

Accidental hypothermia

Hypothermia is a fall in core body temperature below 35°C. Hypothermia may be subdivided into mild (core body temperature 32.2–35°C), moderate (<32.2–28°C) and severe (<28°C).^{1,2} Prevention of hypothermia is crucial as is ensuring there is financial support available to help older people keep warm. This article will discuss the risk factors, management and the prevention of hypothermia, with particular emphasis on how this condition affects older adults.

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Accidental hypothermia is a condition of importance to health workers in both primary and secondary care. Older adults and patients with debilitating disease are susceptible to hypothermia and need to be managed appropriately in emergency units.

The hypothalamus responds to a fall in body temperature by effector mechanisms such as vasoconstriction of peripheral blood vessels, increased muscle tone, shivering and release of catecholamines. Behavioural adaptations include wearing warm clothes and seeking shelter.

and attributed to cardiovascular or respiratory disease rather than to hypothermia.⁷ It is not clear whether excess winter deaths are related to inadequately heated homes or to poverty.^{7,8} The UK Government is monitoring excess winter deaths and is introducing measures to protect vulnerable people during the winter.

Pathophysiology¹⁻⁴

Heat may be lost from the body by radiation, conduction, convection and evaporation. Heat is lost by intra-red radiation to cold surrounding objects, for example the roof, windows or floor in a house. Conduction refers to heat loss by direct contact with cooler objects. For example, immersion in cold water or lying on a cold concrete floor following a fall. Convection refers to heat loss by air currents disrupting the thin warm layer of air that surrounds the body. Gaps in the doors and windows may allow cold air to enter the house and may accelerate heat loss. In addition, heat may be lost by evaporation of water from the body.

Epidemiology

In 1997, the number of deaths from hypothermia was recorded as 357 in England and Wales and this has declined over the preceding few years.^{5,6} This is likely to be an underestimate of the true extent of hypothermia-related death as it is possible that medical practitioners under-report hypothermia as a cause of death or hospital admission.

There have been more deaths in winter months (December to March) compared with non-winter months.^{6,7} In 2010–2011 the number of “excess winter deaths” was approximately 25,700, unchanged from the previous year.⁶ The majority of these deaths are in the elderly

Risk factors for hypothermia

Older adults may be susceptible to hypothermia for several reasons. Studies have shown that the elderly have a reduced peripheral vasoconstrictor response to cold and a lower basal metabolic rate compared to younger adults.⁹⁻¹¹

Accidental falls are more common in the elderly and a subsequent long-lie may lead to heat loss by conduction of heat to the floor.¹²

In patients with dementia there is tendency to wander outdoors and the behavioural response to cold such as dressing in warm clothes or turning on

Box 1: Risk factors for hypothermia²⁴

- Chronic debilitating conditions, for example Parkinson's disease or stroke^{13,15}
- Malnutrition and self-neglect^{15,25,26}
- Dementia¹²
- Hypothyroidism, hypopituitarism, and hypoadrenalism^{1,11}
- Diabetes mellitus and complications such as hypoglycaemic or non-ketoacidotic coma¹⁷⁻²⁰
- Septicaemia, pneumonia, urinary tract infection, and cellulitis^{27,28}
- Alcohol consumption, acute intoxication, and chronic misuse^{13,21}
- Substance misuse, for example cannabis and narcotics²⁹
- Neuroleptic drugs, such as olanzapine and chlorpromazine^{1-4,22}
- Burns, exfoliate dermatitis, and severe psoriasis¹
- Poverty, poor quality accommodation, and social isolation¹⁵
- Insufficient heating and home insulation¹⁵
- Fear of accumulating heating costs¹⁶
- Drowning or immersion^{1,30}

the heating may be lacking.^{13,14} Older adults and other vulnerable groups may be at risk of fuel poverty and may have sub-standard insulation or heating.¹⁵⁻¹⁶

Diabetics may develop hypothermia due to hypoglycaemic induced coma or non-ketoacidotic coma.¹⁷⁻²⁰ Alcohol is frequently implicated in the cause of hypothermia^{17,21} by inducing cutaneous vasodilation and impaired gluconeogenesis. Chronic alcohol consumption may lead to malnutrition. Neuroleptics such as olanzapine and chlorpromazine have been implicated as a risk factor for hypothermia.^{4,22} Myxoedema, adrenocorticoid deficiency and hypopituitarism are also risk factors for hypothermia.¹⁻⁴

Clinical presentation

The symptoms and signs of hypothermia depend on the

severity.^{1-4,23} A history of exposure to cold or immersion will help establish the diagnosis. For other patients, the presentation may be subtle hence a high index of suspicion is required.

