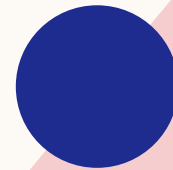


HYPONATREMIA AND HYPERCALCEMIA IN THE ACUTE CARE SETTING

Silya Mazigh, MD

DISCLOSURES

I have no actual or potential conflict of interest in relation to this program/presentation.





OBJECTIVES

- Develop a framework for the workup of hyponatremia and hypercalcemia.
- Identify severity indicators and potential adverse outcomes of delayed recognition.
- Implement corrective measures and monitoring for critical values.



UNDERSTANDING HYPONATREMIA

ROLE OF SODIUM



FLUID
BALANCE

BLOOD
PRESSURE
REGULATION

NERVE
FUNCTION

pH
BALANCE

MUSCLE
CONSTRUCTION

OSMOTIC
BALANCE

DEFINITIONS

- Normal Sodium Level: 135-145 mEq/L

- Hyponatremia: serum sodium concentration below 135 mEq/L

- Mild: 130 to 134 mEq/L
- Moderate: 120 to 129 mEq/L
- Severe: <120 mEq/L

Acute: known development over a period of < 48 hours.

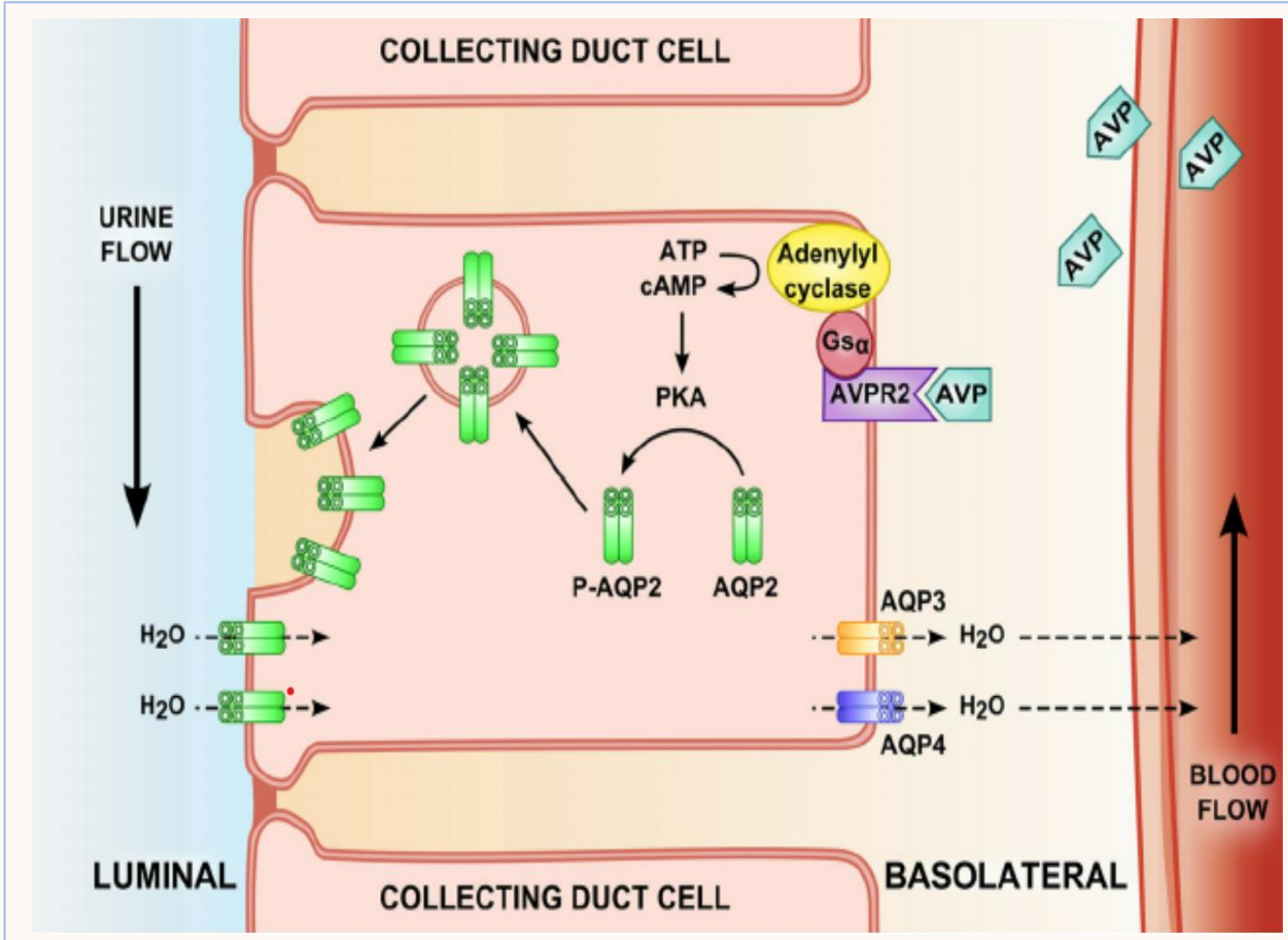
- Parenteral fluids in postoperative patients → ADH hypersecretion.
- Self-induced water intoxication: competitive runners, patients with extreme polydipsia, and users of ecstasy.
- Higher risk of complications (cerebral edema and seizures) and greater need for aggressive therapy.¹

Chronic: known that hyponatremia has been present for 48 hours or more, or if the duration is unclear.

