltration
moderate or severe hypothermia in cardiac arrest: ≤90°F (≤32°C)		
	1st	cardiopulmonary resuscitation (CPR) ± advanced cardiovascular life support
	plus	supportive care
	plus	passive external rewarming
	plus	heated humidified oxygen
	plus	active external rewarming
	plus	warmed intravenous fluids
	plus	extracorporeal life support (ECLS) rewarming
	adjunct	hemofiltration

Treatment algorithm

Please note that formulations/routes and doses may differ between drug names and brands, drug formularies, or locations. Treatment recommendations are specific to patient groups: see disclaimer

Acute

mild hypothermia: >90°F to 95°F (>32°C to 35°C)

1st **passive external rewarming**

» Reduce further evaporative heat loss through removal of wet clothing and insulating the patient (e.g., with warm blankets and dry clothes).[45] [48] [55] Patients should also be given high-calorie food and warm sweet drinks if alert and able to safely consume food and fluids orally; these do not rewarm the patient but will supply energy for shivering.[19] [55] Active movement (e.g., standing, walking) should also be encouraged if possible in patients with shivering who have had adequate time to rewarm.[19] [48]

» Monitor core temperature. Heat redistribution within the body can cause a continued fall in core temperature after removing the patient from a cold environment (also known as afterdrop).

» Avoid hyperthermia during and after rewarming.[19]

adjunct **supportive care**

Treatment recommended for SOME patients in selected patient group

» Mild hypothermia can usually be managed in a prehospital setting, but patients will require transfer to hospital if they are injured, present with altered consciousness, or are not shivering.

» If the patient cannot maintain or protect the airway, it should be secured with an advanced airway (e.g., tracheal tube or supraglottic airway device). Advanced airway placement should be attempted only by those with appropriate training and experience.[20] [45] Patients with an advanced airway should be ventilated at half the standard normothermic rate.[48]

» Placement of an endotracheal tube may be more difficult in cold environments due to hypothermia-induced trismus.[19] [48] If laryngoscopy is not possible, fiber-optic intubation or cricothyroidotomy can help facilitate placement of an endotracheal tube, but it may be preferable to consider a supraglottic airway device until the patient is moved to a warm

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environment.[48] Be aware that endotracheal intubation may cause ventricular fibrillation (VF) in severe hypothermia. However, this risk is small and the benefits of intubation when indicated outweigh the risk of VF.[19] [48]

» Manage cardiac arrhythmias as appropriate. All arrhythmias apart from VF (particularly atrial arrhythmias) are likely to improve without treatment as the patient's core temperature increases.[19] [20] [48] However, if the patient has bradycardia and hypotension that is disproportionate to their hypothermia, consider transcutaneous pacing.[48]

» Treat hypoglycemic patients with dextrose.[48] Hypoglycemia can stop shivering (because the central control of shivering is dependent on glucose), leading to subsequent heat loss.[53] Where blood glucose testing is not available and hypothermic patients present with an altered level of consciousness, empiric dextrose should still be initiated.[48] Monitor blood glucose even after the patient is normoglycemic as rebound hypoglycemia may develop when normal insulin production resumes.

» Insulin should not initially be started in patients with hyperglycemia as high blood glucose has not been shown to be detrimental in patients with hypothermia.[48] Seek expert advice if: hyperglycemia is worsening; there is associated ketosis; hyperglycemia persists after successful rewarming; or the patient has type 1 diabetes.

» Monitor core temperature and vital signs, including pulse rate, blood pressure, respiratory rate, oxygen saturations, blood gases (to ensure resolution of hypoxia and normalization of pH), and end-tidal CO_2 if the patient is intubated.

» Monitor potassium: hypokalemia may occur as a result of hypothermia or the associated treatment and hyperkalemia may occur during rewarming.

adjunct **heated humidified oxygen**

Treatment recommended for SOME patients in selected patient group

» Heated humidified oxygen therapy can be given regardless of oxygen saturations.[48] This reduces heat loss through respiration, but is not effective as a rewarming method on its own; it should be used as an adjunct to other rewarming techniques.

Acute

inadequate response to passive external rewarming

adjunct **active external rewarming**

Treatment recommended for SOME patients in selected patient group

» Should be initiated if there is an insufficient response to passive methods.

» Active external rewarming may involve using electric heat pads or blankets, hot water bottles, chemical heat pads, or forced air warming.[48]

» Monitor core temperature. Heat redistribution within the body can cause a continued fall in core temperature after removing the patient from a cold environment (also known as afterdrop).

