

Hyponatremia and Hypernatremia – What to Think About

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Clinical Case:

A 35-year-old man presents to the ED with severe head trauma and multiple lacerations from a motor vehicle accident. He was transferred to the trauma unit where he became progressively obtunded over several days. He was previously healthy with no medications prior to admit. He is currently normotensive and euvolemic. His laboratory data are as follows: serum Na, 112 mEq/L; K, 3.9 mEq/L, Cl, 80 mEq/L, CO₂, 24 mEq/L; BUN, 12 mg/dL; SCr, 0.8 mg/dL; glucose, 80 mg/dL; serum osmolality, 240 mOsm/kg (normal 230-300); urine osmolality, 530 mOsm/kg (normal 300-900); and urine Na, 55 mEq/L. Arterial blood gas on room air: pH, 7.39; PCO₂, 40; PO₂, 90. Thyroid function and adrenal function are normal. He weighs 70 kg. What is likely cause of his worsening mental status?

The Problem: Hyponatremia

Hypernatremia and hyponatremia are the two dysnatremias encountered. Hyponatremia may be caused by congestive heart failure, renal failure, hyperglycemia, and water overload, but the most common cause is syndrome of inappropriate antidiuretic hormone secretion or SIADH.

SIADH

Pathophysiology

In patients with SIADH, hyponatremia is caused by an abnormally high secretion of antidiuretic hormone (ADH). Overall, SIADH-induced excess water retention results in high urine osmolality and low plasma sodium with levels often falling below 120mEq/L. Common causes of SIADH include central nervous system disorders, pulmonary disorders, carcinomas, and medications as listed in Table 1.

Table 1. Causes of SIADH

CNS disorders	Pulmonary disorders	Carcinomas	Medications
Brain abscess	Asthma	Bronchogenic carcinoma	Amiodarone
Cerebral abscess	Bronchiectasis	Pancreatic cancer	Carbamazepine
Cerebral tumor	Empyema	Mesothelioma	Chlorpromazine
Encephalitis	Lung abscess pneumonia	Prostate cancer	Chlorpropamide
Head trauma	Pneumothorax	Lymphoma	Cyclophosphamide
Hydrocephalus	Positive pressure ventilation	Thymoma	Intravenous cytoxan
Meningitis	Tuberculosis	Duodenum	Oxcarbazepine
Neoplasm		Neuroblastoma	Oxytocin
Pituitary surgery		Small-cell lung carcinoma	Phenothiazine
Psychosis			SSRI
Stroke			Theophylline
Subdural hematoma			TCA
Vascular abnormalities			Vincristine

SSRI=selective serotonin reuptake inhibitor; TCA=tricyclic antidepressant

Clinical Presentation

Patients may be asymptomatic or present with nausea, headache, lethargy, confusion, and disorientation. When plasma sodium levels fall quickly over a period of less than 24 hours, patients may present with signs and symptoms secondary to neuronal cell swelling and cerebral edema. These include nausea, malaise, headache, seizures, and coma. Patients with SIADH typically have **low plasma osmolality** (<280 mOsm/kg), **high urine osmolality** (>100 mOsm/kg) and **urine sodium >25 mEq/L**.

Treatment

The first line of treatment for patients with SIADH is restricting water intake to less than 1L to 1.5L/day with emphasis in correcting the underlying cause. Hypertonic saline (3% NaCl) should be used in acute severe hyponatremia ([Na] < 125mEq/L), but caution should be taken to avoid correcting sodium too quickly (>12 mEq/day). To replace sodium, calculate sodium deficit [(140-observed Na) x 0.6 x weight], and administer half this value over the first 12 hours. Each liter of NaCl contains 513 mEq Na. In this clinical case, the patient's calculated sodium deficit is 1176 mEq. Therefore 588 mEq Na or 1200ml of 3% NaCl should be ordered and infused at a rate of 100ml/hr over 12 hours. Continue infusion until Na > 130 mEq/L. Serum sodium should be monitored every six hours. In addition to hypertonic saline, an intravenous loop diuretic (eg furosemide) may also be initiated to enhance free water excretion.

Clinical Case:

A 52-year-old female is brought to the ED by her family for confusion, persistent headaches, fever, and neck stiffness for the past 24 hours. She is highly febrile with a temperature of 39°C, tachycardic, and normotensive. Upon physical examination, she was found to have nuchal rigidity and a positive Brudzinski's sign. Analysis of her CSF revealed the following: protein, 358 mg/dL (normal <50 mg/dL); glucose, 40mg/dL; and 10,000 WBC/mm³ (normal < 10 WBC/mm³) (96% polymorphonuclear leukocytes). Ceftriaxone and vancomycin were empirically initiated for bacterial meningitis. She was transferred to the MICU where she became more lethargic and confused. She developed polyuria with urinary output increasing from 1.2 ml/kg/min to 2.5 ml/kg/min overnight. Her serum sodium concentration also escalated from 136 mmol/L to 155 mmol/L. Measured urine osmolality was 210 mOsm/kg. What may be causing this acute change?

The Problem: Hypernatremia

Hypernatremia in the acute care setting may be due to water loss, hypertonic fluid administration, or sodium ingestion. When water loss (such as voluminous urination) occurs in the setting of hypernatremia, diabetes insipidus should be considered.

Diabetes Insipidus

Pathophysiology

Hypernatremia due to diabetes insipidus (DI) is caused by excess urinary water loss. Depending on etiology, DI is categorized as either central or nephrogenic, where central DI is caused by impaired ADH secretion and nephrogenic DI is caused by either ADH resistance or ADH impairment. The most common cause of central DI is neurohypophysis damage secondary to head trauma and other central nervous system processes listed in Table 2. Most cases of nephrogenic DI are attributable to medications, namely lithium. Other causes of nephrogenic DI are listed in Table 2.

