Disordersoffluid balanceinICU patients

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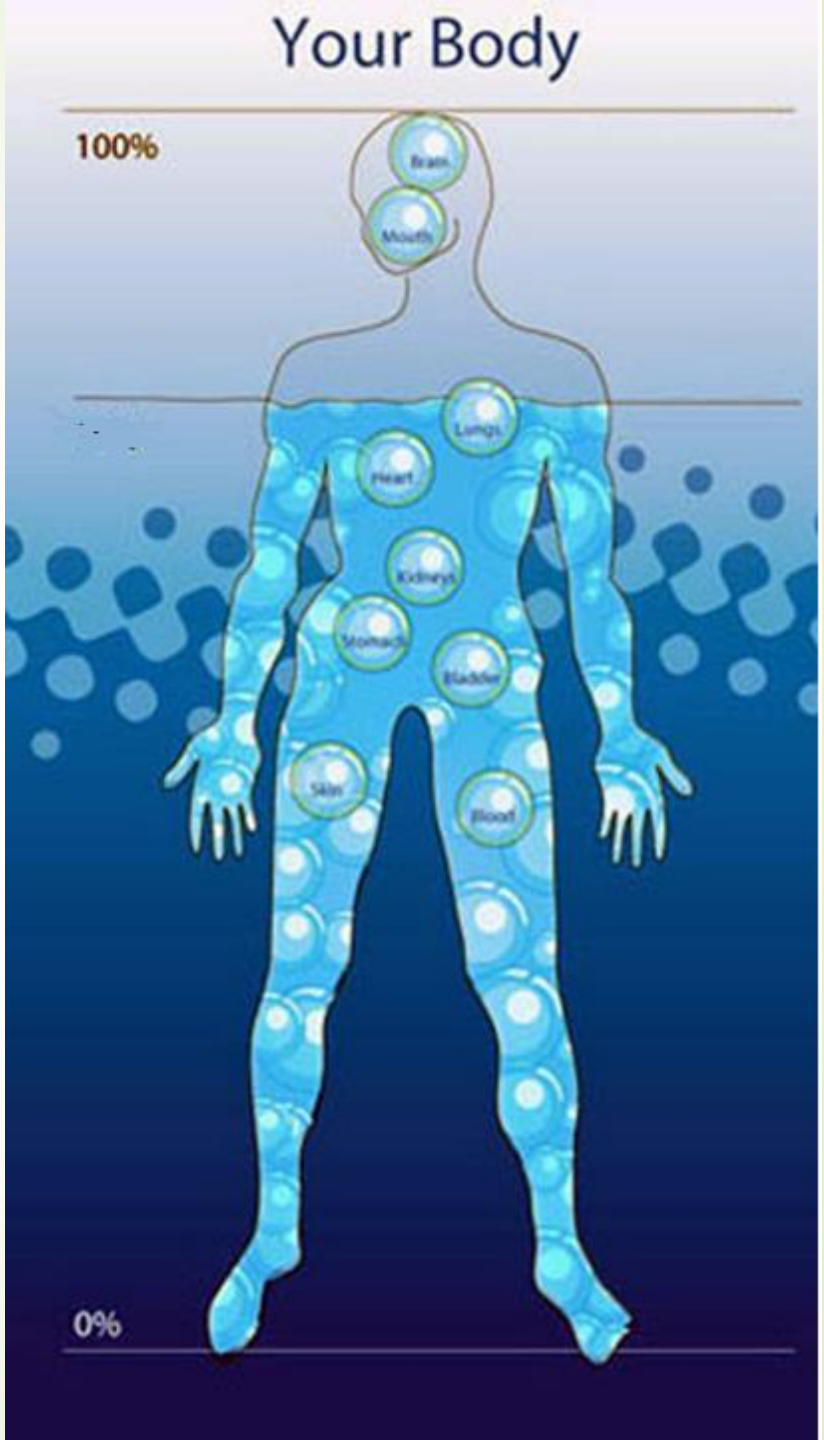
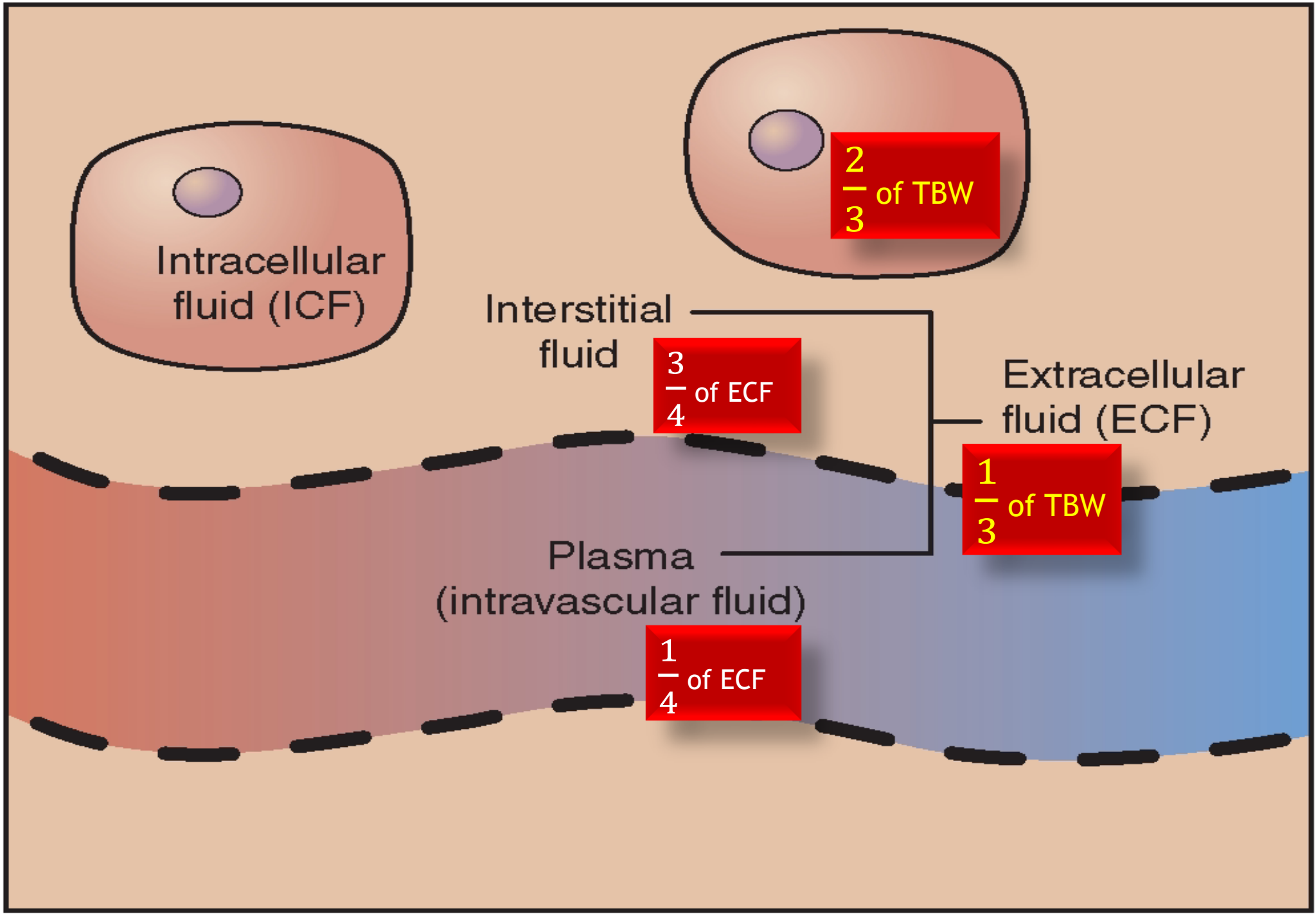
COMPOSITION OF BODY FLUIDS