» Avoid hyperthermia during and after rewarming.[19]

adjunct **warmed intravenous fluids**

Treatment recommended for SOME patients in selected patient group

» Consider warmed intravenous fluids, especially once rewarming measures have been started. This should be with normal saline, warmed to 104°F to 107.6°F (40°C to 42°C).[48] Warmed intravenous fluids help to prevent heat loss but do not actively rewarm the patient. Infusing warmed intravenous fluid also offers the additional advantage of improved absorption of administered drugs. Lactated Ringer solution should be avoided as the liver will not be able to metabolize lactate in hypothermia.[48]

» Circulatory access via a peripheral intravenous catheter is the preferred method, though this may be difficult to achieve in hypothermic patients because of cold-induced peripheral vasoconstriction.[48] If not immediately possible, intraosseous access should be established instead.

» It is important that patients are carefully monitored for signs of fluid overload and volume depletion. Large volumes of fluid may be required because vasodilation during rewarming causes expansion of the intravascular space and subsequent hypotension.[19] [48] Warmed intravenous fluids should ideally be administered via boluses, guided by vital signs (heart rate and blood pressure) as opposed to continuous infusion, as this will help avoid issues with fluid cooling or lines freezing.[19] [48]

moderate or severe hypothermia not in cardiac arrest: ≤90°F (≤32°C)

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1st **supportive care**

» Move the patient very carefully and keep them in a supine position. This is crucial as movement can precipitate ventricular fibrillation (VF), especially if the patient's temperature is <82.4°F (<28°C).[20] [48]

» If the patient cannot maintain or protect the airway, it should be secured with an advanced airway (e.g., tracheal tube or supraglottic airway device). Advanced airway placement should be attempted only by those with appropriate training and experience.[20] [45] Patients with an advanced airway should be ventilated at half the standard normothermic rate.[48]

» Placement of an endotracheal tube may be more difficult in cold environments due to hypothermia-induced trismus.[19] [48] If laryngoscopy is not possible, fiber-optic intubation or cricothyroidotomy can help facilitate placement of an endotracheal tube, but it may be preferable to consider a supraglottic airway device until the patient is moved to a warm environment.[48] Be aware that endotracheal intubation may cause VF in severe hypothermia. However, this risk is small and the benefits of intubation when indicated outweigh the risk of VF.[19] [48]

» Manage cardiac arrhythmias as appropriate. All arrhythmias apart from VF (particularly atrial arrhythmias) are likely to improve without treatment as the patient's core temperature increases.[19] [20] [48] However, if the patient has bradycardia and hypotension that is disproportionate to their hypothermia, consider transcutaneous pacing.[48]

» Treat hypoglycemic patients with dextrose.[48] Hypoglycemia can stop shivering (because the central control of shivering is dependent on glucose), leading to subsequent heat loss.[53] Where blood glucose testing is not available and hypothermic patients present with an altered level of consciousness, empiric dextrose should still be initiated.[48] Monitor blood glucose even after the patient is normoglycemic as rebound hypoglycemia may develop when normal insulin production resumes.

» Insulin should not initially be started in patients with hyperglycemia as high blood glucose has not been shown to be detrimental in patients with hypothermia.[48] Seek expert advice if: hyperglycemia is worsening; there is associated

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ketosis; hyperglycemia persists after successful rewarming; or the patient has type 1 diabetes.

» Monitor core temperature and vital signs, including pulse rate, blood pressure, respiratory rate, oxygen saturations, blood gases (to ensure resolution of hypoxia and normalization of pH), and end-tidal CO_2 if the patient is intubated.

» Vasoactive drugs are generally avoided when managing hypotension in a patient with significant hypothermia, unless the hypotension is due to other causes (e.g., sepsis) or in highly specialist scenarios (e.g., if the patient is undergoing extracorporeal life support [ECLS]).[20] Always seek urgent advice from the critical care team before giving vasoactive drugs. If indicated, vasoactive drugs should be withheld until the patient's core temperature is at least ≥86°F (≥30°C).[48] However, the American Heart Association advises that epinephrine (adrenaline) administration is reasonable in cardiac arrest as part of the advanced cardiovascular life support (ACLS) algorithm.[45]

» Monitor potassium: hypokalemia may occur as a result of hypothermia or the associated treatment and hyperkalemia may occur during rewarming.

plus **passive external rewarming**

Treatment recommended for ALL patients in selected patient group

» Reduce further evaporative heat loss through removal of wet clothing and insulating the patient (e.g., with warm blankets and dry clothes).[45][48][55]

» Monitor core temperature. Heat redistribution within the body can cause a continued fall in core temperature after removing the patient from a cold environment (also known as afterdrop).

