



First Aid Management of Accidental Hypothermia and Cold Injuries - an update of the Australian Resuscitation Council Guidelines

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Background

- Australian Resuscitation Council (“ARC”) Guideline 9.3.3 *“Hypothermia: First Aid Management”* was published in February 2009;
- Guideline 9.3.6 *“Cold Injury”* was published in March 2000;
- A review of these Guidelines has been undertaken by the ARC First Aid task-force based on combination of a focused literature review and expert opinion (including from Australian surf life-saving and ski patrol organisations and the International Commission for Mountain Emergency Medicine (the Medical Commission of the International Commission on Alpine Rescue - “ICAR MEDCOM”); and
- It is intended to publish the revised Guidelines as a jointly-badged product of the Australian and New Zealand Committee on Resuscitation (“ANZCOR”).



Defining the scope of the Guidelines

- *The scope of practice:*
 - The ‘pre-hospital’ or ‘out-of-hospital’ setting.
- *Who does this guideline apply to?*
 - This guideline applies to adult and child victims.
- *Who is the audience for this guideline?*
 - This guideline is for use by bystanders, first aiders and first aid providers.



Current Hypothermia Guideline

- Introduction
- Common causes
- Recognition
- Management
- Level of evidence
- Class of recommendation
- References
- Further reading



What is “accidental hypothermia”?

- It is important to differentiate between “accidental hypothermia” and “induced hypothermia” as used in therapeutic medical settings.
- For normal function of all systems and organs, body temperature is kept constant at 37°C ($\pm 0.5^{\circ}\text{C}$);
- Hypothermia is when the body temperature falls below 35°C;
- **Accidental hypothermia** can occur acutely e.g., in cold environmental conditions or falling into icy water;
- It can also occur secondarily to impaired body temperature regulation due to many disease processes; and
- It is most often a gradual and insidious process.



Where do we turn to for guidance?

Resuscitation 95 (2015) 148–201



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Resuscitation

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European Resuscitation Council Guidelines for Resuscitation 2015 Section 4. Cardiac arrest in special circumstances



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circumstances section Collaborators^l

Where do we turn to for guidance?

Paal et al. *Scandinavian Journal of Trauma, Resuscitation and Emergency Medicine*
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Scandinavian Journal of Trauma,
Resuscitation and Emergency Medicine

REVIEW

Open Access



Accidental hypothermia—an update

The content of this review is endorsed by the
International Commission for Mountain Emergency
Medicine (ICAR MEDCOM)

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Isn't the actual body temperature important?

- All sources surveyed conclude that it is very difficult to measure core temperature accurately in the pre-hospital setting of hypothermia (particularly in a cold environment) without specialist equipment (e.g., rectal, oesophageal temperature probes).
- So, it seems reasonable to conclude that we should not expect first aiders to measure temperature in this setting.
- Where does that leave us in assessing the degree of hypothermia?



Staging of accidental hypothermia

The hypothermia staging guidelines provided in the Paal et al. paper (Footnote 73: Brown DJA. Hypothermia. In: Tintinalli JE, editor. *Emergency Medicine*. 8th ed. New York: McGraw Hill; 2015. p. 1357–65.)

Table 1 Staging of accidental hypothermia [73]

Stage	Clinical findings	Core temperature (°C) (if available)
Hypothermia I (mild)	Conscious, shivering ^a	35–32 °C
Hypothermia II (moderate)	Impaired consciousness ^a ; may or may not be shivering	<32–28 °C
Hypothermia III (severe)	Unconscious ^a ; vital signs present	<28 °C
Hypothermia IV (severe)	Apparent death; Vital signs absent	Variable ^b

^aShivering and consciousness may be impaired by comorbid illness (i.e. trauma, CNS pathology, toxic ingestion, etc) or drugs (i.e. sedatives, muscle relaxants, narcotics etc) independent of core temperature
 The lowest temperature from which successful resuscitation and rewarming has been achieved is currently 13.7 °C [11] for accidental hypothermia and 9 °C for induced hypothermia [12]. This does not preclude resuscitation attempts at even lower temperatures if clinical judgment suggests the possibility of successful resuscitation

^bThe risk of cardiac arrest increases below 32 °C, but as it is unlikely to be due solely to hypothermia until the temperature is <28 °C, alternative causes should be considered. Some patients still have vital signs <24 °C and the lowest reported temperature of a patient with vital signs is 17 °C [232, 233]



Staging of accidental hypothermia

More or less the same staging is used in the *ERC Guidelines*, with a different source footnoted (as below) and an additional Hypothermia V category:

34. Pasquier M, Zurron N, Weith B, et al. Deep accidental hypothermia with core temperature below 24 degrees C presenting with vital signs. *High Alt Med Biol* 2014;15:58–63.

