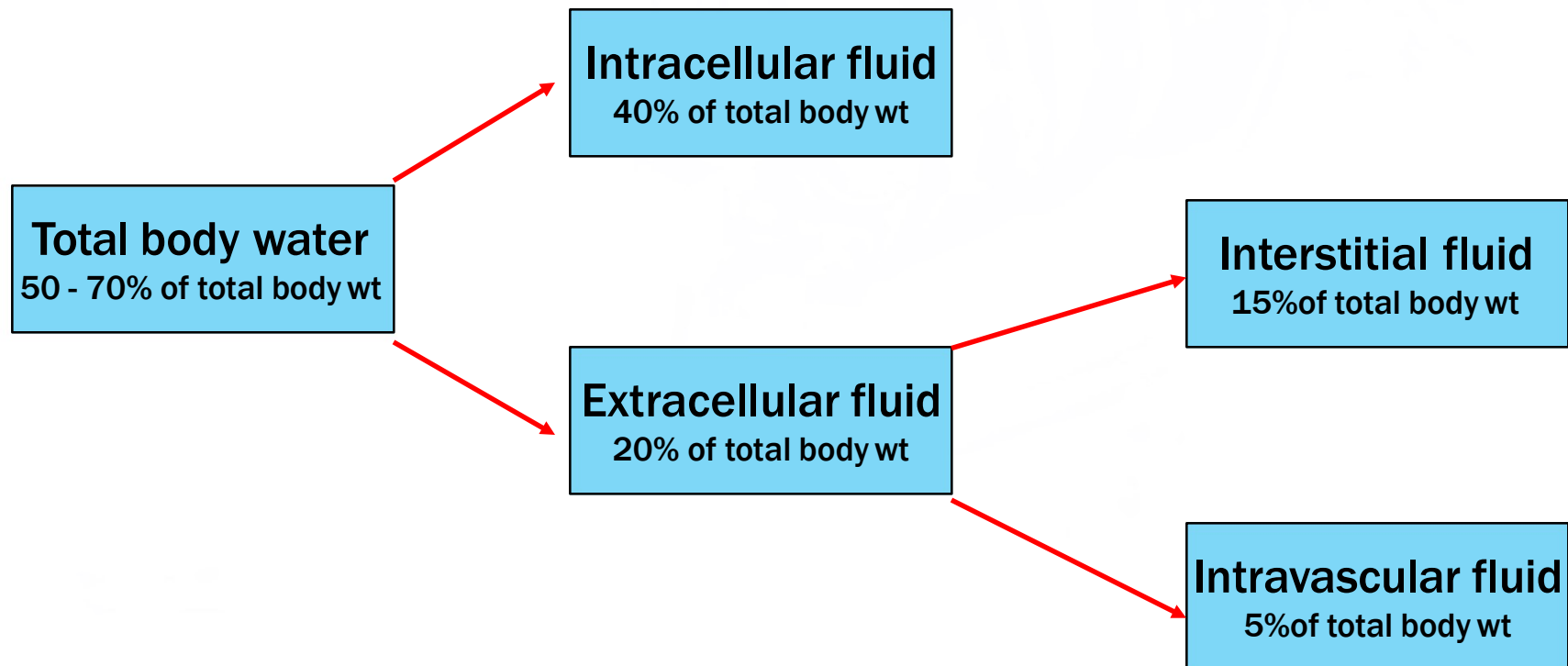


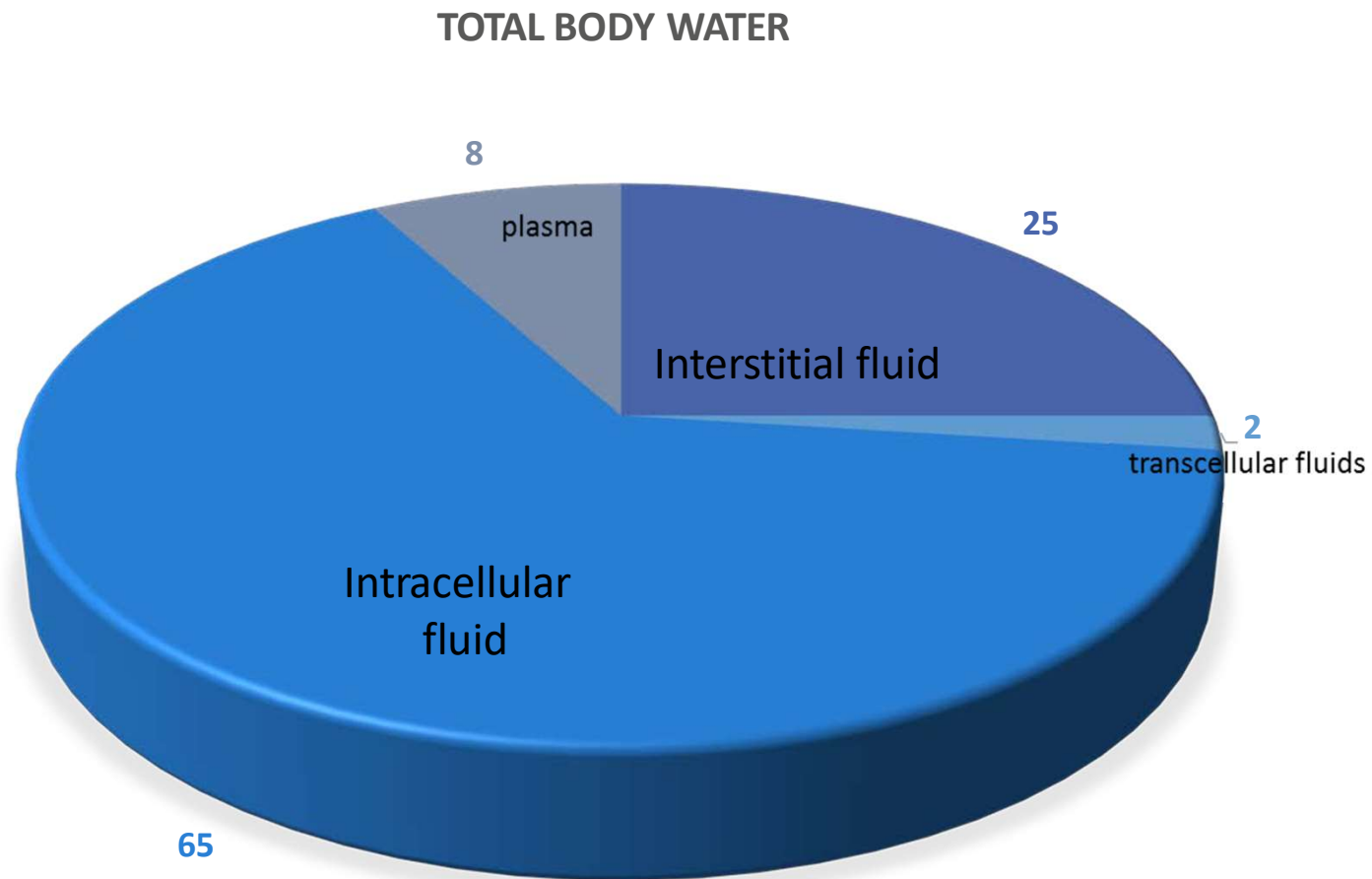
FLUID AND ELECTROLYTE BALANCE -1

DR MOHSIN

Introduction



Introduction



Introduction

- 💧 Male, TBW accounts for 60% of total body weight.
- 💧 An average young adult female, it is 50%.
- 💧 The highest percentage of tbw is found in newborns, with approximately 80% of their total body weight comprised of water.
- 💧 This decreases to approximately 65% by 1 year of age and thereafter remains fairly constant.

Composition of fluid compartments

	<i>plasma</i>	<i>interstitial</i>	<i>intracellular</i>
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Cations			
Na ⁺	140	146	12
K ⁺	4	4	150
Ca ²⁺	5	3	10 ⁻⁷
Mg ²⁺	2	1	7
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Anions			
Cl ⁻	103	104	3
HCO ⁻	24	27	10
SO ₄ ⁻	1	1	-
HPO ₄ ⁻	2	2	116
Organic anion	5	5	0
Protein	16	5	40
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Body fluid disturbances

💧 Classified Into Three Broad Categories:

1. Changes In Volume

💧 Hypovolemia

💧 Hypervolemia

2. Changes In Concentration

💧 Hyponatremia

💧 Hypernatremia

3. Changes In Composition

💧 Acid-base Imbalances

💧 Concentration Changes In Calcium

💧 Magnesium

💧 Potassium

Water Gain

Water Loss

Sensible	max
💧 Oral fluids – 800-1500	1500/h
💧 Solid foods-500- 700	1500/h
Insensible	
💧 Water of oxidation – 250	800



