- Body ... في حالة التعرق.

Water

أهم اشي الـ electrolytes متوازنة على جانبي membrane خاطي بنتلعقهم

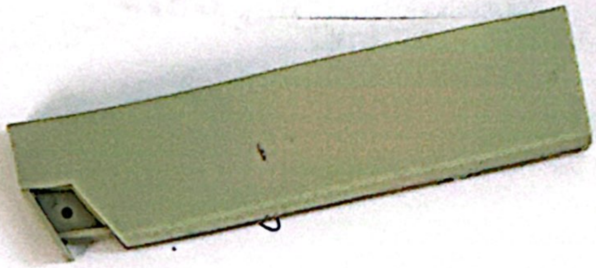
- ❑ The concentration of ions inside the cells and in plasma is maintained by passive diffusion and active transport through ATPase-dependent ion pump
- ❑ Most biological membranes are permeable to water but not ions
- ❑ Water and sodium output كيف بخرج المي؟
  - ❑ Kidneys and gastrointestinal tract
  - ❑ Sweat and expired air: about 1L daily
- ❑ Factors that affect the flow of water across the membrane
  - ❑ Ions and proteins at one side of the membrane
  - ❑ Blood pressure

الأشياء اللي بتأثر على إنهم يطلعوا من الجسم؟

Clinical features of hydration problems

Table 6.1 **The principal clinical features of severe hydration disorders**

Feature	Dehydration	Overhydration
Pulse	Increased	Normal
Blood pressure	Decreased	Normal or increased
Skin turgor	Decreased	Increased
Eyeballs	Soft/sunken	Normal
Mucous membranes	Dry	Normal
Urine output	Decreased	May be normal or decreased
Consciousness	Decreased	Decreased



Control of water balance

- Both intake and loss of water are controlled by osmotic gradient across cell membrane in the brain hypothalamic osmoreceptor centre
- These centres control thirst and secretion of antidiuretic hormone (ADH)=AVP (arginine vasopressin hormone)
- Thirst is the major defense mechanism against hyperosmolality and hypernatremia
- Antidiuretic hormone:
  - Is polypeptide with $t_{\frac{1}{2}}$ of 20 min
  - Synthesized by the hypothalamus and secreted by the posterior pituitary
  - 2% increase in osmolality lead to 4 times increase in ADH
  - Low blood pressure and severe hypovolemia stimulate ADH release
  - Stress due to vomiting, nausea and pain may increase ADH secretion
  - ADH act by increasing the reabsorption of water in cortical and medullary collecting tubules

Control of water balance

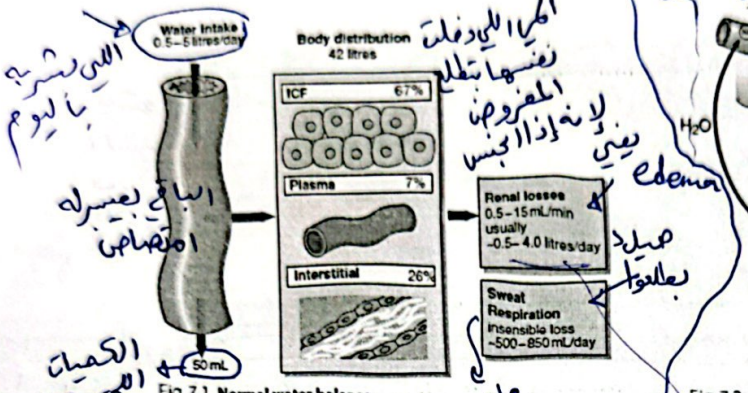


Fig 7.1 **Normal water balance.**

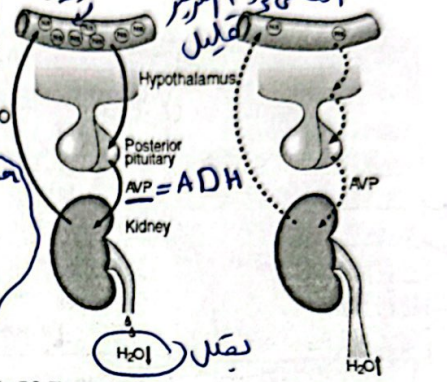


Fig 7.2 **The regulation of water balance by AVP and osmolality.**

Control of water balance

Hypernatremia rarely occurs in a person with a normal thirst mechanism and access to water, it becomes a concern in:

- Infants ①
- Unconscious patients ②
- Anyone who is unable to drink or ask for water. ③
- People who are older than 60 where osmotic stimulation of thirst progressively diminished ④
- In the older patient with illness and diminished mental status, dehydration becomes increasingly likely example of the effectiveness of thirst in preventing dehydration ⑤

A patient with diabetes insipidus (no ADH) may excrete 10 L of urine daily, but as water intake matches output, plasma sodium remains normal ⑥

Dr Mohamad Odeh: lecture notes – Pharmaceutical care and ...