Table 2. Causes of Diabetes Insipidus

Central DI		Nephrogenic DI	
Idiopathic	Hypoxic encephalopathy	Lithium toxicity	Inherited Aquaporin-2 defect
Familial	Sheehan's syndrome	Hypercalcemia	Inherited ADH-V2 receptor defect
Neurosurgery (pituitary surgery)	Vascular accident	Hypokalemia	Demeclocycline
Head trauma	CNS Infection	Cidofavir	Papillary necrosis
CNS malignancy	Deceleration injury	Foscarnet	
	Cerebral hemorrhage	Osmotic diuresis	

Clinical Presentation

Patients may be asymptomatic or present with weakness, restlessness, confusion, and coma. Patients with central and nephrogenic DI typically present with polyuria and are often euvolemic or hypervolemic with low urine osmolality (<250mOsm/kg) and slight hypernatremia (141-145 mEq/L).

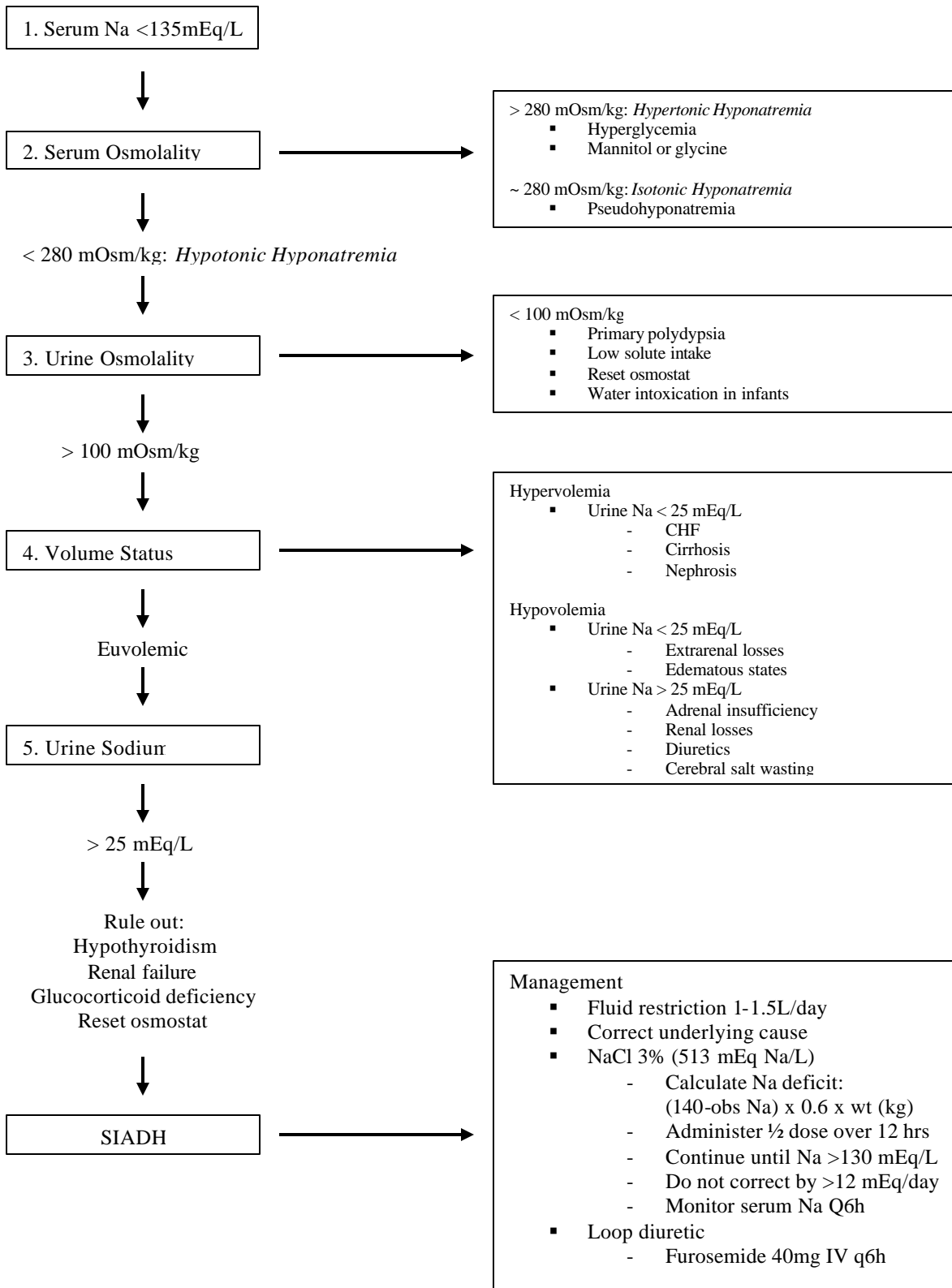
Treatment

This clinical case illustrates a patient with central DI secondary to bacterial meningitis. Patients with central DI may be treated with DDAVP (desmopressin) 10 mcg intranasally once daily, although some patients may require twice daily dosing. Doses should be adjusted to a daily urine volume of 1.5-2 L and sodium levels of 137-142 mEq/L. Nephrogenic diabetes may also be treated with dietary sodium restriction and thiazide diuretics, which produces mild extracellular fluid volume depletion resulting in increased proximal water reabsorption. Amiloride 5-10 mg daily inhibits lithium uptake in the renal collecting duct and therefore may be considered in patients with lithium-induced nephrogenic diabetes insipidus. Serum sodium should be monitored every 3 to 4 days initially, then every 2 to 4 months.

References

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SIADH Diagnosis and Management Algorithm



DI Diagnosis and Management Algorithm

