

HYPOTHERMIA

- A core temperature < 35°C
- Does *not* require extreme of temperatures for hypothermia to establish.

Mild	32 - 35°C
Moderate	28 - 32°C
Severe	< 28°C

Temperature Facts.

- Recall *conduction, convection, evaporation & radiation*.
 - Conduction - direct contact (temperature gradient)
 - Convection - transfer of heat by movement of heated material
 - Radiation - from *non-insulated* body areas
 - Evaporation - eg. via exhalation
- Conduction is main method of heat loss (esp. in water).
 - Water ~ 30x thermal conductivity of air !!
- Protection against the cold.
 - Peripheral vasoconstriction
 - Behavioural response (addition clothing, moving indoors, pacing ...)
 - Shivering

Dementia, intoxication & trauma prevent certain behavioural responses to cold, ∴ predisposing to hypothermia.

Causes of Hypothermia	
Accidental (environmental) exposure	Sepsis
Metabolic disorders <ul style="list-style-type: none"> - Hypoglycaemia - Hypothyroidism - Hypoadrenalism - Hypopituitarism 	Drugs <ul style="list-style-type: none"> - Ethanol - Sedative-hypnotics
Hypothalamic & CNS dysfunction <ul style="list-style-type: none"> - Head trauma - Stroke - Wernicke's 	Dermal disease <ul style="list-style-type: none"> - Burns - Exfoliative dermatitis
Massive fluid/blood resuscitation	Acute incapacitating illness

Pathophysiology & Clinical Features.

32-35°C

- *Excitation stage.*
- HR, cardiac output & blood pressure all increase.

< 32°C

- Excitation phase → slowing (adynamic) stage.
- Progressive slowdown of bodily functions & metabolism.
- ↓ O₂ utilisation & CO₂ production.

< 30-32°C

- Shivering ceases !!
- CO & BP markedly depressed [negative inotropy & chronotropy]
 - Compounded by concomitant hypovolaemia.

Metabolic changes all act to ↓ metabolic rate;

- Hypothyroidism, hypoadrenalism, hypopituitarism.
- Hypoglycaemia can potentiate hypothermia.

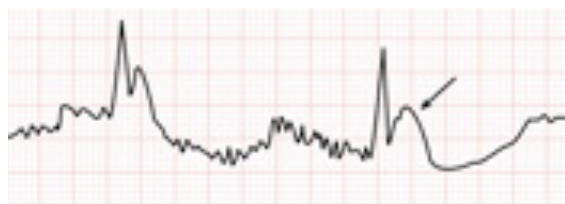
Other contributing factors;

- Alcohol [& other sedative-hypnotics]
 - Vasodilator. Alters adaptive behaviour.
- Sepsis.
 - Alters hypothalamic temperature set-point.
- Severe dermal disease.
 - eg. burns, exfoliative dermatitis
 - Prevents vasoconstriction & potentiates water loss.
- *Any incapacitating illness...*
 - Severe infection, DKA, Immobilising injuries, Head trauma, stroke, intracerebral haemorrhage.

There are no pathognomonic ECG changes in Hypothermia - more a myriad/spectrum of ECG.

ECG Manifestations.

- Bradydysrhythmias
 - Sinus, junctional
 - AF
 - Varying AV blocks.
- Prolongation of PR & QT interval
- Osborne or J-wave.
 - "Camel hump" sign.
 - A positive deflection at the junction between QRS & ST-segment.
 - Most prominent in precordial leads.
 - Consistently present with body-temperatures < 25°C.
- Atrial fibrillation.
 - Occurs in 50-60% of patients w/ temperatures < 29°C.
 - Ventricular rate may be normal or slow.
- Shivering artefact.



In **severe hypothermia** the following can be seen;

- Bradycardia
- Asystole
- Ventricular fibrillation

< 30°C

- At risk of dysrhythmias.
 - Hypothermic myocardium is *extremely irritable*. VF can be induced by simple patient manipulations & interventions.
- Typical sequence is a progression.

Sinus bradycardia → AF w/ slow ventricular response → VF → asystole

Respiratory considerations.

- Progressive ↓ RR & tidal volume.
- Cold-induced bronchorrhoea, depressed gag & cough reflex.
 - High aspiration risk.
- ABG interpretation must be corrected for body temperature using nomogram.
 - Analyzer automatically corrects for 37°C body temp.

Neurological considerations.

- Progressive depression of consciousness
- Incoordination, lethargy → coma !
- Pupils may dilate (& be unreactive)

Other considerations.

- Impaired renal concentrating ability - "*COLD DIURESIS*".
 - Potentiates volume loss.
- Potential for *rhabdomyolysis*.
- Thrombotic risk.
 - 2* to haemoconcentration, cold-induced ↑ viscosity & sluggish circulation.
 - DIC can result.
- Pancreatitis is common.

Always look for (1) underlying precipitating event & (2) consequences of hypothermia

Treatment.

Involves general supportive measures & specific rewarming techniques.

Basics.

- Wet clothing removed, patient dried !
- Gentle handling !!
- Resuscitation area w/ full cardiorespiratory monitoring.
- Meticulous assessment for pulses & respiratory activity.
 - Aim to avoid inappropriate CPR (& subsequent initiation of VF).
 - May take 30-45 secs.
- Warmed/humidified O₂.
- Warmed IV fluids.

Indications for intubation are the same for normothermic patients.

RSI drugs may not be effective w/ temps < 30°C

Most dysrhythmias (sinus brady, AF/flutter) pose no threat to life & will revert with warming.

VF may be refractory until the patient is adequately warmed. Pacing & atropine likely unhelpful also.

A single DC-shock is appropriate (then reattempted when Temp > 30°C)

Rewarming techniques.

Passive rewarming (use of endogenous heat).

- Must have intact thermoregulatory mechanisms
- Often fails with severe hypothermia.

Active external rewarming (application of exogenous heat to body surface).

- Forced air rewarming (eg. Bair Hugger)
- Warm water immersion.

May lead to vasodilatation ('rewarming shock') & acidosis (from lactate washout).

Core temp "after-drop" can occur with return of cold blood to the core.

Active core rewarming.

- GI tract lavage (gastric & colonic) w/ warmed saline.
 - Risk of aspiration (w/ gastric lavage)
- Bladder irrigation (instillation of warmed saline).
- Peritoneal lavage (rapid rewarming).
 - Potassium-free dialysis solution
- Pleural lavage via thoracostomy tube.
 - Preferably left side (closest to heart)
 - Caution w/ intrathoracic pressures (?tension physiology)
- ECMO !!

NB. Firm guidelines do not exist. There are *no* prospective RCTs on these warming modalities.

Prognosis.

Uncomplicated hypothermia generally has a good outcome.

- Typically depends on the underlying disease process.
- Preceding asphyxia or near-drowning carries *very poor prognosis*.

Death in hypothermia = failure to revive with rewarming.

- Aim to continue resuscitative efforts to at least 30-32°C.