Hyponatremia: Student Handout

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Hyponatremia: A Student Guide to Low Sodium

Learning Objectives

By completing this handout, you should be able to: - Define hyponatremia and recognize its clinical significance - Explain the physiologic mechanisms that maintain water and sodium balance - Systematically approach a patient with hyponatremia - Calculate and interpret the Furst ratio for fluid restriction response - Implement evidence-based treatment strategies

Quick Definition

Hyponatremia = Serum sodium <135 mEq/L (normal: 135-145 mEq/L)

Think of it as **too much water relative to sodium**, not simply too little sodium.

Severity and Symptoms

Severity	Na+ Level	Symptoms	Timeline
Mild	130-134	Fatigue, difficulty concentrating	Often asymptomatic
Moderate	125-129	Headache, nausea, confusion	Hours to days
Severe	<125	Seizures, coma, respiratory arrest	Immediate concern

Critical Point: Acute hyponatremia (developing in <48 hours) causes more severe symptoms at milder sodium levels compared to chronic hyponatremia. A patient with Na+ 128 developed acutely may seize, while another patient with Na+ 115 chronically may only have mild symptoms.

The Two Hormone Systems

1. Antidiuretic Hormone (ADH) System

- **Regulates:** Water balance
- **Monitored by:** Blood osmolality (280-290 mOsm/kg)
- **Response:** High ADH ☐ water retention ☐ concentrated urine
- **Key test:** Urine osmolality

2. Aldosterone System (RAAS)

- **Regulates:** Sodium balance
- **Monitored by:** Effective arterial blood volume
- **Response:** High aldosterone ☐ sodium and water retention
- **Key test:** Urine sodium + Clinical volume assessment

Think of it this way: One thermostat controls temperature (ADH=water), another controls humidity (aldosterone=sodium). They work independently!

Clinical Assessment: The Four Questions

1. How severe is it?

- Serum sodium level
- Symptom presence (especially neurologic)
- Rate of development (acute vs. chronic)

2. What is the volume status?

Hypovolemic (total body sodium ☐, water ☐☐) - Signs: Orthostatic hypotension, tachycardia, dry mucous membranes, flat neck veins - Causes: Vomiting, diarrhea, diuretics, third-spacing

Euvolemic (total body sodium normal, water ☐) - Signs: Normal BP, normal physical exam, no edema - Causes: SIADH, hypothyroidism, adrenal insufficiency

Hypervolemic (total body sodium ☐, water ☐☐) - Signs: Edema, elevated JVP, pulmonary edema - Causes: Heart failure, cirrhosis, nephrotic syndrome, renal failure

3. What is the urine osmolality?

This is the **most important test** - tells you about ADH activity.

- **<100 mOsm/kg:** ADH suppressed (primary polydipsia, beer potomania)
- **100-300 mOsm/kg:** Partial effect or mixed picture
- **>300 mOsm/kg:** Significant ADH effect (SIADH, hypovolemic states)
- **>500 mOsm/kg:** Strong ADH effect (classic for SIADH)

4. What medications is the patient taking?

Common culprits: - **SSRIs/SNRIs** (paroxetine, venlafaxine) ☐ SIADH pattern - **Thiazide diuretics** (HCTZ) ☐ mixed picture initially - **Carbamazepine, oxcarbazepine** ☐ SIADH - **NSAIDs, ACE inhibitors** ☐ impaired water excretion

The Diagnostic Algorithm

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HYPONATREMIA (Na+ <135)
    ↓
Assess volume status (physical exam)
    ↓
├─ HYPOVOLEMIC → Causes: GI losses, diuretics, adrenal insufficiency
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│  └─ Urine Na+ usually <20 mEq/L (appropriate kidney retention)
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├─ EUVOLEMIC → Causes: SIADH, hypothyroidism, polydipsia
│  └─ Urine osmolality >300 suggests SIADH
│
└─ HYPERVOLEMIC → Causes: Heart failure, cirrhosis, renal disease
   └─ Urine Na+ >20 mEq/L (kidney can't conserve despite volume overload)
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The Furst Ratio: Predicting Fluid Restriction Response

Formula: Furst Ratio = (Urine Na+ + Urine K+) / Serum Na+

Interpretation: - **<0.5:** Likely to respond to fluid restriction - **0.5-1.0:** May respond to severe restriction (<500 mL/day) - **>1.0:** Unlikely to respond; consider alternative therapy

Clinical Significance: Up to 60% of SIADH patients have unfavorable Furst ratios, meaning fluid restriction alone won't work effectively. These patients need urea therapy, SGLT2 inhibitors, or vaptans.