» Avoid hyperthermia during and after rewarming.[19]

plus **warmed intravenous fluids**

Treatment recommended for ALL patients in selected patient group

» Give warmed intravenous fluids, especially once rewarming measures have been started. This should be with normal saline, warmed to 104°F to 107.6°F (40°C to 42°C).[48] Warmed intravenous fluids help to prevent heat loss but do not actively rewarm the patient. Infusing warmed intravenous fluid also offers the

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additional advantage of improved absorption of administered drugs. Lactated Ringer solution should be avoided as the liver will not be able to metabolize lactate in hypothermia.[48]

» Circulatory access via a peripheral intravenous catheter is the preferred method, though this may be difficult to achieve in hypothermic patients because of cold-induced peripheral vasoconstriction.[48] If not immediately possible, intraosseous access should be established instead.

» It is important that patients are carefully monitored for signs of fluid overload and volume depletion. It is likely that large volumes of fluid will be required because vasodilation during rewarming causes expansion of the intravascular space and subsequent hypotension.[19] [48] Warmed intravenous fluids should ideally be administered via boluses, guided by vital signs (heart rate and blood pressure) as opposed to continuous infusion, as this will help avoid issues with fluid cooling or lines freezing.[19] [48]

plus **active external rewarming**

Treatment recommended for ALL patients in selected patient group

» Active external rewarming may involve using electric heat pads or blankets, hot water bottles, chemical heat pads, or forced air warming.[48]

» It is critical that patients with moderate or severe hypothermia have their core temperature and hemodynamic status continuously monitored during rewarming.[48] Heat redistribution within the body can cause a continued fall in core temperature after removing the patient from a cold environment (also known as afterdrop).

» Avoid hyperthermia during and after rewarming.[19]

plus **active internal rewarming**

Treatment recommended for ALL patients in selected patient group

» Active internal (also known as active core) rewarming, used alone or in combination with active external rewarming, is the most aggressive strategy and is indicated in moderate to severe hypothermia. Active internal rewarming methods include: lavage with warmed normal saline, extracorporeal life support (ECLS), veno-venous rewarming, continuous renal replacement therapy (CRRT), and hemodialysis.[19]

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» ECLS rewarming provides sufficient circulation and oxygenation while the core body temperature is increased at a rewarming rate of 39.2°F to 50°F per hour (4°C to 10°C per hour).[19] Patients with severe hypothermia, hemodynamic instability, or witnessed out-of-hospital cardiac arrest and those at risk of imminent cardiac arrest should be transferred to centers capable of providing ECLS.[20] [48] Patients are at risk of imminent cardiac arrest if they have any of the following: core temperature <86°F (<30°C), or <89.6°F (<32°C) if the patient is frail with multiple comorbidities; ventricular arrhythmia; systolic blood pressure <90 mmHg.

» For patients with hemodynamic instability, ECLS rewarming should be considered as it may provide some benefit.[48] Evidence suggests that ECLS rewarming offers a better survival outcome than other treatment modalities.[19] [57] [58] Preferably, ECLS rewarming should be performed with extracorporeal membrane oxygenation (ECMO) over cardiopulmonary bypass (CPB).[48]

» Patients with severe trauma should be treated aggressively with active rewarming, regardless of the severity of their hypothermia; hypothermia is associated with higher mortality among trauma patients.[3] [26] [48]

» Other methods of active internal rewarming (lavage, veno-venous rewarming, CRRT, and hemodialysis) are less effective and may only be recommended where ECLS rewarming is unavailable.[19]

» Irrigation with normal saline (lavage) can be peritoneal, thoracic, gastric, bladder, or colonic, warmed to 104°F to 107.6°F (40°C to 42°C).[19] [48]

» It is critical that patients with moderate or severe hypothermia have their core temperature and hemodynamic status continuously monitored during rewarming.[48] Heat redistribution within the body can cause a continued fall in core temperature after removing the patient from a cold environment (also known as afterdrop).

» Avoid hyperthermia during and after rewarming.[19]

plus **heated humidified oxygen**

Treatment recommended for ALL patients in selected patient group

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» Patients with hypothermia should receive heated humidified oxygen therapy, regardless of their oxygen saturations.[48] This reduces heat loss through respiration, but is not effective as a rewarming method on its own; it should be used as an adjunct to other rewarming techniques.

adjunct **hemofiltration**

Treatment recommended for SOME patients in selected patient group

» Continuous veno-venous hemofiltration (CVVH), a type of continuous renal replacement therapy, may be considered in patients with hyperkalemia (e.g., due to rewarming or rhabdomyolysis) or acidosis.[61] CVVH is also a form of active internal/core rewarming.[19]

moderate or severe hypothermia in cardiac arrest: ≤90°F (≤32°C)

1st **cardiopulmonary resuscitation (CPR) ± advanced cardiovascular life support**

» CPR should be initiated promptly and without interruption in patients where vital signs cannot be detected after 1 minute and in patients with a nonperfusing rhythm (including ventricular fibrillation [VF], ventricular tachycardia [VT], and asystole).[20] [48] Where possible, ECG monitoring, end-tidal CO_2, and ultrasound should also be used to detect cardiac arrest.[20] [48]

