Electrolyte imbalance

(Sodium & Water) [Part 1&2]

REVISED BY THE DOCTOR

Objectives:

- Recognize the systems that control body sodium and water contents.
- Differentiate between total body sodium content (volumestatus) and serum sodium concentration (Hypo-and Hypernatremia).
- Use the different types of IV fluids in clinical practice.
- Calculate the water deficit in Hypernatremia.
- Explain the workup of Hyponatremia.

[Color index: Important | Notes | Extra]

[Cases | Editing file | Feedback | Share your notes | Shared notes]

Resources:

Doctor's slides+Kumar+davidson+setup to medicine+master the board

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"Medicine is an art , nobody can deny it"

Recognize the systems that control body sodium and water contents

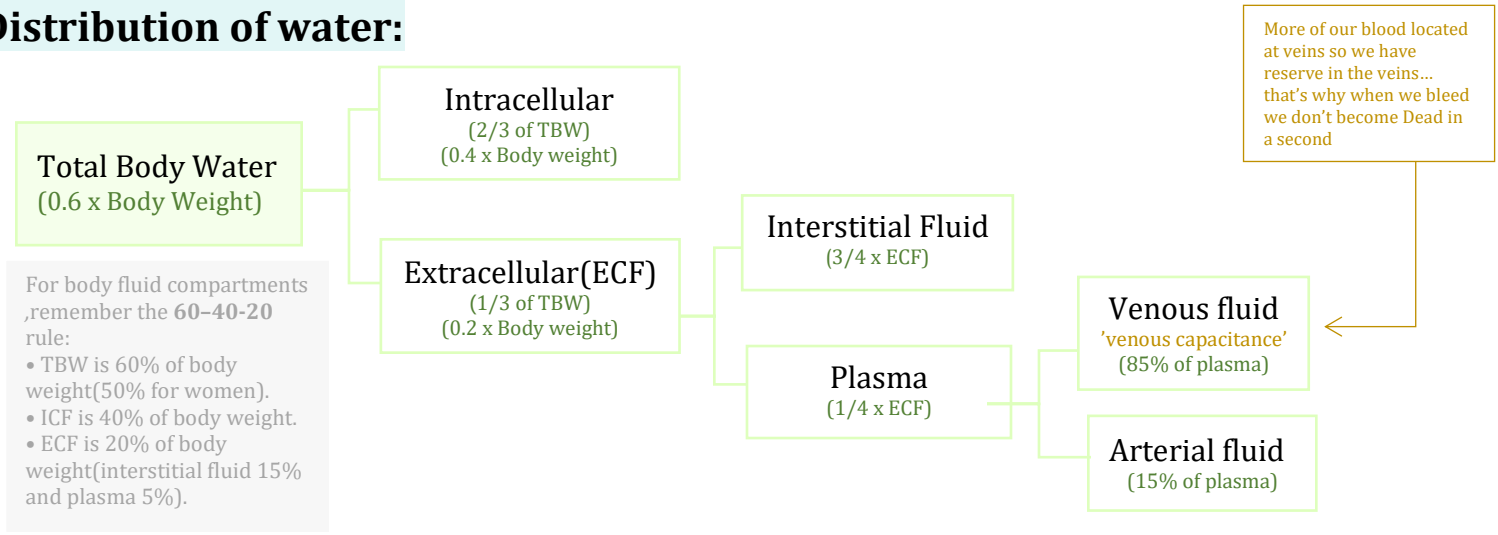
Basic Review

Total Body Water:

Percentage of TBW decreases with age and increasing obesity (TBW decreases because fat contains very little water):

- Men: Total body water (TBW) = 60% of body weight.
- Women: TBW = 50% of body weight. females have proportionately more body fat than males.

Distribution of water:

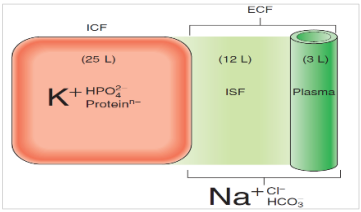


For body fluid compartments ,remember the **60–40-20** rule:
- TBW is 60% of body weight(50% for women).
- ICF is 40% of body weight.
- ECF is 20% of body weight(interstitial fluid 15% and plasma 5%).

Composition of the fluid compartments:

- **Electrolyte concentration(mmol/L):**

	Plasma	Interstitial fluid	Intracellular fluid
Na	142	144	10
K	4	4	160



How much K inside the cell? actually it's more than 140 mmol/L , but **140** is the exchangeable amount (what can move in & out the cell)

How much Na outside the cell? for simplicity remember it as **140** mmol/L ;)

- The dominant cation in the ICF is potassium, while in the ECF it is sodium:
  - The major force maintaining the difference in cation concentration between the ICF and ECF is the sodium–potassium pump.

How to calculate total body cation content(including Na & K)?
42 L(TBW) **X** 140mmol/L =5880

- An important difference between the plasma and the interstitial ECF is that only plasma contains significant concentrations of protein:
  - The difference in protein content between the plasma and the interstitial fluid compartment is maintained by the protein permeability barrier at the capillary wall. This protein concentration gradient contributes to the balance of forces across the capillary wall that favour fluid retention within the capillaries (the colloid osmotic, or oncotic, pressure of the plasma البروتين يحافظ على الإنكوتيك بروشرداخل اوعية الدم ,والإنكوتيك بروش دايما انائي ياخذ السوائل من برى ويدخلها عنده), maintaining circulating plasma volume.

What is the starling forces?
Hydrostatic + oncotic pressure, forces across the capillary wall
الهايدرو ستاتيك ببروشر دائما معطاء ياخذ السوائل الي عنده ويطلعها لبرى
فالتغير في هذي القوى يحدد
whether fluid will move out of the blood into the interstitial fluid or in the opposite direction.
Starling forces will dictate fluid movement to the interstitial compartment to "bathe" the cells with nutrition and oxygen.

