# Diagnosis and Management of Hyponatremia

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**Hyponatremia**

- Serum sodium concentration <135 mEq/L
- Severe hyponatremia <120 mEq/L
- Disorder of water, not salt
- Occurs in ~15% of all hospital inpatients
- Increased morbidity and mortality
- Symptoms depend on rate of fall

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Total Body Water
(60% of Body Weight)

- Intracellular
- Interstitial
- Intravascular

Normal Water Regulation via ADH

- Water load, causing decreased serum osmolality
- Leading to suppressed ADH (vasopressin)
- Leading to water excretion in dilute urine (decreased Uosm)

Impaired Renal Water Excretion

1. Inability to suppress ADH
   - True hypovolemia: low Sosm, low arterial blood volume
   - Effective arterial blood volume depletion: cirrhosis, CHF
   - Endogenous stimuli: nausea, pain
   - Thiazide diuretics: reabsorb water, less NaCl reabsorption in distal tubule
   - SIADH
2. Suppressed ADH but overwhelmed excretory capacity of kidney
   - Advanced renal failure
   - Primary polydipsia
   - Beer potomania
When should I worry a lot?

1. Symptoms:
   - Headache
   - Muscle cramps
   - Reversible ataxia
   - Psychosis
   - Lethargy
   - Apathy
   - Agitation
   - Seizures
   - (Coma, respiratory arrest, death)
   - Duration:
     - Last sodium level
     - If it’s not broke, don’t fix it quickly
   - Clinical history:
     - Adrenal crisis (hypotension, weakness, shock)
     - Hypothyroidism/ myxedema coma (altered mental status, hypothermia, bradycardia, hypotension)
     - Cerebral salt-wasting syndrome (head injury, intracranial surgery, subarachnoid hemorrhage, stroke, brain tumor)
     - Marathon runner

Evaluation of Hyponatremia

- History
  - Urgent indication
  - Fluid loss
  - Free water intake
Medications
Other medical problems
Small cell carcinoma
CNS disease

Physical Exam:
Volume status
Pulmonary
Neurologic
Stigmata of chronic illness

Labs:
Serum osmolality
- Compared to calculated
- Sosm = 2(Na) + glu/18 + BUN/28
- Difference should be less than 20, or unmeasured osmols present
Urine sodium: marker of intravascular volume status and ability of kidney to reabsorb Na
- <20 mEq/L = low effective circulating volume
- >20 mEq/L = no hypovolemia and/or renal salt-wasting
Urine osmolality: marker of ADH level
- <100 mOsm/kg = suppressed ADH
- >300 mOsm/kg = inability to suppress ADH

Before You Can Call it SIADH
You Must Find:
- Low serum osmolality
- High urine sodium
- High urine osmolality (high ADH)
- Normal creatinine
- Normal acid-base and K
- Normal adrenal and thyroid function

SIADH
CNS process
Lung process
Cancer
Medications
- SSRI’s
- Desmopressin
- NSAID’s
- Tricyclics
- Nicotine
- Other
Idiopathic
Hyponatremia Treatment:
Normal or high serum osmolality

Hyponatremia: Normal/High $S_{osm}$

Normal/High $S_{osm}$
- Normal: pseudohyponatremia
- Hypertriglyceridemia
- Cholestatic and obstructive jaundice
- Hyperproteinemia

High, $>295$ mOsm/Kg H2O = redistributive
- Hyperglycemia
- Mannitol, maltose, sucrose, glycine, or sorbitol administration
- Azotemia
- Alcohol intoxication

- Correct underlying problem
  - Lipids, multiple myeloma, bilirubin
  - Hyperglycemia
    - Need to correct if indirect potentiometry
    - Add 1.6-2.4 mmol/L to Na for every 100 mg/dL glu above 100 mg/dL
  - Remove other solutes, toxins
  - Dialysis
Hyponatremia Treatment:
Low Sosm:

### Hyponatremia: Low Sosm

| Hypovolemic | Hypovolemic | Euvolemic 

| Una < 20 mEq/L | Una > 20 mEq/L | Uosm < 100 mOsm/kg | Uosm > 300 mOsm/kg | Una < 20 mEq/L | Una > 20 mEq/L |
| 1. Dehydration | 1. Drug effect (thiazides, ACE-I) | 1. Psychogenic polydipsia | 1. SIADH | Uosm > 300 mOsm/kg | Uosm < 100 mOsm/kg |
| | 5. Endurance exercise |
| | 6. Glucocorticoid deficiency |

### General Principles
- If it’s not broke, don’t fix it quickly
- Treat if acute
- Treat if symptomatic
- If not acute or symptomatic, consider etiology and trending
- Actual correction often exceeds what is intended
- If replacing potassium, likely will raise serum sodium level
- Go slow and check often
- Do not exceed 1-2 mEq/L/hour or 12 mEq/L in 24 hours
- 4-6 mEq/L increase in serum sodium level enough to reverse most severe manifestations of acute hyponatremia

### Central Pontine Myelinolysis
- Osmotic demyelination syndrome
Hyponatremia corrected too rapidly
- Mental status changes, seizures, horizontal gaze paralysis, spastic quadriplegia
- Do not exceed 1-2 mEq/L/hour or 12 mEq/L in 24 hours
- Risk increased if Na<121, alcoholism, liver disease, malnutrition, severe hypokalemia, goal 4-6 mEq/L per 24 hours, do not exceed 9 mEq/L in 24 hours

**Low Sosm: Hypovolemia**
- **1. Hypovolemia:**
  - Isotonic saline (Na 154 mEq/L)
    - Corrects hyponatremia a little
    - Removes stimulus for ADH release
  - Fix underlying reasons

**Low Sosm: Euvolemia**
- **2. Euvolemia:** SIADH, psychogenic polydipsia, beer potomania, endocrine, medication
  - Fluid restriction to below level of urine output, usually <800 mL/day
  - Urine to serum electrolyte ratio (Una + Uk)/Sna
  - Hyponatremia likely to improve with fluid restriction alone if <0.5
  - Fluid restriction alone may be insufficient if >1
  - Loop diuretic +/- oral salt tablets in SIADH if urine to serum electrolyte ratio >1
  - Isotonic saline likely to worsen hyponatremia

**Low Sosm: Hypervolemia**
- **3. Hypervolemia with effective circulating volume depletion:** heart failure, cirrhosis, nephrotic syndrome
  - Fluid restriction to below level of urine output, usually < 800 mL/day
  - If very concentrated urine (>500 mOsm/kg), fluid restriction alone may be insufficient
  - May require diuresis with loop diuretic
  - Advanced renal failure (renal failure with hypervolemia and Una>20) may require hemodialysis for hypervolemia

**Hypertonic Saline: Emergencies Only**
- 100 mL of 3% (hypertonic) saline bolus, only in patients with severe symptoms
- May repeat 1-2 more times at 10 min intervals
- ER or ICU setting

**While Treating in Inpatient Setting**
- Monitor electrolyte levels every:
  - 2 hr minimum if giving saline
  - If fluid restriction alone, depends on change
- Monitor serum osmolality, urine sodium, and urine osmolality as needed to evaluate for:
  - Suppression of ADH release and renin release after fluid resuscitation in true hypovolemia
  - Response to diuretics in CHF, cirrhosis
Summary

- Diagnosis of hyponatremia: History, Physical, SosmUnaUosm
- Treatment of hyponatremia:
  - Normal/high serum osmolality
    - Treat underlying etiology
  - Low serum osmolality
    - Hypovolemia: isotonic saline
    - Euvolemia: fluid restrict + correct underlying etiology
    - Hypervolemia: fluid restrict
- Monitor closely
- Do not exceed 1-2 mEq/L/hour or 12 mEq/L in 24 hours (or max 9 mEq/L in 24 hr in high risk patients)
- 4-6 mEq/L improvement to reverse severe manifestations

References:

- WakiL A, Ng JM, Atkin SL. Investigating hyponatraemia. BMJ. 2011; 342:d1118.