Sensible	max
💧 Urine – 800-1500	1400/h
💧 Intestinal - 0-250	2500/h
💧 Sweat	4000/h
Insensible	
💧 Lungs & skin- 600	1500/h

Fluid Volume Deficit

Terminology



- Dehydration – extracellular fluid volume deficit (ECFVD)
- Hypovolemia – “isotonic dehydration” - Water and electrolyte losses are equal; vascular fluid volume deficit.
- Mild = 2% of body weight loss
- Moderate = 5% of body weight loss
- Severe = 8% or more of body weight loss

Causes of Fluid Volume Deficits

- 💧 Lack of intake
 - 💧 NBM
 - 💧 Dysphagia
 - 💧 Tube fed individuals
 - 💧 Impaired thirst mechanism

- 💧 Excessive fluid losses
 - 💧 Vomiting
 - 💧 Diarrhea
 - 💧 Fever
 - 💧 GI suction
 - 💧 Blood loss
 - 💧 Burns

Assessment of Fluid Balance

- 💧 History of recent input & output
- 💧 Blood pressure
- 💧 Heart rate
- 💧 Daily Weight
- 💧 Skin Turgor
- 💧 Mucous Membranes
- 💧 Mental status
- 💧 Lab Analysis

Physical signs and symptoms of fluid volume imbalance

Hypovolemia

- 💧 Poor skin Dry mucous membranes
- 💧 Dry axilla
- 💧 Flat neck
- 💧 Tachycardia
- 💧 Orthostatic hypotension
- 💧 Hypothermia
- 💧 Weight loss
- 💧 Sunken eyes
- 💧 Azotemia
- 💧 Oliguria

Hypervolemia

- 💧 Shortness of breath at rest or with exertion
- 💧 JVD
- 💧 Hepatojugular reflex
- 💧 Ascites
- 💧 Pitting edema
- 💧 Weight gain

Common laboratory tests to evaluate body fluid disturbances

Hypovolemia

- 💧 Serum electrolytes
- 💧 SUN/Cr
- 💧 Hematocrit
- 💧 Urine electrolytes and specific gravity
serum albumin
- 💧 24-hour urine for Cr clearance

- HYPER VOLE
- Serum electrolytes
- 💧 Urine-specific gravity
- 💧 •24-hour urine for Cr clearance
- 💧 • Total protein
- 💧 Cholesterol
- 💧

Sodium

- 💧 Normal serum sodium level is 135 to 145 mEq/L. Hyponatremia is defined as serum sodium levels less than 135 mEq/L.
- 💧 Acute symptomatic hyponatremia usually does not become clinically evident until serum sodium levels of 130 mEq/L.
- 💧 Chronic hyponatremic states usually remain asymptomatic until serum sodium levels fall below 120 mEq/L.
- 💧 Serum osmolality is the laboratory test most critical for the diagnosis of hyponatremia

Clinical manifestations of Hyponatremia

Body System	Hyponatremia
Central nervous System	Headache, confusion, hyperactive or hypoactive deep tendon reflexes, seizures, coma, increased intracranial pressure
Musculoskeletal	Weakness, fatigue, muscle cramps/twitching
GI	Anorexia, nausea, vomiting, watery diarrhea
Cardiovascular	Hypertension and bradycardia if intracranial pressure increases significantly
Tissue	Lacrimation, salivation
Renal	Oliguria

Clinical manifestations of Hyponatremia

Body System	Hyponatremia
Central nervous System	Restlessness, lethargy, ataxia, irritability, tonic spasms, delirium, seizures, coma
Musculoskeletal	Weakness
Metabolic	Fever
Cardiovascular	Tachycardia, hypotension, syncope
Tissue	Dry sticky mucous membranes, red swollen tongue, decreased saliva and tears
Renal	Oliguria

Etiology and management of hyponatremia

Hyponatremia	Etiology	Treatment
💧 Iso-osmotic	💧 Pseudohyponatremia (hyperlipidemia and hyperproteinemia), isotonic infusions, laboratory error	💧 Correct lipids and protein level
💧 Hyperosmotic	💧 Hyperglycemia or hypertonic infusions,	💧 Correct hyperglycemia discontinue hypertonic fluids

