Medicine

3rd year

Lecture 1

الدكتور

مُحَمَّد يونس العطبي

الاختصاص الدقيق بأمراض وزرع الكلى

اختصاص الطب الباطني

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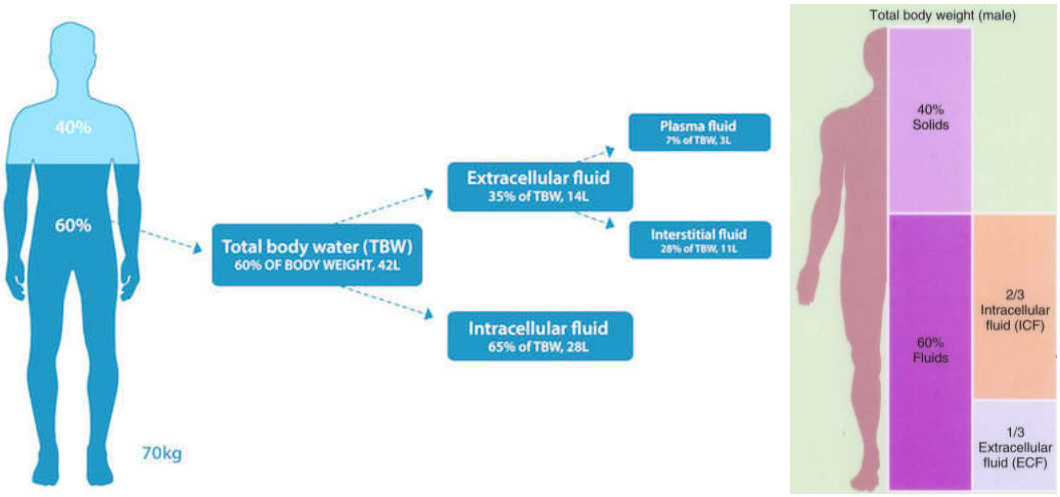
DISTRIBUTION AND COMPOSITION OF BODY WATER

In normal, healthy people, the total body water (TBW) constitutes 60% of bodyweight in men and 50% in women. In a healthy 70 kg male, total body water is approximately 42 L. This is contained in three major compartments:

- **Intracellular fluid** :(**65% of TBW**).
- **Extracellular fluid** :(**35% of TBW**) ,The ECF is further subdivided into:
  1. Interstitial fluid (extravascular space) : (**28 % of TBW**)
  2. Plasma compartment (intravascular space): (**7 % of TBW**)



The dominant **cation** in the ICF is **potassium**, while the dominant **cation** in the ECF is **sodium**. Phosphates and negatively charged proteins constitute the major intracellular **anions**, while chloride and, to a lesser extent, bicarbonate dominate the ECF **anions**. An important difference between the plasma and interstitial compartments of the ECF is that only plasma contains significant concentrations of protein.

The hydrophobic cell membrane acts as a barrier between intra- and extracellular fluid, and the capillary wall separates plasma from the interstitium. Every compartment maintains osmotic pressure through an actively retained specific solute:
1)**Intracellular fluid**: K^+ (pumped inwards by Na^+/K^+ ATPase).
2) **Extracellular fluid**: Na^+ salts predominate in the ***interstitial fluid***, and proteins in the ***plasma*** (esp. albumin, impermeable through the normal endothelial barrier)

The unifying hypothesis of extracellular volume regulation in health and disease proposed by Schrier states that the fullness of the arterial vascular compartment – or the so-called **effective arterial blood volume (EABV)** – is the primary determinant of renal sodium and water excretion. Thus effective arterial blood volume constitutes effective circulatory volume for the purposes of body fluid homeostasis.

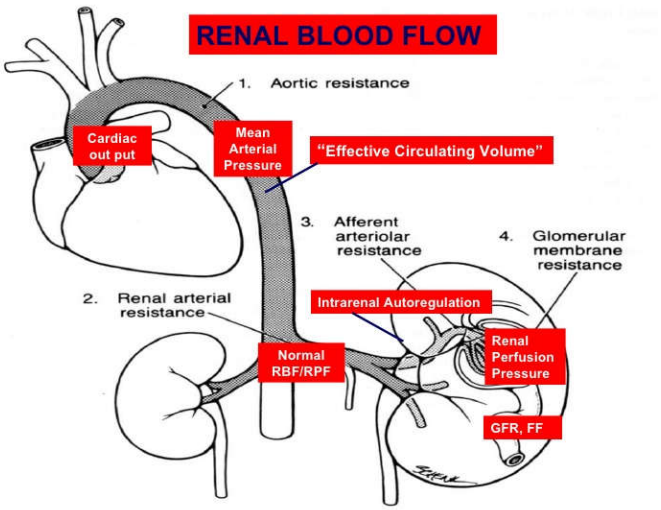
Changes in EABV (due to hypovolaemia) are sensed by:
• Systemic baroreceptors (carotid sinus, aortic arch).
• Intrarenal volume sensors (juxtaglomerular apparatus).