Important: Fluid restriction has LIMITED EVIDENCE and poor adherence rates (<50%). If Furst ratio unfavorable, don't waste time on fluid restriction—move to proven therapies.

Treatment by Severity and Cause

Severe Symptomatic Hyponatremia (Seizures/Coma)

- **Goal:** Raise Na+ by 4-6 mEq/L to stop symptoms
- **Treatment:** 3% hypertonic saline
  - Bolus: 150 mL over 10-20 minutes, repeat 2-3 times
  - Check Na+ after each bolus
- **Key concept:** Correct just enough to stop symptoms, then slow down

Symptomatic Without Severe Neurologic Symptoms

- **Goal:** Gradual correction, 6-10 mEq/L per 24 hours
- **Treatment:** Based on cause
  - Hypovolemic ☐ isotonic saline (0.9%)
  - Euvolemic ☐ fluid restriction initially; if fails ☐ urea or SGLT2i
  - Hypervolemic ☐ address underlying condition (diuretics, etc.)

Asymptomatic Hyponatremia

- **Goal:** Gradual correction, 6-8 mEq/L per 24 hours
- **Treatment:** Address underlying cause
- **Caution:** Slow correction minimizes osmotic demyelination syndrome risk

The Saline Paradox (Critical Concept!)

Normal saline can WORSEN hyponatremia in SIADH!

Why? - Normal saline has osmolality ~308 mOsm/kg - If urine osmolality >308 mOsm/kg, kidneys excrete saline's sodium in smaller water volume - Result: Patient retains free water ☐ Na+ drops further

Solution: Check urine osmolality before giving IV fluids - If >350 mOsm/kg ☐ use hypertonic (3%) saline - If <300 mOsm/kg ☐ normal saline is safe

Emerging Therapies

Urea (15-60g daily)

- Osmotic agent promoting free water excretion
- Safe, predictable, inexpensive
- Now **preferred second-line therapy**
- Mix with juice to improve taste

SGLT2 Inhibitors (e.g., empagliflozin 10mg daily)

- Induce glucosuria ☐ osmotic diuresis
- Dual benefit in heart failure patients
- Takes days to work
- Contraindicated in severe renal impairment

Overcorrection Prevention

Osmotic Demyelination Syndrome (ODS) risk when: - Correction >8-10 mEq/L per 24 hours - Severe hyponatremia (<115 mEq/L) - Chronic alcoholism, malnutrition, liver disease

Management if overcorrection occurs: 1. Stop sodium-containing infusions immediately 2. Give desmopressin (dDAVP) 2-4 μg IV/SC 3. Start D5W infusion 4. Monitor Na+ every 1-2 hours 5. Goal: Re-lower sodium to safer range

Clinical Pearls

1. **Urine osmolality is king** - This single test provides most diagnostic information
2. **Always check volume status first** - Determines initial treatment approach
3. **Medications matter** - SSRIs, thiazides are common culprits
4. **Correct slowly, especially if chronic** - Risk of ODS outweighs benefits of rapid correction
5. **Address the cause** - Treating hyponatremia without fixing underlying problem leads to relapse
6. **Concurrent hypomagnesemia prevents potassium correction** - Always check and replace Mg2+

Practice Questions

Question 1: A 72-year-old woman on hydrochlorothiazide presents with Na+ 128 mEq/L, urine osmolality 45 mOsm/kg, and orthostatic hypotension. What's the likely diagnosis?

