Management of acute hypothermia

Gordon Morrison

Abstract

Hypothermia is an involuntary drop in core body temperature to <35 °C and is associated with considerable morbidity and mortality. The accurate measurement of core temperature can be difficult, and individuals' physiological responses to a cold insult can vary widely. Hypothermia can be primary or secondary. This article reviews the likely presenting features, classification and management options in acute hypothermia. Prognosis has been greatly improved through advances in the safety and availability of rewarming techniques, especially in cardiac arrest with the use of extracorporeal membrane oxygenation (ECMO) and cardiopulmonary bypass. In severe hypothermia, the use of ECMO can improve survival and recovery rate by 47–63%, even following hypothermia-related cardiac arrest.

Keywords Accidental hypothermia; cold; hypothermia; resuscitation; rewarming; wilderness medicine

Key points

- Hypothermia is an involuntary drop in core body temperature to <35 °C
- Severity is graded by core temperature and presenting signs
- Treatment of mild to moderate hypothermia is largely by non-invasive, external rewarming
- The risk of arrhythmia and cardiac arrest increases at temperatures <32 °C
- Treatment of moderate to severe hypothermia is invasive rewarming with haemodialysis, extracorporeal membrane oxygenation or cardiopulmonary bypass
- In cardiac arrest, resuscitation attempts should continue and death should not be declared until the core temperature is >35 °C

Introduction

Hypothermia is an involuntary drop in core body temperature to <35 °C (95.8 °F).[1–3] Adults aged 30–49 years are most commonly affected, while death is more likely in those >65 years of age.[4] It can occur in a wide variety of scenarios, from people taking part in outdoor work, recreation and expeditions, to the other end of the scale with people suffering homelessness or the use of alcohol or other intoxicating substances that impair mobility and judgement. One must not forget neglect as a potential risk factor in vulnerable groups such as children and elderly or disabled individuals. Accidental hypothermia may be underdiagnosed, particularly in temperate climates. It is a condition associated with significant morbidity and mortality, and certain treatments may only be available in specialist centres.

Presentation

The human body attempts to maintain a core temperature of 37 ± 0.5 °C. Hypothermia occurs when excessive cold exposure overcomes the body's ability to compensate and produce heat. Thermoregulation is controlled in the brain by the hypothalamus, which responds to signals from peripheral and central thermal receptors.[2] When thermoregulation is impaired, for example in the very young or the elderly, hypothermia can follow even a mild insult and can occur even in a warm environment.

Initial exposure to cold causes active movement and shivering in order to generate heat, raise metabolism and attempt to maintain core temperature.[3] Vigorous shivering can increase heat production by 5–6 times the resting metabolic rate, and raise core temperature by 3–4 °C per hour. It uses a large amount of energy, stresses the cardiovascular system and causes the individual a great degree of discomfort. It is dependent on nutritional reserves and the degree of body insulation.

Accompanying shivering, the initial physiological response is increased ventilation and cardiac output up until the point where core temperature falls to <32 °C; ventilation and cardiac output then start to decline.[3] Neurological activity deteriorates at <34 °C, and patients are typically unconscious by <28 °C (Table 1).

Bradycardia usually occurs and shivering typically ceases at <30 °C. Cardiac rhythm disturbances such atrial ectopics, atrial fibrillation and ventricular fibrillation (VF) can occur. Below <28 °C, the heart is very susceptible to VF and asytole.[3] As core temperature drops, hypoventilation leads to hypoxia, hypercarbia and respiratory acidosis. Antidiuretic hormone release is reduced, causing a cold diuresis and fluid shifts to the extravascular space, compounding circulatory collapse.[5] As the cells become hypoxic and die, potassium levels increase.[2] Clotting factor activity and platelet function also decrease, potentially resulting in coagulopathy.

