BMJ Learning

Accidental hypothermia

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Hypothermia is a life threatening condition, and management can be challenging, with little robust evidence to support the various treatments. This article should help doctors to understand the condition better

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Hypothermia can be defined as an unintentional fall in core body temperature below 35°C.[1] It can be classified as mild (core body temperature 32.2-35°C), moderate (< 32.2-28°C), or severe (< 28°C).

Why is temperature homoeostasis important?

Maintaining a normal body temperature is essential for our metabolism to function optimally. The human body has developed an elaborate system for balancing heat production and heat loss.

How is heat generated?
In simple terms, heat is generated by the metabolic processes that occur within the tissues of the body, such as fat and muscle.[2] Metabolic rate refers to the rate of heat liberated during these chemical reactions.[2] In a cold environment, involuntary contraction and expansion of muscle groups generates warmth. This process is known as shivering.

How is heat lost from the body?
Heat is lost by radiation, conduction, convection, and evaporation.[2]

- Radiation—Loss of heat may occur to surrounding cooler objects in the form of infrared radiation
- Conduction—Heat may be lost to objects close to the skin, such as a chair, a bed, or the floor. Heat may also be lost by conduction to the surrounding air
- Convection—Removal of body heat by air currents
- Evaporation—Heat may be lost by evaporation of water from the body.

How is core body temperature regulated?
Thermoreceptors are located centrally and peripherally.[1 2]

Clinical tips

As a general rule
- Mild hypothermia should usually be treated with passive rewarming
- Moderate and severe hypothermia should usually be treated with active rewarming

Summary points

- Older adults and people with debilitating disease and malnutrition are at risk of hypothermia
- Hypothermia may be mild, moderate, or severe. If severe, patients are at risk of lethal arrhythmias and respiratory failure
- Rewarming methods include giving warm intravenous fluids, using forced air rewarming systems, and covering the head and body with warm blankets
- Cardiac arrest in a patient with severe hypothermia needs special consideration
- Healthcare professionals are in a position to advise elderly people on how to keep warm in the winter

Peripheral thermoreceptors are present in the skin. In a cold or warm environment impulses from the thermoreceptors are transmitted to the hypothalamus.

Central thermoreceptors located in the pre-optic nucleus in the anterior hypothalamus are stimulated when the core body temperature changes.

The hypothalamus responds to changes in body temperature with various effector mechanisms, such as shivering (to increase heat production) and vasoconstriction of peripheral and cutaneous arterioles (to limit heat loss). Behavioural adaptations include wearing warm clothes and seeking shelter.

How does hypothermia develop?

In a cold environment effector mechanisms attempt to maintain normal body temperature. If exposure to the cold continues, the body becomes fatigued and is unable to generate sufficient warmth.

How common is hypothermia?

Hypothermia is an unusual cause of hospital admission[3] and death,[4] but this may reflect deficiencies in reporting procedures. Hypothermia was mentioned on the death certificate for 236 people in 2003 (in England and Wales).[4] The death rate is highest in older adults. The number of deaths from hypothermia has gradually fallen since 1997.[4]

What conditions predispose to hypothermia?

Old age—Compared with younger adults, elderly people have a lower basal metabolic rate,[2 5] an impaired vasoconstrictor response to cold,[6] and reduced ability to recognise lower ambient temperature.[7]

Malnutrition, self neglect, and chronic debilitating conditions (such as Parkinson's disease or stroke)—These patients are less likely to be able to generate heat by mobilisation. Furthermore, reduced muscle mass depresses the size of the shivering response to cold. Malnourished patients have a low basal metabolic rate,[8] as a consequence of a reduction in muscle and fat reserves.

Dementia—The behavioural response to cold is impaired in people with dementia, and they may not seek shelter or dress in warm clothes in cold weather.[9]

Hypothyroidism, hypopituitarism, and hypoadrenalism—These patients have a reduced metabolic rate.[1 5]

Septicaemia, pneumonia, urinary tract infection, and cellulitis—Sepsis may cause peripheral vasodilation and subsequently promote cutaneous heat loss. Release of cytokines may impair thermoregulation.[10 11]

Alcohol consumption, acute intoxication, and chronic misuse—Alcohol compromises gluconeogenesis, thereby heat production. Chronic alcohol use predisposes to malnutrition.[12 13]

Substance misuse (such as cannabis and narcotics)—These drugs may reduce the person's awareness of a cold environment.[14]

Neuroleptic drugs (such as chlorpromazine)—These drugs interfere with hypothalamic function, thereby compromising thermoregulation.[15]

Burns, exfoliate dermatitis, and severe psoriasis—Dermal adaptive mechanisms such as vasoconstriction of cutaneous arterioles are disturbed. Heat is lost through evaporation of fluid from weeping skin.[1]

Poverty, poor quality accommodation, and social isolation—Living in poor quality and insufficiently heated accommodation may lead to heat loss by conduction to the surrounding air and by radiation to cooler objects in the vicinity. Failure to draughtproof a house may cause heat loss by air currents.[16 17]

Drowning or immersion—Water has greater conductivity for heat compared with air.[1 2]

How do I diagnose it?