» Be aware that vital signs may be very difficult to detect in a patient with hypothermia, especially in the prehospital setting; a very hypothermic patient may appear dead but still survive with resuscitation.[20][45][48][49] Do not declare a patient dead prior to full resuscitative measures and aggressive rewarming, unless in the case of nonsurvivable traumatic injury or rigor mortis.[45]

» The American Heart Association (AHA) recommends providing standard basic life support (BLS) and advanced cardiovascular life support (ACLS) treatment for patients with accidental hypothermia, combined with the appropriate rewarming techniques in line with the patient's clinical status.[45] In some cases, patients may be unresponsive to cardiovascular drugs, pacemaker stimulation, and defibrillation, although there is an absence of robust data to support this; defibrillation should still therefore be attempted for VF and VT.[45] If defibrillation fails to restore a normal heart rhythm after a single shock, continue adhering to standard BLS and ACLS protocol; there is uncertain

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evidence regarding the effectiveness of deferring defibrillation until a target core temperature is achieved.[45]

» Vasoactive drugs should generally be avoided until patients have been rewarmed to at least 86°F (30°C).[48] This is because drug metabolism and protein binding are both affected in hypothermia so drugs that are administered in patients with very low core temperatures may reach toxic levels with rewarming. However, the AHA advises that epinephrine administration is reasonable in cardiac arrest as part of the ACLS algorithm.[45]

» For a patient in cardiac arrest, hyperkalemia can indicate that hypoxia preceded hypothermia (e.g., if the patient was found in an avalanche).[19] Severe hyperkalemia and very low initial core temperatures may predict unsuccessful resuscitation efforts; serum potassium is part of the HOPE (Hypothermia Outcome Prediction after ECLS rewarming for hypothermic arrested patients) score for prognostication of successful rewarming.[20][45] [48] The Wilderness Medical Society states an initial serum potassium >12 mEq/L (>12 mmol/L) is associated with irreversible death if the patient is in cardiac arrest.[48]

» See Cardiac arrest .

plus **supportive care**

Treatment recommended for ALL patients in selected patient group

» Move the patient very carefully and keep them in a supine position. This is crucial as movement can precipitate ventricular fibrillation (VF), especially if the patient's temperature is <82.4°F (<28°C).[20] [48]

» If the patient cannot maintain or protect the airway, it should be secured with an advanced airway (e.g., tracheal tube or supraglottic airway device). Advanced airway placement should be attempted only by those with appropriate training and experience.[20] [45] Patients with an advanced airway should be ventilated at half the standard normothermic rate.[48]

» Placement of an endotracheal tube may be more difficult in cold environments due to hypothermia-induced trismus.[19] [48] If laryngoscopy is not possible, fiber-optic intubation or cricothyroidotomy can help facilitate placement of an endotracheal tube, but it may be preferable to consider a supraglottic airway

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device until the patient is moved to a warm environment.[48] Be aware that endotracheal intubation may cause VF in severe hypothermia. However, this risk is small and the benefits of intubation when indicated outweigh the risk of VF.[19] [48]

» Manage cardiac arrhythmias as appropriate. All arrhythmias apart from VF (particularly atrial arrhythmias) are likely to improve without treatment as the patient's core temperature increases.[19] [20] [48] However, if the patient has bradycardia and hypotension that is disproportionate to their hypothermia, consider transcutaneous pacing.[48]

» Treat hypoglycemic patients with dextrose.[48] Hypoglycemia can stop shivering (because the central control of shivering is dependent on glucose), leading to subsequent heat loss.[53] Where blood glucose testing is not available and hypothermic patients present with an altered level of consciousness, empiric dextrose should still be initiated.[48] Monitor blood glucose even after the patient is normoglycemic as rebound hypoglycemia may develop when normal insulin production resumes.

» Insulin should not initially be started in patients with hyperglycemia as high blood glucose has not been shown to be detrimental in patients with hypothermia.[48] Seek expert advice if: hyperglycemia is worsening; there is associated ketosis; hyperglycemia persists after successful rewarming; or the patient has type 1 diabetes.

» Monitor core temperature and vital signs, including pulse rate, blood pressure, respiratory rate, oxygen saturations, blood gases (to ensure resolution of hypoxia and normalization of pH), and end-tidal CO_2 if the patient is intubated.

» Monitor potassium: hypokalemia may occur as a result of hypothermia or the associated treatment and hyperkalemia may occur during rewarming.

plus **passive external rewarming**

Treatment recommended for ALL patients in selected patient group

» Reduce further evaporative heat loss through removal of wet clothing and insulating the patient (e.g., with warm blankets and dry clothes).[45] [48][55]

» Monitor core temperature. Heat redistribution within the body can cause a continued fall in

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core temperature after removing the patient from a cold environment (also known as afterdrop).