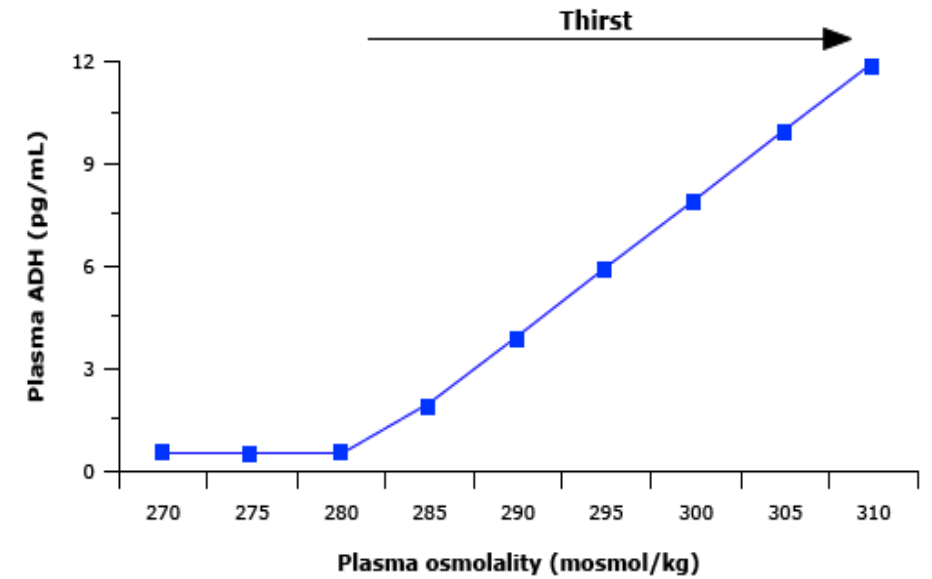
- The lower serum sodium concentration, the greater the risk of complications from overaggressive therapy and the greater the need for monitoring to avoid overcorrection.²

PATHOPHYSIOLOGY

Schematic representation of kidney collecting duct cell



Osmotic regulation of ADH release and thirst



Relation between plasma ADH concentration and plasma osmolality in normal humans in whom the plasma osmolality was changed by varying the state of hydration. The osmotic threshold for thirst is a few mosmol/kg higher than that for ADH.

ADH: antidiuretic hormone.

Data from Robertson GL, Aycinena P, Zerbe RL. Neurogenic disorders of osmoregulation. *Am J Med* 1982; 72:339.



ETIOLOGIES OF HYPONATREMIA

- Excessive Fluid Intake
- Syndrome of Inappropriate Antidiuretic Hormone (SIADH)
- Renal Failure
- Heart failure
- Cirrhosis
- Medications (Diuretics, Antidepressants/SSRIs, antiepileptics)
- Hormonal Imbalances