The most abundant constituent in the body

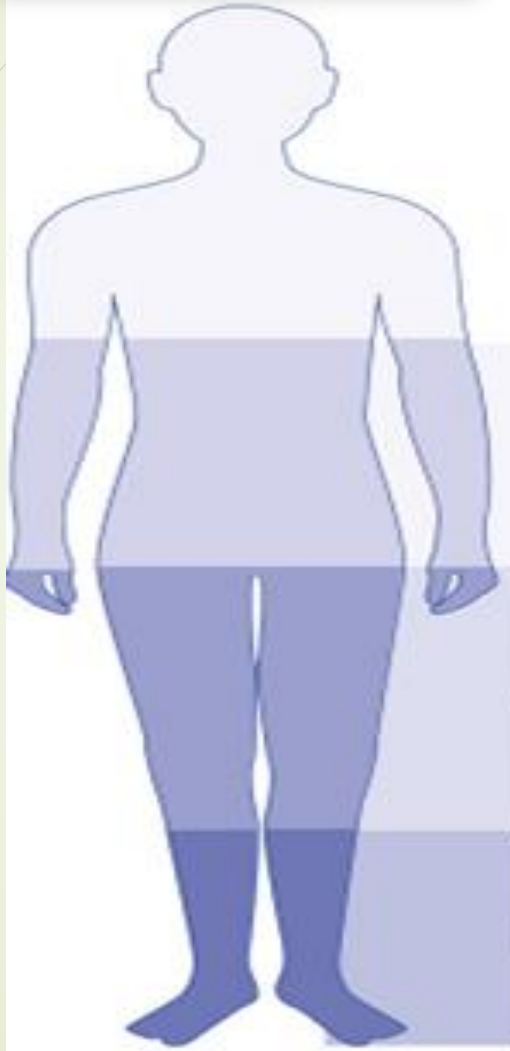
- **50% of body weight in woman**
- **60% of body weight in man**




Intracellular fluid (ICF)
2/3 of TBW
Interstitial fluid
3/4 of ECF
Extracellular fluid (ECF)
1/3 of TBW
Plasma (intravascular fluid)
1/4 of ECF

A 70 kg man

Intracellular Water (2/3)		Extracellular Water (1/3)	
		Interstitial (2/3)	Blood (1/3)
25	Na	140	
150	K	4.5	
15	Mg	1.2	
0.01	Ca	2.4	
2	Cl	100	
6	HCO_3	25	
50	Phos	1.2	



ICF= 2/3 TBW (28 L)

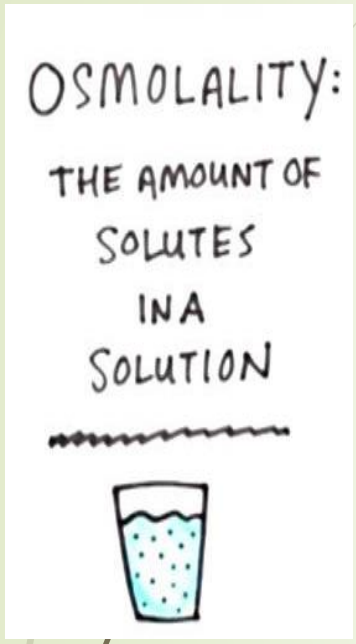
ISF= 3/4 ECF (10.5 L)

ECF= 1/3 TBW (14 L)

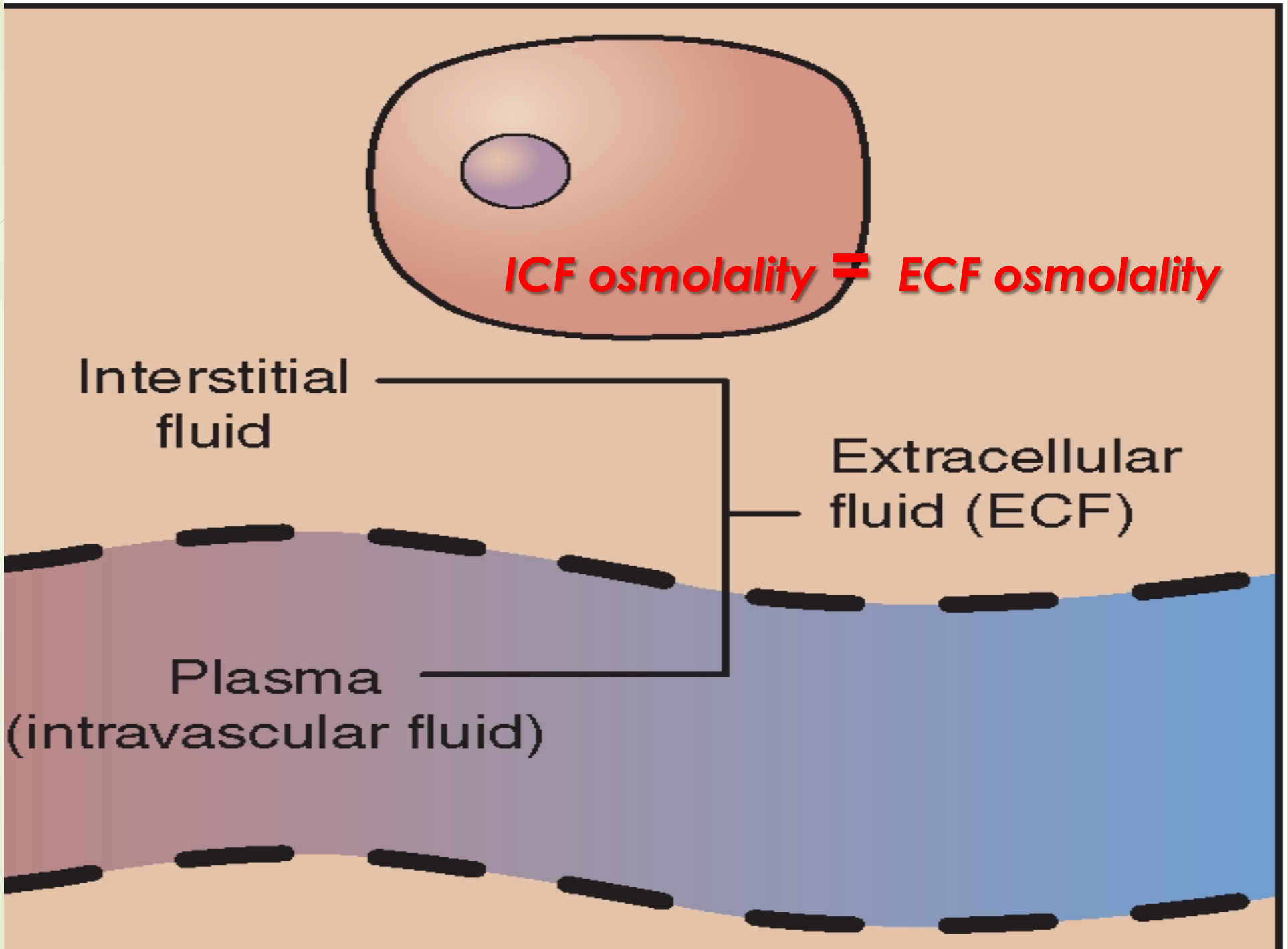
TWB= 60% weight (42 L)

IVF= 1/4 ECF (3.5 L)

- Osmolality?
- Osmolarity?
- Tonicity?



