

## **Hyponatremia**

**DEFINITION:** Hyponatremia is a condition characterized by a plasmatic sodium concentration lesser than 136 mEq/l caused by an excess of water relative to total solute.

### **CLASSIFICATION:**

We classify hyponatremia according to the volume of extracellular fluids (ECF). So we recognize:

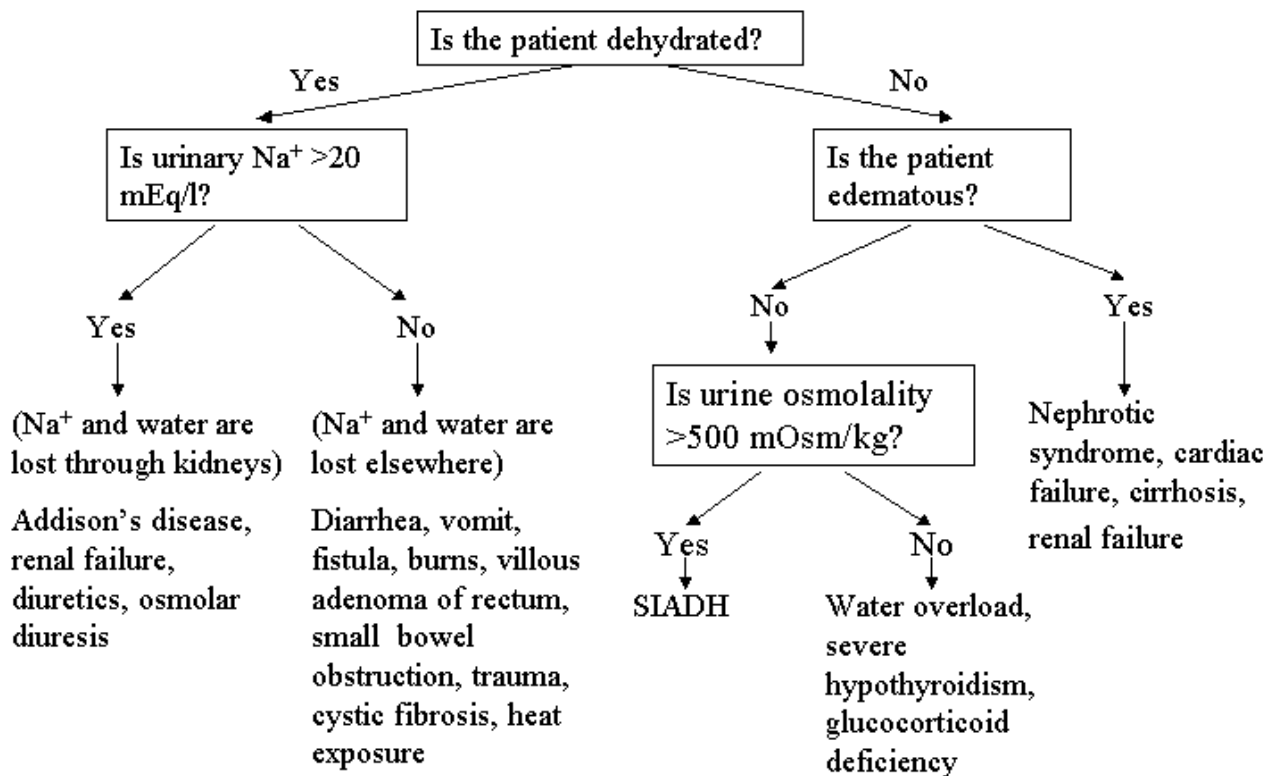
- Hyponatremia with hypovolemia: decrease of Total Body Water (TBW) and sodium; this is caused by dehydration
- Hyponatremia with euvolemia: decrease of sodium; e.g., SIADH
- Hyponatremia with hypervolemia: increase of total body sodium with a relative higher increase of TBW; this occurs in conditions of edema (heart failure, cirrhosis)

We could also classify hyponatremic conditions in hyponatremia due to renal causes and hyponatremia due to extra-renal causes, according to the patient's clinical history and to sodium urinary concentration. So we have:

- Low plasmatic sodium and low urinary sodium (less than 10 mEq/l): extra-renal cause
- Low plasmatic sodium and high urinary sodium (more than 20 mEq/l): renal cause

There is an exception: metabolic alkalosis, in which the high urinary concentration of bicarbonate causes a high urinary level of sodium too, in order to maintain the electrical neutrality; so, even though the cause is extra-renal, the urinary concentration of sodium is high. In this case we could make a differential diagnosis by looking at the urinary concentration of chloride.