CLINICAL PRESENTATION

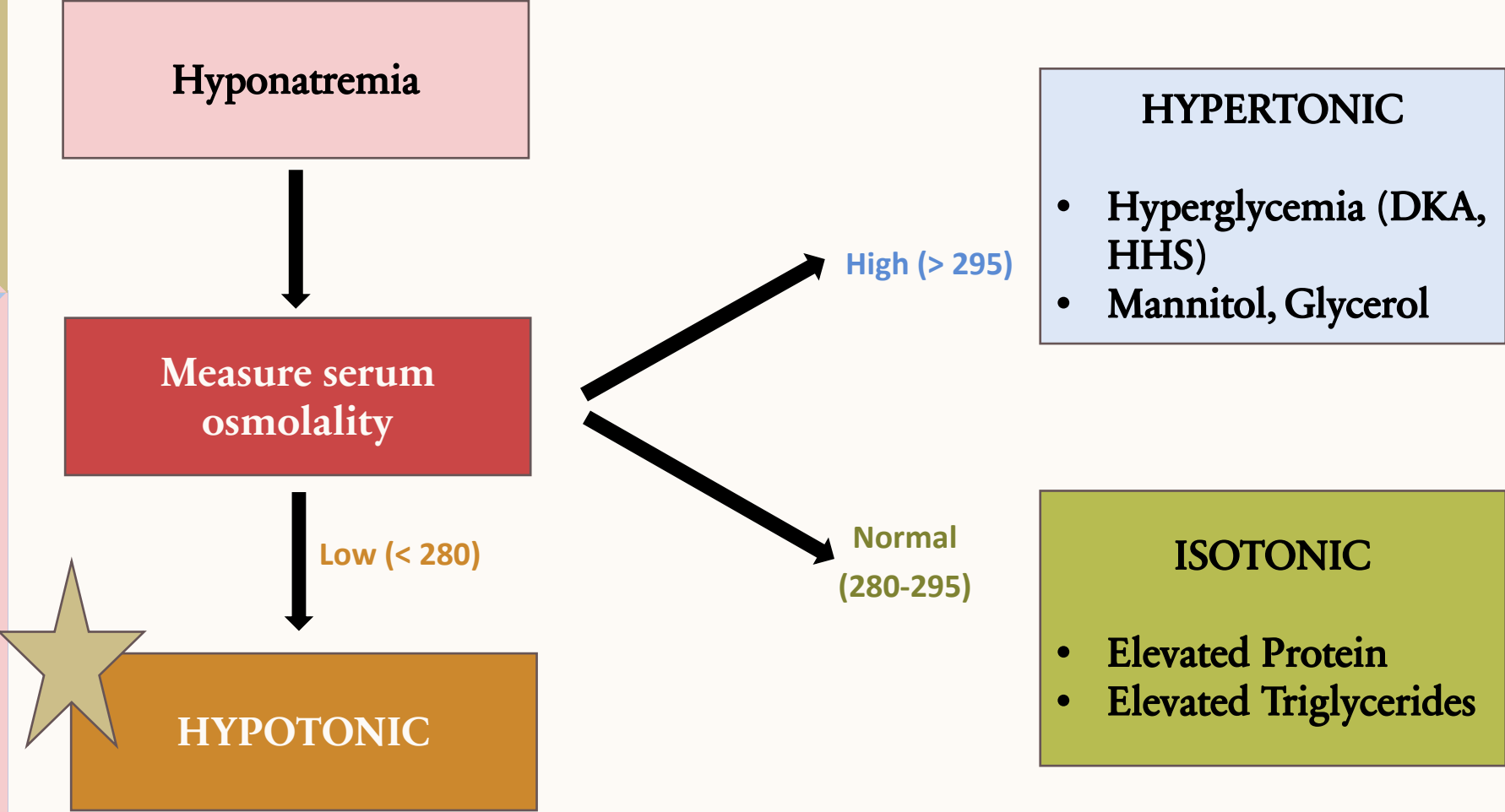
- Variable and nonspecific symptoms: nausea, vomiting
- Neurological manifestations: headache, encephalopathy, seizures, coma



THE FRAMEWORK FOR HYPONATREMIA

DETERMINE TONICITY

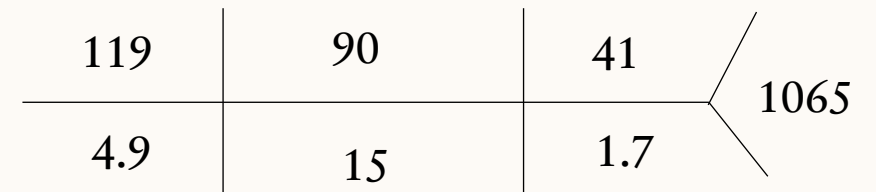
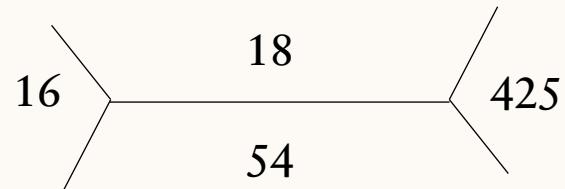
Step 1



CASE REVIEW

John Doe is a 25 year old male with a PMH of DM type I presents with a 2-day nausea, vomiting, and confusion.

- Hx – recent viral illness, lapse in insurance coverage
- PE
 - BP 110/70 mmHg, HR 120 bpm, RR 22 breaths/min, Temp 38.5°C (101.3°F), SpO2 98% on room air.
 - General appearance: Appears fatigued, mildly dehydrated
 - Skin: Dry mucous membranes, poor skin turgor
 - Abdomen: Mild tenderness in the epigastric region
 - Neurological: Alert and oriented, x 1. No focal deficits
- Labs:



HYPERGLYCEMIA

The sodium concentration will fall by 1.6 mEq/L for each 100 mg/dL (5.5 mmol/L) increase in glucose concentration above the first 100 mg/dL.