Osmolarity vs Osmolality?

- **OsmolaLity Defined as=** the number of osmoles per kiLo of water (mOsm/kg water)
- OsmolaLity can be measured in the lab(by freezing point)(كلما كان السوليتس اكثر بالمحلول كلما اخذ وقت اطول بالتجمد (زي الايسكريم ياخذ وقت اطول بالتجمد من الماء.
- **Normal osmolality of body fluids: 283-292** (mOsm/kg water)
- **OsmolaRity Defined as=** the number of osmoles per liteR of plasma (mOsm/ L Plasma)
- The plasma osmolarity can be calculated from the plasma concentrations of sodium, urea and glucose, as follows:

Calculated plasma osmolarity= (2 x serum $[Na^+]$) + blood urea + glucose

The factor of 2 applied to sodium concentration allows for associated anions(chloride and bicarbonate). The other extracellular solutes, e.g. calcium, potassium and magnesium, and their associated anions exist in very low concentrations and contribute so little to osmolality that they can be ignored when calculating the osmolality.

Notice: here Na between brackets$[Na^+]$ which means sodium CONCENTRATION, Remember concentration means that it depends on two things:**(water and sodium)**
plasma osmolarity mainly depends on the concentration of sodium

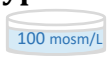
Blood urea Do Not contribute to effect osmolarity because it moves easily across cellular membrane therefore it's not included in calculation even with AKI. BUT The only situation we include blood urea in calculation when we do acute dialysis s of uremic patient cuz they have very high blood urea ,which may across Brain(BBB)"time dependent".

In normal situation (Glucose = 5.5 mmol) almost negligible. Unless if there's hyperglycemia

Tonicity vs Osmolarity?

- Osmolarity describes the concentration of one solution.
- while Tonicity is used to compare between the osmolalities of two or more solutions separated by a semi-permeable membrane. In medicine, it Used to compare the osmolality of intravenous solutions to that of the serum, Tonicity is also used to compare the urine and oral fluids to the plasma in terms of osmolality:

hypotonic



Solutions have more water than solutes comparing to ECF

isotonic

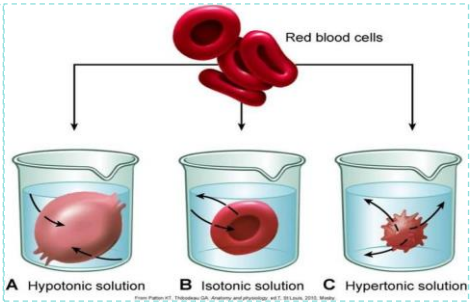
Solutions have the same solute concentration as the ECF

hypertonic

Solutions have more solutes than water comparing to ECF

- **Effect of osmotic pressure on the cells:**

To equilibrate osmotic pressures:
water tend to move from area of low solutes concentration to area of high solutes concentration.



Water movement between intracellular & extracellular space BASED on osmolarity(water move from low osmolarity to high osmolarity)
What dictate water movement between intravascular & interstitial space?
Osmolality in addition to oncotic pressure +hydrostatic pressure(starling forces)
the researches did not prove starling forces 100% accurate but we still use it in the bed side

Regulation Mechanisms of Fluid and Electrolytes:

Regulation of osmolality and volume is achieved through thirst and the osmoreceptor-antidiuretic hormone system (vasopressin):

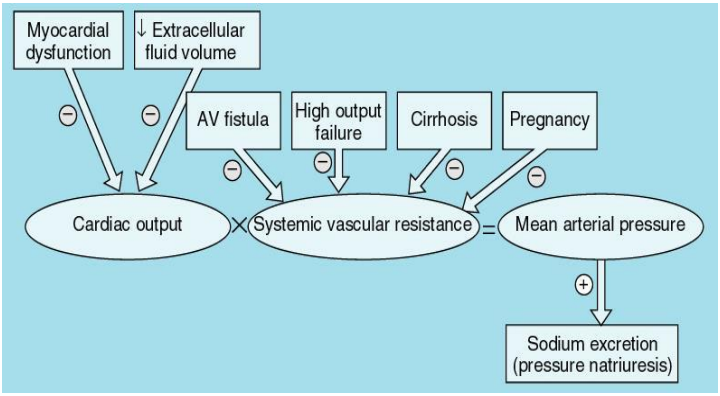
- ↑plasma hypertonicity→stimulation of Osmoreceptors in the hypothalamus→ thirst.
  → Stimulate secretion of ADH→ADH increases water reabsorption.

✓ ADH controlled by osmoreceptor and volume receptor but
✓ Volume is more important than osmolality(As survival mechanism since hemodynamics affect the perfusion to the tissues with oxygen delivery)

- u can live with low osmolality but u can't live with low volume.
- Volume is more important than osmolality in controlling ADH secretion e.g. (if there is low blood volume ADH will be secreted even if there is low osmolality). E.g : in heart failure although there is low Na the ADH still being secreted because there is low effective arterial blood volume تحت بتكلم عنها

The regulation of volume also occurs through neurological and renal mechanisms:			
The stretch receptors (baroreceptors)	The Renin-Angiotension-Aldosterone System: ***RAAS is the main dictate of volume in the body*** decrease in renal perfusion pressure results in activation of the RAAS system. Which enhances Aldosterone releases →increases Na reabsorption from the late distal tubules. Also RAAS will directly constrict efferent arteriole→↑oncotic pressure within the vessel →will absorb water more	The Natriuretic peptides: produced by heart atrium in response to an increase in blood volume lead to increase sodium excretion.	Kinins& Prostaglandins vasodilator Have minor role

Effective Arterial Blood Volume (EABV):



- **What is EABV:**(it is the fullness of the arterial vascular compartment)is the amount of arterial blood volume required to adequately 'fill' the capacity of the arterial circulation.