Accidental hypothermia

Definition. Every year approximately 1500 people die of primary accidental hypothermia in the United States.³³ Accidental hypothermia is defined as an involuntary drop of the body core temperature $<35^{\circ}\text{C}$. The Swiss staging system is used to estimate core temperature at the scene. Its stages are based on clinical signs, which roughly correlate with the core temperature:

- hypothermia I; mild hypothermia (conscious, shivering, core temperature $35\text{--}32^{\circ}\text{C}$);
- hypothermia II; moderate hypothermia (impaired consciousness without shivering, core temperature $32\text{--}28^{\circ}\text{C}$);
- hypothermia III; severe hypothermia (unconscious, vitals signs present, core temperature $28\text{--}24^{\circ}\text{C}$);
- hypothermia IV; cardiac arrest or low flow state (no or minimal vital signs, core temperature $<24^{\circ}\text{C}$);
- hypothermia V; death due to irreversible hypothermia (core temperature $<13.7^{\circ}\text{C}$).³⁴

Change is not always easy...

The existing version of the ARC hypothermia Guideline has a more extensive set of descriptors for “mild” and “moderate” to “severe” hypothermia:

Mild hypothermia:	Moderate to severe hypothermia:	Severe hypothermia:
<ul style="list-style-type: none"> • victim shivering, • pale, cool skin, • impaired coordination, • slurred speech, • responsive but with apathy or confusion. 	<ul style="list-style-type: none"> • absence of shivering, • increasing muscle stiffness, • progressive decrease in consciousness, • slow irregular pulse, • hypotension. 	<p>In more severe cases there may be dangerous cardiac arrhythmias and cardiac arrest, fixed dilated pupils. The victim may appear dead, particularly if they have a weak slow pulse.</p>



Change is not always easy...

The revised Guideline has a pared-back 'recognition' section:

RECOGNITION:

- **Mild hypothermia:**
 - Conscious victim; and
 - Shivering present.
- **Moderate hypothermia:**
 - Impaired consciousness; and
 - May be shivering lightly or not at all.
- **Severe hypothermia:**
 - Unconscious victim; and
 - Weak signs of life may or may not be present.
- In more severe cases the victim may appear dead with no detectable signs of life. However, a deeply hypothermic victim may have a very slow, small-volume irregular pulse and unrecordable blood pressure.



Reasons for change

There is a number of reasons why a simplified classification of hypothermia based on the Paal *et al.* and ERC staging systems has been suggested for the revised Guideline:

- **The first is to make it simple for first aiders.** For instance, if I am a ski patroller out on the side of a hill in freezing conditions it is in the best interests of both the victim and myself to make a quick and straight-forward assessment of the level of hypothermia and to arrange for efficacious management/transport;
- The second is that a revised simplified staging system would **make it easier for first aiders to remember** without having to refer to a checklist or guideline by just having key criteria like shivering, level of consciousness, and presence or absence of vital signs;
- The third is that it **frees first aiders up** from the responsibility of having to try to obtain an accurate temperature reading on the hypothermic person; and
- The fourth is that these staging systems **represent the best expert opinion** that is available to us at the present time.



The Wilderness Medical Society (“WMS”) Guidelines

- The respected US-based WMS also publishes a set of **“Practice Guidelines for the Out-of-Hospital Evaluation and Treatment of Accidental Hypothermia”** (last updated in 2014).
- These resources include a useful algorithm (Figure 2) for assessment and management of accidental hypothermia.
- The WMS guidelines also suggest that if temperature measurement is not possible, clinical judgment may be helpful to distinguish whether a victim is hypothermic or not:
 - **Recommendation.** The key factors to guide treatment are level of consciousness, shivering intensity, and cardiovascular stability, based on blood pressure and cardiac rhythm (Figure 2). Core temperature can provide additional helpful information (panel consensus).



The WMS Algorithm

- It was discussed whether an algorithm could be included in the revised Guideline.
- The WMS algorithm has a lot of merit, but is not so useful in a purely first-aid type setting, and a simplified algorithm would have to be developed.