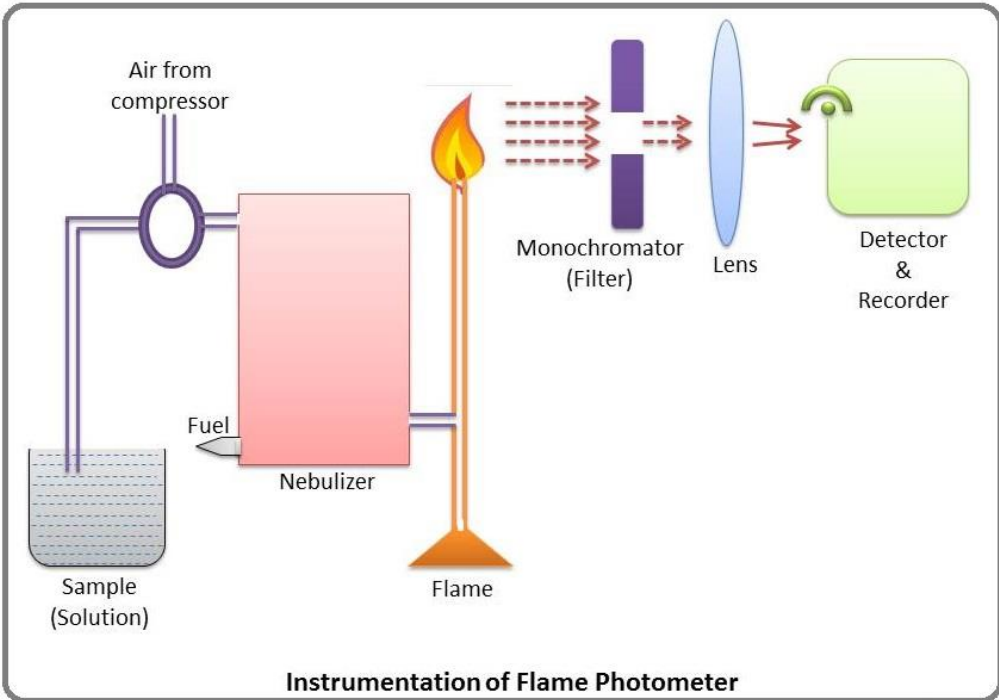
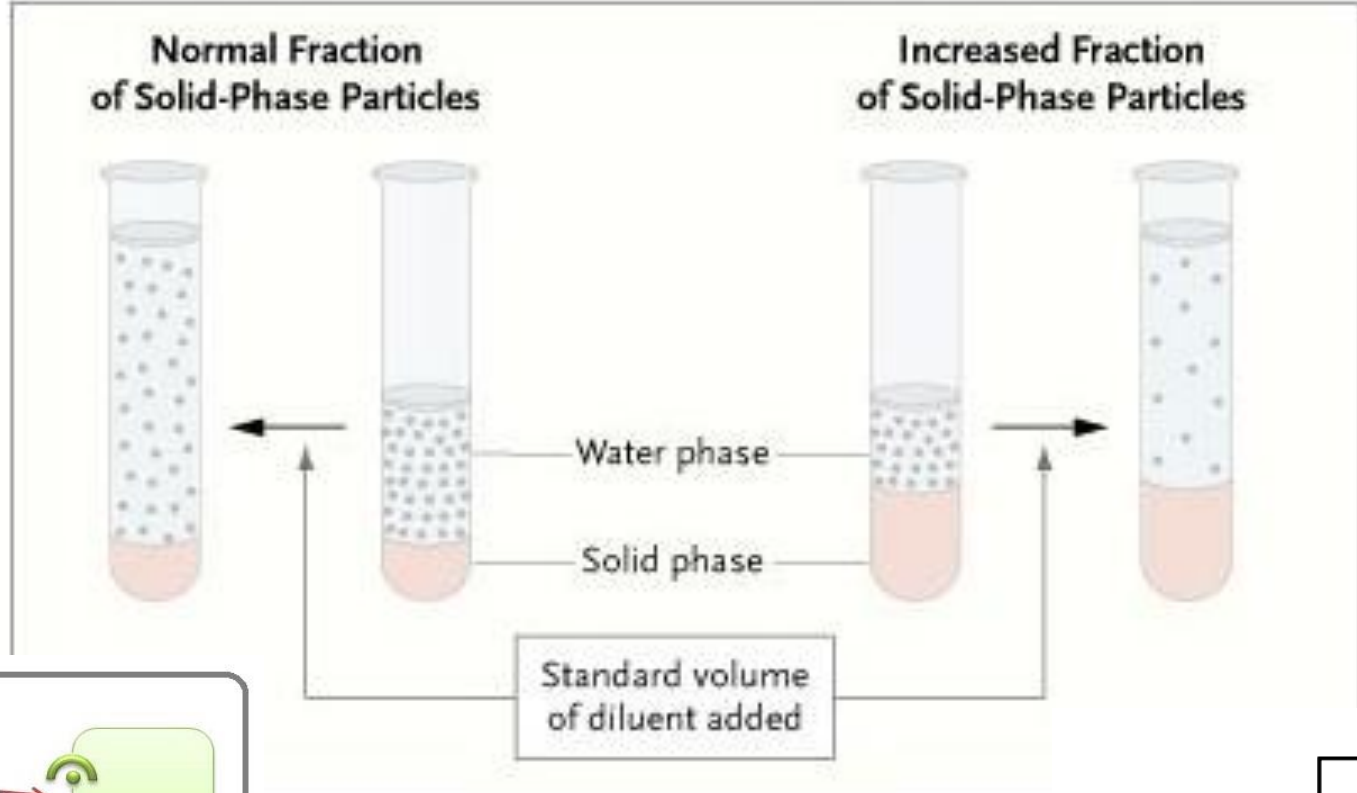
$$\text{Corrected Sodium (mEq/L)} = \text{Measured Sodium (mEq/L)} + \left[\frac{\text{Glucose (mg/dL)} - 100}{100} \right] \times 1.6$$

