Normal conscious level

Suspected Hypothermia
• Temp <35 °C or
• 36 °C or less if trauma

Decreased conscious level

• Trauma?
  NO  Passive rewarming:
  • Warm environment
  • Warm, dry clothes
  • Warm, sweet drinks
  • Food
  • Physical activity

  YES  CVS & respiratory stable

  CVS & respiratory unstable

Hypothermic Cardiac Arrest

Active, noninvasive or minimally invasive warming

Initially: Active noninvasive or minimally invasive rewarming, If these fail: ECMO or locally available alternatives

Proposed strategy for rewarming of patients with hypothermia in New Zealand Emergency Departments (Sept 2018, v1.0 Dr Malin Zachau)

To be used with “Explanatory notes”
**Explanatory notes:** Proposed strategy for rewarming of patients with hypothermia in New Zealand Emergency Departments (Sept 2018, v1.0 Dr Malin Zachau)

**Normal conscious level:**

**Passive rewarming:**

1) Warm environment: **28°C** is the temp at which an uninjured, normothermic person does not lose heat. This temp has become the accepted standard for ambulances, helicopters and hospital. It is often not achieved. It is easier to obtain if in a room rather than in a curtained cubicle. Air currents are not helpful, radiant heat is better.

2) Warm, dry clothes: If the patient is retrieved from a location other than their home they are unlikely to have access to their own warm, dry clothes. What does the ED provide? A surgical gown is not appropriate, possibly consider polyprop / micro fleece tracksuit pants and hoodie to be lent to patient and washed in-between patients like hospital blankets are. A doona/sleeping bag is far superior than hospital blankets. Alternatively, a commercially available HPMK ("hypothermia prevention management kit" which is a vapour barrier, reflective insulated shell with chemical heating packs could be used).

3) The latent heat capacity of a human is approx 0.83 kcal / kg bodyweight /°C. Thus a 70 kg person needs 58 kcal per degree. However, patients with low body fat content, malnutrition, various medical conditions and on various medications* require much more that that may be unable to produce heat even if provided with the nutritional energy. A drink should be warm, not hot. A hot drink makes gastric thermo receptors reduce shivering (shivering is good) Milo or hot chocolate made with milk is less likely to be vomited up than a cup of tea with 5 spoons of sugar (equi-caloric). Proper food is also necessary, not just carbohydrates but fat and protein too. Is there a very strong reason for keeping the patient nil by mouth?

4) If the patients medical condition allows then gentle exercise helps to generate heat. This could be done whilst laying on a trolley if necessary: elevating & flexing legs and arms. It is kinder to let them eat and drink first, though. This is in stark contrast to the more severely hypothermic patient who should **not** have their limbs moved about.

A rate of rewarming can be 0.5 – 4°C (without exercise) 5°C (with exercise)/ hour is possible. If the rewarming does not achieve 0.5 °C/hour then active rewarming should be seriously considered.

*would you like me to list those conditions & medications?
Decreased conscious level, CVS& respiratory stable:
Noninvasive or Minimally invasive active warming
(usually deployed when temp <32 °C but conscious level is more important i.e. individual physiological response to temperature rather than actual temperature)

Should always be used in patients with trauma since they cannot utilize any metabolic reserves to reheat themselves endogenously.

1) Avoid sudden movements, keep patient flat, remove clothes by cutting, minimize airway manoeuvres or instrumentation, ensure close monitoring.

2) Careful active external (noninvasive) rewarming: Torso initially (not arms & legs since this can cause “after-drop” which is dangerous for an irritable myocardium).
The extent of vasoconstriction will influence the effectiveness of noninvasive rewarming attempts.
The commonest is warmed forced air warming (FAW), the commonest branded product is the Bair Hugger blanket.
Rewarming rate achieved can be 0.5-4°C/hour (dependent on severity of vasoconstriction).

Active Internal (minimally invasive) rewarming
3) All IV fluids must be warmed to 40-42°C but each litre will only increase body temperature by at most 0.3 °C/hour.
   It is much easier to make a person more hypothermic by giving cold IV fluids than it is to warm them up by giving warmed fluids.

