Hospital Management of Hypernatremia

Hypernatremia is a common electrolyte disorder in the hospital setting, often indicating an underlying imbalance in water or sodium homeostasis. If untreated, it can lead to significant morbidity and mortality. This pamphlet provides) students with a guide to diagnose, evaluate, and manage hypernatremia in the hospital setting, with clinical scenarios to apply the knowledge.

Clinical Presentation

• Definition:

- Hypernatremia: Serum sodium (Na) >145 mEq/L (severe if >150 mEq/L).
  - Reflects a relative water deficit or sodium excess, often due to impaired thirst, water access, or renal water handling.
  - Symptoms:
    - General: Thirst (early, protective mechanism), lethargy, irritability, confusion, muscle twitching, seizures (severe, Na >160 mEq/L), coma.
    - Neurologic: Due to brain cell shrinkage (hyperosmolarity); risk of cerebral edema if corrected too rapidly.
  - Volume Status: Depends on underlying cause (hypovolemic, euvolemic, or hypervolemic).

• Vital Signs/Exams:

- Hypovolemic Hypernatremia:
  - BP: Hypotension (SBP <90 mmHg), orthostatic changes (SBP drop >20 mmHg or HR increase >20 bpm on standing).
  - HR: Tachycardia (HR >100 bpm).
  - Skin: Dry mucous membranes, poor skin turgor, sunken eyes.
- Euvolemic Hypernatremia:
  - BP/HR: Often normal (no significant volume loss).
  - Neuro: Lethargy, confusion, seizures (if Na >160 mEq/L).
- Hypervolemic Hypernatremia:
  - BP: Hypertension (SBP >140 mmHg, if sodium overload).
  - Exam: Edema, JVD, crackles (volume overload).

- **Associated Conditions:**

Dehydration (hypovolemic), diabetes insipidus (euvolemic), sodium overload (hypervolemic), renal dysfunction, altered mental status (limiting water intake).

Causes and Differential Diagnosis

- **Hypovolemic Hypernatremia (Water Loss > Sodium Loss):**

  - Causes:
    - GI Losses: Vomiting, diarrhea, nasogastric suction (e.g., bowel obstruction).
    - Renal Losses: Osmotic diuresis (hyperglycemia, mannitol), loop diuretics (furosemide), post-obstructive diuresis.
    - Insensible Losses: Fever, burns, sweating (e.g., marathon runners), respiratory losses (tachypnea).
    - Impaired Water Intake: Elderly, infants, altered mental status (dementia, sedation), intubation.
    - Features: Dry mucous membranes, tachycardia, hypotension, concentrated urine (urine osmolality >300 mOsm/kg), low urine Na (<20 mEq/L if non-renal cause).

- **Euvolemic Hypernatremia (Pure Water Loss):**

  - Causes:
    - Diabetes Insipidus (DI):
      - Central DI: Lack of ADH (head trauma, pituitary surgery, tumors).
      - Nephrogenic DI: Impaired renal response to ADH (lithium, hypercalcemia, hypokalemia, sickle cell disease).
    - Features: Normal volume status, dilute urine (urine osmolality <150 mOsm/kg), high urine output (>3 L/day in DI).

- **Hypervolemic Hypernatremia (Sodium Gain > Water Gain):**

  - Causes:
    - Iatrogenic: Hypertonic saline (e.g., 3% NaCl), sodium bicarbonate administration.
    - Salt Ingestion: Excessive salt intake (e.g., soy sauce, seawater ingestion).
    - Mineralocorticoid Excess: Hyperaldosteronism (Conn’s syndrome), Cushing’s syndrome.

- Features: Edema, hypertension, high urine Na (>20 mEq/L), low urine osmolality (if renal water loss).

• Differential Diagnosis:

- Hyponatremia: Opposite (Na <135 mEq/L), often with edema, confusion, seizures; check serum osmolality to differentiate.
- Hyperglycemia: Can mimic hypernatremia (pseudohyponatremia corrected for glucose); true hypernatremia if serum osmolality >295 mOsm/kg.
- Renal Failure: May cause hypernatremia (impaired water conservation), but often with elevated Cr, BUN.
- Sepsis: Fever, tachycardia, but with leukocytosis, lactate >2 mmol/L, not primary cause of hypernatremia.

