IV Fluids

Body → 40% Non water → Intracellular 2/3 → plasma 1/4
Body → 60% water → Extracellular 1/3 → Interstitial 3/4

water Intake 2L/day

urine 1L/day ← | → stool 0.25L/day
sweat
exhale 0.75L/day

* Can loss also by fever / Burns

IV Fluids (crystalloid Solution)

Normal Saline
NaCl
* 0.9 normal Saline
* Same plasma Osm = 285 mOsm/L
* Isotonic
* remain extracellular → 25% plasma
* used for volume replacement in hypovolumic + septic shock
* plasma normally balanced in charge

+Ve = -Ve
$Na^+ - Cl^- + HCO_3^-$ + Anion gap (protein / phosphate / sulfate)

* So the normal saline will ↑ Cl^- which cause HCO_3^- to shift inside the cell → Acidosis → Cause K^+ go inside the cell with switching k^+ out → Cause hyper kalemia

Lactated Ringers
* Contain NaCl / K^+ / Ca^{++} / Lactate
* Isotonic = 285 osmo
* Lactate convert to HCO_3^- (⇌)
act as buffer in acidic states
so give in trauma resuscitation
Acidosis
* Not cause Hyper kalemia (Low k)

HALF normal Saline
Half
* 0.45 normal Saline
* HYPOtonic
* Doesn't remain extracellular will go inside so used to maintaince fluids in Cells GIs
* we can add 5% dextrose → D5 1/2 NS
* we can add k^+ → D5 1/2 NS with k

D5W
Dextrose + water
Correct HYPERNATREMIA

Hypertonic Saline
Half
* 3% Saline
* 900 mOsm
Fluids out the tissue
* used in elevated intracranial pressure
+ sever hyponatremia

* Colloid solutions → water + albumin

Hypovolemic
* Common *
* Causes → Vomiting / diarrhea
Poor oral intake / third spacing (trauma)

* ↓JVD, Dry mucous membranes
Loss of the skin turgor (elasticity)
↓BP

* treated by oral intake / IV fluids

Isotonic Hypovolemia
* Loss of fluids and electrolytes in same amounts from ECF
* in most cases

Hypertonic Hypovolemia
* fluids loss more than electrolytes
Loss from ECF
* in DKA

Hypotonic Hypovolemia
* loss of Electrolytes more than loss of fluids
* Cause shock (fluid move from blood to cells) increase intracranial pressure

Hypervolumic
* Causes → HF / Cirrhosis / nephrotic
* ↑JVD / pitting edema / ↑JVP / P.edema
* Treated by diuretics

2) Soduim

in plasma ↳ major solutes

← Normal Na → 135 - 145 mEq/L طبيعي خطيرة

hypo / hyper → affect the brain → malaise / coma / stupor / Nausea

↓Na → ↓ plasma Osm → brain swells

↑Na → ↑ plasma Osm → brain shrink

A-HYPOnatremia

1* plasma Osmolality → amount of Solutes in plasma (mainly sodium) = 285 mOsm /L (275-295)

$$\text{serum osm} = 2 * [Na^+] + \frac{\text{Glucose}}{18} + \frac{\text{BUN}}{2.8}$$

2* ADH / vasopressin → secrete from posterior pituitary in Hypovolumic case after RAAS activation by AII stimulator → which cause increase water reabsorbtion → so contral plasma sodium and cause hyponatremia

So normally urine should be diluted in hyponatremia [Uosm < 100 , U_{Na} < 30] to get rid from excess water

normally Osm 50 - 1200 ↵ with low ADH

when urine concentrated → ↑ADH → cause hyponatremia but when persist the water intake cause hyponatremia → Pathological Condition

High ADH Causes

Hypovolemia

perceived hypovolemia: the patient had HF / cirrhosis → hypervolumic but low volume in blood

True hypovolemia: Diuretics (Thiazide) vomiting Diarrhea sweating Exercise

Adrenal Insufficiency

↓cortisol → ↓ inhibition of ADH → ↑ADH

Addison's Disease

Loss of aldosteron → Loss of Na^+ / water

hypovolemia → ↑ADH

Hypothyroidism

↑ADH

SIADH

↑ADH without cause

normal kidney function

Euvolumic

↑Uosm / U_{Na}

Na ↓ reab due to ↑K

Causes

Drug (Carbamazepine, cyclophosphamide)

small cell lung Cancer

CNS disorder

Pneumonia

Non ADH Causes

Renal failure

- advanced CKD → kidney can't excrete free water → urine concentrated 250-1200 (increase)

↑Uosm ↓Na

- euvolumic / hypervolumic

Psychogenic polydipsia

drink > 18 L/day

↓ Uosm (< 100) → kidney excrete water

water restriction (deprivation) solve the hyponatremia

Special Diets

Tea / Toasts / Beer

Low sodium ingestion + H_2O intake > output

↓ Uosmo < 50

* How to approch Hyponatremia?