- The fullness of the arterial compartment depends on a normal ratio between cardiac output and peripheral arterial resistance. Thus, diminished EABV is initiated by a fall in cardiac output or a fall in peripheral arterial resistance. When the EABV is expanded, this in turn leads to an increase in urinary sodium excretion and vice versa, To sum up:

  (EABV has 3 components: Cardiac output,Systemic vascular resistance & intravascular volume)

↓ EABV leads to: كتعويض اذا قل الدم داخل الفيزل وش بيصير:	**↑ EABV leads to :**
○ ↑CO ○ ↑Systemic vascular resistance ○ ↑renal Na retention=↑volume	○ ↓CO ○ ↓Systemic vascular resistance ○ ↓renal Na retention=↓volume

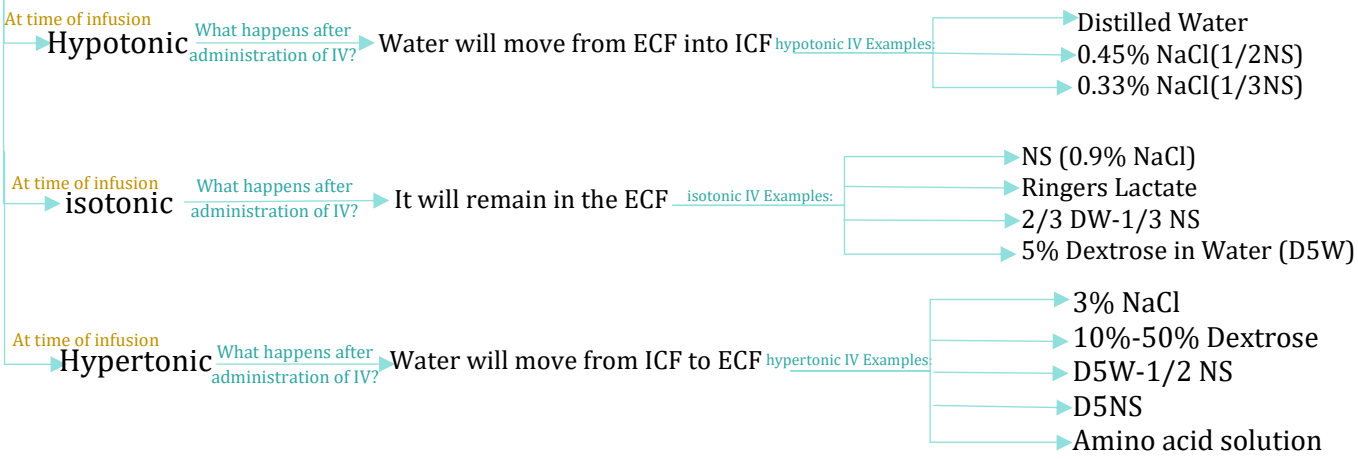
- **ECF volume and EABV can be independent of each other:**
  - Edematous states:increase in total ECF volume and decreased EABV(in Edematous states there's intravascular volume depletion(drop in EABV) and accumulation of fluid in interstitial space). (eg:Heart failure, cirrhosis, nephrotic syndrome)
  - Postural changes: may cause shifts that influence the EABV without affecting the total blood volume.مثلا لما اوقف الدم الي داخل الاوعيه بيتغير مكانه لكنه لم يزل داخل الوعاء

Use the different types of IV fluids in clinical practice

I guarantee u will understand everything about IV fluid after watching this video

IV Fluids

Types of IV Fluids:



What will happen after administer IV ?
Recall: water always tend to move from area of low solutes concentration to area of high solutes concentration.

Intravenous Solutions (Crystalloids vs Colloids):

- **Crystalloids** are intravenous solutions that contain solutes that readily cross the capillary membrane(contents: water+electrolytes). Examples: Dextrose and electrolyte solutions

- **Colloids** are intravenous solutions that DO NOT readily cross the capillary membrane(contents: water+protien)., Examples: Blood, albumin, plasma.

  - ✓ If u need **volume expander**[1] u must use **colloid** or **isotonic saline** bc u don't want fluid goes inside the cell at this point , u need to maintain the perfusion of tissue which comes from raising **BP.** U may get case in the exam with severe hypotension asking to choose the appropriate IV? albumin or NS

  - ✓ **Can u give free water iv?** NO bc free water cause cell lysis & thrombophlebitis(if given in peripheral line).

  - ✓ several researches & meta-analysis show No benefit of colloid over crystalloid in term of decrease mortality or morbidity + albumin can cause allergy& cost huge.