- **Osmolality=** TOTAL NO. OF SOLUTE PARTICLES PER **KG** OF A FLUID (**MOSM/KG**)
- **Osmolarity=** TOTAL NO. OF SOLUTE PARTICLES PER **LITER** OF A FLUID(**MOSM/L**)
- **Tonicity=** EFFECTIVE PLASMA OSMOLALITY


ICF osmolality = ECF osmolality
Interstitial fluid
Extracellular fluid (ECF)
Plasma (intravascular fluid)

Plasma osmolality

Unit of measurement?

$$milliosmol/kg$$

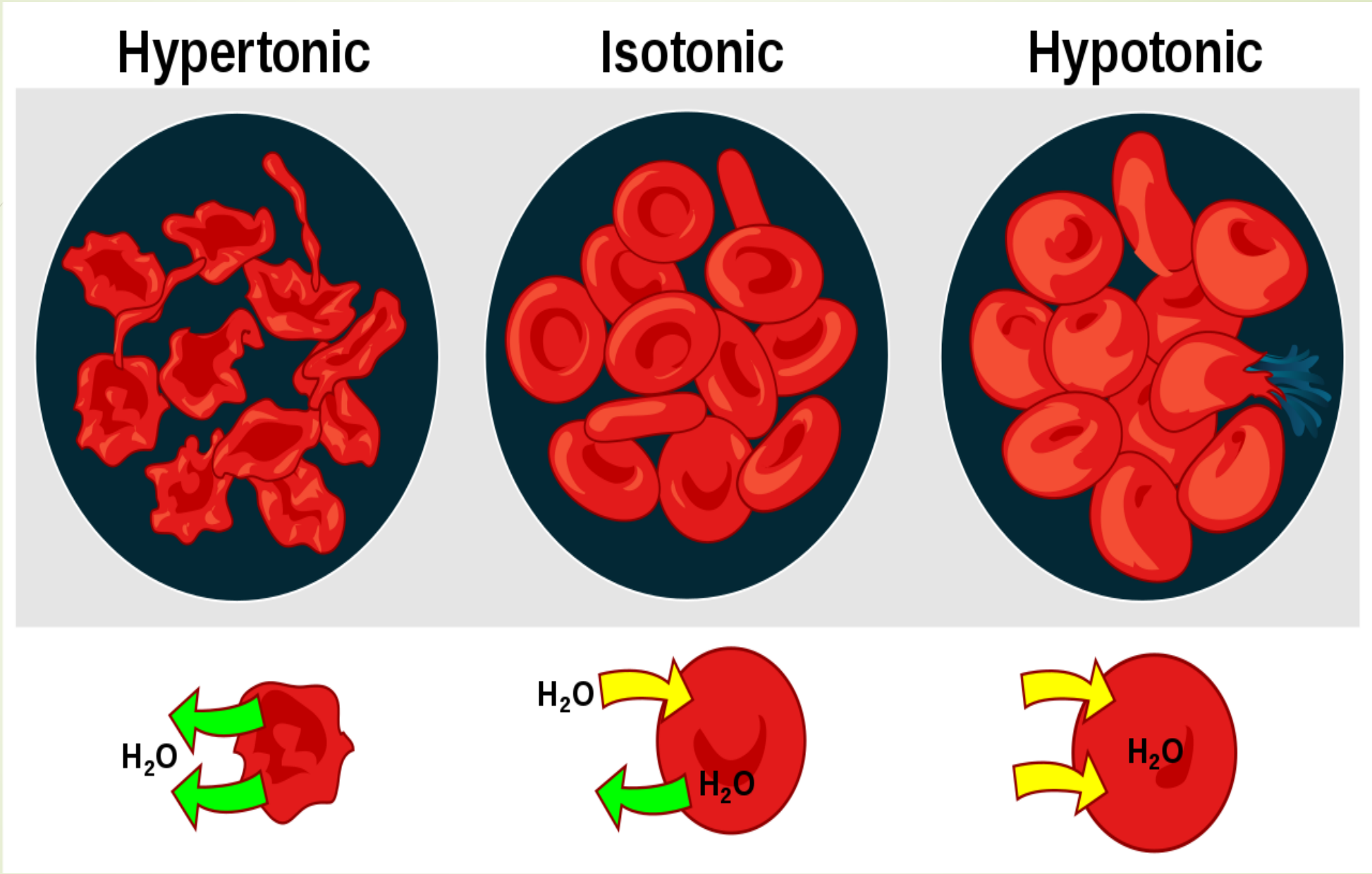
$$\textit{Plasma osmolality} = 2 \times Na + \frac{Glucose}{18} + \frac{BUN}{2.8}$$

The normal plasma osmolality is 280 to 295 mosmol/kg.

Effective Osmolality

- Solutes that are restricted to the ECF or the ICF determine the *effective osmolality* (or *tonicity*) of that compartment.

- Certain solutes, such as urea, do not contribute to water shift across cell membranes and are known as *ineffective osmoles*.

