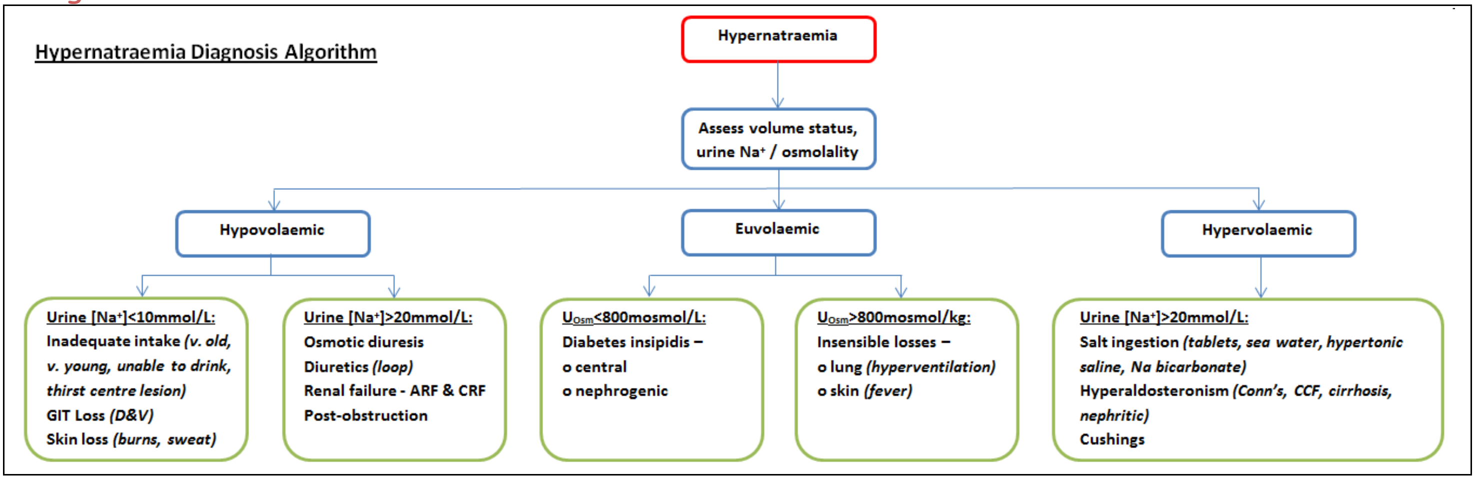
# Hypernatraemia



$[Na^+]$>145-150mmol/l resulting from a net water loss or salt gain → hypertonic hyperosmolality and cell dehydration. Relatively uncommon outside hospital. Sustained hypernatraemia can occur only when thirst or access to water is impaired e.g. elderly, infants, ALOC, hypothalamic lesions.

## Diagnosis




- Also very rarely intracellular shift of water:
  - Strenuous exercise or ECT induced seizures causes transient rise in cell osm

## Presentation

If pathways intact thirst is raised → polydipsia & polyuria (in DI).
Other signs and symptoms in hypernatraemic states relate mainly to CNS dysfunction (lethargy, weakness, confusion, irritability, myoclonic jerks and seizures) or to dehydration and hypovolaemia (dry mouth, abnormal skin turgor, oliguria, tachycardia, orthostatic hypotension).

## Investigations

*Urine:* Sodium & osmolality – need to be interpreted in light of volume status
*Blood:* Serial UEC, Ca, BSL, lithium level if appropriate

## Management

*Main Aims:*

- Exclude pseudohypernatraemia which may occur with hypoproteinaemia
- Establish severity - whether acute and rapidly changing or chronic and stable
- Correct hypernatraemia
  - Treat any underlying disorder if possible.
  - Correct dehydration by replacing free water losses.
  - Correct hypovolaemia, if present, by giving electrolytes in addition to free water.

*Correction of hypernatraemia:*

- Address the underlying cause where possible
  - E.g. Desmopressin or carbamazepine may be given for DI
- Fluids should be administered orally or enterally if possible rather than IV
- Regular monitor patient and the serum Na, adjusting the hypotonic infusion accordingly.