Mild hypothermia

The patient may present with apathy, disorientation, lassitude, slurred speech and uncooperative behaviour. Physical examination may reveal tachycardia, elevated blood pressure, shivering and ataxia. Paradoxical undressing refers to the phenomenon whereby the patient takes off their clothes as their core body temperature is lowered.

Moderate hypothermia

As core body temperature decreases, the patient may develop progressive deterioration in level of consciousness and shivering may cease. Tendon reflexes tend to be diminished. Pulse rate and respiratory rate

decreases and atrial or ventricular arrhythmia may develop. The J wave may be present on ECG.

Severe hypothermia

The level of consciousness, pulse rate, blood pressure and respiratory rate progressively declines, tendon reflexes may be absent and pupils may be dilated and non-reactive. The risk of ventricular arrhythmias or asystole rises. Pulmonary oedema may occur and reduced renal perfusion leads to oliguria.

Tympanic thermometers are frequently used to determine core body temperature in patients with hypothermia; however, their accuracy has been questioned.³¹⁻³³

Immediate investigations

The priority is to check blood glucose as hypoglycaemia or hyperglycaemia may cause coma.

Hypoglycaemia may be a result of diabetes; however there are other causes of hypoglycaemia such as insulin secreting tumour or adrenocortical deficiency.

Urea and electrolytes

Urea and electrolytes need to be checked and it should be remembered that Na and K may be available as part of an arterial blood gas measurement. Hypokalaemia or hyperkalaemia may be detected. Hyperkalaemia may be severe in patients with hypothermia³⁴ and if elevated will need urgent treatment. Renal insufficiency may be caused by rhabdomyolysis or a consequence of reduced renal perfusion.

Full blood count

Hypothermia causes a cold diuresis and as a result of decreased plasma volume, hematocrit increases.

Electrocardiography

This may detect the classic J wave. More commonly, arrhythmias such as atrial fibrillation may be recognised.

Arterial blood gases

Arterial blood gas measurement should usually be checked in critically ill patients. Metabolic acidosis is a feature of severe hypothermia and may be a consequence of lactic acidosis consequent upon poor tissue perfusion. Type I or type II respiratory failure may be present.

Interpreting arterial blood gases is difficult in people with hypothermia as blood gas analysers warm the sample to 37°C and potentially report misleading partial pressure of pO₂ and PCO₂. This is a complex area for

discussion and beyond the scope of this article; however, many experts are of the opinion that the values uncorrected for temperature should be used.^{1-4, 24}

Management

The priority for a patient with reduced level of consciousness is to assess the airway, breathing and circulation.³⁵ If there are concerns that airway is not maintained or patient has respiratory or circulatory failure then, if appropriate, the critical care team will need to be informed.

Warm humidified oxygen therapy is recommended. The patient may be dehydrated and infusion of warm intravenous fluid,^{1-4, 36} heated to a temperature of 40–42 deg C,² is indicated. In the past, there were concerns that invasive procedures such as intubation may cause lethal arrhythmias, however recent resuscitation guidelines have stated that these procedures may be performed, if required.³⁵

For patients that are haemodynamically stable with mild hypothermia passive rewarming is indicated. This involves covering the body and head with warm blankets.

For patients with moderate to severe hypothermia, use of active external rewarming methods may be used. The forced air rewarming blanket, commercially known as the Bair Hugger blanket, is made up of long tubular channels attached to a heating unit that is able to deliver warm air to the body.