[1] Volume expander fluid:tend to stay within the vascular space and increase intravascular pressure

The Differences between each Intravenous Solutions:

solution	Components	OsmolaRity (mmol/L)	indication	Distribution No need to memorize the numbers in this column
D5W	Glucose=5(g/100 mL) Or 50 (g/L) It composed of 5%dextrose ,& water	253 Isotonic initially, but after a while the glucose will be metabolized and the solution becomes hypotonic.	hypoglycemia. **maintenance fluid**, the amount of glucose here is sufficient to prevent ketogenesis but not nutritional , هل يبطل الصيام ام لا ؟هومو مغذي :)فما اشوفه يبطل	If u take 1 Liter of D5W (80 ml will stay IV, 250 ml will shift to ISF & 670 ml will go inside the cell) - **NOT volume expander** fluid bc small amount stay iv
D10W	Glucose =10 (g /100 mL)	506 for pt with hypoglycemia. It's hypertonic initially, but after a while the glucose will be metabolized and the solution becomes hypotonic.	hypoglycemia.	Same as D5W(see above)
Normal saline (NS) (0.9% NS)	Na=154 (mEq /L) Cl =154 (mEq /L)	308 154 Na+154 Cl=308 omsolarilty Is it really isotonic? If u measure the osmolaLity it would be (286 mmol**kg**) which is similar to plasma osmolaLity so it's isotonic	mainly **resuscitation** fluid (ex:if someone is hypovolemic u need to support blood pressure volume u should give saline) - also given **after surgery**	If u take 1 Liter of NS (250 ml will stay IV and 750 ml will shift to ISF) NS is isotonic so why it will shift to another compartment? Bc the hydrostatic pressure goes up. - **When saline go to interstitial ,what will happen to the pt?** pitting EDEMA. - **If u keep pushing NS what will happen to Cl in plasma?** Cl will go up while bicarbonate will pushed out →**dilutional acidosis .**
Half saline (½ NS) (0.45% NS)	Na=77 (mEq /L) Cl =77 (mEq /L) It composed of half Liter of saline & half Liter of water	154 Hypotonic 77 Na+77Cl=154 omsolarilty	**maintenance** fluid (when someone is eating a little bite ,not worry about hypoglycemia ,1\2 NS is enough) - intracellular dehydration	If u take 1 Liter of ½ NS (165 ml will stay IV, 500 ml will shift n ISF & 335 ml will Go inside the cell) so ½ NS can be used when someone has intracellular dehydration,But can NOT be used when someone hypotensive'not resuscitance' Bc only 165 stay intravenously which not support blood pressure.that's why ½ NS used as a maintenance not for replacing ACUTE volume loss
D5 NS	Glucose =5 (g/100 mL) Na=154(mEq /L) Cl=154(mEq /L)	561		Same as NS(see above)
D5 ½ NS	Glucose = 5 (g/100 mL) Na=77 (mEq /L) Cl =77 (mEq /L)	407	**Before surgery**	Same as ½ NS(see above)
2/3 D5W + 1/3 NS	Glucose =33 (g/L) Na=50(mEq /L) Cl =50(mEq /L)	285 isotonic		
Ringer's Lactate	Na= 130(mEq /L) K=4 (mEq /L) Ca=3 (mEq /L) Cl=109 (mEq /L) Lactate=28 (g /L)	274 isotonic	**(resuscitation fluid)**	NOTE: More physiological"balanced" but **BE CAUTION with(AKI & sepsis)** - bc it has k (4 mmol\L)if someone get 4 L of ringer lactate he will develop hyperkalemia - if someone has septic shock "his liver Is shocked" & has acidemia if I give lactate it will accumulate in liver and make acidemia worse

- ✓ **The alternative to NS** that given in ICU & surgeons love is **Albumin(colloid)** will stay intravascularly however it's not true in reality bc when someone sick mainly septic shock has capillary wall leaking the starling forces will get missed up & albumin will go to interstitial & pull some water with it ,yes it might **has better effect on rising BP** & **longer duration** than saline but eventually albumin will go interstitial & pull water with it .

BASAL REQUIREMENTS

Basal Water:	**Calculation of Maintenance Fluids:** 4/2/1 rule: - (4 mL/kg for first 10 kg)+(2 mL/kg for next 10 kg)+(1 mL/kg for every 1 kg over 20) - For example, for a 70kg man: (4 × 10 = 40)+ (2 × 10 = 20)+(1 × 50 = 50) Total = **110 mL/hour.**
Insensible water loss:	- **Stool, breath, sweat:** 800 ml/d - Increases by 100-150 ml/d for each degree above 37.
Electrolytes:	- **Na**:1 meq/kg/day=1 mmol/kg/day=1 mOsm /kg/day - **Cl**: 1 meq/kg/day - **K**: 1 meq/kg/day
Carbohydrates:	- Dextrose: 100-150 g/d - IV Dextrose minimizes protein catabolism and prevents starvational ketoacidosis (enough for ketogenesis suppression not for nutritional use)

DIFFERENTIATE BETWEEN TOTAL BODY SODIUM CONTENT(VOLUME STATUS) AND SERUM SODIUM CONCENTRATION (HYPO-AND HYPERNATREMIA)

Sodium and Water:

- **ECF volume=** absolute amounts of Sodium and water
- **Plasma sodium concentration=** ratio between the amounts of Sodium and water (Concentration)

[Na+] =sodium concentration

Sodium balance disorder	Water balance disorder
✓ Disturbance of Na balance may lead to hypovolemia or hypervolemia. ✓ The main determinant of volume is sodium content ✓ any tendency for plasma sodium amount to change is usually corrected by the osmotic mechanisms, As a result, disorders in sodium balance present chiefly as altered ECF volume rather than altered sodium concentration.	✓ Disturbance of water balance may lead to hyponatremia or hypernatremia ✓ Water disorders:(causes a disturbance in Na concentration, not amount)
- ***Hypervolemia*** have = Sodium Excess ("Edema") (high volume=high sodium content) امم ليش زيادة كمية الصوديوم بمكان يؤدي الى زيادة الموية فيه؟هذا بسبب **الاوزموتك بروشر**, فمثلا اذا زادت كمية الصوديوم بالسيروم اكثر من الى جوا الخليه هنا الموية تروح للمكان الأعلى كمية بالصوديوم فتنتقل معظم الماء الى السيروم	- ***Hyponatremia*** have= Water Excess (Low sodium conc.=high water) هنا نتكلم عن تركيز الصوديوم فإذا قل تركيز الصوديوم في محلول فمعناته يمكن بسبب زيادة الموية خلت المحلول مخفف بالصوديوم hyponatremia refers to too much water in relation to sodium in the serum
- ***Hypovolemia*** have = Sodium Deficit("Dehydration") (low volume=Low sodium content)	- ***Hypernatremia*** have = Water Deficit (High sodium conc.=low water) Hypenatraemia reflects less water in relation to sodium;