Answer

Thiazide-induced hyponatremia with hypovolemia. The low urine osmolality indicates appropriate ADH suppression (kidneys trying to retain water). The orthostasis confirms volume depletion. Treatment: discontinue diuretic and give isotonic saline carefully (risk of overcorrection once volume is restored).

Question 2: A 55-year-old man with SIADH from lung cancer has Na+ 128 mEq/L and urine osmolality 580 mOsm/kg. Furst ratio is 1.2. He's miserable from thirst despite 800mL fluid restriction. What would you do?

Answer

Don't continue torturing him with fluid restriction! Furst >1.0 predicts failure. Start urea 30g daily or SGLT2 inhibitor. These have proven efficacy and allow more liberal fluid intake, improving quality of life while safely correcting sodium.

Question 3: A 45-year-old with acute symptomatic hyponatremia (Na+ 115, seizures) receives 150mL 3% saline. Na+ rises to 120. What's your next step?

Answer

STOP aggressive correction. The seizure risk is gone at Na+ 120. Continue careful correction (target 6-8 mEq/L per 24 hours). Consider dDAVP clamp if high ODS risk. Seizing patients need urgent treatment, but once symptoms resolve, switch to conservative approach.

Key Takeaways for Exams

- Hyponatremia = water excess (or sodium deficit)
- Always assess volume status first
- Urine osmolality distinguishes SIADH from hypovolemic hyponatremia
- Furst ratio >1.0 means fluid restriction will fail
- Urea and SGLT2i are now preferred second-line therapies
- Correct slowly, especially in chronic hyponatremia
- Urine osmolality >350 ☐ use hypertonic saline (normal saline paradox)
- Overcorrection causes osmotic demyelination ☐ prevent with desmopressin if needed

References

- Hyponatremia-treatment standard 2024. Nephrology Dialysis Transplantation
- Winzeler B, et al. Predictors of nonresponse to fluid restriction in SIADH. J Clin Endocrinol Metab. 2019
- Current review synthesizes 2024-2025 evidence on emerging therapies

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Study Tip: Draw a simple diagram with "total body Na+" on one axis and "total body water" on the other. Hypovolemic hyponatremia is down-left. Euvolemic is right. Hypervolemic is up-right. This helps organize the clinical approach.

See Also

Related Student Handouts

- Hypernatremia and SIADH
- Acid-Base Disorders
- AKI Workup and Diagnosis
- Cirrhosis and Ascites (HV hyponatremia)
- Heart Failure (HV hyponatremia)

Clinical Content (01-Clinical-Medicine/Nephrology)

- Electrolyte Disorders Hub
- Sodium Disorders Clinical Reference
- Essential Renal Laboratory Tests

Atomic Notes (ZK)

- Hyponatremia Classification and Pathophysiology
- Medication-Induced Hyponatremia
- Overcorrection Prevention in Hyponatremia
- Specialized Hyponatremia Treatment

Butler-COM Resources

- Butler COM - Nephrology Deep Dive

References

- Hyponatremia-treatment standard 2024. Nephrology Dialysis Transplantation
- Winzeler B, et al. Predictors of nonresponse to fluid restriction in SIADH. J Clin Endocrinol Metab. 2019
- Current review synthesizes 2024-2025 evidence on emerging therapies

Clinical Resources

- Clinical Review: Hyponatremia Paper — Comprehensive clinical review with PubMed references
- Clinical Review: Literature Review Correction Speed Of Hyponatremia And Associated Risks Of Mortality And Osmotic Demyelination Syndrome — Comprehensive clinical review with PubMed references
- Clinical Review: Hyponatremia Complete Student Guide — Comprehensive clinical review with PubMed references
- Clinical Review: Mercy Nursing Hyponatremia — Comprehensive clinical review with PubMed references
- Clinical Review: Hyponatremia Comprehensive Hyponatremia Guide May 22 2025 — Comprehensive clinical review with PubMed references

- Clinical Review: Hyponatremia Furst Ratio Comprehensive Evidence Based Expansion — Comprehensive clinical review with PubMed references
- Clinical Review: Ich Hyponatremia Report — Comprehensive clinical review with PubMed references