Complications of the forced air rewarming blanket

include hypotension as a consequence of peripheral vasodilatation. Afterdrop is a fall in core body temperature due to peripheral vasodilatation and release of cold blood to the body core. Clinical trials are limited but reported that the incidence of complications is low and the device is effective in rewarming.^{37, 38} In view of aforementioned concerns, it is essential to monitor vital signs closely during rewarming.

Observational studies have reported the effectiveness of extracorporeal methods of rewarming such as cardiopulmonary bypass.³⁹ For patients with hypothermia and cardiac arrest, cardiopulmonary bypass should be strongly considered if available and guidelines support their use.³⁵ Peritoneal dialysis or pleural cavity lavage with warm fluids are methods of rewarming.

If the patient has a suspected or known history of alcoholism or is malnourished, thiamine replacement is necessary. Parental thiamine may be replaced in the form of Pabrinex. It is important to prescribe intravenous Pabrinex immediately for susceptible patients to avoid the risk of Wernicke-Korsakoff syndrome and permanent neurological damage.

Intravenous steroids may be administered if hypoadrenalism or myxoedema coma is suspected. In the acute scenario it may be difficult to spot features of these conditions hence steroids may be administered if there is a clinical suspicion. Parental steroids are not appropriate for routine use in the patient with hypothermia.

Signs of sepsis are not necessarily usually present in patients with hypothermia. Some studies have shown that infection is common in patients with hypothermia and may be missed in the acute phase, leading to delays in administration of antibiotics.²⁸ Therefore, if sepsis is suspected antibiotics may be administered.

Resuscitation

Case studies have shown that patients with severe hypothermia and cardiac arrest may survive even if resuscitation continues for several hours. Hypothermia exerts protective effects on the brain, illustrated by one case report that documented recovery after resuscitation for 6.5 hours.⁴⁰ Therefore, some patients with hypothermia may require prolonged resuscitation. The statement “no one is dead until warm and dead” is included in modern resuscitation guidelines and is a useful guide.^{35,41} Rewarming should continue until core body temperature is 30–32°C.²

The decision to terminate resuscitation may be made by the attending senior physician. For example, if a patient has a terminal illness such as disseminated malignancy or in the terminal stages of dementia then the physician may decide to terminate resuscitation.

Arrhythmia management

Atrial arrhythmias usually do not require treatment and usually resolve following rewarming. For patients with ventricular arrhythmias there are clear guidelines. If ventricular fibrillation is present and core

body temperature is below 30°C, three shocks maximum should be given. Moreover, below 30°C, adrenaline or other CPR drugs are not recommended.³⁵ Once core body temperature has reached 30°C the interval between drug administration should be doubled compared to recommendations for normothermic patients.³⁵ The reason is that drugs may accumulate in the venous circulation in a patient with hypothermia and released upon rewarming.

Preventing hypothermia

It is the responsibility of health workers, with support from the public, to help older adults and vulnerable people keep warm in the winter.

The Age UK and NHS websites have listed helpful advice on keeping warm.⁴²⁻⁴⁴ Included in these documents is advice on maintenance of central heating and gas boilers, insulating the loft, draught proof doors and windows, checking the safety of electrical equipment and ensuring electric fires are guarded. Advice on keeping warm includes wearing several thin garments rather than one thick garment, wearing a hat and scarf in cold weather, keeping mobile and healthy eating.

There are several financial grants to help including the winter fuel payment, the cold weather payment and warm home discount. Healthcare workers are in a position to advise vulnerable adults on keeping warm and what grants are available to help with

finances. Age UK have initiated a “spread the warmth” campaign to help elderly people keep warm. The public are asked to donate a coat or another item or to provide information to older people to help keep warm.

Conclusion

This article has discussed the management of hypothermia, including passive and active rewarming methods. Patients with hypothermia and cardiac arrest may require prolonged resuscitation and it is important to remember the statement “no one is dead until warm and dead”. Hypothermia is not a common cause of hospital admission; however, healthcare workers need to be familiar with management. Healthcare workers in the community need to focus on prevention and need to educate older people on the need to keep warm.

Conflict of interest: none

References are available from online version at www.gmjjournal.co.uk