- Determine:

**1. Fluid requirements:**

- Water deficit. - amount of free water req to return the serum [$Na^+$] to normal:
  Water deficit (L) = TBW x ( ( serum [$Na^+$] /140 ) - 1 )
  TBW=wt x 0.6 (child, adult M) or 0.5 (adult F, elderly M) or 0.45 (elderly F)
  If $Na^+$ is lost in addition to free water (e.g. hypotonic fluid loss) then total water deficit will be more than this.
- Ongoing measured and insensible fluid losses.
  May be useful to calculate the ongoing urinary free water loss by electrolyte-free water clearance (EFWC) as this will need to be replaced too:
  EFWC = Volume of urine * (1 - ( ($U_{Na}$ + $U_K$ + $U_{glucose}$/2) / serum [$Na^+$] ) )
  Where volumes are in L and concentrations in mmol/L.

**2. Rate of correction:**

- Acute & [$Na^+$] ≤160 mmol/L: Can give replacement free water over 24h as low risk of cerebral oedema & rapid correction may prevent osmotic demyelination
- Chronic (>24h) or [$Na^+$] >160 mmol/L: 0.33-0.5 mmol/L/hour or 8-12 mmol/L/day

**3. Appropriate fluids & rate:**

- If significantly hypovolaemic, use 0.9% saline to restore circulating volume
- If hypervolaemic from salt gain, give diuretics and 5% dextrose
- If renal failure or the serum [$Na^+$] >170 mmol/L consider dialysis
- Otherwise give hypotonic fluids (0.45% saline, 5% dextrose, oral water)
  NB any $Na^+$ or $K^+$ containing fluid will only provide a proportion of its volume as free water. E.g. 0.45% saline + 40 mmol/L KCl is just 25% free water.
- Generalising the Adrogué-Madias equation for any volume of infusate:
  $\Delta[Na^+] = Vol_{infusate} \times ([Na^+]_{infusate} - [Na^+]_{init})/(TBW + Vol_{infusate})$
  Rearranging: $Vol_{infusate} = (TBW \times \Delta[Na^+]) / ([Na^+]_{infusate} - [Na^+]_{target})$
  And if: Duration = Δ[Na+] / RateΔ[Na+] where RateΔ[$Na^+$] usually 0.33-0.5mmol/L/hr
  Then: Infusion rate = 1000 x $Vol_{infusate}$ x RateΔ[$Na^+$] / Δ[$Na^+$]
  __**Example:**__ If serum [$Na^+$] = 163mmol/L in 70kg man, free water deficit or the volume of 5% dextrose required to replace it would be 70 x 0.6 x (140-163) / (0-140) = 6.9L. The Infusion rate (chronic) = 1000 x 6.9 x -0.33 / (140 – 163) = 100ml/hr over 69hr. However if the fluid used was 0.45% saline + 2.5% glucose, then: $Vol_{infusate}$ = 15.33L and the Infusion rate = 220ml/hr over same period. NS cannot be used to achieve a serum $Na^+$ below its own conc of 154mmol/L (i.e. it has no free water) so cannot be used to reach target of 140mmol/L. Even if the target were only 155mmol/L then 336L of NS would be req at a rate of 14L/hr for 24hr!!
- The formulae are estimates as final [$Na^+$] & ECF vol determined by TBW variation, redistribution and also renal $Na^+$ excretion/H2O reabsorption. So ongoing treatment must be determined by serial electrolyte levels.

## Complications

Acute & severe hypernatraemia: Brain shrinkage → cerebral bleeding, SAH, central pontine myelinolysis & permanent brain damage and death
Aggressive treatment with hypotonic fluids → cerebral oedema

## Prognosis

Mortality 50-70% or higher if [$Na^+$]>160mmol/L
Depressed LOC is best prognostic indicator
Acute hypernatraemia mortality>chronic
66% survivors have significant residual CNS deficits