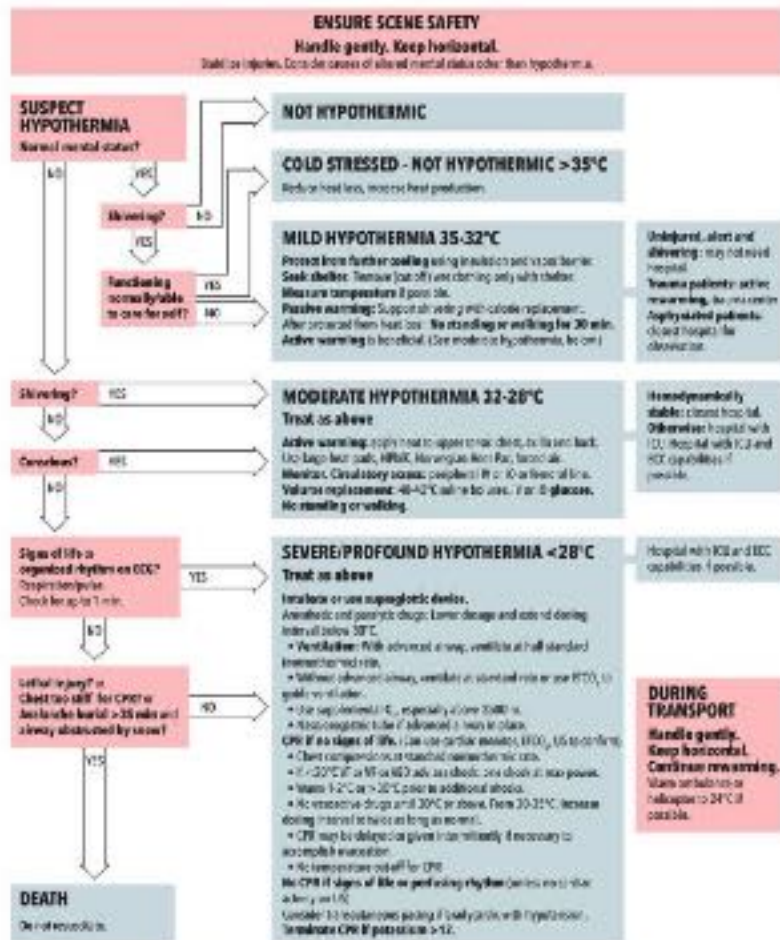


Figure 2. Recommendations for out-of-hospital evaluation and treatment of accidental hypothermia. ECG indicates electrocardiogram; CPR, cardiopulmonary resuscitation; HPMP, Hypothermia Prevention Management Kit; IV, intravenous; IO, intraosseous; ETCO₂, end-tidal carbon dioxide; VT, ventricular tachycardia; VF, ventricular fibrillation; AED, automatic external defibrillator; US, ultrasound; ICU, intensive care unit; ECC, extracorporeal circulation.

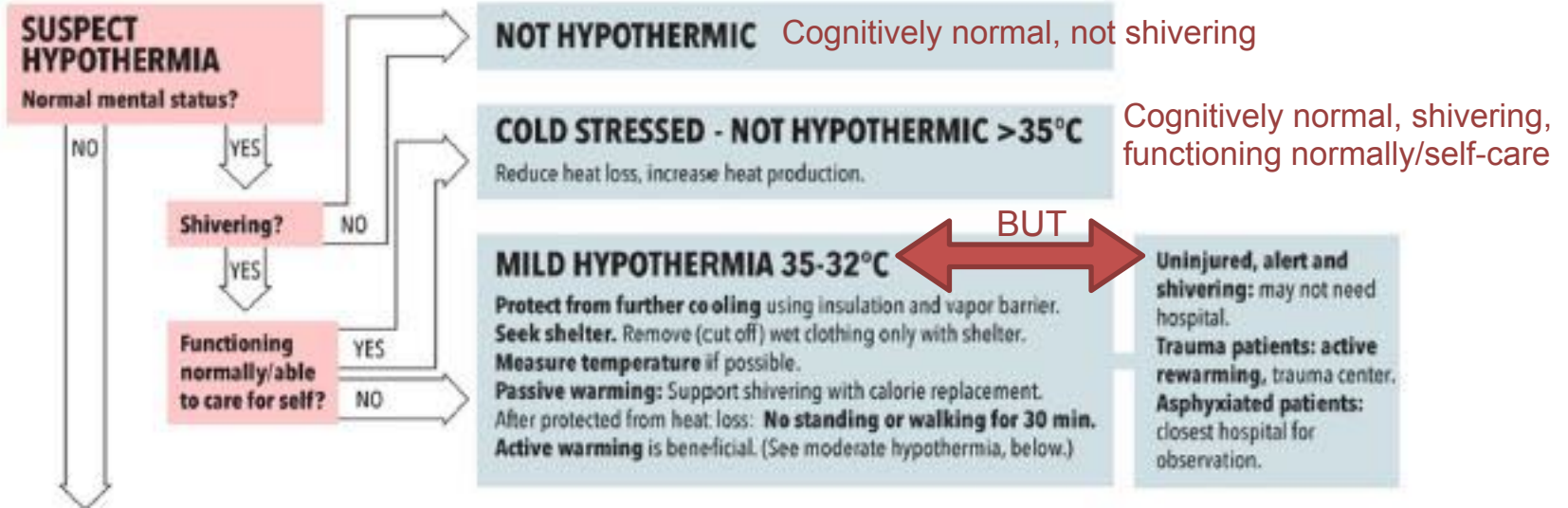
Feeling cold?