PSEUDO-HYPONATREMIA (ISOTONIC)

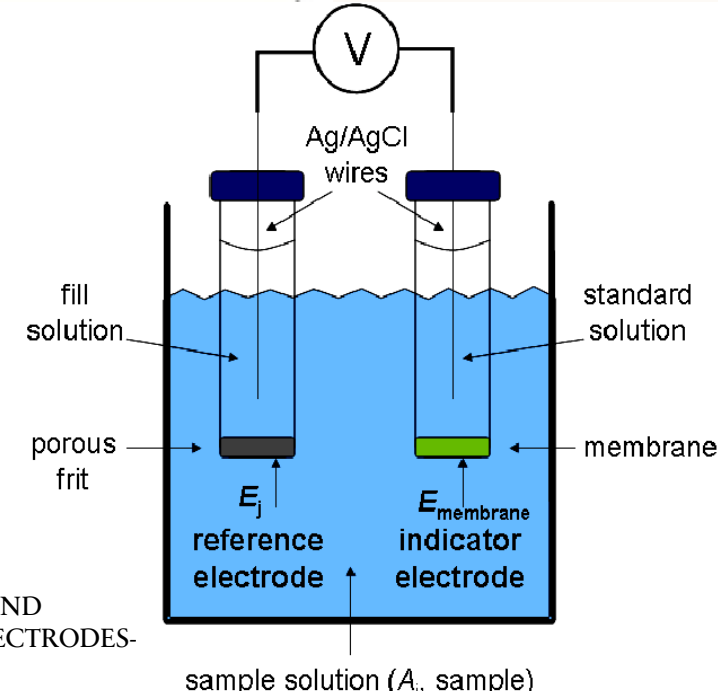
- Lipemic serum
- Severe obstructive jaundice
- Plasma cell dyscrasia

Laboratory artifact → occurs if the sodium is measured with flame photometry or indirect potentiometry using ion-selective electrodes when the solid phase portion of serum or plasma is increased due to severe elevations of triglycerides, lipoprotein-X, or protein.

The true concentration of sodium in plasma water can be measured using direct ion-selective electrodes, which are not susceptible to the artifact. Such direct ion-selective electrodes are utilized by most *"point of care" bedside analyzers and devices used to measure blood gases.*³



Namrata Heda



Naik, V.A., & Sc, M. (2016). PRINCIPLE AND APPLICATIONS OF ION SELECTIVE ELECTRODES- AN OVERVIEW.



HYPOTONIC HYPONATREMIA

True Hyponatremia

VOLUME STATUS

VS, mucous membranes, JVD, Cap refills, skin turgor, edema.

Step 2

Assess ECF volume status

Hypovolemia

Euvolemia

Hypervolemia

↓ Water
↓↓ Sodium

↑ Water
↔ Sodium

↑↑ Water

Step 3

LAB INTERPRETATION

HYPOVOLEMIA

Urine Na
> 20

Renal Losses
Diuretics - Thiazides
Hypoaldosteronism
Cerebral Salt Wasting

Urine Na
< 20

Extra Renal Losses
GI losses
Third spacing

EUVOLEMIA

Urine Osm
< 100

Dilute
Primary polydipsia
Beer potomania

Urine Osm
> 100

SIADH
Hypothyroidism
Adrenal insufficiency

HYPERVOLEMIA

Urine Na
> 20

Renal Failure

Urine Na
< 20

Heart Failure
Cirrhosis

TREATMENT PRINCIPLES

- Addressing the underlying cause
- Fluid restriction in euvolemic and hypervolemic cases
- Loop diuretics, sodium chloride tablets, and vasopressin receptor antagonists
- Hypertonic saline
 - Acute hyponatremia → 3% hypertonic saline for asymptomatic patients with a sodium level < 130 mEq/L or patients manifesting *any* symptoms due to increased intracranial pressure unless there is evidence of autocorrection [increasing output of dilute urine and/or evidence that serum sodium concentration is increasing without treatment].⁴
- Monitoring electrolytes and adjusting treatment accordingly
- Rate of correction : not to exceed 4 to 6 mEq/L in 24 hours
- Avoid excessive correction → osmotic demyelination syndrome (ODS)

