Hyponatraemia

Defined as a [Na^+]<135mmol/L. Serum [Na^+] dependent on Na & water balances controlled by Renin-Angiotensin-Aldosterone axis/ANP (volume) & thirst/ADH regulation (osmolality) resp.

Epidemiology

Commonest electrolyte abnormality esp in ICU and post-surgery.

Presentation

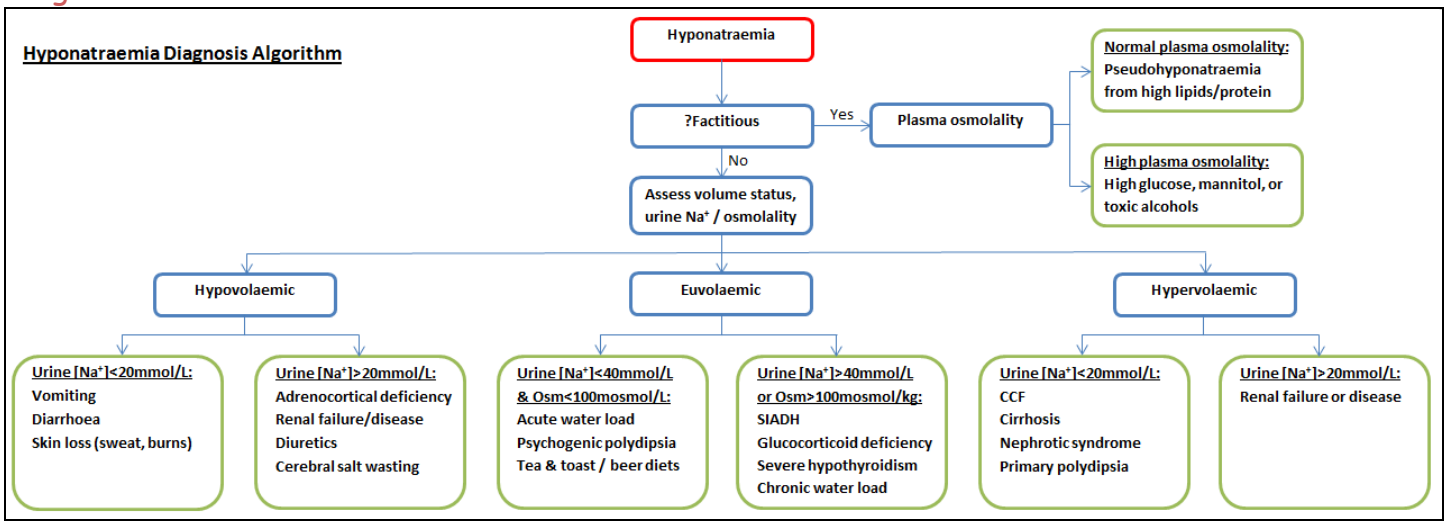
May be asymptomatic if ↓[Na^+]<0.5mmol/L/h or not severe (>125mmol/L). May have ↑↓volaemia.

- Mild - anorexia, headache, nausea, vomiting, lethargy
- Moderate - personality change, muscle cramps and weakness, confusion, ataxia
- Severe (commoner if acute) - drowsiness, fits, coma, brainstem herniation → resp arrest

Investigations

Urine: Osmolality (<100mosmol/kg = complete & appropriate suppression of ADH in context of hypoNa, >100mosmol/kg impaired water excretion), electrolytes (Na, Cl, K)
Blood: Osmolality (↓ unless factitious), UEC (↓Na. ↑K in Addison's), LFT, TFT, cortisol, urate
Imaging: CXR if ?CCF or CT brain if confused.

Diagnosis



SIADH

Syndrome of inappropriate ADH secretion leads to hyponatraemia and concentrated urine by causing excess water retention. Sodium balance (controlled by aldosterone & ANP) is normal.

Causes

- *Neuro:* tumour, trauma, infection, Guillain-Barré, MS, SLE, CVA/ICH, AIDS, porphyria
- *Pulmonary:* lung small cell Ca, mesothelioma, pneumonia, abscess, TB, CF, asthma, IPPV
- *Other Ca:* oropharyngeal, stomach, pancreas, GUT, leukaemia, lymphoma, thymoma
- *Drugs:* chlorpropramide, carbamazepine, SSRI, TCA, Li, MDMA/Ecstasy, barbiturates, haloperidol, tramadol, fluphenazine, vincristine, desmopressin, omeprazole, cytotoxics
- *Misc:* idiopathic, hereditary, pain, postop, stress, endurance exercise, herpes zoster

Diagnostic features

- Plasma hypo-osmolality proportional to hyponatraemia
- Inappropriately ↑urine osmolality (>100mosmol/kg) usually > reduced plasma osmolarity
- Persistent urine [Na^+] excretion >20-40mmol/l if normal salt intake
- Euvolaemia
- Normal renal, thyroid, cardiac, liver and adrenal function
- Also elevated ADH ± low urate levels