- A new development stemmed from a comment by a surf life-saving representative that “sometimes people are not hypothermic, but ‘feeling cold’, and just need a nice warm shower before they go home”.
- This issue is specifically addressed in the WMS Guidelines, and the Figure 2 algorithm addresses three classes of persons who may be cold but still able to recover and proceed home without needing a hospital admission.





Feeling cold?



Feeling cold?

The commentary in the WMS Guidelines states: “Some patients are cold, but not hypothermic”.

- Because shivering is triggered by skin cooling as a mechanism for preventing hypothermia, patients can be cold and shivering but not hypothermic.
- A cold, shivering patient with a core temperature over 35°C is cold stressed, but not hypothermic.
- If temperature measurement is not possible, *clinical judgment may be helpful* to distinguish whether a patient is hypothermic or cold stressed but not hypothermic.
- For example, a patient who was not cold before being briefly immersed in cold water may be shivering, but will not be hypothermic.
- Many alert, shivering patients who are well nourished and not exhausted are not hypothermic.
- **Recommendation.** A patient who is shivering but able to function well and to care for himself or herself *is unlikely to be hypothermic*. A patient who is shivering, becoming incapacitated, and having difficulty caring for himself or herself *is likely to be hypothermic*. *If there is any doubt, assume that the patient is hypothermic* (panel consensus).



Cold water shock

- Another suggestion from surf-life saving representatives was that the revised Guideline should include a section on “cold water shock”.
- It was also mentioned as a concern that in the water-sports situation people may become severely hypothermic very quickly when immersed in cold water, and not be able to hold onto buoyancy objects such as an upturned boat any longer, and they will drown.
- Anyone who has watched the movie “Titanic” will have witnessed such a heart-breaking moment.



Cold water immersion - how we respond

- The physiological response to cold water immersion/ submersion can be divided into three phases:
 - Initial immersion and cold shock response;
 - Short-term immersion and loss of performance; and
 - Long-term immersion and hypothermia.



Phase 1: Initial immersion and cold shock response

- Rapid skin cooling initiates a **gasp response**, which can cause drowning;
- **Hyperventilation** causes **hypocapnoea** and disorientation, which can contribute to drowning;
- Profound **peripheral vasoconstriction** occurs with an increase in cardiac output, heart rate and blood pressure; and
- **Myocardial ischaemia** or **arrhythmias** can occur.



Phase 2: Short-term Immersion and Loss of Performance

- Profound **conductive heat loss** causes **decreased neuromuscular activity** and loss of both **fine and gross motor control** and activity;
- This results in difficulty swimming and holding onto objects; and
- **Can occur in less than 30 minutes.**



Phase 3: Long-term Immersion and Hypothermia

- Few survivors reach this phase (other than those wearing personal flotation devices devices (“PFDs”));
- The physiology of immersion and non-immersion hypothermia is basically the same; BUT
- **Immersion hypothermia occurs much more quickly:**
 - The heat conductivity of water is **25 times that of air**; and
 - The **insulative effects** of clothing are **lost in water**.



A quick refresher re heat loss

Loss of body heat occurs by one or more of:

- **Radiation:** heat is radiated from the body to surrounding colder areas e.g., air;
- **Conduction:** heat is conducted from the body through contact with colder surfaces e.g., snow;
- **Convection:** heat from the body warms the surrounding air or water and this warmer area rises allowing it to be replaced by cooler air or water;
- **Evaporation:** the evaporation of perspiration or water requires heat which is drawn from the body; and
- **Respiration:** inhaled air is warmed and humidified by the body, causing loss of heat. Increased respiration causes increased heat loss.



What is ‘circumrescue collapse’?

- The WMS Guidelines refer to ‘circumrescue collapse’ as “syncope or sudden death occurring in victims of cold-water immersion just before, during, or after rescue and removal from water.
- Circumrescue collapse can be caused by life-threatening hypotension or by sudden onset of VF.”



What is ‘circumrescue collapse’?

- The key contributing factors to the syncope or collapse include:
 - *Removal of the aqueous hydrostatic pressure support* contributing to venous pooling and decreased venous return;
 - The effect on the heart of *cooled venous blood* returning into the central circulation (*core temperature ‘afterdrop’*);
 - *Work-related stresses on cold cardiac muscle*, including increased demand for cardiac output to maintain blood pressure, and also physical exertion; and
 - Adverse effects of *loss of sympathetic drive from mental relaxation as rescue is imminent* e.g., loss of consciousness, reduced blood pressure.