OSMOTIC DEMYELINATION SYNDROME (ODS)

- Manifestations of ODS are typically **delayed** for two to six days after over correction of serum sodium has occurred.
- Most cases of ODS occur in patients with severe hyponatremia with correction rates of 10 to 12 mEq/L within 24 hours or > 18 mEq/L within 48 hours.⁵
- Symptoms: dysarthria, dysphagia, paraparesis or quadriparesis, behavioral disturbances, movement disorders, seizures, lethargy, confusion, disorientation, obtundation, and coma

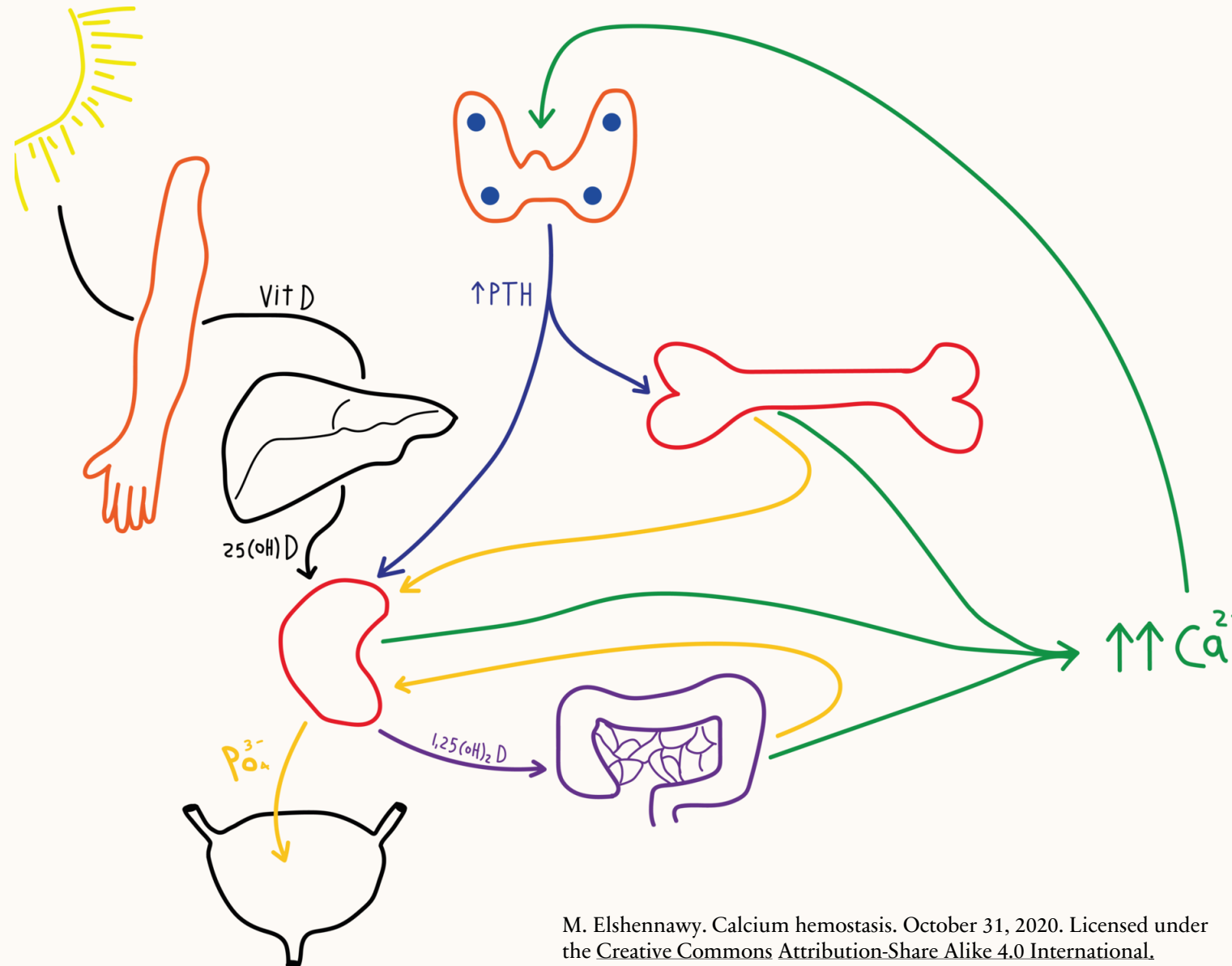


HYPERCALCEMIA

Unraveling the Calcium Conundrum

CALCIUM HOMEOSTASIS

- **Intake and Absorption:**
 - Dietary Calcium
 - Absorption in the Intestines
- **Storage and Release:**
 - Bone Resorption and Formation
- **Blood Calcium Regulation:**
 - Parathyroid Hormone (PTH)
 - Calcitonin
- **Renal Regulation:**
 - Kidney Function
- **Hormonal Interactions:**
 - Vitamin D
- **Feedback Mechanisms:**
 - Negative Feedback