The symptoms and signs of hypothermia depend on the severity.[1] They can be subtle initially so you need a high index of suspicion.

Mild hypothermia

- The initial excitation phase in response to cold consists of shivering, tachycardia, tachypnoea, and vasoconstriction
- If hypothermia persists apathy, slurred speech, ataxia, and impaired judgment occur
- Paradoxical undressing refers to the phenomenon whereby affected people take off their clothes as their core body temperature is lowered.

Moderate hypothermia

- Decreased level of consciousness, decreased heart rate with atrial arrhythmias, decreased respiratory rate, hyporeflexia, dilated pupils
- Shivering activity ceases
- Electrocardiographic changes—presence of the J wave.

Severe hypothermia

- Coma, apnoea, asystole and ventricular arrhythmia, non-reactive pupils, pulmonary oedema, oliguria.

What investigations should I perform and why?

Urea and electrolytes—Hypothermia may cause oliguric renal failure. This may be a consequence of low cardiac output or rhabdomyolysis. Hyperkalaemia may be severe.[18]

Full blood count—Thrombocytopenia may be a consequence of hepatosplenic sequestration.[1] The packed cell volume increases slightly as core body temperature falls.

Glucose—This is an important investigation for any patient with a reduced level of consciousness. All patients should have a blood glucose test on admission.

Coagulation—Hypothermia may cause coagulopathy, but this is difficult to detect in clinical practice. This is because the laboratory assay is performed at 37°C, and at this temperature the coagulopathy resolves.

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

Arterial blood gases—Metabolic acidosis is a feature of severe hypothermia and may be a consequence of lactic acid generation due to poor tissue perfusion. You may also identify type I or type II respiratory failure. Interpreting arterial blood gases is difficult in people with hypothermia. In simple terms, the pH of neutrality increases on cooling. Blood gas analysers heat samples to 37°C before analysis and may calculate corrected values according to the core temperature of the patient. However, some authorities currently support the use of uncorrected arterial blood gas measurements to guide treatment.[1 19]

Thyroid function tests—Hypothyroidism is a known precipitant of hypothermia and should be recognised and treated.

What is the acute management?

Core body temperature may be reliably measured with a tympanic[20] or rectal thermometer. Hypothermia is a potentially life threatening condition. Acute management is as follows.

- Stabilise the patient—the basic principles of resuscitation apply
- Ensure the airway is patent and give oxygen—if facilities are available, give warm humidified oxygen

- Establish intravenous access
- Intubation and mechanical ventilation may be necessary if the patient is not maintaining an airway or has respiratory failure. Discuss management with a critical care team if necessary
- Ensure blood glucose is checked immediately
- Assess fluid status—this is vital because patients with hypothermia are often hypovolaemic due to dehydration and sepsis
- If dehydrated, give warm, intravenous fluids (see below)
- Insert a urinary catheter, if necessary, to monitor urine output
- Insert a central venous line if necessary to guide fluid replacement therapy and prevent the complications of fluid overload.

Other important management considerations

Thiamine deficiency—Patients who are malnourished or have a history of alcohol abuse are potentially deficient in thiamine. There is a risk of developing Wernicke's encephalopathy during rewarming if thiamine deficiency remains uncorrected. Therefore, these patients should receive immediate intravenous thiamine.

Myxoedema coma—This is a serious condition with a high mortality. If you suspect myxoedema you should consider immediate administration of intravenous triiodothyronine. Treating myxoedema coma with thyroid hormone may precipitate an adrenal crisis if adrenal insufficiency coexists; it is therefore prudent to give parenteral corticosteroids.

Intravenous corticosteroids—These are not required routinely for patients with hypothermia unless you suspect hypoadrenalism.

Sepsis—Sepsis is common in patients with hypothermia, but it can be difficult to detect because the classic features may not be present.[10] Broad spectrum antibiotics may be indicated if you suspect sepsis, even if it is not clinically obvious.[10]

Resuscitation—In patients who have had a cardiac arrest, remember that hypothermia may exert protective effects on the brain. You may reliably certify death only once core body temperature reaches 35°C. Remember the dictum: "You're not dead until you're warm and dead." You may, however, use your discretion to decide when resuscitation should be stopped according to the individual circumstances.[21] Guidelines state that the patient's doctors may make the decision to end resuscitation if it is clinically indicated.[21]

Defibrillation—Cardiac defibrillation is usually ineffective in severely hypothermic patients. If core body temperature is below 30°C and the patient develops ventricular tachycardia or fibrillation, then DC cardioversion should be attempted.[21] Guidelines recommend that if this is unsuccessful, then there should be no further attempts until core body temperature has surpassed 30°C.[21]

Vasoactive drugs—Drugs such as adrenaline and lignocaine are not recommended until core temperature reaches 30°C.[21] This is because these drugs are usually ineffective and may accumulate in the venous circulation of a hypothermic patient. During rewarming the drug may then be released in toxic quantities. Once core body temperature has exceeded 30°C vasoactive drugs may be used, but the interval between doses should be increased.[21]

Learning bite

Are invasive procedures contraindicated in people with hypothermia?