» Avoid hyperthermia during and after rewarming.[19]

plus **heated humidified oxygen**

Treatment recommended for ALL patients in selected patient group

» Patients with hypothermia should receive heated humidified oxygen therapy, regardless of their oxygen saturations.[48] This reduces heat loss through respiration, but is not effective as a rewarming method on its own; it should be used as an adjunct to other rewarming techniques.

plus **active external rewarming**

Treatment recommended for ALL patients in selected patient group

» Active external rewarming may involve using electric heat pads or blankets, hot water bottles, chemical heat pads, or forced air warming.[48]

» It is critical that patients with moderate or severe hypothermia have their core temperature and hemodynamic status continuously monitored during rewarming.[48] Heat redistribution within the body can cause a continued fall in core temperature after removing the patient from a cold environment (also known as afterdrop).

» Avoid hyperthermia during and after rewarming.[19]

plus **warmed intravenous fluids**

Treatment recommended for ALL patients in selected patient group

» Give warmed intravenous fluids, especially once rewarming measures have been started. This should be with normal saline, warmed to 104°F to 107.6°F (40°C to 42°C).[48] Warmed intravenous fluids help to prevent heat loss but do not actively rewarm the patient. Infusing warmed intravenous fluid also offers the additional advantage of improved absorption of administered drugs. Lactated Ringer solution should be avoided as the liver will not be able to metabolize lactate in hypothermia.[48]

» Circulatory access via a peripheral intravenous catheter is the preferred method, though this may be difficult to achieve in hypothermic patients because of cold-induced peripheral vasoconstriction.[48] If not immediately possible, intraosseous access should be established instead.

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» It is important that patients are carefully monitored for signs of fluid overload and volume depletion. It is likely that large volumes of fluid will be required because vasodilation during rewarming causes expansion of the intravascular space and subsequent hypotension.[19] [48] Warmed intravenous fluids should ideally be administered via boluses, guided by vital signs (heart rate and blood pressure) as opposed to continuous infusion, as this will help avoid issues with fluid cooling or lines freezing.[19] [48]

plus **extracorporeal life support (ECLS) rewarming**

Treatment recommended for ALL patients in selected patient group

» For patients with severe hypothermia (core temperature ≤86°F [≤30°C]) and cardiac arrest, extracorporeal rewarming is the preferred method as it allows for rapid rewarming.[19] [20] [45][48][49] Patients with severe hypothermia, hemodynamic instability, or witnessed out-of-hospital cardiac arrest and those at risk of imminent cardiac arrest should be transferred to centers capable of providing ECLS.[20][45][48] Patients are at risk of imminent cardiac arrest if they have any of the following: core temperature <86°F (<30°C), or <89.6°F (<32°C) if the patient is frail with multiple comorbidities; ventricular arrhythmia; systolic blood pressure <90 mmHg.[20]

» ECLS rewarming provides sufficient circulation and oxygenation while the core body temperature is increased at a rewarming rate of 39.2°F to 50°F (4°C to 10°C) per hour.[19] Preferably, ECLS rewarming should be performed with extracorporeal membrane oxygenation (ECMO) over cardiopulmonary bypass (CPB).[48]

» Other methods of active internal rewarming (lavage, veno-venous rewarming, continuous renal replacement therapy [CRRT], and hemodialysis) are less effective and may only be recommended where ECLS rewarming is unavailable.[19] Irrigation with normal saline (lavage) can be peritoneal, thoracic, gastric, bladder, or colonic, warmed to 104°F to 107.6°F (40°C to 42°C).[19] [48]

» It is critical that patients with moderate or severe hypothermia have their core temperature and hemodynamic status continuously monitored during rewarming.[48] Heat redistribution within the body can cause a continued fall in core

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temperature after removing the patient from a cold environment (also known as afterdrop).

» Avoid hyperthermia during and after rewarming.[19]

adjunct **hemofiltration**

Treatment recommended for SOME patients in selected patient group

» Continuous veno-venous hemofiltration (CVVH), a type of continuous renal replacement therapy, may be considered in patients with hyperkalemia (e.g., due to rewarming or rhabdomyolysis) or acidosis.[61] CVVH is also a form of active internal/core rewarming.[19]

Primary prevention

Dressing appropriately for cold weather conditions and staying dry and out of the wind are essential to prevent effects from cold temperatures. Alcohol and overexertion should be avoided in very cold weather.

Healthcare workers should cover cold patients with warming blankets, which may also be used during and after surgical procedures. Homes with older people and/or young children should set the indoor thermostat to an appropriate temperature during the day and night.