4) Bladder lavage only adds slow additional warming (0.5-1°C/hour) because of small surface area and is not very useful.

5) Warmed humidified oxygen provides only a modest benefit.

6) Gastric lavage and colonic irrigation has a high risk to benefit ratio and should be avoided.

Trauma Induced Coagulopathy & hypothermia (below 34°C) Normal clotting screens are not accurate in hypothermia.
TEG analysis is required to direct the use of blood products to control the coagulopathy. The TEG cup should be at the temperature of the patient, not the standard 37°C since it will result in inaccurate results.
1. Reduced conscious level and Respiratory/ circulatory instability: i.e. Hypotension, ventricular arrhythmia, bradypnea, problems with maintaining patent airway (likely to have a core temp. <28°C)

   1) This patient may develop cardiac arrest, thus avoid sudden movements, remove clothes by cutting, keep patient flat, minimize airway manoeuvres or instrumentation, ensure close monitoring.

2) Active external (FAW, trunk only) and active minimally invasive warming techniques (as in the previous section) should be deployed. (Warmed IV fluids)(warmed, humidified oxygen)

3) Ideally the management of this patient should be able to include ECMO if it were to become necessary. The current indications for rewarming by ECMO are:

   a) Failure to improve with active external & minimally invasive rewarming,  
   b) life threatening arrhythmia  
   c) hypotension (systolic < 90mmHg )  
   d) respiratory failure  
   e) refractory acidosis  
   f) comorbidities which limit the tolerance for low flow states of hypothermia class 3.

If the patient fails to warm up and ECMO is not available, consider alternative ECLS (Cardio Pulmonary Bypass) but be aware that that has significantly inferior outcomes. If CPB is not available, consider using pleural lavage and peritoneal lavage but be aware that these have high risk benefit ratios.
Hypothermic Cardiac Arrest:
There is some local variation in interpretation of St John Ambulance clinical guidelines, but generally speaking, a patient will not be transferred by road ambulance or helicopter whilst undergoing CPR.
In South Island there are no pre-hospital mechanical CPR devices currently being deployed (September 2018).
Core temperature is not determined when a person is verified life extinct by paramedics in the community. Thus, the probability of patients arriving to hospital in Hypothermic Cardiac Arrest in South Island is currently low. However this does not mean those patients did not exist, it could be that they may not be recognised or conveyed.

In conclusion, the most likely Hypothermic Cardiac Arrest you will encounter is the patient who had already been admitted to the ED, was undergoing active rewarming and arrested whilst being treated. **Prolonged CPR (6 hours+)** whilst waiting for the patient to warm up (**continue FAW on trunk only & warmed IV fluids, do not warm head**) and for the heart restart (when electricity can be conducted again) can result in good, neurologically normal outcomes.

Neurologically intact survival in Poland is up to 70% and similar in Minnesota (when rewarmed by VA ECMO) this compares to 15% survival of normothermic OHCA in NZ currently. This is why a new local / South Island ECMO service would be highly beneficial. Dr. David Bowie is championing establishing a Christchurch ECMO service. The adult ECMO service in Auckland to needs to recognise **Accidental Hypothermia rewarming as an indication and agree to retrieve patients since this is not currently the case.**

Until either of those options are realised, **CBP, pleural lavage or peritoneal lavage** could be used. In absence of circulation the effectiveness of pleural lavage & peritoneal lavage is reduced. Pleural lavage can hinder effective CPR.

**Serum potassium levels are no longer considered prognostic. Please consult the HOPE score (Hypothermia Outcome Prediction after ECLS for hypothermic cardiac arrest) calculator for prognosis**  
https://www.urg-admin.ch/hope/

**Drugs** are not active at body temps <30°C due to enzymatic inactivity and accumulate, causing undesired effects when patient warms up and the drugs regain potency. **Defibrillation** damages the cold myocardium and should not be repeated without an increase in temperature between shocks. If the heart does not restart at core temp 32°C resuscitation attempts can be stopped (it isn’t hypothermia which is making them “dead”)