

HYPERNATREMIA

A problem of decreased total body water rather than increased total body sodium

- Defined as serum sodium >145 mEq/L
- Body usually protected by renal concentration of urine and powerful thirst mechanisms
- Patients present with non specific signs such as dehydration, lethargy and weakness
- Neurologic signs can include increased tone, brisk reflexes and nuchal rigidity
- Severe presentations are due to movement of fluid into the extracellular space leading to acute loss of brain volume, hemorrhage or venous sinus thrombosis
- Causes include:

Excess sodium intake	Concentrated formula, salt ingestion (seawater, accidental, Munchausen-by-proxy), hypertonic IV fluids, sodium bicarbonate, blood products
Increased free water losses	1) Renal: diabetes insipidus, diuretics, tubular dysfunction 2) GI: diarrhea, vomiting, colostomy/ileostomy, malabsorption 3) Insensible: fever, tachypnea, burns
Decreased free water intake	Ineffective breastfeeding, poor access to water, blunted thirst mechanisms, fluid restriction

- Management=replacing free water deficit
- Always prioritize hemodynamic stability over sodium correction
- Formula to estimate free water deficit: 4mL x body weight x desired change in sodium
 - Represents minimum amount of free water necessary to correct sodium
 - Does not account for maintenance needs or ongoing losses (insensible, GI losses etc.)
 - Larger amount of fluids will need to be given based on free water composition
 - ½ NS contains 50% free water, ¼ NS contains 75% free water
- Goal is to decrease sodium no faster than 0.5 mEq/L/hour
- Fluid calculations are an estimate so sodium should be checked every 2 hrs until patient is stable
- Neurologic sequelae such as developmental delay or hypertonicity occur despite appropriate rates of correction

HYPONATREMIA

- Defined as serum sodium <135
- Occurs in 3% of hospitalized patients
- Kidney usually protects the body by excreting free water as dilute urine
- Causes include:

Decreased total body water	GI losses (diarrhea, emesis), diuretics, RTA, 3rd spacing
Increased total body water	CHF, acute renal failure, SIADH, water intoxication (dilute formula feeding)
Normal total body water	Hypoglycemia
Pseudohyponatremia	Severe hyperlipidemia or hypoproteinemia

- Correction for hyperglycemia: 1.6mEq/L decrease in serum sodium per 100mg/dL elevation of serum glucose above normal
- Patients present with symptoms secondary to cerebral edema including vomiting, headache, changes in mental status or seizure; can rapidly progress to cerebral herniation
- Symptomatic hyponatremia is a **medical emergency** to be managed in a monitored setting with 3% hypertonic saline

- If patient is seizing, give 3-4cc/kg/hour with goal of raising serum sodium 4-8 mEq/L/hour
- Once seizures stop, give 1-2cc/kg/hour with goal of raising serum sodium 1mEq/L/hour until alert
- Asymptomatic hyponatremia should be managed with a goal of correcting at a rate no faster than 0.5 mEq/L/hour
 - Usually safely accomplished with 0.9%NS and close serum sodium monitoring
- Neurologic sequelae from demyelination can happen several days following correction
 - Rate of correction may have little to no effect on development of demyelination
 - Magnitude of correction and underlying illness are more important contributing factors

Key References:

- 1) Chung C, Zimmerman D. Hyponatremia and hypernatremia: current understanding and management. *Clin Ped Emerg Med.* 2009; 10: 272-278.
- 2) Moritz M and Ayus JC. Disorders of water metabolism in children: hyponatremia and hypernatremia. *Pediatr Rev.* 2002; 23: 371-380.