Serums Na^+ → plasma Osm → volume • **Hyponatremia:-** Na < 135 mEq/L

Urine → Na^+ → urine Osm

↓

Plasma Osmolarity (mainly Na) $(285) = 2 * Na + \frac{Gluc}{18} + \frac{BUN}{2.8}$

Hyperosmo	Normal Osmo	HypoOsmo
Hyperglycemia /mannitol which cause high out water → dilutional hyponatremia	Hyperlipidemia Hyperproteinemia (multiple myeloma) ↳ pseudohyponatremia	look for volume

*Every 100 increase in glucose above 100 → causes ↓ Na^+ by 2 or 1.6 to measure corrected Na^+ to see if there true hyponatremia

*should the osmolar gap between measured & calculated ±10

added to hypotonic solution

Euvolumic	Hypervolumic	True Hypovolumic
	HF / Cirrhosis	Diuretics
	nephrotic /malaposrbtion	Addison D.
	hypoalbumenemia	Diarrhea/vomiting
	↓ percieved hypovolumic	sweating
		exercise

Check the urine osm/Na

added to pure water

>100 >40 (ADH)	<100 <40	>100 <40
SIADH	polydipsic	Hypovolumic
hypothyroidism	Special diets	(RAAS + SNS)
Adrenal Insufficiency		

* How to treat HypoNatremia?

1) Acute <48 hours → mild 130-134 / moderate 125-129 / severe < 125

Give 3% hypertonic saline 100cc bolus → 10 minutes → 100cc → 100cc

2) Chronic >48 hours + in cases you don't know → Give 100 on 6 hours → to rise 8 mEq/L in 24 hr

12 mEq/L in 48 hr

18 mEq/L in 72 hr

vaprisol

treat the cause / H_2O restriction / NACL tablets Just for euvolumic hyponatremia

HF + hyponatremia → Vaptan (block ADH)

SIADH → demeclocycline (ADH antagonist) not used Normal Saline ⊖

* Central Pontine Myelinolysis "osmotic demyelination Syndrome" when rapid correction of hyponatremia

> 10 meq / 24 hr → cause Demylination of pontine axons → quadriplegia

3] Hypernatremia

Na > 145 mEq/L

① lack of water input

② free water loss >> sodium loss in febrille illness / burns / diarrhea / diuretics

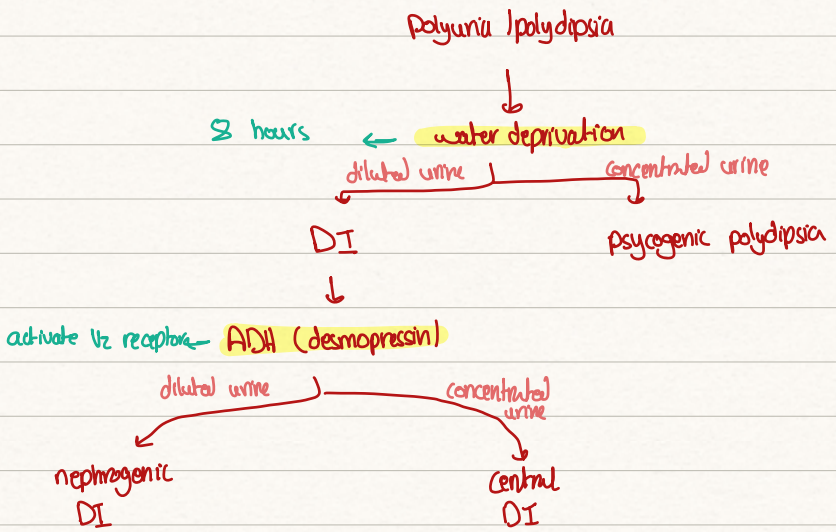
Causes:-

Diabetes insipidus → loss of ADH effect → loss of water → polyuria and polydipsia → cause hypernatremia or normal sodium when drink water * low Uosm (diluted 50-200osm)

2 Types:- 1] Central DI → traum / tumors → cause no release of ADH in pituitary

2] Nephrogenic DI → Hyper calcemia / Hypokalemia / Lithium (psyco) / Amphotericin B (fungal) → ADH release but nephrone not respond

* Diagnosis



* Treatment:-

water / D5W * انتبه → rapid correction cause cerebral edema >10 mEq/day

Central → desmopracin

Nephrogenic →

Thiazide diuretics → more H2O absorbtion in proximal tubules

NSAIDs → inhibit prostaglandin (ADH Antagonist)