Historically, it was thought that invasive procedures, such as intubation, might precipitate ventricular fibrillation in people with hypothermia. It is now thought that these risks were exaggerated; current guidelines support the use of invasive procedures if they are necessary

Rewarming strategies

Passive rewarming

For most patients that are admitted with mild hypothermia, rewarming may be effectively achieved by covering the head and body with warm blankets.[1]

Active rewarming

Consider active rewarming for patients with moderate to severe hypothermia. The following techniques are available.

Forced air rewarming (Bair Hugger) blanket

This system consists of a warming device and single use, disposable, laminate blankets that allow warm air to flow directly onto the patient's skin. Possible disadvantages of forced air rewarming include:

- Hypotension may occur during rewarming, probably a consequence of peripheral vasodilation
- Afterdrop—This refers to a drop in core body temperature during rewarming. Afterdrop is thought to occur as a consequence of peripheral vasodilation and release of cold peripheral blood to the body core.

One randomised controlled trial reported that the rate of rewarming was greater with use of a Bair Hugger blanket compared with passive rewarming.[22] Furthermore, evidence suggests that afterdrop and hypotension are probably clinically insignificant.[22]

Warm intravenous fluids

Many emergency departments have facilities to warm bags of intravenous fluids. A microwave or "blood warmer" may be used. The temperature of fluids should be 42-44°C. An observational study has shown that giving warm intravenous fluids is a safe and effective form of treatment,[23] but there are no randomised controlled trials supporting the use of warm intravenous fluids for patients with moderate to severe hypothermia.

Other techniques

If available, consider using the following techniques:

- Warm humidified oxygen or air[1]
- Peritoneal dialysis or pleural cavity lavage with warm fluids[1]
- Cardiopulmonary bypass for severely hypothermic patients with cardiac arrest[19]
- An observational study supported the use of cardiopulmonary bypass for patients with cardiac

Sample questions

Here is a small sample of the questions that you can find at the end of this module. To see all the questions and to get the answers, go to http://www.bmjlearning.com/ and search for "accidental hypothermia"

1. A 78 year old man with Parkinson's disease is taken to the emergency department. He had started taking antidepressants four days previously. His neighbours found him unresponsive and lying on the floor. When he reached the department his Glasgow coma scale was 14 and his core temperature was 34°C. Which one of the following statements is correct?
   a. A forced air rewarming blanket should be applied immediately
   b. Passive rewarming with blankets covering the patient's head and body is a reasonable treatment option
   c. Immediate treatment with corticosteroids is mandatory
   d. It may be assumed that hypothermia was the cause of his fall

2. A 56 year old homeless man is brought to the emergency department. He was found unresponsive in the street by the police. On examination he was noted to be neglected and malnourished. His core temperature is 27°C and his Glasgow coma score is 10. Which one of the following statements is correct?
   a. There is no place for immediate administration of intravenous thiamine
   b. Passive rewarming is the initial treatment of choice
   c. Active rewarming with a Bair Hugger blanket and warm intravenous fluids is suitable treatment
   d. The rectal thermometer is the only reliable method to measure core body temperature

3. Which one of the following statements about active rewarming is correct?
   a. Afterdrop refers to a fall in arterial blood pressure during forced air rewarming
   b. Clinical trials have shown that forced air rewarming improves mortality in patients with moderate hypothermia
   c. There are no randomised controlled trials supporting the use of warm intravenous fluids for patients with moderate to severe hypothermia
   d. Randomised controlled trials support the use of cardiopulmonary bypass for patients with severe hypothermia and cardiac arrest

4. A 21 year old woman was found unresponsive in her bedsit. She has a history of depression and was recently prescribed drugs. On arrival at the emergency department, her core temperature was 30°C and her Glasgow coma score was 10. She had pinpoint pupils but no focal neurological signs. Her respiratory rate was 6 per minute and her pulse was 60 beats/min, regular. She has needle track scars in her left cubital fossa and groin. After rewarming her core temperature is now 34°C, but her Glasgow coma score is still 10. Which one of the following statements is correct?
   a. Administration of naloxone is not indicated because agitation may occur as a side effect
   b. She has classic features of tricyclic antidepressant overdose
   c. She is likely to have taken a heroin overdose

arrest and severe hypothermia.[24] All patients recruited to this study were younger than 35 years.

Preventing hypothermia

Healthcare professionals are in a position to advise patients on how to keep warm in the winter. Elderly people who are socially isolated are an important group to target. Useful advice includes:[25]

- Eat well to maintain adequate nutrition
- Keep mobile
- Dress in warm clothes
- Wear several layers of thin clothing rather than one thick garment.

Patients can also seek advice on how to keep warm and save on energy bills from Help the Aged and Age Concern. Grants are available to help people finance heating costs.[25] These include:

- The winter fuel and cold weather payment, which is a grant to contribute towards heating costs
- The warm front scheme for people on low incomes. This grant is available to improve home energy efficiency (such as insulation or draughtproofing).

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