Active prewarming of patients for at least 30 minutes before general anesthesia is recommended to prevent hypothermia and reduce shivering.[32] [33]

Public health strategies aimed at mitigating the health impact of cold weather on homeless people is critical.[16]

[CDC: preventing hypothermia] (https://www.cdc.gov/winter-weather/prevention/index.html)

Patient discussions

Although typically associated with trauma, outdoor exposure, or cold-water submersion, hypothermia may occur indoors and in hospitalized patients. At-risk patients should dress appropriately for conditions, stay dry, avoid cold and windy conditions, and avoid drinking alcohol or overexertion in very cold weather. Homes with older people, infants, or anyone else at risk of hypothermia should set their thermostat to an appropriate level at all times. People submerged in cold water should only attempt to swim when close to a boat or near the shore, to conserve energy. [CDC: preventing hypothermia] (https://www.cdc.gov/winter-weather/prevention/index.html)

Monitoring

Monitoring

Patients with mild hypothermia (temperatures of 90°F to 95°F [32°C to 35°C]) who have been rewarmed and are in stable medical condition may be discharged from the hospital, with no further follow-up required. Those with associated underlying medical problems or with core temperature <90°F (<32°C) require continued hospitalization for careful monitoring.

FOLLOW UP

Complications

Complications	Timeframe	Likelihood
cardiac arrhythmias secondary to hypothermia	**short term**	**high**
May occur due to the effect of cold temperatures on the heart. All types of cardiac arrhythmias are known to occur, the most common being atrial fibrillation and ventricular fibrillation. Atrial fibrillation may resolve spontaneously as the patient is rewarmed. Ventricular fibrillation may be refractory to treatment and may require defibrillation.[19] [20] [45] If defibrillation fails, it may be appropriate to defer further defibrillation until the patient is rewarmed above 86°F (30°C).[19] The hypothermic heart is very sensitive to movement, so movement should be minimized.		
hypoglycemia	**short term**	**medium**
Requires treatment with 50 mL of a 50% dextrose intravenous push.		
hyperkalemia	**short term**	**medium**
Hyperkalemia may occur during rewarming. With ECG changes, hyperkalemia requires prompt treatment with calcium gluconate to stabilize the myocardium, and an insulin dextrose infusion. Sodium bicarbonate infusion is required if the hyperkalemia is the result of acidosis.		
rhabdomyolysis	**short term**	**medium**
May occur in those exposed to the cold for a prolonged time and/or enduring a crush injury. The symptoms are often nonspecific. Up to 15% of patients develop acute kidney injury.[67] This is a direct result of mechanical obstruction of the renal tubules by myoglobin precipitate and is associated with a high morbidity and mortality. The release of vasoactive kinins by the damaged muscles interferes with the renal hemodynamics. A creatine kinase (CK) level of ≥16,000 units is associated with the development of acute kidney injury.[67] As a direct consequence of rhabdomyolysis, hypocalcemia, hyperkalemia, cardiac arrhythmias, cardiac arrest, acute compartment syndrome (day 3 through 5 of presentation), and disseminated intravascular coagulation may occur. The objectives are to alkalinize the urine to a pH >6.5 and to ensure flushing of myoglobin. Forced diuresis with sodium bicarbonate infusion may prevent acute kidney injury. Urine output must be maintained at a rate of >300 mL/hour and normal saline infusion is given at rate of 1.5 L/hour until the myoglobinuria stops or the CK level is <1000 units/L. Serial CK levels should be monitored.		
gastrointestinal disorders	**short term**	**medium**
At temperatures <93.2°F (<34°C), intestinal motility is impaired resulting in paralytic ileus. Punctate hemorrhages and gastric erosions, known as Wischnewski ulcers, may occur, but are clinically insignificant.[68] Hepatic impairment can develop, probably due to the reduced cardiac output. Pancreatitis is discovered in 20% to 30% of autopsies performed on hypothermic patients.[69]		