Category	Cause	Clinical Features	Key Diagnostic Clues
Hypovolemic	GI losses (vomiting, diarrhea)	Dry mucous membranes, tachycardia	Urine Na <20 mEq/L, high urine osmolality.
Hypovolemic	Impaired water intake (elderly)	Dry mucous membranes, confusion	Urine Na <20 mEq/L, high urine osmolality.
Euvolemic	Diabetes Insipidus	Normal volume, high urine output	Urine osmolality <150 mOsm/kg, high urine Na.
Hypervolemic	Hypertonic saline	Edema, hypertension	High urine Na, low urine osmolality.

Diagnosis and Labs

• Initial Assessment:

- History: Onset of symptoms, thirst, water intake, recent illnesses (fever, vomiting, diarrhea), medications (diuretics, lithium), neurologic history (head trauma, pituitary surgery).
- Physical Exam: Assess volume status (hypovolemic, euvolemic, hypervolemic), neurologic signs (confusion, seizures), signs of dehydration (dry mucous membranes, poor skin turgor).

• Labs:

- Serum Sodium: Na >145 mEq/L (confirm with repeat measurement to rule out lab error).
- Serum Osmolality: >295 mOsm/kg (hyperosmolar state); confirms true hypernatremia.

- Urine Osmolality:
  - High (>300 mOsm/kg): Hypovolemic (GI losses, insensible losses).
  - Low (<150 mOsm/kg): Euvolemic (DI).
- Urine Sodium:
  - Low (<20 mEq/L): Non-renal losses (GI, insensible), DI.
  - High (>20 mEq/L): Renal losses (diuretics, osmotic diuresis), sodium overload.
- CMP:
  - Glucose: Rule out hyperglycemia (pseudohyponatremia); correct Na for glucose: Add 1.6 mEq/L to Na for every 100 mg/dL glucose >100.
  - Creatinine/BUN: Elevated Cr/BUN (hypovolemia, AKI), BUN/Cr >20 (dehydration).
  - Potassium: Hypokalemia (diuretics, vomiting), hyperkalemia (renal failure).
  - Serum Uric Acid: Low in DI (<4 mg/dL), high in hypovolemic states (>6 mg/dL).
- Urine Output: High in DI (>3 L/day), low in hypovolemia (<500 mL/day).
- ADH Testing (if DI suspected):
- Water Deprivation Test: Confirms DI (urine osmolality remains <150 mOsm/kg despite dehydration); desmopressin (DDAVP) differentiates central vs. nephrogenic DI.
  - Not performed in acute setting; manage empirically.

- **Imaging/Diagnostic Tests:**

- Head CT/MRI: If central DI suspected (pituitary lesion, trauma); not urgent.
- Chest X-ray: If fever, respiratory symptoms (rule out pneumonia as cause of insensible losses).
- EKG: If severe hypernatremia (Na >160 mEq/L), risk of arrhythmias (peaked T waves, prolonged QT).

Diagnostic and Treatment

Category	Diagnostic Approach	Treatment Strategy	Notes
Hypovolemic	Urine Na <20 mEq/L, high urine osmolality	Correct deficit with D5W, NS for volume	Correct Na by ≤0.5 mEq/L/h, monitor q4h.
Euvolemic (DI)	Urine osmolality <150 mOsm/kg	DDAVP (central DI), fluids (nephrogenic)	Avoid overcorrection, risk of cerebral edema.
Hypervolemic	High urine Na, low urine osmolality	Furosemide 40 mg IV, D5W to correct Na	Monitor for volume overload, slow correction.

Category	Diagnostic Approach	Treatment Strategy	Notes
General	Serum Na, osmolality, urine output	Correct Na by ≤10 mEq/L/day	Check Na q4-6h, adjust fluids accordingly.

