



Mountain Rescue England & Wales

Prehospital management of *Severe Hypothermia*

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Assess responsiveness, breathing and carotid pulse for at least 1 minute

'Signs of life'

No 'signs of life'

If **any** present, pronounce life extinct. Arrange appropriate evacuation.

FEATURES INCOMPATIBLE WITH LIFE

- Lethal injury or illness
- Prolonged asphyxia/airway obstructed
- Incompressible chest/abdomen

Assess with electrocardiogram (ECG) and/or apply AED

Sudden loss of signs of life

Shock advised by AED (VF/VT)

- Defibrillate – NB not more than 3 times
- Do NOT give ALS drugs if temperature <30°C
- If defibrillation ineffective, manage as asystole

ECG rhythm compatible with life
Assume weak pulse present = Treat as alive

Asystole

Handle carefully to avoid precipitating cardiac arrest

- Prevent further heat loss by shelter & insulation. Be careful if removing wet clothes (see Explanatory Notes).
- Place heat packs inside casualty bag around trunk but not directly on skin and not on the limbs.
- Start oxygen.
- Monitor ECG. If not available, RV with doctor or paramedic for ECG support.
- Measure temperature (oral or ear. Not rectal or armpit).
- Protect airway if necessary (Note: heavy-handed insertion of airway devices can precipitate VF).
- If possible, arrange for AutoPulse to meet evacuating party in case of cardiac arrest.

- Prevent further heat loss by shelter & insulation.
- Place heat packs inside casualty bag around trunk but not directly on skin and not on the limbs.
- Secure airway (e.g. i-Gel, LMA or ETT) and ventilate on oxygen gently (rate 8-10/min + small bag squeezes).
- Measure temperature (oesophageal if possible; otherwise oral or ear).
- If possible, arrange for AutoPulse to meet evacuating party.
- Chest compressions should be done continuously. If the AutoPulse is not available or cannot be used, do manual CPR. If this cannot be done continuously, consider intermittent CPR within the guidance overleaf.

Hospital Referral

- Discuss all severely hypothermic patients with ECMO centre if:
 - Signs of life + temperature <32°C, no shivering, reduced conscious level, or irregular pulse
 - No signs of life and no features incompatible with life
 - Combination of severe hypothermia plus any injuries
- ECMO centre will advise if it is more appropriate to send casualties with severe hypothermia + serious injuries to a Major Trauma hospital
- If admission for ECMO is not possible, transport as quickly as possible to nearest Emergency department

Local ECMO Centres for Lake District Casualties

- Wythenshawe Hospital, Manchester (ECMO Co-ordinator: 07837 541143 or 0161-291-4836)
- Royal Victoria Infirmary, Newcastle (0191-233-6161. Ask for Resuscitation area for major casualties in the Emergency Dept.
- Alder Hey Children's Hospital (ECMO Co-ordinator 0151-228-4811 x4164. Main switchboard 0151-228-4811)

Explanatory Notes

ON-SITE CLINICAL STAGING OF HYPOTHERMIA

Stage I – Clearly conscious and shivering	35°-32°C	Mild
Stage II – Impaired consciousness, not shivering	32°-28°C	Moderate
Stage III – Unconscious, vital signs present	<28°C	Severe
Stage IV – Apparent death; vital signs absent	Usually <24°C	Severe
Vital signs may be present <24°C. The risk of cardiac arrest increases <32°C but is unlikely to be due solely to hypothermia until the temperature is <28°C.		

NB - Check for hypoglycaemia and treat if this could be contributing to reduced conscious level.

Reducing the risk of causing arrhythmias in severe hypothermia

Always handle and move severely hypothermic casualties very carefully. When moving the casualty (including winching), keep them horizontal. Never raise the legs. Sudden movements or influx of cold blood from the legs to the heart can cause a cardiac arrest.

Dead or alive? Interpreting sustained breathing; What if the ECG looks normal but can't feel a pulse?

Sustained breathing, no matter how slow, shallow or irregular, shows that the heart is still working. The cold heart can have a normal-looking ECG yet pump too weakly for you to feel a carotid pulse but strongly enough to maintain blood flow to the brain. *In both situations, proceed as though the casualty is alive.* Do NOT start CPR. *Monitor closely.* A normal ECG can change to VF or asystole at any time. Breathing will then stop.