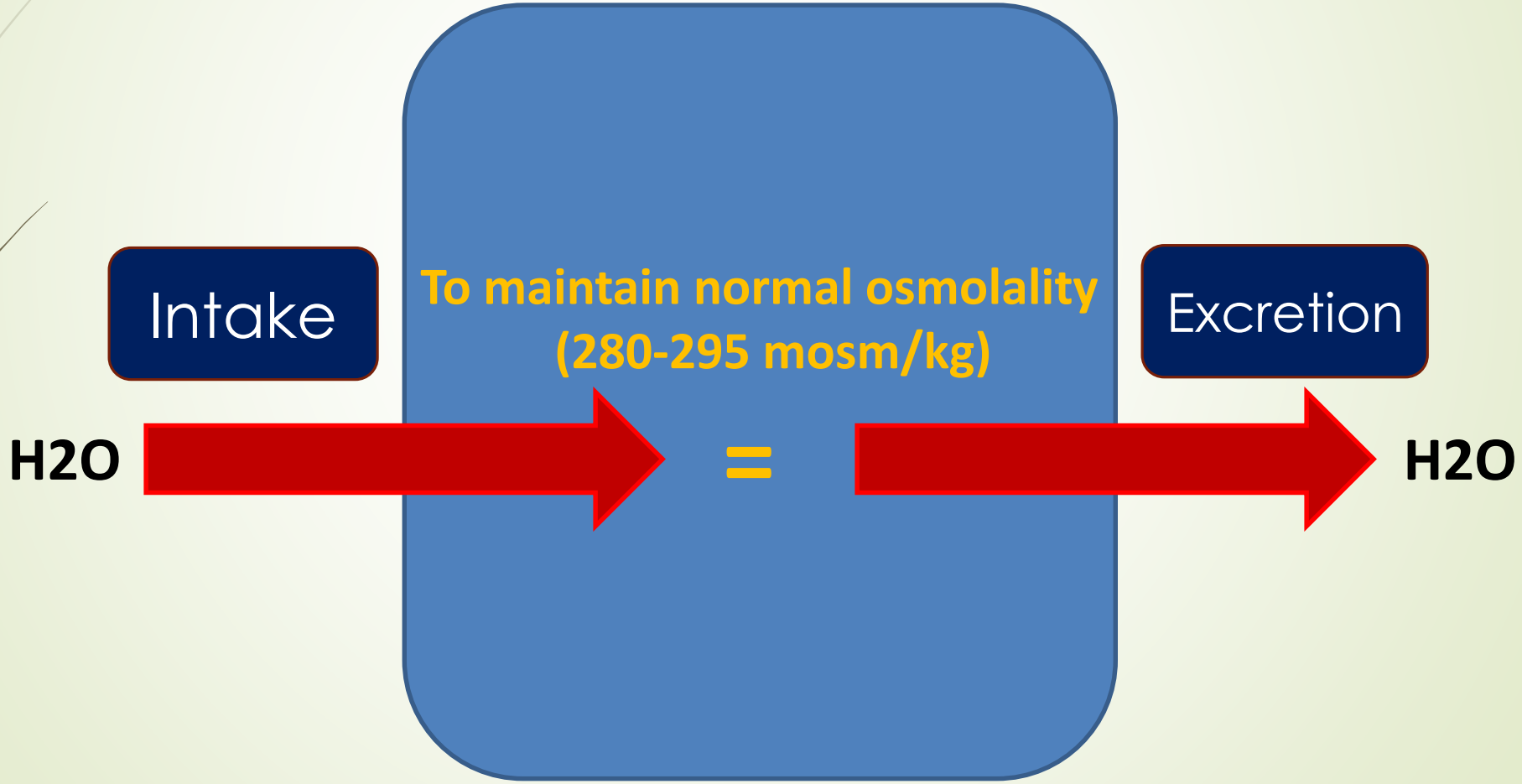

Hypertonic
Isotonic
Hypotonic
H_2O
H_2O
H_2O
H_2O

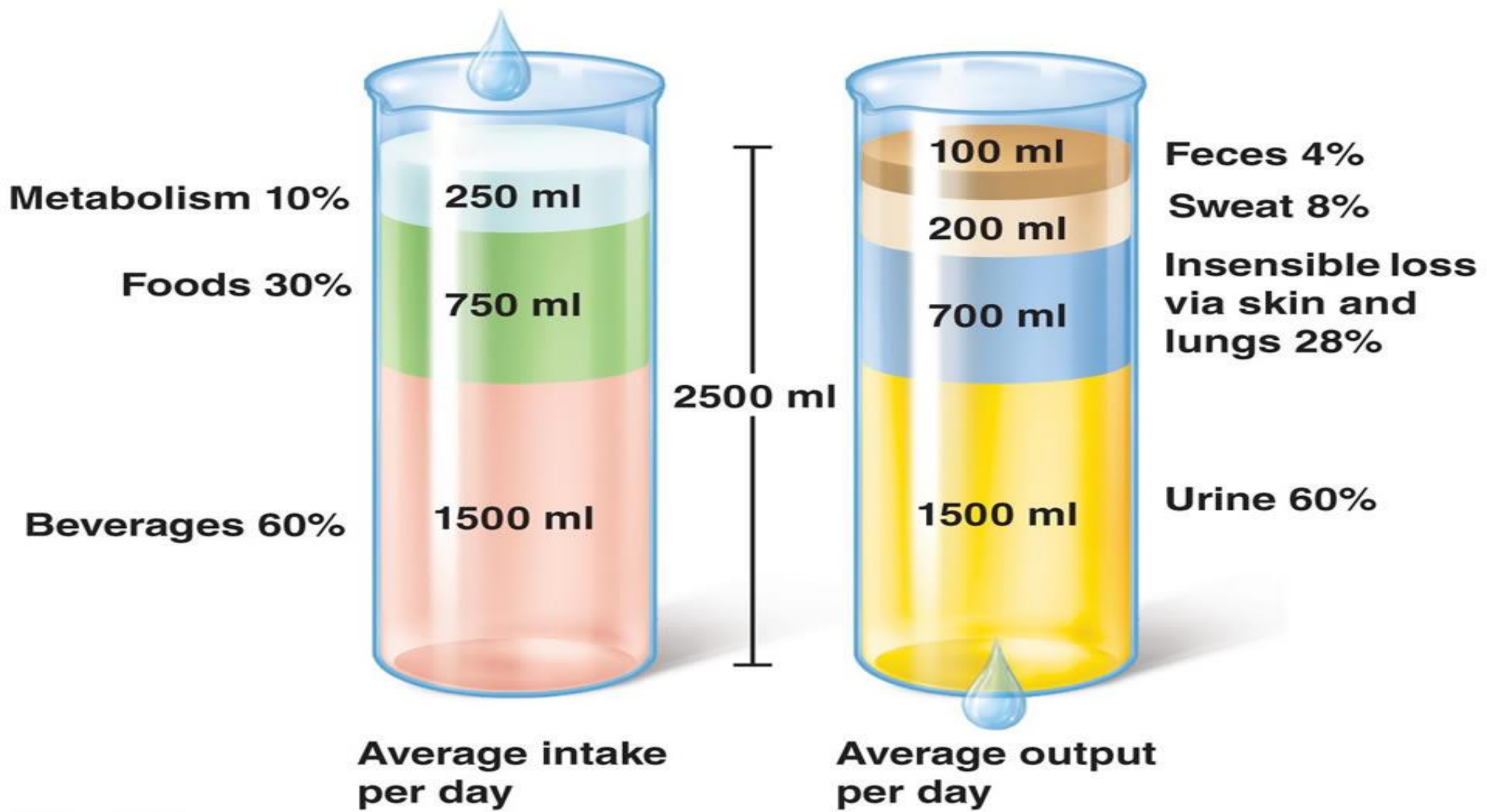

Water Balance

WATER BALANCE

- The normal plasma osmolality is 280–295 mosmol/kg and is kept within a narrow range by mechanisms capable of sensing a 1–2% change in tonicity.
- To maintain a steady state, water intake must equal water excretion.
- Disorders of water homeostasis result in hypo- or hypernatremia.

WATER BALANCE





Water Intake

- The primary stimulus for water ingestion is *thirst*, mediated either by an *increase in effective osmolality* or a *decrease in ECF volume or blood pressure.*

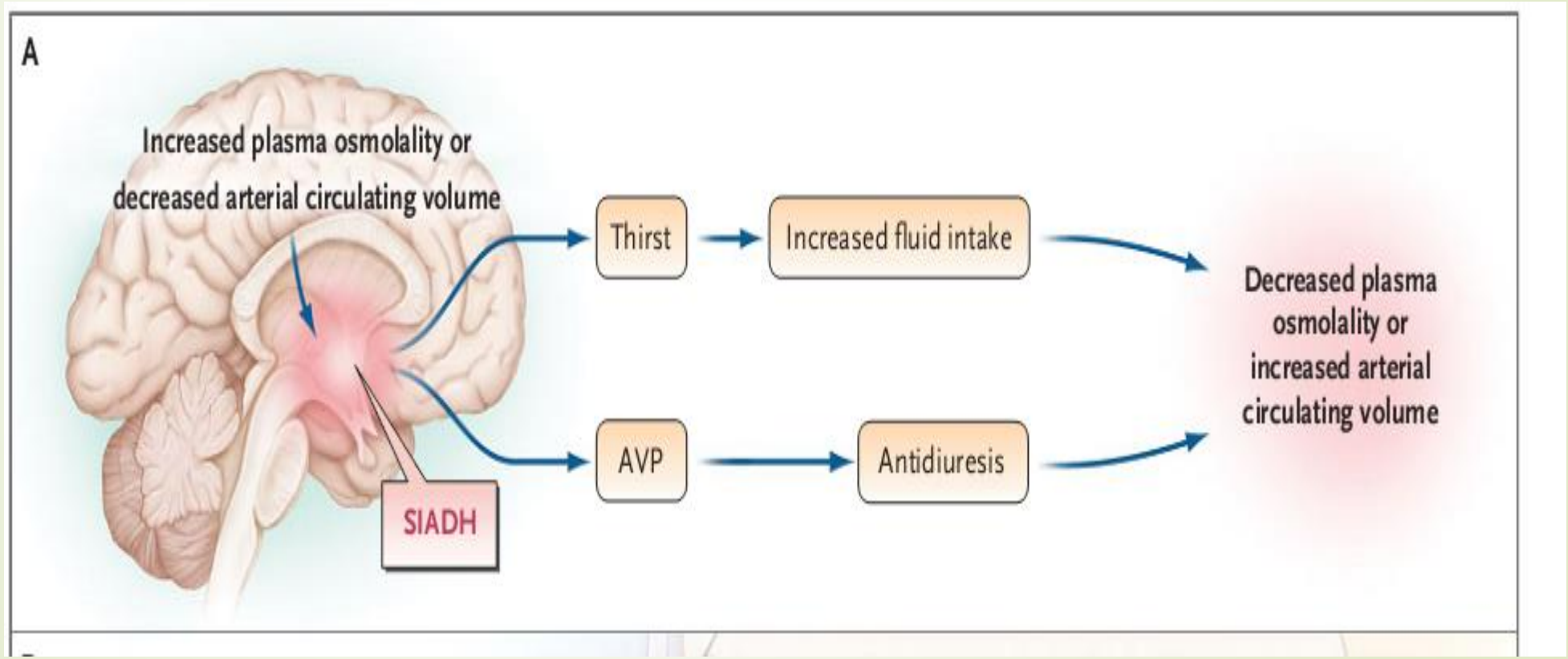
- *Osmoreceptors*, located in the anterolateral hypothalamus, are stimulated by a rise in tonicity.