Disorder in Sodium Balance

Clinical features of Hypovolemia & Hypervolemia:

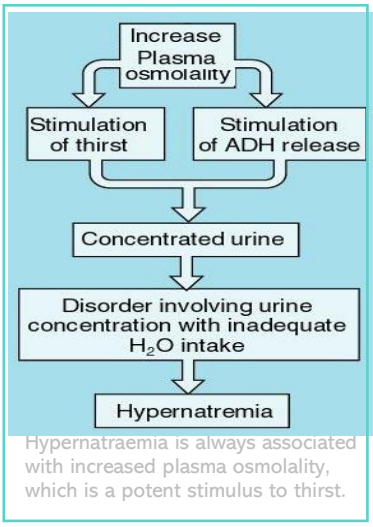
	Hypovolemia	Hypervolemia
Symptoms:	Thirst	Ankle swelling
	Dizziness on standing	Abdominal swelling
	Weakness	Breathlessness
Signs:	Low JVP	Raised JVP
	Postural hypotension	Peripheral edema
	Tachycardia	Pulmonary crepitations
	Dry mouth	Pleural effusion
	Reduced skin turgor pic	Ascites
	Reduced urine output	Hypertension (sometimes)
	Weight loss	Weight gain
	Confusion, stupor(unconsciousness)	

Disorder in Water Balance

Hypernatremia

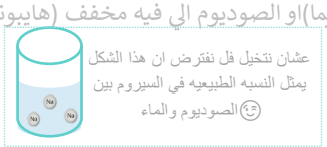
General characteristic:

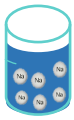
- Defined as a plasma Na+ concentration **>145 mmol/L**
- Hypenatraemia reflects less water in relation to sodium; affected patients may or may not have a concurrent abnormality in sodium balance.
- This is much rarer than hyponatraemia and nearly always indicates a water deficit



Hypernatraemia is always associated with increased plasma osmolality, which is a potent stimulus to thirst.

لما نتكلم عن الهايبر والهابو نتريما فإحنا نقصد **تركيز الصوديوم للماء** ,هل المحلول مركز بالصوديو(هايبرنتريما)او الصوديوم الي فيه مخفف (هايبونتريميا),نروح لموضوعنا الهايبر نتريميا ونفكر بأسبابها ,ياترى ايش الي خلى البلازما مركزه بالصوديوم؟



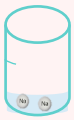
امم ممكن لان الصوديوم زاد والموية زادت لكن زيادة الصوديوم اكثر بكثير من الموية فصار البلازما مركز This called(hypervolemic hypernatremia)	او حتى ممكن ان كمية الصوديوم طبيعيه لكن الموية قلت فصار البلازما مركز بالصوديوم This called(euvolemic hypernatremia)	او ممكن كلهم قلو لكن الموية قلت اكثر بكثير من الصوديوم فصارة البلازما مركزه This called(hypovolemic hypernatremia)
		

Causes & Treatment of hypernatremia:

Hypernatraemia may occur in the presence of normal, reduced or expanded extracellular volume, and does not necessarily imply that total body sodium is increased.

The Causes of Hypernatraemia Classified Based On The Volume

Hypovolemia



- Total body water↓↓
- Total body sodium↓

(Na deficit with a relatively greater water deficit)

Urinary Na>20

Due to renal losses:

- Loop or osmotic Diuretic(bc it inhibits Na reabsorption& cuz water loss)
- Postobstructive diuresis(which copious amounts of salt and water are eliminated after the relief of a urinary tract obstruction)
- Intrinsic renal disease(in which renal tubular function is lost→↓↓reabsorption of water & Na)

Urinary Na<20

Extrarenal losses:

- Burns
- Diarrhea
- Fistulas

Treatment

- ✓ **Correction of volume deficit:**
  1- Pt is hypovolemic!!Administer isotonic saline till *hypovolemia* improves.
  2- After that correct the *sodium level* by calculating water deficit accordingly Administer: (Half saline or D5W or oral water replacing the free water deficit & ongoing losses).
- ✓ **Treat causes of losses:** (removal of diuretics, insulin…..)

Euvolemia(no edema)

- Total body water↓
- No change in Total body sodium

(water deficit alone)

Urinary Na variable

Due to renal losses:

- **Diabetes insipidus**(there's high volume water loss from insufficient ADH)
- Hypodipsia(hypodipsia refers to a partial deficiency of the thirst mechanism →person unable to feel thirsty →↓water intake)

Extrarenal losses:

Insensible losses: (respiratory, dermal)

Treatment

- ✓ **Correction of volume deficit:**calculate water deficit accordingly Administer: (Half saline or D5W or oral water replacing the free water deficit & ongoing losses).
- ✓ **In central diabetes insipidus with severe loss:** give aqueous vasopressin(ADH)'pitressin' but monitor serum Na carefully to avoid water intoxication.
- ✓ **Long term therapy: in nephrogenic diabetes insipidus**:(the causes of nephrogenic diabetes insipidus r: lithium ,chronic kidney disease, hypokalemia ,hypercalcemia. they make ADH ineffective at kidney tubule) so u have to treat NDI according to the cause:(correct plasma Ca & K conc. , give amiloride for lithium induced NDI, remove offending drug)
- ✓ Long term therapy: low Na diet

Hypervolemia

- Total body water↑
- Total body sodium↑↑

(Na retention with relatively less water retention)

Urinary Na>20

Sodium Gains:

- Primary hyperaldosteronism(bc aldosterone cuz Na water retention)
- Cushing's syndrome(bc high Cortisol cause mineralocorticoid effect)
- **Hypertonic dialysis**
- Iatrogenic:(hypertonic Na HCO3 ,NaCl tablests)

Treatment

- ✓ Remove Na.
- ✓ Discontinue offending agents.
- ✓ Administer furosemide.
- ✓ Provide hemodialysis as needed for renal failure.