Etiology and management of hyponatremia

Hyponatremia	Etiology	Treatment
<ul style="list-style-type: none">💧 Hypo-osmotic<ul style="list-style-type: none">💧 Hypovolemic—hypo-osmotic	<ul style="list-style-type: none">💧 Urine Na⁺ >20: renal losses: RTA, adrenal insufficiency, diuretics, partial obstruction💧 Urine Na⁺ <10: extrarenal losses: vomiting, diarrhea, skin and lung loss, pancreatitis	<ul style="list-style-type: none">💧 Na⁺ deficit replaced as isotonic Saline

Etiology and management of hyponatremia

Hyponatremia	Etiology	Treatment
<ul style="list-style-type: none">💧 Hypo-osmotic<ul style="list-style-type: none">💧 Euvolemic–hypo-osmotic	<ul style="list-style-type: none">💧 H2O intoxication💧 renal failure💧 Syndrome of inappropriate antidiuretic hormone💧 Hypothyroidism💧 Pain drugs💧 Adrenal insufficiency	<ul style="list-style-type: none">💧 Water restriction

Etiology and management of hyponatremia

Hyponatremia	Etiology	Treatment
<ul style="list-style-type: none">💧 Hypo-osmotic<ul style="list-style-type: none">💧 Hypervolemic –hypo-osmotic	<ul style="list-style-type: none">💧 Urine Na⁺ <10: nephritic syndrome, congestive heart failure, cirrhosis Water restriction💧 Urine Na⁺ >20: iatrogenic volume overload, acute/chronic renal failure	<ul style="list-style-type: none">💧 Water restriction

Hypernatremia



serum sodium greater than 145 mEq/L.



The signs and symptoms



Confusion



Lethargy



Coma



Seizures



Hyperreflexia



The neurologic symptoms of hypernatremia result from dehydration of brain cells





Laboratory tests

- 💧 SUN and Cr

- 💧 Urine Na⁺, and urine osmolality.

- 💧 A fluid deprivation test may be performed to distinguish central from nephrogenic diabetes insipidus

Etiology and management of hypernatremia

Hypernatremia	Etiology	Treatment
 hypervolemic	 Administration of hypertonic sodium-containing solutions,  Mineralocorticoid excess	 Diuretics

Etiology and management of hypernatremia

Hypernatremia	Etiology	Treatment
💧 Isovolemic	💧 Insensible skin and respiratory loss, 💧 diabetes insipidus	💧 Water replacement

Etiology and management of hypernatremia

Hypernatremia	Etiology	Treatment
💧 Hypovolemic	<ul style="list-style-type: none">💧 Renal losses💧 Gastrointestinal losses,💧 Respiratory losses,💧 Profuse sweating,💧 Adrenal deficiencies	💧 Isotonic NaCl, then hypotonic saline

Potassium

Normal serum potassium level
is 3.5 to 5.1 mEq/L.

Hypokalemia

💧 Hypokalemia is defined as serum potassium less than 3.5 mEq/L.

💧 Causes of hypokalemia

- 💧 Decreased dietary intake
- 💧 Gastrointestinal losses
- 💧 Renal losses
- 💧 Cellular shifts

Hypokalemia

Signs and symptoms



Neuromuscular



Muscle weakness



Paralysis



Rhabdomyolysis



Hyporeflexia



Renal



Polyuria



Polydipsia



Cardiac



EKG findings: T-wave flattening/ inversion



U-wave, ST depression



Cardiac toxicity to digitalis



Gastrointestinal



Paralytic ileus

Hypokalemia

Treatment

- 💧 Treatment for hypokalemia initially is aimed at correcting the existing metabolic abnormalities.
- 💧 Potassium chloride is administered at 10 mEq/L/h peripherally or 20 mEq/L/h centrally if EKG changes are present.
- 💧 Hypokalemia alone rarely produces cardiac arrhythmias.

Hyperkalemia --is defined as serum potassium greater than 5.1 mEq/L.