Circumrescue collapse - key management points

Handle carefully and transport horizontally!

- The **ERC guidelines** say:
“Hypovolaemia after prolonged immersion may cause a circum-rescue collapse/arrest. *Keep the victim in a horizontal position during and after retrieval from the water.*”
- The **Paal *et al.* article** also has a couple of short references re this:
 - “In water incidents, management is as for hypothermia on dry land, including *careful movement to avoid precipitating a life-threatening arrhythmia* and *keeping the casualty in a horizontal position* when pulled from the water to minimise the likelihood of rescue collapse.”
 - “*Careful handling and avoidance of rough movements are mandatory*, especially in patients who have not arrested. Patients should ideally be *transported horizontally* by stretcher to decrease position-associated changes in venous return, which may increase the risk of post-rescue cardiac arrest (rescue collapse), particularly if removed from cold water.”





What about CPR for severe hypothermia?

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EUROPEAN
RESUSCITATION
COUNCIL

Commentary and concepts

Delayed and intermittent CPR for severe accidental hypothermia^{*}



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Delayed and intermittent CPR

The algorithm for intermittent CPR (from Paal *et al.*):

Paal et al. Scandinavian Journal of Trauma, Resuscitation and Emergency Medicine (2016) 20:111

Page 8 of 20

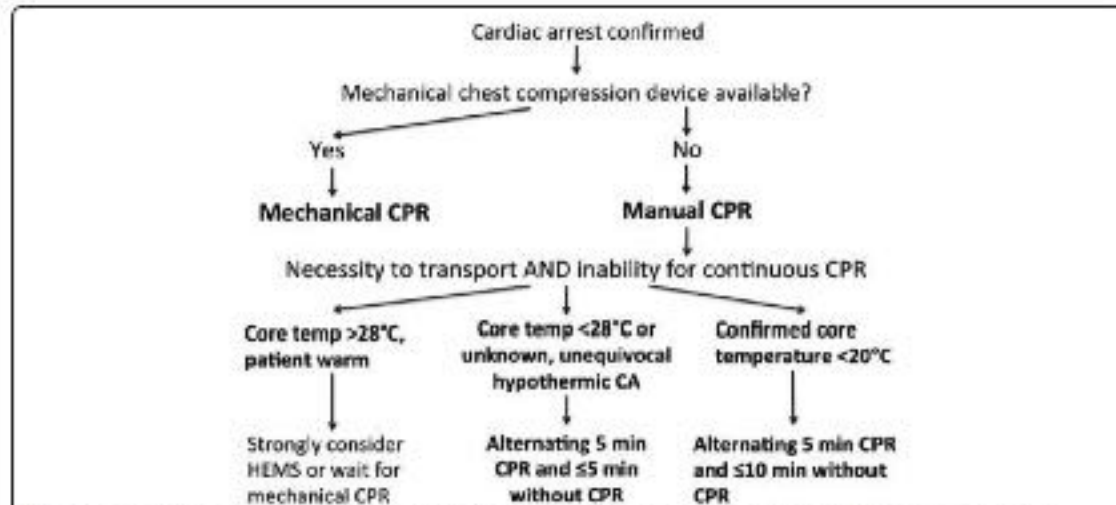


Fig. 2 Delayed and intermittent CPR in hypothermic patients when continuous CPR is not possible during difficult rescue missions [9]

Delayed and intermittent CPR

The description of intermittent CPR from the ERC Guidelines:

Intermittent CPR, as rescue allows, may also be of benefit.⁴⁴ If continuous CPR cannot be delivered, a patient with hypothermic cardiac arrest and a core temperature $<28^{\circ}\text{C}$ (or unknown), should receive 5 min of CPR, alternating with periods ≤ 5 min without CPR. Patients with a core temperature $<20^{\circ}\text{C}$, should receive 5 min of CPR, alternating with periods ≤ 10 min without CPR.⁴⁵

In light of the level of difficulty for first responders in measuring body temperature accurately in the pre-hospital setting, it was decided to remove the references to specific temperature in the section of the revised Guideline dealing with intermittent CPR.