Skin can become white or oedematous and can also show signs of hypothermic tissue injury. This occurs particularly at the peripheries such as the hands and feet, but also in other exposed areas such as the ears, nose and cheeks.[4] In severe cases, cardiac arrest can be the presenting condition. The risk of cardiac arrest increases at <32 °C and even more at <28 °C.[1] In summary:

- <36 °C – shivering, increased cardiac output and ventilation
- <34 °C – neurological function (and Glasgow Coma Score) declines
- <32 °C – increased risk of cardiac arrhythmias and cardiac arrest

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Signs of altered level of consciousness[1–3]

- Irritability
- Apathy
- Confusion
- Amnesia
- Poor decision-making
- Slurred speech
- Hallucinations
- Lethargy
- Somnolence
- Coma

Table 1

- <30 °C – bradycardia, shivering ceases
- <28 °C – unconsciousness and cardiac arrest.

The risk of hypothermia is increased by alcohol or drug ingestion. Similarly, exhaustion, concurrent illness or trauma can make it more likely by decreasing physiological reserve and diminishing shivering.

Primary and secondary causes of hypothermia

Primary hypothermia is caused by exposure to excessive cold that overcomes the body's ability to maintain a normal core temperature. Secondary causes are shown in Table 2.

Assessment

History-taking may be difficult in those with an altered level of consciousness, and treatment and resuscitation must be the priority. When possible, a history should be taken, from either the patient or a witness. The history should seek to determine the exposure and duration of the cold insult. A full past medical history should aim to identify potential secondary causes and likely continuing risk in the future – this is particularly important with elderly individuals.[1]

The patient should be assessed in line with acute life support guidelines using the ABCDE approach as normal. Be aware, however, that co-morbidity, sepsis, toxicity, head injury and trauma can also be contributing to the patient's condition. The aim of the examination is to determine the severity of hypothermia and, in doing so, ascertain the correct management. All vital signs should be recorded and monitored regularly until normal temperature has been achieved. Continuous cardiac monitoring is essential in all cases.

Body temperature readings may vary from site to site depending on perfusion. A properly calibrated tympanic membrane thermometer will give an accurate reading of brain temperature if the ear canal is free of debris such as ice, but it relies on adequate cardiac output.[2] The most accurate measurement of core temperature is an oesophageal thermometer, which can only realistically be used in intubated patients. It gives an accurate reading of cardiac temperature.[3]

Bladder and rectal thermometers are not recommended as the readings often lag behind core temperature.[3] Oral and infrared thermometers are typically unable to read temperatures accurately <35 °C and are therefore not recommended.[2]

Secondary causes of hypothermia[1–3]

Impaired thermoregulation

- Central failure due to:
  - Anorexia nervosa
  - Cerebrovascular accident
  - Central nervous system trauma
  - Hypothalamic dysfunction
  - Metabolic failure
  - Neoplasm
  - Parkinson's disease
  - Drugs or toxins
  - Subarachnoid haemorrhage
- Peripheral failure due to:
  - Acute spinal cord transection
  - Decreased heat production
  - Neuropathy
- Endocrine failure due to:
  - Alcoholic or diabetic ketoacidosis
  - Hypoadrenalism
  - Hypopituitarism
  - Lactic acidosis
- Insufficient energy due to:
  - Extreme physical exertion
  - Hypoglycaemia
  - Malnutrition
- Neuromuscular compromise due to:
  - Recent childbirth or advanced age with inactivity
  - Impaired shivering

Increased heat loss

- Dermatological disorder due to burns or exposure to medications or toxins
- Iatrogenic causes, such as:
  - Emergency childbirth
  - Cold infusions
  - Heat stroke therapy
- Other associated clinical states, including:
  - Carcinomatosis
  - Cardiopulmonary disease
  - Major infection (bacterial, viral, parasitic)
  - Multisystem trauma
  - Shock

Table 2

Classification of severity

The most common classification is determined by core temperature (Table 3).[3,5] The alternative method is the Swiss classification system (Table 4), which is designed to 'estimate' core temperature using the presenting signs; this is useful in the prehospital setting.

Tests that should be undertaken are:

- bloods – full blood count, clotting, urea and electrolytes, C-reactive protein, lactate, pH, blood cultures
- electrocardiography
- chest X-ray
- trauma imaging series (computed tomography) if appropriate.

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