Cause of hyperkalemia

Pseudohyperkalemia

Transcellularshift

Impaired renal excretion

💧 Excessive intake

💧 Blood transfusions

Hyperkalemia

Signs and symptoms

💧 Neuromuscular

- 💧 Weakness
- 💧 Paresthesia
- 💧 Flaccid paralysis

💧 Cardiac

- 💧 EKG findings: peaked T waves
- 💧 flattened P waves, prolonged PR,
- 💧 widened QRS
- 💧 Ventricular fibrillation
- 💧 Cardiac arrest

Treatment of hyperkalemia

Treatment	Dosage	Rationale
💧 Calcium gluconate	💧 10–30 mL in 10% solution intravenously	💧 Membrane stabilization
💧 Sodium bicarbonate	💧 50 mEq intravenously	💧 Shifts K ⁺ into cells

Treatment of hyperkalemia

Treatment	Dosage	Rationale
💧 Glucose insulin	💧 1 ampule D50 with 5 U regular insulin	💧 Shifts K ⁺ into cells
💧 Sodium polystyrene	💧 50–100 g enema with 50 mL 70% sorbitol and 100 mL water, or 💧 20–40 g orally	💧 Remove excess

Treatment of hyperkalemia

Treatment

💧 Sulfonate

💧 Dialysis

Rationale

💧 K⁺ through
gastrointestinal
tract

💧 Removes K⁺
from serum

Calcium

- 💧 Normal calcium concentration is 8.8 to 10.5 mg/dL. The normal range for ionized calcium is 1.1 to 1.28 mg/dL.
- 💧 Calcium concentrations must be interpreted with respect to the serum albumin, because 40% to 60% of total serum calcium is bound to albumin.

Hypocalcemia

Hypocalcemia is defined as serum calcium less than 8.5 mg/dl

Signs and symptoms

Hypotension
laryngeal
spasms
paresthesias,

Tetany (Chvostek's and Trousseau's signs),
anxiety,
depression,
Psychosis

In adults who have normal renal function, calcium replacement is 1 g (gluconate or chloride) in 50 mL dextrose 5% in water or normal saline. Intravenous solutions should be infused for 30 minutes.

Hypercalcemia

💧 Hypercalcemia is serum calcium greater than 10.5mg/dL. The signs and symptoms

- 💧
- 💧 Hypertension
- 💧 Bradycardia,
- 💧 Constipation,
- 💧 Anorexia,
- 💧 Nausea, vomiting,
- 💧 Nephrolithiasis,
- 💧 Bone pain,
- 💧 Psychosis
- 💧 Pruritus.

💧 Treatments include hydration with normal saline, bisphosphonates, calcitonin, glucocorticoids, and phosphate.

Magnesium

- 💧 Magnesium concentration in the extracellular fluid ranges from 1.5 to 2.4 mg/dL.
- 💧 Uncorrected magnesium deficiencies impair repletion of cellular potassium and calcium.
- 💧 Hypomagnesemia is greater than 1.8 mg/dL.
- 💧 Signs and symptoms include
 - 💧 Arrhythmias,
 - 💧 Prolonged PR and QT intervals on EKG
 - 💧 , Hyperreflexia,
 - 💧 Fasciculations,
 - 💧 Chvostek's and trousseau's signs.

Guidelines for magnesium replacement

Magnesium serum
Concentration

Magnesium
dosages

💧 <1.5 mg/dl

1 mEq/kg

💧 1.5–1.8 mg/dl

.5 mEq/kg

Hypermagnesemia

- 💧 • Hypermagnesemia is serum magnesium greater than 2.3 mg/dL.
- 💧 • Signs and symptoms include
 - 💧 Respiratory depression
 - 💧 Hypotension,
 - 💧 Cardiac arrest,
 - 💧 Nausea and vomiting,
 - 💧 Hyporeflexia, and somnolence
- 💧 Treatment for hypermagnesemia may include calcium infusion, saline infusion with a loop diuretic, or dialysis.

Phosphate

💧 Normal phosphorus level is 2.5 to 4.9 mg/dL.

💧 • **Hypophosphatemia** is serum phosphate less than 2.5 mg/dL

💧 • symptomatic hypophosphatemia usually is less than 1 mg/dL.

💧 • Signs and symptoms

- 💧 Lethargy,
- 💧 Hypotension, Irritability,
- 💧 Cardiac arrhythmias, and
- 💧 Skeletal demineralization.

💧 • One millimeter of phosphate supplies 1.33 mEq sodium or 1.47 mEq potassium

Hyperphosphatemia

- 💧 Hyperphosphatemia is defined as serum phosphate greater than 5 mg/dL.
- 💧 Pruritus is the only remarkable symptom of hyperphosphatemia.
- 💧 Treatment
 - 💧 Dietary phosphate restriction
 - 💧 Phosphate binders (calcium acetate or carbonate),
 - 💧 Hydration (to promote excretion)
 - 💧 D50 and insulin to shift phosphate into cells

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