Delayed and intermittent CPR - key points

- Patients in hypothermic arrest will need *prolonged CPR* (many hours).
- During an evacuation from difficult terrain in a remote area, manual CPR may be impaired or impossible. If available, *use a mechanical chest compression device* if trained how to use it safely.
- Hypothermic arrest victims have reduced oxygen and blood flow requirements in comparison with normothermic people and because of this, two modifications can be made to the resuscitation protocol provided that the rescuer is sure it is a hypothermic arrest:
 - If a severely hypothermic person arrests in front of the rescuer and they are in a dangerous location, *starting CPR can be delayed for up to five minutes* while the rescuer moves them to a safer place;
 - Although continuous CPR is preferable, in a hypothermic arrest, if a mechanical CPR device is not available and the victim must be moved e.g., to an evacuation point, *it is safe to interrupt chest compressions for up to five minutes:*
 - *The rule of thumb is “five minutes on; five minutes off”, but resume continuous CPR as soon as possible.*



Prevention of hypothermia

- The Council agreed to include some wording:
 - **Addressing prevention** in the setting of occupational, recreational and sporting settings generally (this would encompass activities such as boating, water sports, snow sports, bushwalking/hiking, mountaineering, etc.); and
 - About **preventing the rescuer from becoming a second victim** (this is especially pertinent for cold alpine environments, which can be found in both Australia and New Zealand).





Prevention - a (pre)cautionary tale!

- Voltaire (1765): “*Le sens commun est fort rare*”. (“Common sense is not so common”).
- **Prevention** is the key to all cold-related problems as adequate treatment is often not possible in the out-of-hospital setting.
- In general, **prevention** will include elements such as:
 - Forward planning;
 - Checking forecasts;
 - Being informed/educating others;
 - Adequate food/ hydration;
 - Adequate/extra clothing;
 - Shelter (activate early);
 - Buddy system; and
 - Communications/notifications.

Prevention of COLD INJURY

In cold temperatures you have to dress warmly to prevent hypothermia and frostbite.

You need:

- Multiple layers of clothing (to help trap warm air)
- Outer windproof layer (to keep warm air)
- Mittens are better than gloves

THE 1ST LAYER IS FOOD.
You need a full stomach so that your body can generate energy to help warm itself.

2 THE 2ND LAYER

3 THE 3RD LAYER

4 THE 4TH LAYER

5 THE 5TH LAYER

The infographic illustrates a five-layer approach to cold injury prevention. Layer 1 is food. Layer 2 is the first clothing layer. Layer 3 is the second clothing layer. Layer 4 is the third clothing layer. Layer 5 is the final clothing layer. Each layer is represented by a colored bar with a corresponding number and a small image of a person wearing that layer.



Yes, there are mountains in Australia! (well, sort of...)

- Most Australians live at or near sea level.
- A trip to the snow involves a significant change in altitude.
- Most snow sports activities occur between altitudes of 1300m – 2200m.
- Mt Kosciuszko is Australia's highest mountain at 2,228m.





Prevention of hypothermia

- The Australian Ski Patrol Association has a web site and Facebook page for “**SnowSafe**”, devoted to providing people with practical information for staying safe and warm whilst they enjoy the alpine environment.
- With many ‘day trippers’ visiting for ‘snow play’, these resources are seen as playing an important role in educating the public.
- Web page: <http://snowsafe.org.au/>
Facebook: <https://www.facebook.com/snowsafeaustralia>

What are “cold injuries”?

- ‘Freezing’ Cold Injuries:
 - Frostbite;
 - Frostnip;
- ‘Non-Freezing’ Cold Injuries:
 - ‘Trench Foot’/’Immersion Foot’;
 - Chillblains (Perniosis); and
 - Cold Urticaria.



‘Freezing’ cold injuries

- **Frostbite** and **Frostnip** occur in areas of localised hypothermia and are usually restricted to the extremities or exposed areas.
- **Frostbite** represents a spectrum of injury severity ranging from the reversible changes that emerge after rewarming to irreversible cellular destruction.
- **Frostnip** is the early stage of frostbite (with or without superficial freezing), and if identified and treated early is easily reversed by passive rewarming.



‘Non-freezing’ cold injuries

- ‘**Trench/Immersion Foot**’ is a condition characterised by a peripheral neuropathy which develops when the lower extremities are exposed for prolonged periods to wet conditions at temperatures just above freezing;
- Think of feet with wet boots and socks and no opportunity to dry them out; and
- Not uncommon in the military setting; and
- Has helped to shape history (e.g., Napoleon’s disastrous 1812 Russian campaign).



‘Non-freezing’ cold injuries

- **Chillblains (perniosis)** are an inflammatory condition affecting the extremities. Symptoms include erythema, pruritus, and ulceration; they may be acute or chronic.
 - **Chillblains** are common in cold, damp and windy conditions (wind can increase the cold conductivity).
- **Cold urticaria** is essentially an allergic reaction to a cold exposure and can be controlled with avoidance of the cold.



Management of Frostbite - I

- There are three phases of frostbite treatment:
 - Pre-hospital (pre-thaw) care phase;
 - Immediate hospital (rewarming) phase; and
 - Post-thaw care phase (weeks to months).
- Avoid thawing and protect from further harm until definitive care is reached.