## **Diagnostic algorithm for hyponatremia**



### ***ETIOLOGY:***

- Hyponatremia with hypovolemia:
  - Extra-renal losses:
    - GI losses: diarrhea and vomiting
    - Other losses: pancreatic disease, peritonism, rhabdomyolysis, burns
  - Renal losses:
    - Diuretics (especially thiazides)
    - Osmolar diuresis (raised glucose, urea, etc.) → high plasma osmolality (normally, in hyponatremia, plasma osmolality is low)
    - Addison's disease
    - Metabolic alkalosis
    - Renal diseases with electrolytes losses
- Hyponatremia with euvolemia:
  - SIADH
  - Water intoxication, primary polydipsia → urine osmolality is <100 mOsm/kg (normally, urine osmolality is higher)
  - Excess of 5% dextrose IV

- Diuretics (especially thiazides)
  - Hypothyroidism
  - Addison's disease
  - Pain, stress
- Hyponatremia with hypervolemia:
    - Extra-renal diseases:
      - Heart failure
      - Cirrhosis
    - Renal diseases:
      - Nephrotic syndrome
      - Renal failure

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### Syndrome of Inappropriate ADH secretion (SIADH)

It is an important cause of hyponatremia. The diagnosis requires concentrated urine (sodium  $>20$  mEq/l and osmolality  $>500$  mOsm/kg) in the presence of hyponatremia ( $<125$  mEq/l) or low plasma osmolality ( $<260$  mOsm/kg), and the absence of hypovolemia, edema or diuretics.

Causes:

- Malignancy: eg, lung small-cell, pancreas, prostate, lymphoma
- CNS disorders: meningoencephalitis, abscess, stroke, subarachnoid/subdural hemorrhage, head injury, Guillain-Barré, vasculitis (e.g., SLE)
- Chest disease: tuberculosis, pneumonia, abscess, aspergillosis
- Metabolic disease: porphyria, trauma
- Drugs: opiates, chlorpropamide, psychotropics, SSRIs, cytotoxics

Treatment: treat the cause, fluid restriction, occasionally Demeclocycline.

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### ***SIGNS AND SYMPTOMS:***

Hyponatremia causes cell swelling. This is especially important in the CNS: symptoms of CNS dysfunction are common. Symptoms of hyponatremia appear when the osmolality is less than 240 mOsm/kg but it is also important how quickly the osmolality diminishes. So we have:

Osmolality between 150 and 240 mOsm/kg:

- Modifications of the personality
- Lethargy
- Confusion
- Sense alterations

Osmolality less than 150 mOsm/kg:

- Hyporreflexia
- Cheyne-Stokes breathe
- Hypothermia
- Seizures
- Coma

Pathological findings:

- Cerebral edema
- Demyelination
- Pontine myelinolysis

### ***MANAGEMENT:***

Do not base treatment on plasmatic sodium concentration alone.

The presence of symptoms, duration and state of hydration influence treatment. If possible, correct the underlying cause. The goal is a plasmatic sodium concentration of at least 125 mEq/l.

➤ Acute hyponatremia:

- Hypertonic solutions of mannitol or sodium with or without Furosemide. Raise plasmatic sodium concentration (1.5-2 mEq/h) until it reaches 125-130 mEq/l, but not too quickly, in order to avoid central pontine myelinolysis.

➤ Chronic hyponatremia:

- Free-water restriction
- Slow correction of plasmatic sodium concentration (less than 1 mEq/h)
- Eventually ADH-receptor antagonists (Demeclocycline) (300-600 mg twice a day)
- Eventually Lithium (but it is more toxic and less predictable than Demeclocycline)
- Eventually urea (30-60 g/100 ml of water a day), NaCl, Furosemide (20 mg once/twice a day)

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### Central pontine myelinolysis (osmotic demyelination)

Severe hyponatremia, especially if acute in onset, leads to cerebral edema (due to osmotic water movement into the brain), and can potentially cause irreversible neurologic damage and death. This scenario most often occurs when large volumes of hypotonic fluids are given to postoperative patients, or with acute thiazide-induced hyponatremia.

Within the first day of acute hyponatremia, the brain begins to lose extracellular water into the cerebrospinal fluid and loses intracellular water by extruding sodium and potassium salts and certain organic solutes (called osmolytes), thereby lowering the brain volume toward normal. The net effect of these adaptations is that slowly developing hyponatremia (over more than two to three days) is associated with a lesser likelihood of neurologic symptoms. In this setting in which the excessive brain volume has returned toward normal, rapid correction of severe hyponatremia (plasma sodium concentration usually less than 110 to 115 meq/L) can lead to the development of a neurologic disorder called osmotic demyelination or central pontine myelinolysis (although demyelination may be more diffuse and not necessarily involve the pons).

The clinical manifestations of osmotic demyelination are typically delayed for two to six days after the elevation in the plasma sodium concentration. The symptoms, which are often irreversible or only partially reversible, include dysarthria, dysphagia, paraparesis or quadriparesis, lethargy, and coma; seizures may also be seen but are less common.

Demyelinating lesions are most common when the plasma sodium concentration in severe hyponatremia is raised more than 20 mEq/L per day and are rare at a rate below 10 to 12 meq/L per day.

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