Complications of hyponatraemia

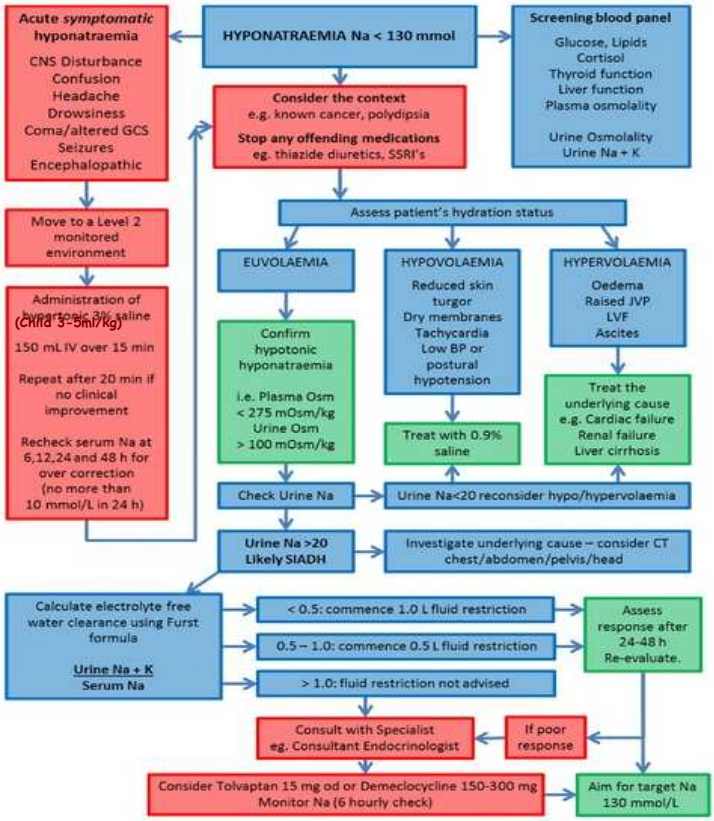
Cerebral oedema

- Acutely, esp if [Na^+]<125mmol/L, before brain cells have shed some of their osmogenic molecules (takes>24h), there will be a tendency for water to move into cells from the less tonic ECF & if rapid may cause cerebral oedema and severe CNS symptoms.

Central pontine myelinolysis (also known more generally as osmotic demyelination syndrome)

- Conversely in chronic severe ↓[Na^+], the now osmogenically depleted brain cells can have water drawn out of them damaging the myelin sheaths if the serum [Na^+] is raised too rapidly for them to compensate.
- Delayed by 2-4 days, causes quadriplegia & pseudobulbar palsy or 'locked-in' syndrome.

Management



- If **Hypovolaemic** & giving 0.9% saline: as euvolaemia regained, ADH↓ & a diuresis may ↑↑[Na+], if so desmopressin (ADH) ± 5% glucose (free water).
- If **Euvolaemic** - If fluid restriction inadequate/not advised consider:
  - NaCl tablets PO (e.g. 3g daily) or 3% saline IV – not 0.9% saline
  - Frusemide may help if urine osmolality > 2 x plasma osmolality
  - Urea has sometimes used
  - Demeclocycline blocks ADH & induces partial nephrogenic DI
  - Vaptans (new vasopressin receptor antagonists e.g. tolvaptan), but induce thirst, expensive, limited availability & may ↑[Na^+] too rapidly
- Child fluid restriction ~10-20ml/kg
- If KCl given for assoc hypoK^+, it will ↑[Na^+] by transcellular ion shifts of K^+, Cl^- & H^+

Why isotonic normal saline should not be used in SIADH:

Giving a saline solution will only help the hyponatraemia if the urine osmolality is less than the effective osmolarity of the administered saline assuming the patient is euvolaemic & urine osmolarity is relatively constant. So if urine osmolarity is >~308mosm (i.e. NS osmolarity), then all the salt but not all the water will be excreted worsening the [Na^+] further. 3% Saline has a much higher osm (1026mosm) & so usually some free water will be excreted.

Some formulae *(useful for **initial** correction approximations, using only saline solutions)*

- Na^+ deficit =TBW x ($[Na^+]_{target}$ – $[Na^+]_{init}$) where total body water, TBW= wt x 0.5 (F/>75y) or 0.6 (M/child)
- $\Delta[Na^+]$ = $Vol_{infusate}$ x ($[Na^+]_{infusate}$ – $[Na^+]_{init}$)/(TBW + $Vol_{infusate}$) assuming conservation of Na^+ & no fluid shifts
- The Adrogué-Madias equation is a simplified case of this formula for when $Vol_{infusate}$ = 1L only
- NB. $[Na+]_{infusate}$ = (171 x S% saline) mmol/L. So $[Na+]_{infusate}$=154mmol/L for NS, and 513mmol/L for 3% saline
- Thus $Vol_{infusate}$ = (TBW x $\Delta[Na^+]$) / ($[Na^+]_{infusate}$ – $[Na^+]_{target}$) in litres
- Duration = $\Delta[Na^+]$ / Rate$\Delta[Na^+]$ where Rate$\Delta[Na^+]$ usually 0.33-0.5mmol/L/hr
- Therefore Infusion rate = 1000 x $Vol_{infusate}$ / Duration
- When using 3% Saline, rules of thumb for a child/adult male are:
  - 3-5ml/kg 3% NaCl should give $\Delta[Na^+]$ = 2-3mmol/L in usual ranges of hyponatraemia
  - Similarly an initial rate of 0.5 x wt ml/hr of 3% NaCl should produce a Rate$\Delta[Na^+]$ ~ 0.33mmol/L/hr
- The formulae are only estimates as final [Na^+] & ECF vol determined by TBW variation, redistribution and also renal Na^+ excretion/H_2O reabsorption controlled by aldosterone & ADH which may vary with therapy. Thus progress must be monitored by serial electrolyte levels and the fluids/rates adjusted appropriately.