Equation for Professional development

Professional Development = (CXC)R

...ment) (Behaviour + Attitude)

... formal education.

osmolality

- Physical property based on the conc. of solutes (in mmol) per kg of solvent (w/w). This affect different properties of solution as:
  - Freezing point depression
  - Vapor pressure decrease
- Increase in osmolality will induce secretion of ADH enzyme while decrease in osmolality will lead to turning off ADH secretion
- Osmolal gap is the difference between the measured osmolality and the calculated osmolality
- Osmolal gap indirectly indicates the presence of osmotically active substances other than sodium, urea, or glucose such as ethanol, methanol, ethylene glycol, lactate, or β- hydroxybutyrate.

Significance of osmolality

- Because it is the parameter by which the hypothalamus responds
- It affects Na concentration as it represents 90% of osmotic activity in Plasma
- Na concentration is also affected by blood volume

Determination of osmolality

- Osmolality may be measured in serum or urine.
- Plasma use is not recommended because osmotically active substances may be introduced into the specimen from the anticoagulant.
- Samples must be free of particulate matter to obtain accurate results.
- Turbid serum and urine samples should be centrifuged before analysis

Determination of osmolality

- Osmometers are standardized by NaCl solution, then the freezing point of the sample is measured and this is compared to the calculated value as double of serum sodium or according to the following 2 formulas:

$$2\,Na + \frac{\text{glucose (mg/dL)}}{20} + \frac{\text{BUN (mg/dL)}}{3}$$

$$1.86\,Na + \frac{\text{glucose}}{18} + \frac{\text{BUN}}{2.8} + 9 \quad \text{(Eq. 15-1)}$$

measured osm... = 290 mOsm/kg

Na^+ = 142 mmol/L / Glucose = 90 mg/dL / BUN = 14 mg/dL

calculated osm = $1,86 * 142 + \frac{90}{18} + \frac{14}{2,8} + 9$

$= 264,1 + 5 + 5 + 9$

$= 283,1$ mOsm/kg

Normal ranges

osmolal gap = measured osm − calculated osm

$290 - 283,1 = 6,9$

TABLE 15-1 REFERENCE RANGES FOR OSMOLALITY

Serum	275–295 mOsm/kg
Urine (24 h)	300–900 mOsm/kg
Urine:serum ratio	1.0–3.0
Random urine	50–1200 mOsm/kg
Osmolal gap	5–10 mOsm/kg

Electrolytes, Sodium (Na)

Body contains about 3000 mmol of sodium mainly in ECF ❑

Extra cellular fluid

Sodium daily intake is about 60-150 mmol ❑

Sodium balance is regulated by blood flow and aldosterone ❑
(hormone secreted by adrenal cortex)

Electrolytes, Sodium (Na)

Sodium is the most abundant cation in the ECF (90% of all extracellular cations) and largely determines the osmolality of the plasma.

Sodium concentration in the ECF is much larger than inside the cells, because a small amount of sodium can diffuse through the cell membrane.

To prevent equilibrium from occurring, active transport systems, such as ATPase-dependent ion pumps (moves 3 Na out of cell for each 2 K moving into the cell) are present in all cells

3 Na^+

2 K^+

Regulation of sodium

The plasma sodium concentration depends on: the intake and excretion of water and the renal regulation of sodium

Three processes are of primary importance:

(1) The intake of water in response to thirst, as stimulated or suppressed by plasma osmolality

(2) the excretion of water, largely affected by ADH release in response to changes in either blood volume or osmolality

(3) the blood volume status, which affects sodium excretion through aldosterone- angiotensin II and ANP (atrial natriuretic peptide)

The kidneys have the ability to conserve or excrete large amounts of sodium, depending on the sodium content of the ECF and the blood volume, normally, 60-75% of filtered sodium is reabsorbed in the proximal tubule

some sodium is reabsorbed in the loop and distal tubules (controlled by aldosterone) exchanged for K in the connecting segment and cortical collecting tubule.