Electrolyte Disorders (Sodium & Potassium)

Introduction

- **Electrolyte balance** essential for homeostasis
- **Electrolyte imbalance:** disturbance in blood mineral levels
- **Severity** and **type** determine clinical manifestations
- Many disorders reflect **water imbalance** rather than electrolyte loss

Hyponatremia

Definition

- **Serum Na <135 mEq/L**
- Usually due to **failure to excrete free water**
- Reflects **water excess** rather than sodium deficiency

Pathophysiology

- In healthy individuals:
  - **ADH suppressed**
  - Excess water excreted as **dilute urine**

Types of Hyponatremia

☑ **Based on Osmolality**

Condition	Measured Osmolality	Na (Autoanalyzer)	Na (Direct ISE)
Normal	Normal	Normal	Normal
Hypotonic hyponatremia	Low	Low	Low
Hyperglycemia/mannitol	High	Low	Low
Absorbed irrigants	Normal	Low	Low
Pseudohyponatremia	Normal	Low	Normal

☑ **Pseudohyponatremia**

- **Artefactual low Na**
- Due to **hyperlipidemia or hyperproteinemia**
- Mechanism:
  - ↓ **plasma water fraction**
- Rare with modern assays

Causes of Hypotonic Hyponatremia

☑ **ADH not elevated**

- **Primary polydipsia**
- **Low solute intake** (beer potomania, tea & toast)

- ☑ **Impaired urine dilution with normal ADH suppression**
  - ◈ **Advanced renal failure**
  - ◈ **Diuretic-induced hyponatremia**
- ☑ **Impaired urine dilution with unsuppressed ADH**
  - ◈ **Hypovolemic:** true volume depletion
  - ◈ **Hypervolemic:** heart failure, cirrhosis
  - ◈ **Euvolemic (SIADH)**
- ☑ **SIADH Causes**
  - ◈ **Malignancy:** small cell lung cancer
  - ◈ **Pulmonary disease**
  - ◈ **CNS disorders**
  - ◈ **Drugs**
  - ◈ **Post-surgery**
  - ◈ **Endocrine deficiency**
- ☑ **SIADH Diagnostic Criteria**
  - ◈ **Plasma osmolality <270 mOsm/kg**
  - ◈ **Urine osmolality >100 mOsm/kg**
  - ◈ **Euvolemia**
  - ◈ **Urine Na >40 mmol/L**
  - ◈ Exclude **hypothyroidism & adrenal insufficiency**

✧ **CLINICAL MANIFESTATIONS**

- ☑ **Acute**
  - ◈ **Headache**
  - ◈ **Confusion**
  - ◈ **Seizures**
  - ◈ **Coma**
  - ◈ **Cerebral edema**
- ☑ **Chronic**
  - ◈ May be **asymptomatic** even if Na <120 mmol/L
  - ◈ **Fatigue**
  - ◈ **Nausea**
  - ◈ **Gait disturbance**
  - ◈ **Confusion**
  - ◈ **Muscle cramps**

✧ **DIAGNOSIS**

- ◈ **Serum osmolality**
- ◈ **Urine sodium**
- ◈ **Volume status**

- ✧ **Corrected Sodium**
  - ◈ Na decreases **~2 mEq/L per 100 mg/dL glucose**
  - ◈ Formula:
    - ↳ **Corrected Na = measured Na + 2 × [(glucose −100)/100]**
- ✧ **Complications**
  - ◈ **Hyponatremic encephalopathy**
  - ◈ **Osmotic demyelination syndrome (ODS)**
- ✧ **Treatment**
  - ☑ **Goals**
    - ◈ Prevent further Na drop
    - ◈ Reduce cerebral edema
    - ◈ Relieve symptoms
    - ◈ Avoid rapid correction
  - ☑ **Management**
    - ◈ **Hypovolemic:** isotonic saline
    - ◈ **Hypervolemic:** fluid restriction ± diuretics
    - ◈ **Euvolemic:** treat cause, correct hormones
    - ◈ **Correction rate:**
      - ↳ **≤0.5 mEq/L/hr**
      - ↳ **≤8 mEq/L/day**

Hypernatremia

- ✧ **Definition**
  - ◈ **Serum Na >145 mEq/L**
  - ◈ Common in **elderly**
- ✧ **Mechanisms**
  - ◈ **↓ water intake**
  - ◈ **AVP dysfunction**
  - ◈ **Renal unresponsiveness to AVP**
  - ◈ **Excess water loss**
- ✧ **Causes**
  - ◈ **Unreplaced water loss**
  - ◈ **Diabetes insipidus**
  - ◈ **Osmotic diuresis**
  - ◈ **Sodium overload**
- ✧ **Clinical Manifestations**
  - ◈ **Lethargy**
  - ◈ **Weakness**
  - ◈ **Seizures**
  - ◈ **Coma**
  - ◈ Severe if Na **>158 mEq/L**
  - ◈ Very high mortality if **>180 mEq/L**

- ✧ **Treatment**
  - ◈ Calculate **water deficit**
  - ◈ Correct ½ **deficit in first 24 h**
  - ◈ Avoid correction:
    - ↳ **<6 mEq/L/day**
    - ↳ **>12 mEq/L/day**

Hyperkalemia

- ✧ **Definition**
  - ◈ **Serum K ≥5.5 mEq/L**
- ✧ **Causes**
  - ☑ **Increased release from cells**
    - ◈ **Acidosis**
    - ◈ **Insulin deficiency**
    - ◈ **Tissue breakdown**
    - ◈ **Beta blockers**
    - ◈ **Digitalis toxicity**
  - ☑ **Reduced renal excretion**
    - ◈ **Hypoaldosteronism**
    - ◈ **ACEi/ARBs**
    - ◈ **CKD**
    - ◈ **Potassium-sparing diuretics**
- ✧ **Clinical Manifestations**
  - ◈ **Muscle weakness**
  - ◈ **Paralysis**
  - ◈ **Arrhythmias**
  - ◈ **Cardiac arrest**
- ✧ **ECG Changes**
  - ◈ **Tall peaked T waves**
  - ◈ **Loss of P waves**
  - ◈ **Wide QRS**
  - ◈ **Sine wave**
  - ◈ **Asystole**
- ✧ **Treatment**
  - ☑ **Stabilize membrane**
    - ◈ **Calcium gluconate**
  - ☑ **Shift K into cells**
    - ◈ **Insulin + glucose**
    - ◈ **β_2 agonists**
    - ◈ **Sodium bicarbonate**
  - ☑ **Remove K**
    - ◈ **Loop diuretics**
    - ◈ **Resins**
    - ◈ **Hemodialysis**

Hypokalemia

Definition

- Serum K <3.5 mEq/L

Causes

- Decreased intake
- GI losses
- Renal losses
- Redistribution
- Hypomagnesemia

Clinical Manifestations

- Muscle cramps
- Rhabdomyolysis
- Respiratory failure
- Arrhythmias
- Ileus

Renal Effects

- Impaired concentrating ability
- Metabolic alkalosis
- Hypokalemic nephropathy
- Hypertension

Treatment

- Oral/IV K replacement
- Correct Mg
- Treat cause
- Frequent K monitoring