Management of Frostbite - II

Immediate hospital care is directed at reducing progressive dermal ischaemia:

- **Rewarming** (typically in hot water) should be done at 40°C-42°C for 15-30 minutes or until thawing is complete;
- Opioid **analgesia** as indicated;
- Ibuprofen 400mg every 12 hours;
- Initial **debridement** of white blisters;
- Tetanus immunisation/booster as required;
- Benzylpenicillin 600mg every 6 hours;
- Regular hydrotherapy and **wound care**; and
- Smoking and alcohol prohibited during recovery.



Frostbite - Imaging

- Various imaging techniques have been used in seeking accurate assessments of tissue viability:
 - Plain film radiographs;
 - Venous radio isotope scanning (^{131}I , ^{133}Xe , and ^{99}Tc);
 - Angiography;
 - Digital plethysmography; and
 - Magnetic resonance imaging and magnetic resonance angiography;

BUT

- Still **need to wait 3-4 weeks to determine definitive treatment.**



Frostbite - Experimental treatments

- These include:
 - Infusion of low molecular-weight dextran to reduce blood viscosity;
 - Anticoagulation with heparin to reduce thrombosis of the superficial dermal plexus;
 - Thrombolysis with streptokinase or Tissue Plasminogen Activator;
 - Hyperbaric oxygen; and
 - Synthetic prostaglandin infusions.
- None of these appear to improve tissue viability over that seen with rapid rewarming alone but clinical studies are ongoing.



Non-freezing cold injuries - ‘Trench foot’

Management approaches:

- Avoid secondary exposure;
- Do not actively rewarm extremities with isolated NFCI: rapid rewarming increases pain and oedema;
- Extremities with NFCI should be allowed to rewarm gradually with bed rest, elevation of the legs or hands, and air-drying at room temperature;
- Replace fluid losses, which may be substantial. If available, use isotonic intravenous fluids warmed to 42°C to both rehydrate and prevent hypothermia;
- Give tetanus prophylaxis. Do not give prophylactic treatment for other infections or for pain;
- Non-steroidal anti-inflammatory drugs (NSAIDs) and opioids may be administered initially for pain relief but are usually ineffective;
- UpToDate suggests treating pain as soon as it begins with amitriptyline. If amitriptyline is not effective, neuropathic pain medications such as gabapentin can be administered; and
- Obtain immediate surgical consultation for any sign of possible tissue necrosis, such as haemorrhagic blistering.

(Information on this slide regarding modified from “UpToDate” (see credits for full information))



Non-freezing cold injuries - chilblains (pernio)

Management approaches:

- The management of **pernio** primarily consists of **avoidance of precipitating conditions**;
- Patients should be instructed to **keep the affected areas warm** by wearing appropriately insulated clothing and **avoiding unprotected exposure to cold conditions**;
- Smokers should be encouraged to quit; and
- For adults with refractory **pernio**, UpToDate suggests treatment with nifedipine.

(Information on this slide regarding modified from "UpToDate" (see credits for full information))



Cold urticaria

- **Cold urticaria** is a sub-type of physical urticaria, characterised by itchy wheals and/or angioedema due to skin mast cell activation and the release of pro-inflammatory mediators after cold exposure.
- Symptoms are usually limited to cold-exposed skin areas and develop within minutes of cold exposure. However, extensive cold contact may result in systemic reactions.
- Occurrence of severe anaphylactic reactions or suffocation due to oropharyngeal oedema is possible.
- The underlying causes are largely unknown. Most cases of **cold urticaria** are idiopathic, although a minority is related to an underlying disorder, such as an infection or a haematologic disorder. Cold-induced systemic inflammation (e.g., fever, arthralgias) or purpuric lesions in response to cold suggests other disorders.

(Information on these two slides regarding Cold Urticaria taken from "UpToDate" (see credits for full information).)

Cold urticaria: Management

- In a patient with an appropriate clinical history, the diagnosis of **cold urticaria** is confirmed by the presence of a positive cold stimulation test (“CST”).
- **Avoidance and education:**
 - Avoidance of cold exposure is the best prophylaxis, although complete avoidance is difficult for most patients.
 - Patients should be educated about high-risk activities and situations, such as swimming, surgery, and ingestion of cold foods and beverages.
- **Basic pharmacological measures:**
 - *Epinephrine (adrenaline) auto-injectors* should be prescribed for those patients with a history of anaphylaxis, systemic symptoms, or frequent/unavoidable cold exposure. They should carry the auto-injector at all times and periodically review how and when to administer it.
 - *Non-sedating second-generation H1 anti-histamines* are recommended for patients with cold urticaria who are unable to sufficiently avoid cold exposure and have frequent symptoms. Most patients respond (depending on dosing), although some have residual symptoms.