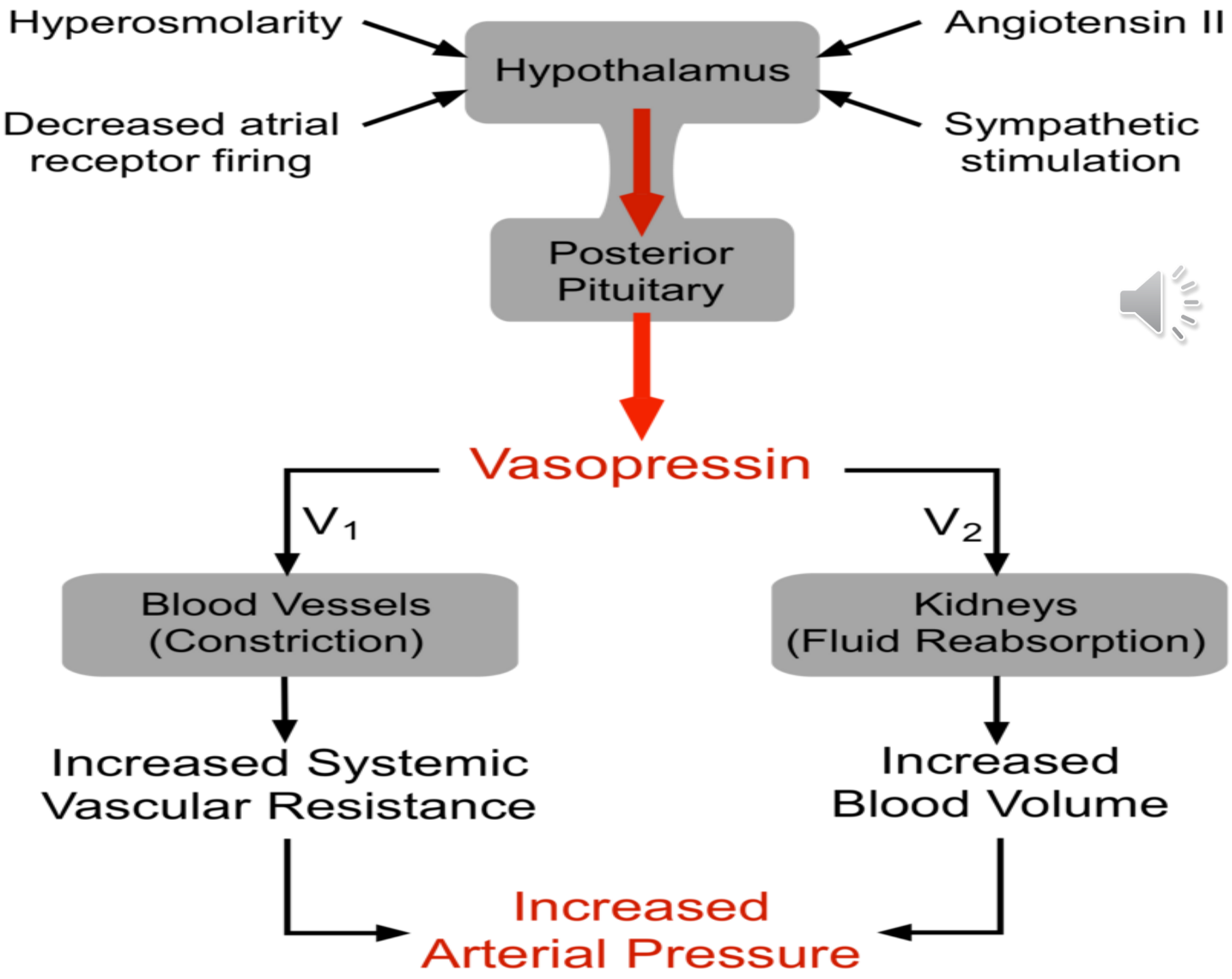
Water Intake

- Ineffective osmoles, such as urea, do not play a role in stimulating thirst.
- The average osmotic threshold for thirst is approximately 285 mosmol/kg and varies among individuals.

Water Excretion

- The principal determinant of renal water excretion is *arginine vasopressin* (**AVP**; formerly antidiuretic hormone=ADH).




Hyperosmolarity
Decreased atrial receptor firing
Hypothalamus
Angiotensin II
Sympathetic stimulation
Posterior Pituitary
Vasopressin
V1
V2
Blood Vessels (Constriction)
Kidneys (Fluid Reabsorption)
Increased Systemic Vascular Resistance
Increased Blood Volume
Increased Arterial Pressure

Stimulus for AVP secretion

- **Hypertonicity:**
  - The osmotic threshold for AVP release is 285 mosmol/kg, and the system is sufficiently sensitive that plasma osmolality varies by no more than 1–2%.
- **Nonosmotic factors :**
  - *Effective circulating (arterial) volume*
  - nausea, pain, stress, hypoglycemia, pregnancy, and numerous drugs.

- ECF (Extracellular fluid)

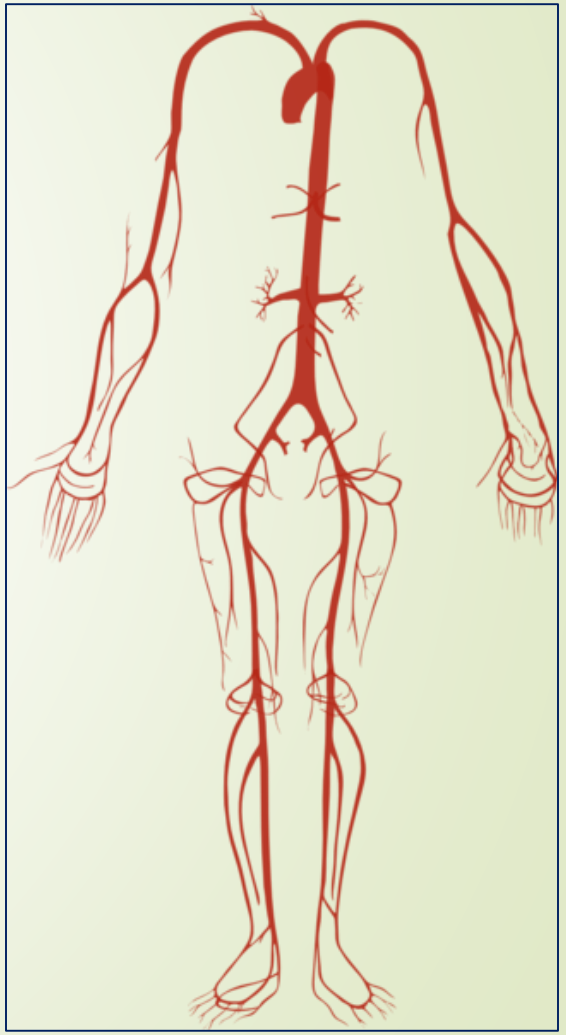
VS

- ECV (Effective circulating vol.)

?