At a glance

Excessively rapid correction of hypernatremia can lead to **cerebral edema** as water shifts into brain cells. Therefore, the rate of correction should not exceed10 mEq/L/day (should be <8 mEq/L in the first 24 hours).
The acuteness of the hypernatremia guides the speed of correction:
acute = rapid correction.
Chronic = longer correction

Water Deficit Calculation: IMPORTANT TO SAFE PT LIFE

- **Water deficit**: (it is the amount of "water" required to lower the Plasma Na to 140 mmol/L)
- can be estimated using the following formula:

Water Deficit= Target TBW – Current TBW

$$\text{Target TBW} = \frac{\text{current TBW} \times \text{Current [Na]}}{\text{Target[Na] which is 140}}$$

Current TBW= male: 0.6 x Current Body Weight
Female: 0.5 x Current Body Weight

Example: 60 kg men, sodium 165 mmol/L, calculate water deficit:

Water Deficit= Target TBW – Current TBW

Target TBW=(36 x 165)÷140=42

Current TBW=0.6 x60=36

Water Deficit=42 – 36 =6 Liter (need to give 6L water plus ongoing free water loses)

U will get case asking u to calculate water deficit

- don't forget potential for ongoing loss either from diarrhea, diuresis or insensible loss.

Clinical features:

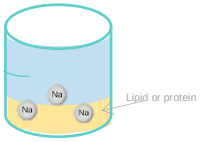
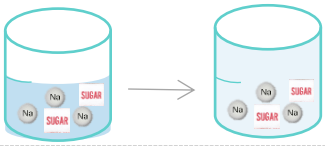
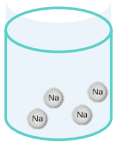
Patients with hypernatraemia generally have reduced cerebral function and cerebral dehydration. This triggers thirst and drinking, and if adequate water is obtained, is self-limiting. If adequate water is not obtained, dizziness, confusion, weakness and ultimately coma and death can result.

HYPONATREMIA

General characteristic:

- This refers to too much water in relation to sodium in the serum.
- It is typically defined as a plasma Na+ concentration **<135 mmol/L.**

Causes and classification (based on serum osmolality):

Isotonic hyponatremia (pseudohyponatremia) (Factitious)	Hypertonic hyponatremia (Translocational Hyponatremia) (dilutional hyponatremia) (true not pseudo)	Hypotonic hyponatremia(True hyponatremia) The causes depend on the associated changes in extracellular volume:		
		Hyponatraemia with hypovolaemia	**Hyponatraemia with Euvolaemia** (water retentionalone)	**Hyponatraemia with hypervolaemia**
				
~increase in plasma solids lowers the plasma sodium **concentration.** But the **amount** of sodium in plasma is normal (hence,**pseudo**hyponatremia). الاجهزه لما تحسب تركيز الصوديوم تعتبر الليبد او البروتين من ماء البلازما فتكون الحسبه($\frac{Na}{water+lipid}$)فالنتيجه بلازما مخففه من الصوديوم مع ان عدد الصوديوم ماقل!! ~can be caused by any condition that leads to elevated protein or lipid levels.	~Results from ***none Na osmoles*** in serum **(often glucose or mannitol)** drawing free H2O from cells اذا زاد السوليوتس في السيروم اكثر من الي داخل الخليه هنا الميه بتروح كعادتها (من المكان الاقل تركيز بالسوليوتس الى المكان الاعلى تركيز بالسوليوتس)فتنقل الى السيروم .فكذا السيروم صار فيه ميه كثييره فأصبح محلول مخفف من الصوديوم (هايبونتريما) مع ان عدد الصوديوم ماقل! ~ [Na+ conc.] declines by ~2.4 mEq/L for each 100 mg/dL [5.5 mmol/L] increase in serum glucose. **EXAMPLE:DM**	See below	See below	See below

The causes of Hypotonic hyponatremia(True hyponatremia) Classified Based on The Volume State

Hypovolemia
- Total body water↓
- Total body sodium↓↓

(Na deficit with a relatively smaller water deficit)

Urinary Na>20

Due to renal losses:
- Diuretic EXCESS(over time with excess use of diuretic ,it will deplete the body of sodium & water)
- Mineralocorticoid deficiency(bc aldosterone cuz Na retention)
- **Osmotic diuresis**(lead to obligating electrolyte excretion):
  *Glucoseuria (caz water & electrolyte losses & thereby ECF volume depletion)
  *Bicarbonaturia (↑ bicarbonate excretion also obligate renal water & electrolyte loss)
  *Ketonuria(↑ ketoacid excretion also obligate electrolyte loss)

Urinary Na<20

Extrarenal losses:
- Diarrhea
- Vomiting
- Third spacing of fluids(occurs when too much fluid moves from the intravascular space into the interstitial or "third" space):
  *Burns
  *pancreatitis
  *Trauma

All of these are also causes of hypernatremia; however, they cause hyponatremia if there is chronic replacement with free water. A little sodium and a lot of water are lost in urine, which is then replaced with free water that has no sodium. Over time, this process depletes the body of sodium and the serum sodium level drops. (MASTER THE BOARD)