Ice cube test for cold urticaria



(Information on these two slides regarding Cold Urticaria taken from “UpToDate” (see credits for full information))



Relevance to Space Exploration

- Space is an inhospitable environment which can be both very hot and very cold;
- Near-Earth space: the temperature ranges from $+120^{\circ}\text{C}$ to -180°C in the shade;
- The mean temperature on the Earth is 13°C ;
- The mean temperature on the Moon is -30°C , and ranges from $+120^{\circ}\text{C}$ (day) to -180°C (night); and
- The mean temperature on Mars is -60°C , and ranges from $+20^{\circ}\text{C}$ (summer at the equator) to -120°C (poles at winter).





What could go wrong ‘off-world’?

- *Some thoughts:*

- Inadequate protective clothing for environmental conditions;
- Protective clothing is inadequately sealed or secured (astronaut glove in orbit);
- Accidental damage to protective clothing e.g., space debris (“Gravity”);
- Explosions;
- Traumatic injury on an extra-terrestrial body;
- Decompression incidents changing internal ambient conditions;
- EVA/surface vehicle accidents;





What could go wrong ‘off-world’?

- *Some thoughts:*

- Even in a sealed space suit, becoming immobile in a shaded environment could result in **increased local or total body conductive heat loss**:
 - *Abnormal amount of moisture in the space suit;*
 - *Thermal cooling system becomes relatively over-efficient for the immobile status;*
 - *Increased thermal conductivity of suit insulation due to compression against an external object; and*
 - *Widespread contact between the suit and a cold lunar, planetary or spacecraft surface;*
and
- **‘The Human Factor’ – poor judgment and/or risk taking** (*Polar/mountaineering experiences - influence of hypothermia*).





~ The End ~

Questions?

References and Image Credits

Cover Slide:

https://www.reddit.com/r/pics/comments/2wt1e0/wooly_mammoth_found_frozen_completely_in_tact/

<https://www.almanac.com/news/home-health/natural-living/cold-fingers-toes-and-nose-watch-cold-injuries> Igor Stepovik/Shutterstock

Slide 2: Sourced from the listed organisations.

Slide 4: Sourced from an ANZCOR Guideline (this does not imply endorsement of this presentation).

Slides 7, 11, 28, 31: European Resuscitation Council Guidelines for Resuscitation 2015. Section 4. Cardiac arrest in special circumstances: Resuscitation 95 (2015) 148–201. (<https://ercguidelines.elsevierresource.com/europeanresuscitation-council-guidelines-resuscitation-2015-section-4-cardiac-arrest-special>).

Slides 8, 10, 28: Accidental hypothermia – an update. The content of this review is endorsed by the International Commission for Mountain Emergency Medicine (ICAR MEDCOM). Paal P *et al.* *Scandinavian Journal of Trauma, Resuscitation and Emergency Medicine* (2016) 24:111 (<https://sjtrem.biomedcentral.com/articles/10.1186/s13049-016-0303-7>).

Slides 15-19, 26-27: Wilderness Medical Society Practice Guidelines for the Out-of-Hospital Evaluation and Treatment of Accidental Hypothermia: 2014 Update. *Wilderness & Environmental Medicine*, 25, S66–S85 (2014) ([https://www.wemjournal.org/article/S1080-6032\(14\)00326-3/abstract](https://www.wemjournal.org/article/S1080-6032(14)00326-3/abstract)).

Slide 25: Sketch cartoon taken from an old external educational presentation on hypothermia. Original attribution unknown.

Slides 29-30: Delayed and intermittent CPR for severe accidental hypothermia. Gordon L, Paal P *et al.* *Resuscitation* 90 (2015) 46–49 ([https://www.resuscitationjournal.com/article/S0300-9572\(15\)00084-2/pdf](https://www.resuscitationjournal.com/article/S0300-9572(15)00084-2/pdf)).

Slide 34: Image taken from an old external educational presentation on hypothermia. Original attribution unknown.

Slide 35: Author's own photographs together with the winter photograph obtained from the public domain.

Slide 38: De-identified images taken from other external educational presentations on hypothermia and cold injuries. Original attributions unknown.

Slides 45-46: The information on these two slides was modified from the UpToDate article on “Nonfreezing cold water (trench foot) and warm water immersion injuries”, Author: Ken Zafren, MD, FAAEM, FACEP, FAWM, topic last updated 29 May 2018 [accessed 15 February 2019].

Slides 47-48: The information on these two slides was modified from the UpToDate article on “Cold urticaria”, Author: Marcus Maurer, MD, topic last updated 29 August 2017 [accessed 15 February 2019].
Slide 48 photo credit: Marcus Maurer, MD.

Slide 52: Author's own photograph.