Effective circulating volume

- Refers to that part of the extracellular fluid (ECF) that is in the arterial system and is effectively perfusing the tissues.

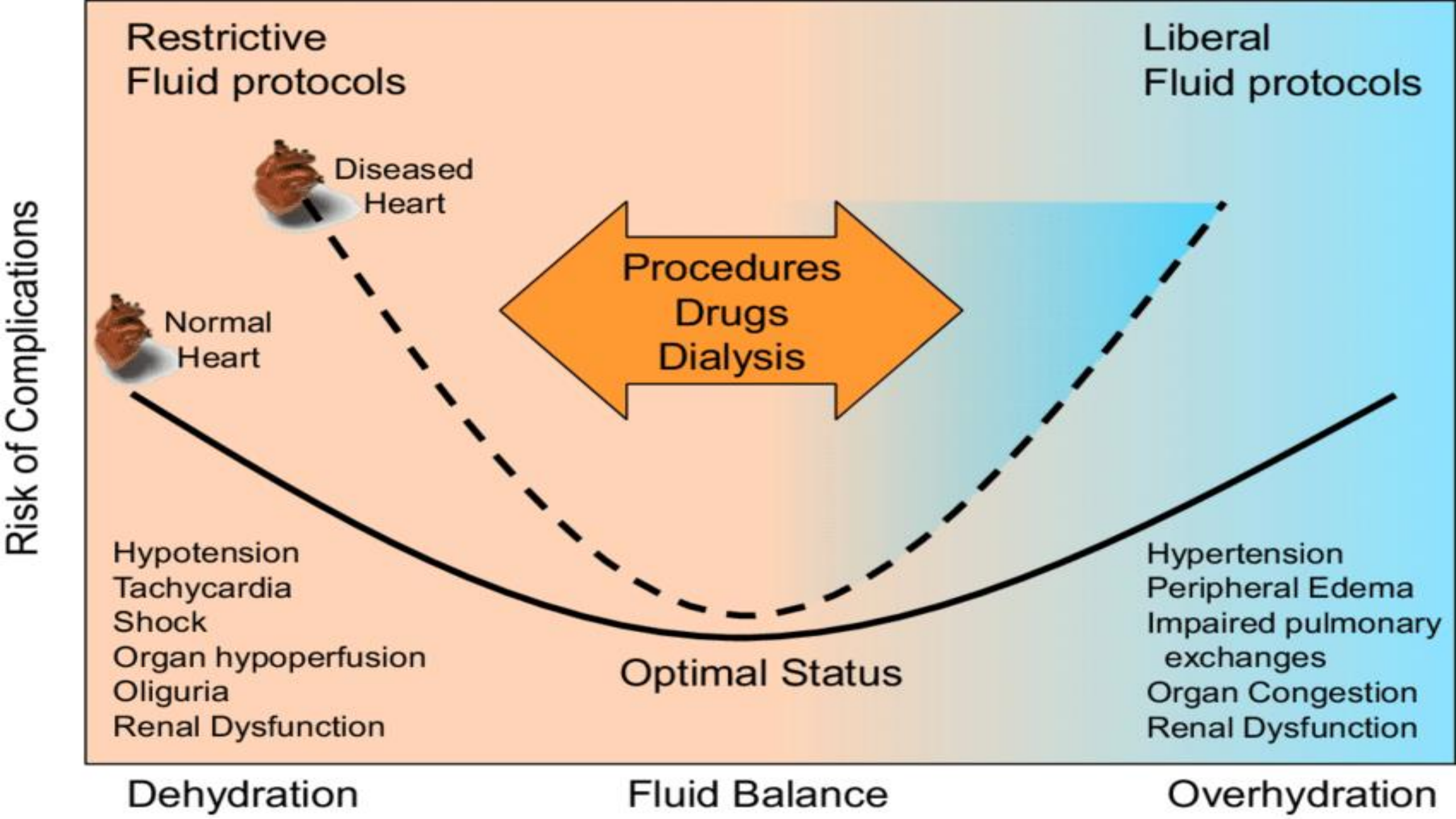


Potential independence of effective arterial blood volume from other hemodynamic measur

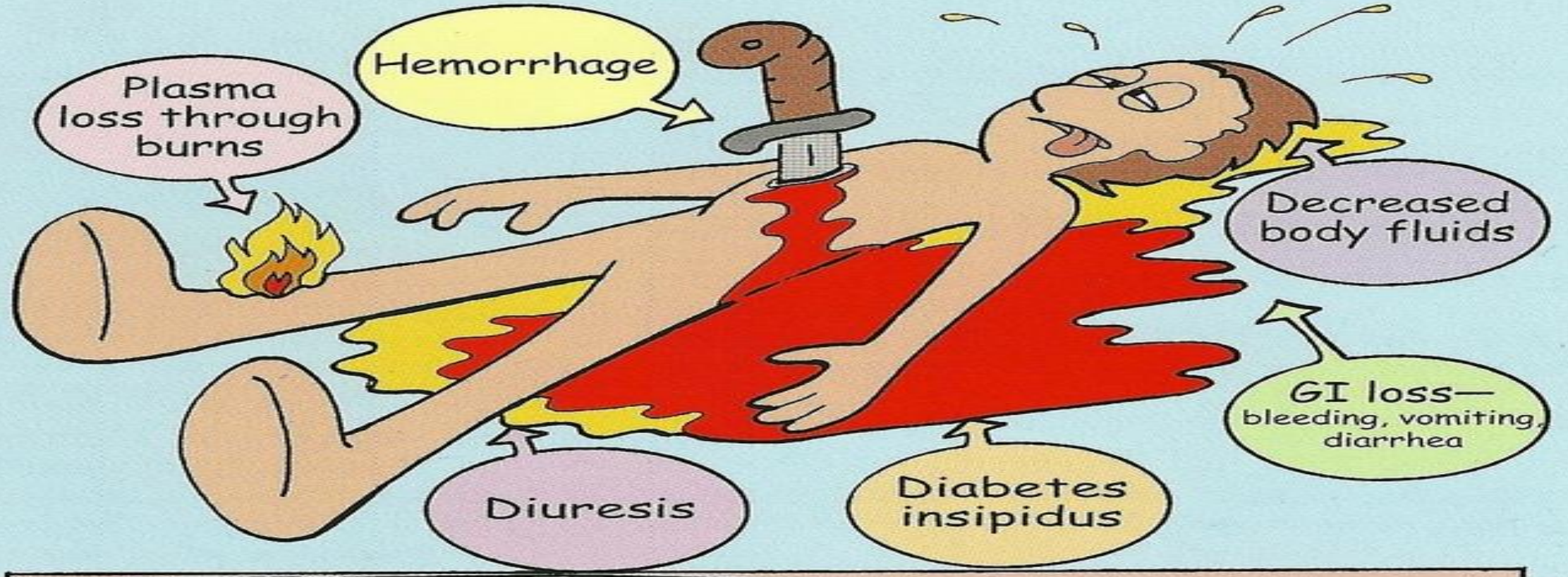
Clinical condition	Effective volume	Extracellular volume
True volume depletion	Decreased	Decreased
Heart failure	Decreased	Increased
Advanced cirrhosis	Decreased	Increased