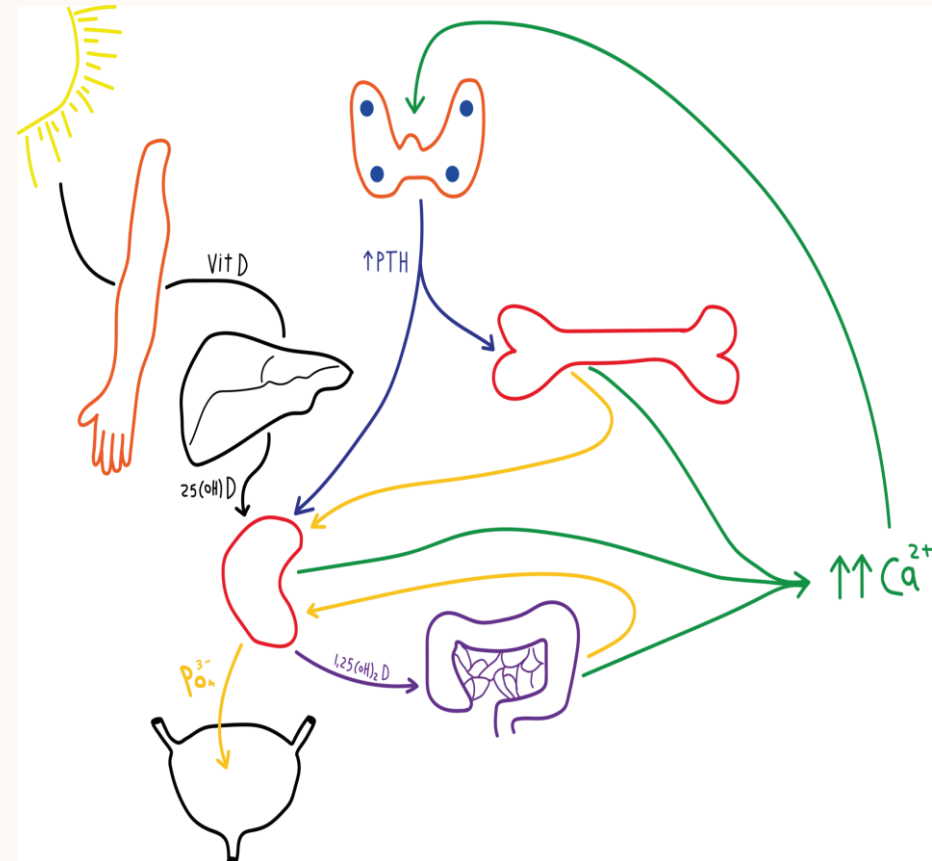


BASIC PRINCIPLES

- Always confirm hypercalcemia with repeated testing
- Hypercalcemia is defined as an elevated serum calcium level above the normal range, typically >10.4 mg/dL.
- **Albumin-calcium correction:** the serum calcium falls by 0.8 mg/dL for every 1 g/dL fall in the serum albumin concentration.
- Mild: < 12 mg/dL
- Moderate: 12-14 mg/dL
- Severe: > 14 mg/dL

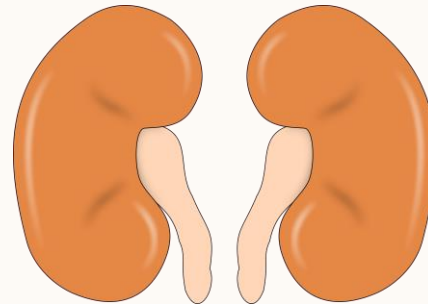
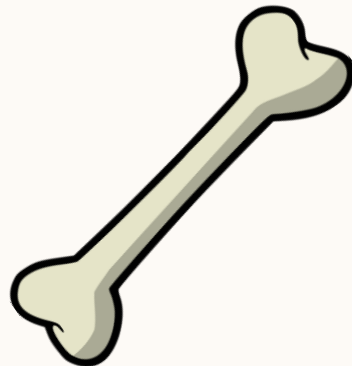
CAUSES OF HYPERCALCEMIA⁶

- **Primary Hyperparathyroidism:** Overproduction of PTH by the parathyroid glands.
- **Malignancy:** Production of parathyroid hormone-related peptide (PTHrP) by tumors.
- **Granulomatous Diseases:** Sarcoidosis, tuberculosis.
- **Medications:** Thiazides, lithium, and excessive vitamin D intake.
- **Other Causes:** Immobilization, hyperthyroidism, and familial hypocalciuric hypercalcemia.