Complications	Timeframe	Likelihood
bleeding diathesis	**short term**	**medium**
Hypothermia leads to coagulopathy due to platelet dysfunction, enhanced fibrinolytic activity, and changes in enzymatic activity. Inhibition of thromboxane B2 production causes a decrease in platelet aggregation. Hypothermia also causes a release of a heparin-like substance, which induces disseminated intravascular coagulation, characterized by prolonged prothrombin time and PTT and an increase in D-dimer. Hypothermia alters enzymatic activity such that the Hageman factor and thromboplastin fail to act effectively. Prolonged bleeding and clotting times result. Patients may require treatment with clotting factors and platelets. Intravenous fluid resuscitation may dilute available clotting factors; these patients may require transfusion with clotting factors and/or platelets. Treatment is often not successful until the associated acid and base derangement is corrected.		
bladder atony	**short term**	**medium**
Usually reversible if the patient survives the hypothermic injury. Requires treatment with an indwelling catheter.		
local injuries	**variable**	**high**
Cold-induced local injuries may vary in severity, from blistering to skin necrosis due to profound vasoconstriction. Severe injuries may require prolonged supportive management, escharotomy, skin grafting, or amputation. If not interfering with movement, blisters should not be drained. If blisters have ruptured, the dead skin must be excised and the wound covered with topical antibiotic ointment. Frostbite is a local cold-induced injury typically affecting exposed body parts such as the face and extremities. The injuries may vary in severity, and may warrant extensive hospitalization and surgical intervention. Typically, in superficial injury, the damage is to the skin and subcutaneous tissue and can be easily recognized on rewarming by the presence of a clear blister. Deep frostbite, on the other hand, affects the bone and on rewarming is associated with hemorrhagic blisters. Tetanus prophylaxis should be given in patients with extensive injury.		
cardiac arrhythmias secondary to active external rewarming	**variable**	**low**
Reduced coronary perfusion may occur during active external rewarming especially if the extremities are rewarmed concurrently. Cardiac arrhythmias may result.[19] [21] [27] [70] The hypothermic heart is very sensitive to movement, so movement of the patient should be minimized. Even with treatment, management of ventricular fibrillation may be problematic. The hypothermic heart may be unresponsive to defibrillation; however, there is an absence of robust supporting data.[20] [45] If defibrillation fails, it may be appropriate to defer further defibrillation until the patient is rewarmed above 86°F (30°C).[19] Most other arrhythmias will improve with rewarming.[19]		

FOLLOW UP

Prognosis

Generally, patients with mild hypothermia will recover without any residual effects.[19] Resuscitation and recovery of patients with moderate and severe hypothermia depends on several factors such as cold exposure duration, associated injuries, comorbidities, and the degree of hypothermia. The triad of coagulopathy, acidosis, and hypothermia is associated with increased mortality, particularly among patients with severe injuries.[2] [3]

The lowest ever recorded temperature in a patient successfully resuscitated from accidental hypothermia with circulatory arrest is 56.7°F (13.7°C).[62] Good physical and mental recovery was also reported in this case. Numerous case reports in the literature have also demonstrated the potential of successful resuscitation with good neurologic recovery even in cases of prolonged cardiac arrest.[63] [64] Patients should not be declared dead prior to full resuscitative measures and aggressive rewarming, unless in the case of nonsurvivable traumatic injury or rigor mortis.[45]

Evidence suggests that extracorporeal life support (ECLS) offers a better survival outcome than other treatment modalities in patients with hemodynamic instability and cardiac arrest.[19] [57] [58] [65] [66] One systematic review found that ECLS rewarming was associated with an 80% survival probability at 5 months follow-up; only 19.4% of survivors reported any long-term cognitive impairments.[57] Survival was associated with serum potassium, initial body temperature, and ECLS rewarming rate, although patient age was not found to be significantly associated.[57] Slower rewarming rates of ≤41°F (≤5.0°C) per hour are associated with improved survival with good neurologic outcomes.[66]

One retrospective cohort study among patients with moderate and severe hypothermia from the International Hypothermia Registry found a 95% survival rate for patients with preserved circulation, and a 36% survival rate for patients with hypothermic cardiac arrest.[17] The majority of cases were secondary to mountaineering accidents in young, healthy men. The study found that predictors of survival included witnessed cardiac arrest, restoration of spontaneous circulation, low potassium and lactate, and the absence of asphyxia.[17]

Serum potassium is part of the HOPE (Hypothermia Outcome Prediction after ECLS rewarming for hypothermic arrested patients) score for prognostication of successful rewarming.[20] [48]

Diagnostic guidelines

International

Clinical practice guidelines for the out-of-hospital evaluation and treatment of accidental hypothermia (https://www.wemjournal.org/content/collection_practice_guidelines) [48]

Published by: Wilderness Medical Society **Last published:** 2019

Clinical staging of accidental hypothermia: the revised Swiss system recommendation of the International Commission for Mountain Emergency Medicine (ICAR MedCom) (https://www.resuscitationjournal.com/article/S0300-9572(21)00096-4/fulltext) [47]

Published by: International Commission for Mountain Emergency Medicine (ICAR MedCom) **Last published:** 2021

Treatment guidelines

International

2020 American Heart Association guidelines for cardiopulmonary resuscitation and emergency cardiovascular care: adult basic and advanced life support (https://cpr.heart.org/en/resuscitation-science/cpr-and-ecc-guidelines) [45]

Published by: American Heart Association **Last published:** 2020

Clinical practice guidelines for the out-of-hospital evaluation and treatment of accidental hypothermia (https://www.wemjournal.org/content/collection_practice_guidelines) [48]