Treatment and Overall Management

• General Principles:

- Stabilize: ABCs (airway, breathing, circulation), IV access, telemetry, monitor for seizures.
- Correct slowly: Avoid rapid correction (risk of cerebral edema); target Na decrease ≤0.5 mEq/L/h or ≤10 mEq/L/day.
- Address underlying cause: Replace water deficit, manage sodium overload, treat DI.

• Step 1: Assess Volume Status:

- Hypovolemic: Treat dehydration first, then correct Na.
- Euvolemic: Focus on free water replacement.
- Hypervolemic: Remove excess sodium while correcting Na.

• Step 2: Calculate Water Deficit:

- Formula: Water Deficit (L) = 0.6 x Body Weight (kg) x [(Serum Na / 140) - 1].
- Example: 70 kg patient, Na 160 mEq/L → Water Deficit = 0.6 x 70 x [(160/140) - 1] = 6 L.

• Step 3: Correct Hypernatremia:

- **Hypovolemic Hypernatremia**:
  - Volume Resuscitation: NS or LR 1-2 L IV bolus (20-30 mL/kg), reassess (HR, BP, urine output).
  - Free Water Replacement: D5W IV (calculate rate to correct Na ≤0.5 mEq/L/h).
    - Example: To correct 6 L deficit over 48h (Na decrease 10 mEq/L), infuse D5W at 125 mL/h.
  - Oral: If patient can drink, provide free water (target 2-3 L/day).
- **Euvolemic Hypernatremia**:
  - Free Water: D5W IV or oral free water (same rate as above, e.g., 125 mL/h for 6 L deficit over 48h).

- Diabetes Insipidus:
  - Central DI: Desmopressin (DDAVP) 1-2 mcg IV/SC q12h (or 10 mcg intranasal q12h); monitor urine output, Na.
  - Nephrogenic DI: Correct underlying cause (stop lithium, treat hypercalcemia), thiazide diuretic (hydrochlorothiazide 25 mg PO daily), amiloride 5-10 mg PO daily (if lithium-induced).
- **Hypervolemic Hypernatremia:**
  - Diuresis: Furosemide 40 mg IV q6-8h (remove sodium), monitor for hypokalemia.
  - Free Water: D5W IV to replace water deficit (e.g., 125 mL/h as above).
  - Avoid Saline: Discontinue hypertonic saline, sodium bicarbonate.

Monitoring:

- Serum Na: Q4-6h (ensure correction rate ≤0.5 mEq/L/h).
- Urine Output: Target >0.5 mL/kg/h (adequate volume), monitor for DI (high output).
- Neurologic Status: Q1-2h (confusion, seizures, risk of cerebral edema if overcorrected).
- EKG: If Na >160 mEq/L (arrhythmia risk), or if hypokalemia develops (U waves, QT prolongation).

Complications to Avoid:

- Cerebral Edema: Rapid correction (>10 mEq/L/day) causes brain swelling, seizures, herniation.
- Volume Overload: In hypervolemic states, monitor for heart failure (crackles, JVD).
- Hypokalemia: Diuresis or D5W can lower K; replace as needed (target K >4 mEq/L).

Key Pearls

- **Hypernatremia:** Na >145 mEq/L, often water deficit; classify as hypovolemic, euvolemic, or hypervolemic.
- **Correct Slowly:** ≤0.5 mEq/L/h or ≤10 mEq/L/day to avoid cerebral edema; use D5W for free water replacement.
- **Hypovolemic:** Treat volume first (NS/LR), then water deficit (D5W); monitor urine Na, osmolality.
- **Euvolemic (DI):** DDAVP for central DI, fluids for nephrogenic DI; confirm with urine osmolality.

- **Hypervolemic:** Diuresis (furosemide) + D5W; avoid saline, monitor for volume overload.
- **Monitor:** Na q4-6h, urine output, neurologic status; avoid rapid correction.
- **Complications:** Cerebral edema (rapid correction), seizures (Na >160 mEq/L), volume overload (hypervolemic).