Minimising further heat loss – shelter; deciding whether to remove wet clothing; using heat packs; packaging

Wet clothes, wind chill and contact with the ground dramatically increase body heat loss. Continued cooling makes cardiac arrest more likely to occur and less likely to respond to treatment. Insulate the casualty from the ground, wind & rain. Heat is of value *before* cardiac arrest as it slows heart cooling and preserves the heart rhythm. Do not attempt to rewarm the limbs. Use heat packs to reduce further cooling, not to start rewarming in the field. Place them only around the trunk on top of a layer of clothes (wet or dry) and never directly on skin as this will cause a burn. A hat may reduce heat loss from the head. In mild hypothermia, wet clothing can be exchanged for dry. However, when body temperature is <32°C, there are risks to removing the clothing (increased cooling during removal or triggering an arrhythmia if the body is handled roughly). It is safer to leave wet clothes in place until the casualty is in hospital. Wrap them in an occlusive sheet, which acts as a vapour barrier, and seal around the openings, ensuring access where necessary. Once the atmosphere inside the enclosure is fully saturated with water vapour, no more heat can be lost by evaporation from the skin, which is the major route of heat loss in this situation. If the patient's clothing is wet, place insulation outside the vapour barrier to keep it dry. Bubble wrap is light-weight and water-resistant, but is available in different thicknesses with different insulation properties so is of limited use on its own. Reflective blankets have little additional value over a heavy-duty plastic bag as little heat loss occurs by radiation as skin temperature is so low. Finally, enclose in a Cas Bag ± blanket(s) on top. If an AutoPulse is on-site, do not lie the patient on it until cardiac arrest occurs, thereby reducing the pressure on the patient's skin from the hard board and making the stretcher lighter. If cardiac arrest occurs, package as above to minimise further cooling. Some experts recommend shielding the head from external heat sources (such as warming blankets) to prevent the brain temperature from rising until an effective circulation is re-established.

Body temperature (if no thermometer available, use the clinical staging above)

Knowing core body temperature guides management. It indicates if the casualty is still potentially alive, how stable the heart is likely to be and whether resuscitation may be possible on the hill if cardiac arrest occurs.

- If the core temperature is $\geq 32^{\circ}\text{C}$, hypothermia is not the cause of unconsciousness or cardiac arrest so look for other causes of these conditions.
- The further the core temperature falls below 32°C , the greater the risk of cardiac arrest. The risk is very high in the high 20's and below.
- In hypothermia, asystole does not usually occur until the temperature is $<24^{\circ}\text{C}$, especially in small children. Look for evidence that significant hypothermia was probably present before cardiac arrest occurred e.g. lightly-dressed casualty. If the temperature is higher (e.g. 30°C) and asystole is present, the casualty may have had a hypoxic cardiac arrest (e.g. avalanche, drowning, inhalation of vomit after drugs overdose) or heart attack before cooling. If these occurred, the casualty will not benefit from prolonged resuscitation attempts.

Thermometer probes must be warm before use or they will error. Avoid rectal & armpit temperatures (unreliable in hypothermia). Oesophageal route is most accurate but is carried by few MR teams. Although accurate in normothermia, in hypothermia, oral/infrared ear thermometers *under read* $\approx 2^{\circ}\text{C}$ (maybe more) if: (1) Cardiac arrest. (2) For *oral*, with mouth breathing or drinking cold fluid. (3) For *ear*, if the ear canal is blocked (e.g. wax), contains water, snow or cold air, the probe is aimed incorrectly or the face is cold. These limitations mean that 100% precision is impossible. However, accuracy is sufficient to indicate the general hypothermia severity e.g. low 30's, upper 20's, mid 20's, etc. Good technique improves accuracy. *Oral*: wait 10 min while casualty nose-breathes (mouth closed) before measuring. Place the probe under the tongue in the midline, as far back as possible; leave in place 2-3 mins; then measure. *Ear*: shield the ear canal from cold air with a hat. In all cases, do at least two readings (more if the first two differ by $>1^{\circ}\text{C}$).