Falling effective arterial blood volume (EABV)

1. **increased** circulating catecholamines, leading to increase cardiac output (CO) and systemic vascular resistance (SVR).
2. Activated renin – angiotensin system, improving renal haemodynamics and salt retention through secondary hyperaldosteronism.
3. **increased** non-osmotic ADH (vasopressin) release.

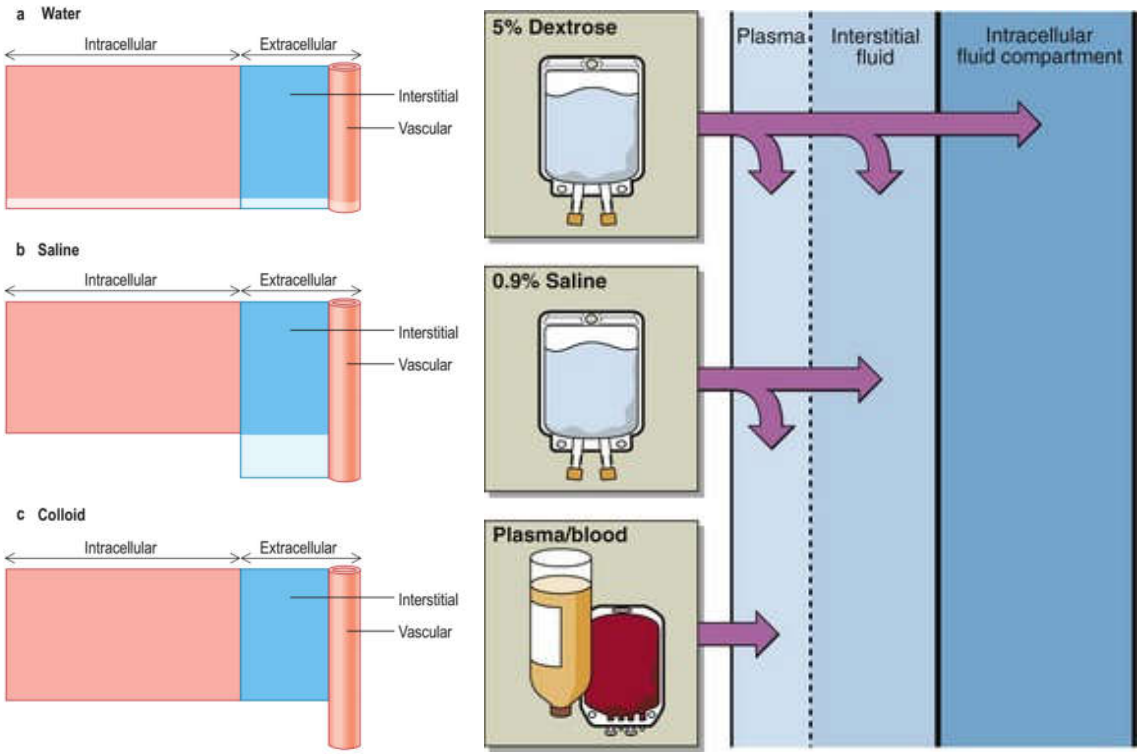
Rising effective arterial blood volume (EABV)

1. **increased** atrial natriuretic peptide (ANP , a potent natriuretic).
2. **Suppressed** renin production and thus angiotensin and aldosterone are decreased.



Distribution of different types of replacement fluids:

The relative effects on the compartments of the addition of identical volumes of water, saline and colloid solutions are variable. Thus, 1 L of water given intravenously as 5% glucose water is distributed equally into all compartments, whereas the same amount of 0.9% saline remains in the extracellular compartment. The latter is thus the correct treatment for extracellular water depletion – sodium keeping the water in this compartment. The addition of 1 L of colloid with its high oncotic pressure stays in the vascular compartment.



PHYSIOLOGY OF WATER BALANCE

The maintenance of the tonicity of body fluids within a narrow physiologic range is made possible by homeostatic mechanisms that control the intake and excretion of water.

1. Vasopressin, also known as arginine vasopressin (AVP) or antidiuretic hormone (ADH), governs the excretion of water by its effect on the renal collecting system.
2. Osmoreceptors located in the hypothalamus control the secretion of vasopressin in response to changes in tonicity. In the steady state, water intake matches water losses. Water intake is regulated by the need to maintain a physiologic serum osmolality of 285 to 290 mOsm/kg.
3. Despite major fluctuations of solute and water intake, the total solute concentration (i.e., the tonicity) of body fluids is maintained virtually constant. The ability to dilute and to concentrate the urine allows wide flexibility in urine flow.