References

- **UpToDate:** “Hypernatremia: Diagnosis and Management in the Hospitalized Patient” (2025).
- **NEJM:** “Electrolyte Disorders: Hypernatremia” (2024).
- **Crit Care Med:** “Management of Hypernatremia in the ICU” (2023).
- **J Clin Endocrinol Metab:** “Diabetes Insipidus: Diagnosis and Treatment” (2024).

Clinical Scenarios

Case 1: A 70-Year-Old Female with Confusion

- **Presentation:** A 70-year-old female with dementia presents with confusion and lethargy for 2 days, found dehydrated at home with limited water access. Exam: BP 110/70 mmHg, HR 90 bpm, dry mucous membranes, poor skin turgor, disoriented.
- **Labs:** Serum Na 158 mEq/L, serum osmolality 320 mOsm/kg, urine osmolality 450 mOsm/kg, urine Na 15 mEq/L, Cr 1.5 mg/dL.
- **Diagnosis:** Hypovolemic Hypernatremia (Impaired Water Intake) → Na 158 mEq/L, signs of dehydration (dry mucous membranes, poor skin turgor), high urine osmolality, low urine Na, elderly with dementia.
- **Management:** Calculate water deficit: 0.6 x 60 kg x [(158/140) - 1] = 4.5 L. Correct over 48h (Na decrease 10 mEq/L): NS 1 L IV bolus to address hypovolemia, then D5W at 94 mL/h IV (4.5 L / 48h) for free water replacement. Monitor Na q4h (target decrease ≤0.5 mEq/L/h). Monitor neurologic status q1-2h (risk of cerebral edema). Address social factors (social work consult for home care).

Case 2: A 50-Year-Old Male with Polyuria

- **Presentation:** A 50-year-old male with schizophrenia on lithium presents with polyuria (5 L/day), thirst, and confusion for 3 days. Exam: BP 120/80 mmHg, HR 85 bpm, normal volume status, disoriented.

- **Labs:** Serum Na 152 mEq/L, serum osmolality 310 mOsm/kg, urine osmolality 120 mOsm/kg, urine Na 40 mEq/L, Cr 1.0 mg/dL.
- **Diagnosis:** Euvolemic Hypernatremia (Nephrogenic DI, Lithium-Induced) → Na 152 mEq/L, high urine output, low urine osmolality, lithium use.
- **Management:** Stop lithium. Calculate water deficit: 0.6 x 80 kg x [(152/140) - 1] = 4.2 L. Correct over 48h: D5W at 88 mL/h IV (4.2 L / 48h). Hydrochlorothiazide 25 mg PO daily (reduces urine output). Amiloride 5 mg PO daily (lithium-induced DI). Monitor Na q4h, urine output q2h, and mental status. Nephrology consult for DI management.

Case 3: A 60-Year-Old Male with Edema

- **Presentation:** A 60-year-old male received 3% saline for traumatic brain injury and presents with edema, hypertension, and lethargy 2 days later. Exam: BP 160/100 mmHg, HR 70 bpm, JVD, peripheral edema, crackles, lethargic.
- **Labs:** Serum Na 162 mEq/L, serum osmolality 330 mOsm/kg, urine Na 50 mEq/L, urine osmolality 150 mOsm/kg, Cr 1.2 mg/dL.
- **Diagnosis:** Hypervolemic Hypernatremia (Iatrogenic, Hypertonic Saline) → Na 162 mEq/L, edema, hypertension, recent 3% saline.
- **Management:** Stop 3% saline. Calculate water deficit: 0.6 x 90 kg x [(162/140) - 1] = 8.4 L. Correct over 72h (Na decrease 10 mEq/L): D5W at 117 mL/h IV (8.4 L / 72h). Furosemide 40 mg IV q6h (diuresis). Monitor Na q4h, urine output, and respiratory status (volume overload). EKG (arrhythmia risk, Na 162 mEq/L). ICU admission if seizures or worsening neurologic status.