

Overview

Spectrum of heat-related illness: ranging from heat cramps→heat exhaustion→heat stroke.
Temperature & associated symptoms and signs defines the type of heat-related illness

Risk factors

- Hot & humid environment (classic), strenuous exercise (exertional)
- Age - infants and elderly
- Physical - obesity, dehydration, unacclimatised, unusual exertion, inappropriate clothing, sleep deprivation, sunburn
- Medical conditions - alcoholism, anorexia, cardiac illness, CF, dehydration, DTs, anhidrosis, DI, epilepsy, poorly-controlled DM, febrile illness, GE, previous heat-related illness, hypokalaemia, Parkinson's disease, spinal injuries, thyrotoxicosis
- Drugs - EtOH, anticholinergics, α -adrenergics, antihistamines, TCAs, SSRIs, diuretics, phenothiazines, BB, CCB, LSD, PCP, cocaine, amphetamines, ecstasy, aspirin, lithium

Heat dissipation

Conduction, convection: 5% of heat loss to air, surface contacts

Radiation: 65% of heat loss but req. lower ambient temperature.

Evaporation: 30% heat loss (sweating, exhaled breath) but decreased with high humidity.

Presentation

Heat cramps

- Body temperature may be elevated, usually $<40^{\circ}\text{C}$
- Intense thirst with muscle cramps and tachycardia
- Sweating and heat dissipation mechanisms preserved
- Normal alertness and higher functions with no neurological problems

Heat exhaustion

- Heat dissipation/sweating still functioning, and temp is usually $\leq 41^{\circ}\text{C}$.
- CNS fn largely preserved. Occ mild confusion, irritability and poor co-ordination.
- Oliguria, weakness, headache, thirst, N&V, sinus $\uparrow\text{HR}$, $\uparrow\text{RR}$, occ syncope, orthostatic $\downarrow\text{BP}$.

Heat stroke

- Hyperthermia ($T_{\text{core}} > 41^{\circ}\text{C}$ classically but may present with lower) with CNS impairment (confusion, $\downarrow\text{LOC}$, fits, coma) and loss of the capacity to dissipate heat \pm sweat.
- $\uparrow\text{RR}$ (always), \uparrow or $\downarrow\text{HR} \pm \downarrow\text{BP}$. Tachyarrhythmias or shock may occur.
- Risk of damage to brain, kidney, liver and muscle. Coagulopathy, DIC, $\downarrow\text{plt}$
- Immunological dysfunction similar to sepsis syndrome.
- Thermoregulatory centre may fail \rightarrow feel cold + dry/vasoconstricted skin \rightarrow vicious cycle.

Differential diagnosis

- Sepsis, neuroleptic malignant syndrome, serotonin syndrome, malignant hyperpyrexia.
- Recreational drug toxicity (cocaine, amphetamines and ecstasy).

Investigations

Deep rectal/oesophageal temperature.

Urine: ?Rhabdo

Blood: U&E ($\downarrow\uparrow\text{K}$, $\uparrow\text{urate}$), CMP ($\uparrow\text{Ca}$, $\uparrow\text{PO}_4$), FBC, BSL, $\uparrow\text{LFTs}$, $\uparrow\text{CK}$, ABG (met acidosis), coags

ECG: ST, SVT, AF, conduction defects. $\uparrow\text{QTc}$, ST/T changes.

Imaging: CXR (?aspiration, APO, ARDS)

Management

Resuscitation with full monitoring:

- Airway & Breathing: Consider early intubation (avoid sux). O₂.
- Circulation: Dehydration ± high output failure.
 - IV fluids as 0.9% NaCl or 0.45% saline+2.5% Dextrose. Avoid K⁺ containing fluids.
 - Gradually reduction of Na⁺ if hypernatremic
 - Beware APO with overzealous rehydration.
 - If inotropes are required, try to use those with less α activity e.g. **dopamine**.

Rapid cooling - aiming for <40°C a.s.a.p.

- Strip patient, spray with tepid water (32°C) & use gentle fanning (cools at ~1°C per 3min).
- Ice-bath immersion most effective cooling method, though it is often not available
- Apply ice packs to neck, axillae & groins (cools at ~1°C per 10min).
- Cold (10°C) gastric/rectal/peritoneal lavage & cooled cardiopulmonary bypass/dialysis.
- Body cooling units may be better than ice-baths but not routinely available
- Modify or discontinue cooling methods once T<38.5°C to avoid overshooting.
- Antipyretics are ineffective, and dantrolene has no proven benefit.

Other:

- **Benzodiazepines** and non-depolarising muscle relaxants should be used to control shivering and fits.
 - **Chlorpromazine** may be used 2nd line to treat excessive shivering.
- Catheterisation should be considered to monitor urine output.
- Treat complications, and any amenable underlying causes.
 - Rhabdo - fluids, ± **furosemide/mannitol, bicarbonate**, dialysis
 - Coagulopathy - **FFP**, platelets

Prognosis

Mortality 80% unless treated early. With good Mx, survival ~90%.

Poor prognostic indicators:

- Rectal temperature > 42.2°C
- Prolonged period of hyperthermia
- Coma lasting > 4 hrs
- AST>1000 IU in <24h
- Coagulopathy
- Lactic acidosis (in absence of severe physical exertion)
- Acute renal failure
- Hyperkalaemia

Prevention

- Adequate hydration
- Avoiding over-exercising in heat
- Acclimatisation: takes 1-2 weeks & daily exercise in heat
 - ↑Aldosterone & ↓Na loss in sweat & urine
 - ↑Sweat production at lower temperatures
 - ↑CVS performance and ability to resist exertional rhabdo