Euvolemia(no edema)
- Total body water↑
- No change in Total body sodium

(water retention alone, dilutional)

Urinary Na >20
- In the post-operative patient there is usually a short period of oliguria occurring as a physiological response to surgery.
- Drug
- **Syndrome of inappropriate ADH** (↑ADH increases water reabsorption)
- Hypothyroidism(hypothyroidism induces hyponatraemia by inappropriate release of ADH)
- Polydipsia.
- Beer potomania(is a specific hypo-osmolality syndrome related to massive consumption of beer)

Hypervolemia(edema)
- Total body water↑↑
- Total body sodium↑

(Na retention with relatively greater water retention)

Urinary Na>20

Acute or chronic **renal failure.**

Urinary Na<20
- **Nephrotic syndrome** (Sodium retention is primarily due to increased sodium reabsorption in the renal collecting tubules directly induced by he renal disease)
- **Cirrhosis** (This is through a complex mechanism, but there is vasodilatation and hence underperfusion of the volume receptors→↑ADH)
- **Cardiac Feilure.** (reduction in cardiac output and impaired perfusion of the volume receptors→↑ADH)

Classification of Symptoms of Hyponatremia:IMPORTANT

All symptoms that can be signs of cerebral edema should be considered as severe or moderate symptoms that can be caused by hyponatremia:

U should be able to classify each symptom wether it's moderately severe or severe 'very imp'

Moderately Severe	Severe
• Nausea without vomiting • Confusion • Headache	• Vomiting • Cardiorespiratory distress • Abnormal and deep somnolence نعاس • Seizures • Coma (Glasgow Coma Scale[2] ≤8)

For **severe** hyponatremia, Need 3% hypertonic saline as emergency treatment

- Symptoms of hyponatremia are dependent on how fast it occurs.

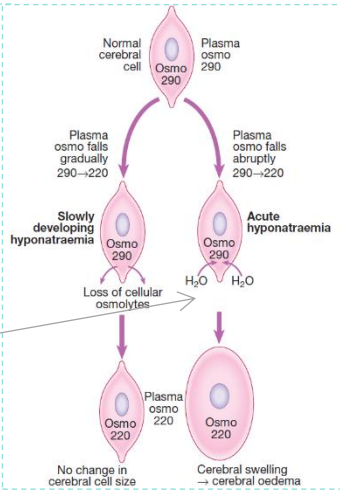
Sodium means CNS symptoms ,wether sodium level above the normal or below it.

[2] **Glasgow Coma Scale** is neurological used to describe the general level of consciousness

The effect of hyponatremia on the brain:

Symptoms of hyponatremia are dependent on how fast it occurs

Osmosis=Water moves from area of low conc. of solutes to area of high conc. of solutes
فهنا عندنا كمية قليلة من الصوديوم بالسيروم مقارنة بداخل الخليه و فالموية بتروح من برى الى داخل الخلية



Hyponatremia Treatment:

TIP: The treatment answer is **NOT** based on the sodium level; it is based on the symptoms.

Severe Hyponatraemia (<125 mmol/L)

Symptomatic

Acute
Duration<48 h

Emergency correction needed:
- Hypertonic saline (1-2 ml\kg\hr).
- Coadministration of furosemide بالذات اذا الشخص مصاب بال SIADH هنا يكون افراز الهرمون المضاد لإدرار البول غزير جدا فنحتاج نعطيه فوروسمايد(مدر للبول).

Chronic
Duration>48 h

- **Some immediate correction needed:**
  - Hypertonic saline
  - Coadministration of furosemide
- **Water restriction.**
- **Perform frequent measurement of serum & urine electrolyte.**