When to start CPR; Efficient manual CPR; Mechanical devices for providing continuous CPR – the Zoll AutoPulse

If no signs of life when you arrive, the time of cardiac arrest is unknown. If no contraindications, start CPR when possible. Check temperature. Witnessed hypothermic cardiac arrest: see below. Manual CPR is exhausting; change rescuers every 1-2 min. Survival is possible after many hours of CPR, but it must be continuous and effective. This is impossible with manual CPR once you start moving the casualty or if rescuers are tired.

Battery-operated mechanical CPR devices enable the delivery of continuous chest compressions for hours, including during transport, and are carried by some MR teams and Air Ambulances. If you have a potentially suitable casualty, *contact one of these as early as possible.* Consider putting a second team on standby in case the first device fails. If this happens and there is no backup device, use manual CPR.

Delayed and intermittent manual CPR in hypothermic cardiac arrest

Brain metabolism falls by 6-10% per degree C fall in temperature below 35°C . Evidence from surgery done with the heart stopped shows that hypothermia protects the brain. This gives some CPR flexibility. In *exceptional circumstances* e.g. difficult terrain, no mechanical CPR device available: *Witnessed* hypothermic cardiac arrest, CPR start can be delayed to allow time to move the casualty to a safer location. *Intermittent manual CPR* can be used during evacuation (see box). **NB: THESE TECHNIQUES MUST ONLY BE USED AS A LAST RESORT IN HYPOTHERMIC ARREST. NEVER use them in any other cardiac arrest.**

Delayed & Intermittent Manual CPR Guide Times

- Witnessed hypothermic cardiac arrest
Can delay start of CPR up to 10 mins if necessary
- Intermittent CPR: Temp $<20^{\circ}\text{C}$
At least 5 mins continuous CPR; up to 10 mins off.
- Intermittent CPR: Temp $20-28^{\circ}\text{C}$ or unknown
At least 5 mins continuous CPR; up to 5 mins off.
- Resume continuous CPR as soon as feasible.

Defibrillation and resistant VF

Below 30°C , VF is usually resistant to defibrillation until the heart rewarms. Do not attempt it >3 times. It won't work & injures the heart muscle. VF can change to asystole. Once this occurs, it is very unlikely that any cardiac rhythm will re-emerge until the heart is rewarmed. Withhold ALS drugs (e.g. adrenaline) if temperature $<30^{\circ}\text{C}$. Above 30°C , double the intervals between doses compared with normothermia intervals.

Airway management

In the absence of breathing, especially when evacuation is going to be prolonged, it is only possible to breathe efficiently for the casualty if you insert a laryngeal mask (LMA), i-Gel or endotracheal tube. The bag-valve-mask should be viewed as a last resort. It is the least effective and most difficult to do, even if you are very experienced with the technique. It is impossible to perform during a stretcher carry.

Referring a casualty to an ECMO centre. TL's and Team doctors have a list of contact details for the UK ECMO Centres

- ECMO is a machine that oxygenates, rewarms & pumps blood around the body. It is only available in specialised centres.
- Ideally, hypothermic casualties in cardiac arrest or cardiovascular instability (e.g. irregular pulse; BP <90) will go to the nearest ECMO Centre. *Discuss all cases with the ECMO centre before sending them in*, especially if a combination of serious injuries + severe hypothermia.
- If appropriate, Lake District hypothermic casualties will go to RVI or Wythenshawe. If this is impossible, ask if Wythenshawe can bring their portable ECMO to Lancaster. If not, contact another ECMO Centre from the list held by TL's/Team doctors. Children: ask Alder Hey for advice.
- Air transfer is preferable. If flying to Newcastle/Manchester is impossible (weather, fuel, etc.), then try to find out (e.g. from National Maritime Operations Centre (NMOC) where is accessible by air, and then contact the nearest ECMO Centre on the flight path.
- If there is no answer from the ECMO number, contact the hospital switchboard. Emphasise the urgency of the case. Ask to be put through to where they receive major casualties in the Emergency Department (don't just ask for A&E or you may just get through to reception).
- Provide the ECMO team with full clinical information recorded on the ECMO Admission Referral Form.
- You **MUST** let the receiving hospital know when you expect to arrive. *This is absolutely imperative.* ECMO takes a good hour to set up.