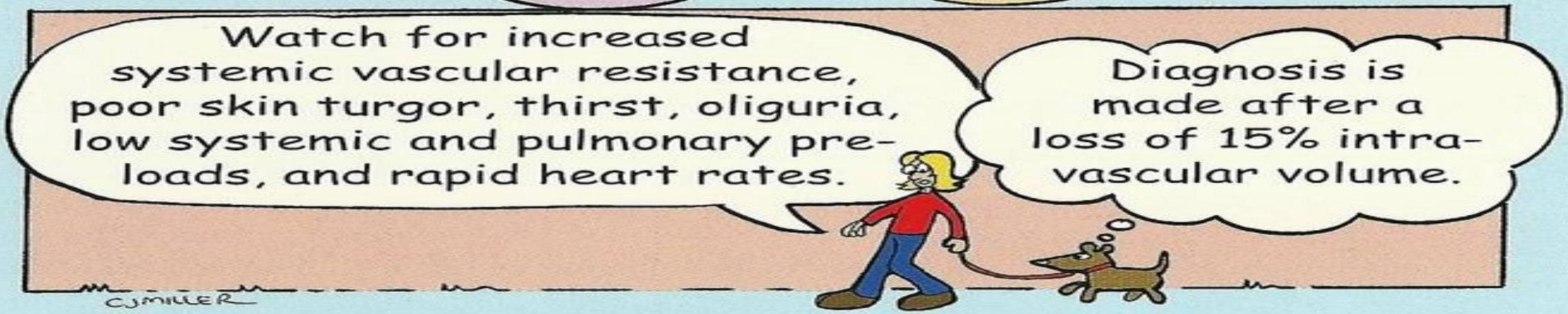
Abnormalities in plasma tonicity and the extracellular volume lead to the following four basic disorders of water and sodium balance:

- **Hyponatremia (too much water)**
- **Hypernatremia (too little water)**
- **Hypovolemia (too little sodium, the main extracellular solute)**
- **Edema (too much sodium with associated water retention)**


Restrictive
Fluid protocols
Liberal
Fluid protocols
Diseased
Heart
Normal
Heart
Procedures
Drugs
Dialysis
Hypotension
Tachycardia
Shock
Organ hypoperfusion
Oliguria
Renal Dysfunction
Optimal Status
Hypertension
Peripheral Edema
Impaired pulmonary
exchanges
Organ Congestion
Renal Dysfunction
Risk of Complications
Dehydration
Fluid Balance
Overhydration

HYPOVOLEMIC SHOCK





Hypovolemia ➨Etiology

➨Renal Causes:

Osmotic diuresis/Diuretics/Hypoaldosteronism/Tubulopathy/DI

➨Extrarenal Causes:

GI , Skin and Respiratory loss/Third space

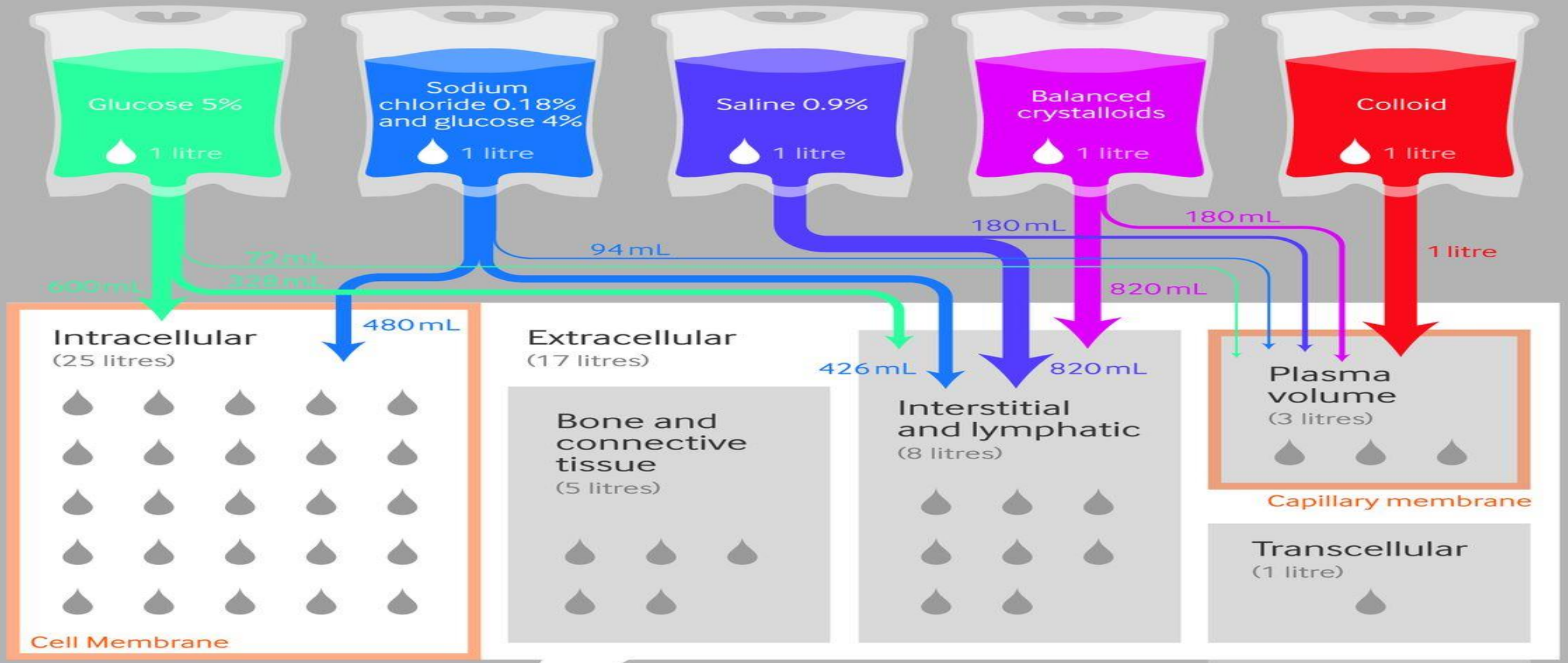
Hypovolemia

- **Evaluation:**
  - **History & P/E**: ↓ JVP/Orthostatic Tach. & Hypotension
  - **Lab:** ↑ BUN,Cr/Acid-base imbalance,……..
- **Rx**
  - Mild:Oral thrapy
  - Sever:Crystalloids(NaCl 0.9% , Ringer)

IV FLUIDS

	Fluid	pH	Osm	[Na+]	[Cl-]	[K+]	[Ca^{2+}]	[Mg^{2+}]	Dextrose	Other
	Human plasma	**7.35-7.45**	**275-295 mOsm/L**	**135-145 mEq/L**	**94-111 mEq/L**	**3.5-5.0 mEq/L**	**2.2-2.6 mg/dL**	**0.8-1.0 mg/dL**	**60-100 mg/dL**	**1-2 mEq/L lactate**
Crystalloid	Normal Saline	4.5-7	308	154	154					
	Lactated Ringer's	6-7.5	280	130	109	4	1.35			29 mEq/L lactate
	1/2 NS	5	154	77	77					
	D5-1/2 NS	3.5-6.5	406	77	77				5 g/dL	
	Plasma-lyte ($$$)	4-6.5	294	140	98	5		1.5		23 mEq/L gluconate 27 mEq/L acetate
H2O	D5W	3.5-6.5	252						5 g/dL	Used in hyperNa (see *Sodium Disorders*)