CLINICAL PRESENTATION

- Hypercalcemia is often detected incidentally
- Symptoms: Fatigue, nausea, vomiting, constipation, and polyuria.
- Severe cases: neurological symptoms (confusion, lethargy) and cardiovascular complications.

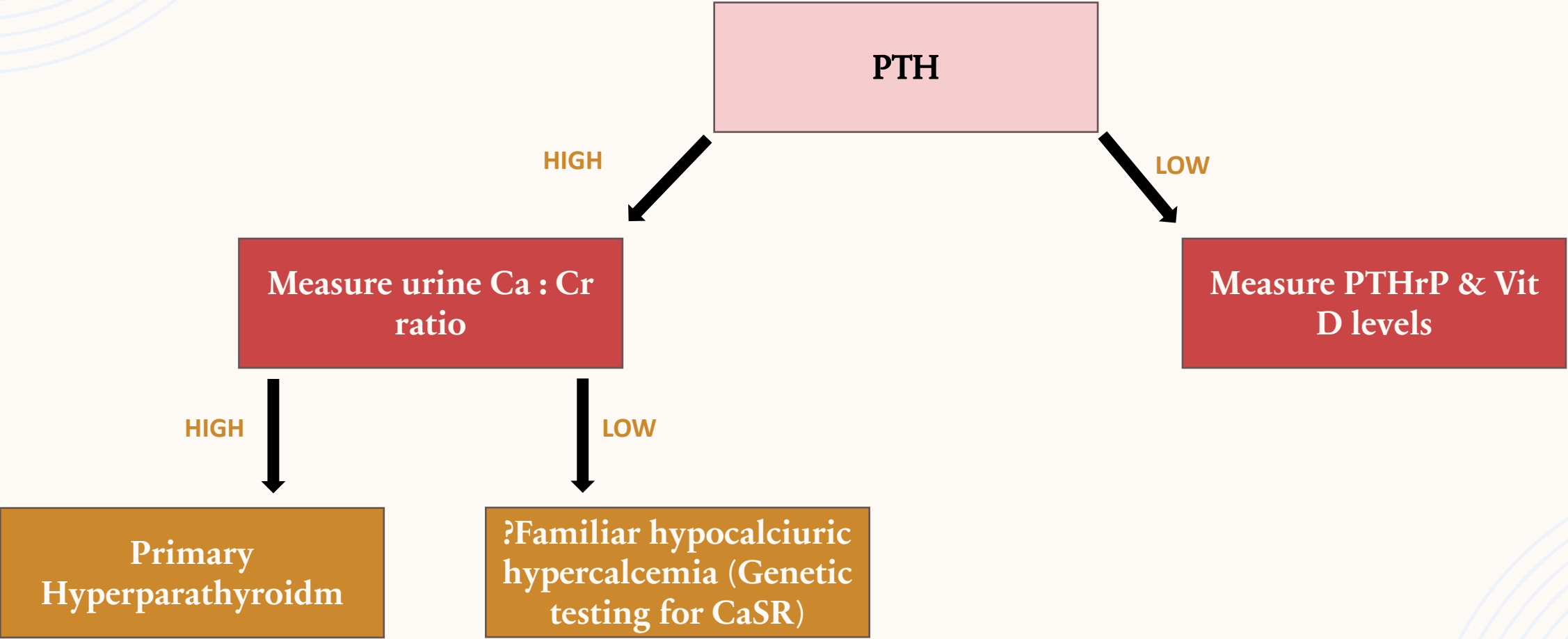




COMPLICATIONS

- Renal complications: nephrolithiasis, nephrocalcinosis, and renal failure.
- Osteoporosis: Increased risk due to chronic hypercalcemia.
- Pancreatitis
- Arrhythmias
- Adrenal insufficiency
- CNS impairment, coma

DIAGNOSTIC EVALUATION



DIAGNOSTIC EVALUATION

PTH

LOW

Measure PTHrP & Vit D levels

Elevated PTHrP

Malignancy

Elevated 1,25 (OH) D

Lymphoma
Granulomatous disorders

Elevated 25 (OH) D

Excess Vit D intake

Normal Vit D and PTHrP

MM
Vit A
Thyroid disorder

MANAGEMENT

- Hemodynamic support for cardiovascular complications
- Hydration with intravenous saline to enhance renal calcium excretion.
- Calcitonin and Bisphosphonates⁷
 - Calcitonin plus saline hydration → substantial reduction in serum calcium concentrations within 12 to 48 hours.
 - Bisphosphonates will be effective by the second to fourth day and provide a more sustained effect.
- Address the underlying causes.

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THANK YOU

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