Published by: Wilderness Medical Society **Last published:** 2019

European Resuscitation Council guidelines 2021: cardiac arrest in special circumstances (https://www.resuscitationjournal.com/article/S0300-9572(21)00064-2/fulltext) [20]

Published by: European Resuscitation Council **Last published:** 2021

Online resources

1. CDC: preventing hypothermia (https://www.cdc.gov/winter-weather/prevention/index.html) *(external link)*

Key articles

- Paal P, Pasquier M, Darocha T, et al. Accidental hypothermia: 2021 update. Int J Environ Res Public Health. 2022;19(1):501. Full text (https://www.mdpi.com/1660-4601/19/1/501) Abstract (http://www.ncbi.nlm.nih.gov/pubmed/35010760?tool=bestpractice.bmj.com)
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Images

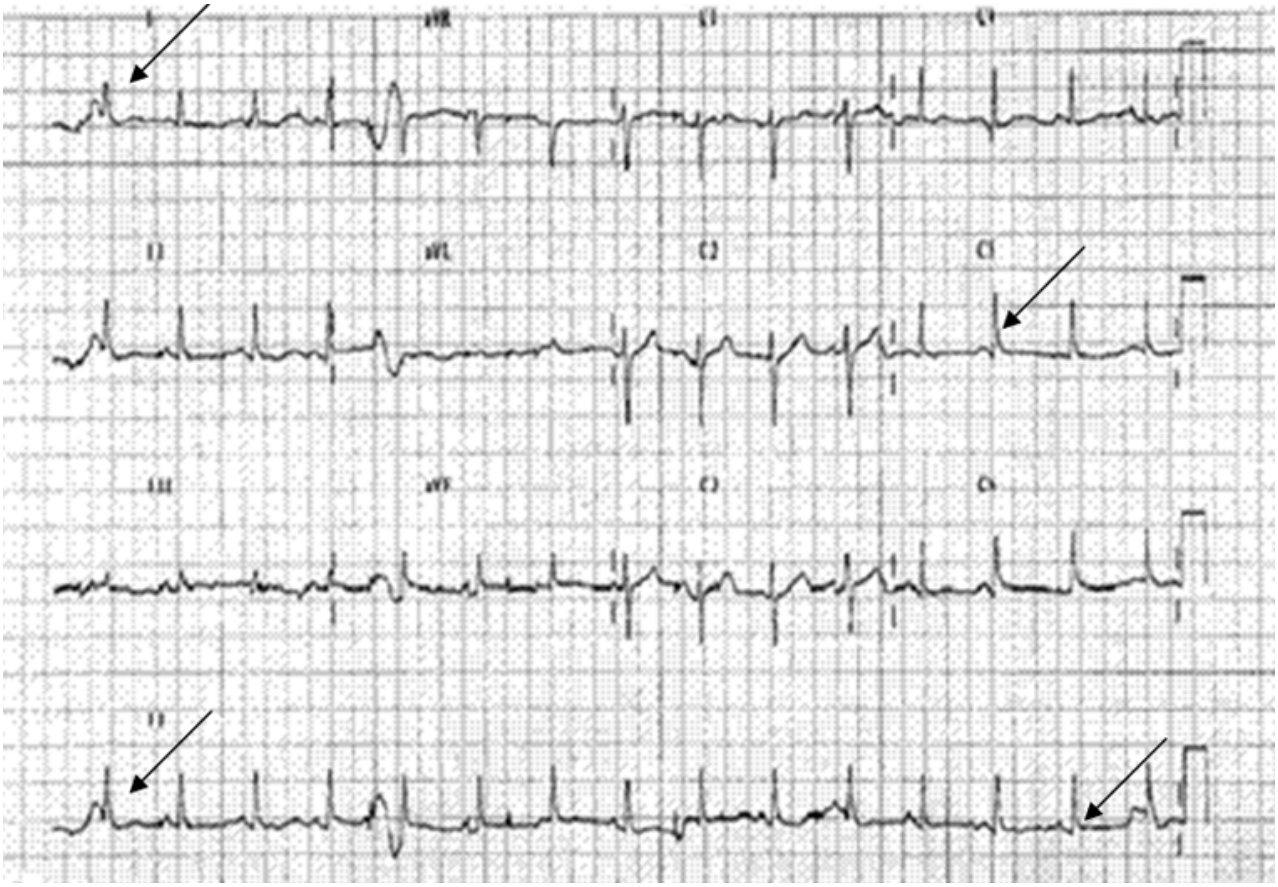

Figure 1: A 12-lead ECG obtained from a hypothermic patient; note, Osborn waves (arrows), which have an extra deflection at the end of the QRS complex

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Figure 1 – BMJ Best Practice Numeral Style

5-digit numerals: 10,000

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