Asymptomatic

Chronic
Duration>48h

No immediate correction needed

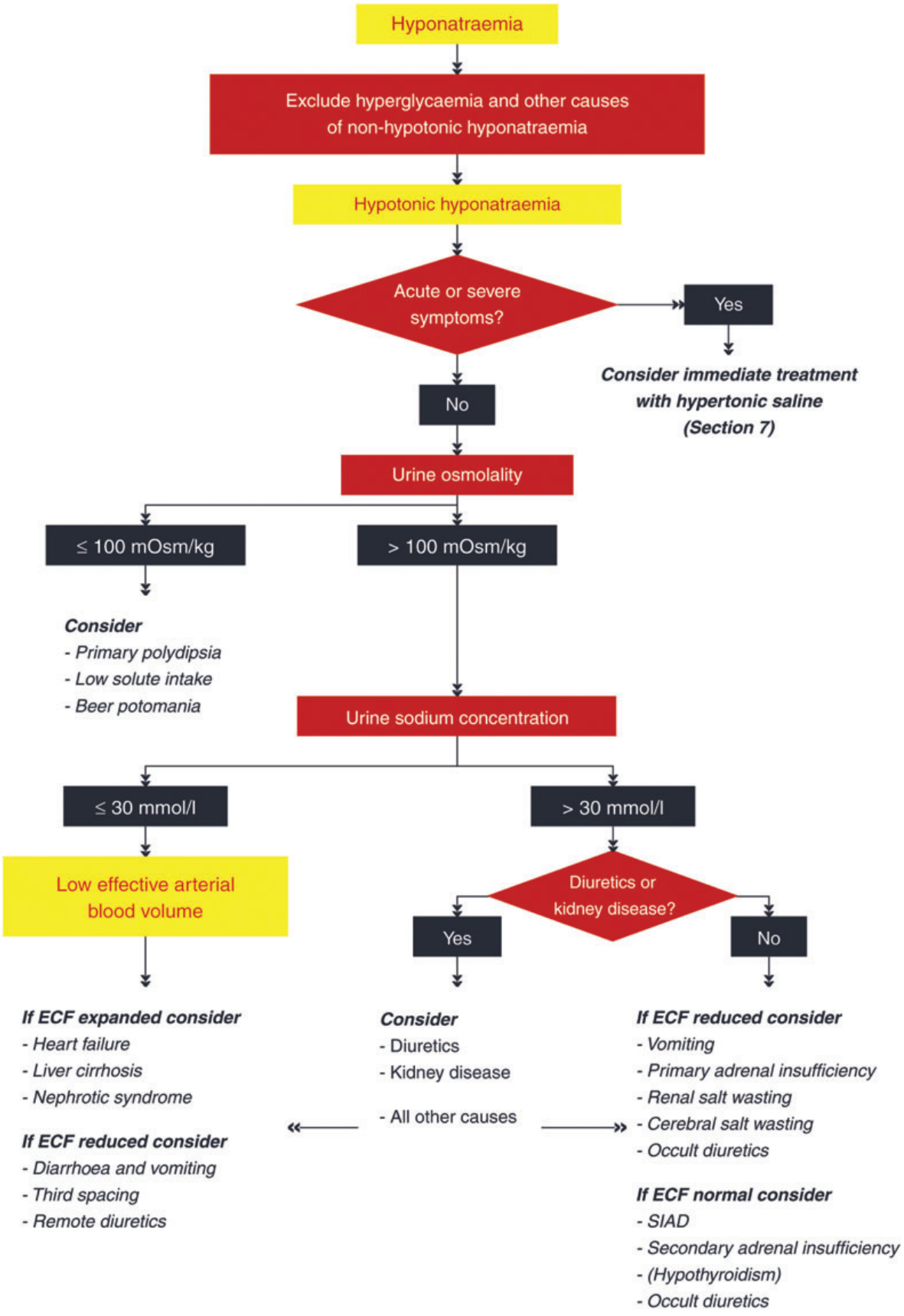
Long term management:
- Identification & treatment of reversible causes.
- Water restriction.
- Demeclocycline(V2 receptor antagonist 'ADH antagonist')(use to treat hyponatremia in pt with inappropriate ADH, this works by reducing the responsiveness of the collecting tubule cells to ADH)

Recommended Rate of correction:
0.5 mmol/L/h ~ 10-12mmol/L/d
In latest guideline:the range become narrower 8-10 mmol/L/d

is it acute or chronic? Most of the time you won't know whether it's acute or chronic because people don't get their labs checked at home. That said, acute hyponatremia can be corrected acutely without risk of **Osmotic Demyelination Syndrome.** Chronic hyponatremia (48h) must be corrected slowly to avoid ODS.

Explain the workup of Hyponatremia:

This is very advance at ur level , no need to memorize it now & u won't be asked about it



syndrome of inappropriate antidiuretic hormone secretion (SIADH)	
Definition	is characterized by excessive unsuppressible release of antidiuretic hormone (ADH) either from the posterior pituitary gland, or an abnormal non-pituitary source. Unsuppressed ADH causes hyponatremia and hypo-osmolality
Causes	**(Lung ,Brain,Drug & Cancer)** pulmonary disorders, CNS diseases, medications ,malignant tumors, and severe stress.
Diagnostic criteria In the absence of a single laboratory test to confirm the diagnosis, the syndrome of inappropriate antidiuretic hormone secretion (SIADH) is best defined by the classic criteria :	***Helpful mnemonic* "HIVE":** ▪ H:Hypoosmolar Hyponatremia (Plasma osm <275 mOsm/Kg H2O) Hypouricemia[3](<238 mcmol/L) and low Urea (<3.5 mmol/L) ▪ I:Inappropriate urine concentration (Urine osm >100 mOsm/Kg H2O) ▪ V:Euvolemia, No diuretic use ▪ E:Endocrine = normal Thyroid, adrenal and renal function The diagnostic criteria for SIADH is advance for u , thus just remember HIVE

HINT: ADH cause water reabsorption & Fractional "little" excretion of (Na, urea & uric acid)in urine.

If you like this work, please make dua' for me If you don't, also make dua' for me :P وبس

SUMMARY

Hypernatremia causes		
Hypovolemic hypernatremia	**Euvolemic hypernatremia**	**Hypervolemic hypernatremia**
▪ Loop or osmotic Diuretic ▪ Postobstructive diuresis ▪ Intrinsic renal disease ▪ sweating ▪ fever ▪ Burns ▪ Diarrhea ▪ Fistulas	▪ **Diabetes insipidus** ▪ Hypodipsia ▪ Insensible losses:(respiratory, dermal)	▪ Primary hyperaldosteronism ▪ Cushing's syndrome ▪ **Hypertonic dialysis**

Hyponatremia causes		
Hypovolemic hyponatremia	**Euvolemic hyponatremia**	**Hypervolemic hyponatremia**
▪ Diuretic **EXCESS** ▪ Mineralocorticoid deficiency ▪ Osmotic diuresis: (Bicarbonaturia,Ketonuria,&Glucosuria) Those can cause hypovolemic hypernatremia initially but Over time, those will deplete the body of sodium& water (hypovolemic hyponatremia): ▪ Third spacing of fluids:(pancreatitis, Trauma) ▪ Sweating ▪ fever ▪ Diarrhea ▪ Vomiting ▪ Burns	▪ **SIADH** ▪ Polydipsia. ▪ post-operative ▪ Drug ▪ Hypothyroidism	▪ **Nephrotic syndrome** ▪ **Cirrhosis** ▪ **Cardiac Failure**. ▪ **Renal failure**

[3] level of uric acid in blood serum that is below norma