Theoretical distribution of intravenous fluids on infusion

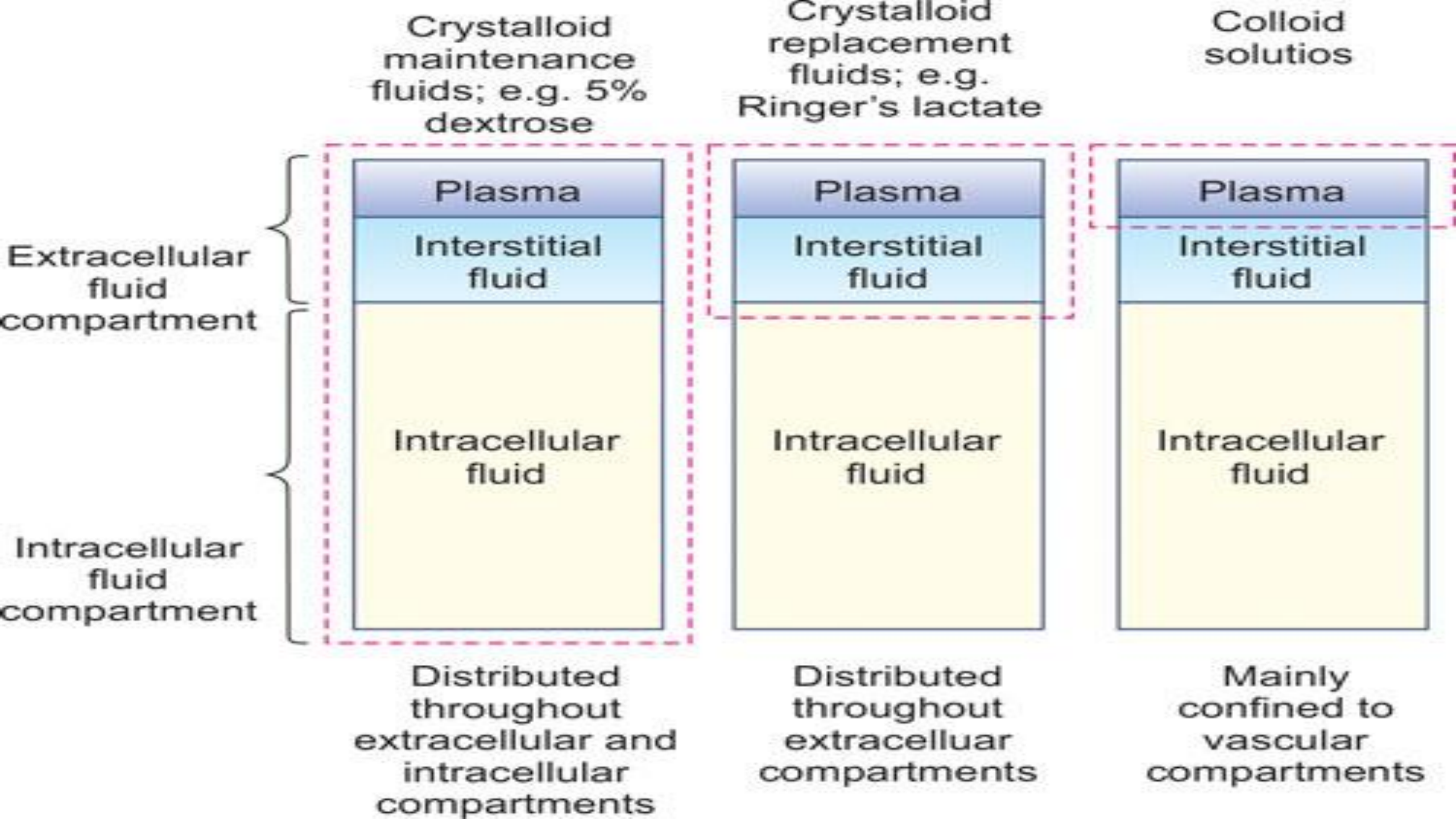


70 kg man
42 litres total body water

💧 = 1 litre

Electrolyte composition of some transcellular fluids (mmol/L)

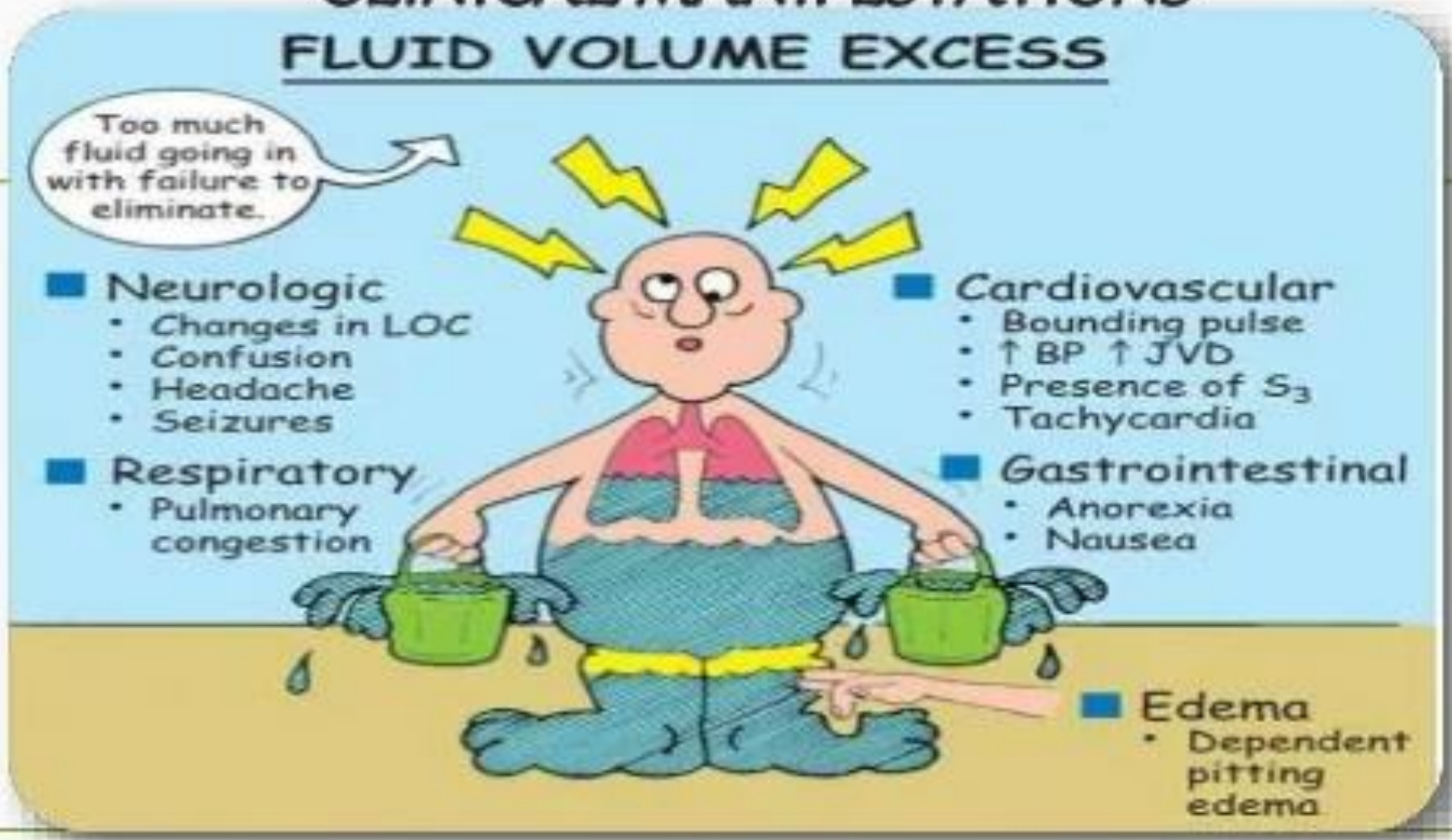
Fluid	Na^+	K^+	Cl^-	HCO^{3-}
Sweat	65	8	39	16
Gastric	20—100	5—10	120—160	0
Bile	150	5—10	40—80	20—40
Ileal	140	5	105	40


Crystalloid maintenance fluids; e.g. 5% dextrose
Crystalloid replacement fluids; e.g. Ringer's lactate
Colloid solutios
Plasma
Interstitial fluid
Intracellular fluid
Plasma
Interstitial fluid
Intracellular fluid
Plasma
Interstitial fluid
Intracellular fluid
Extracellular fluid compartment
Intracellular fluid compartment
Distributed throughout extracellular and intracellular compartments
Distributed throughout extracelluar compartments
Mainly confined to vascular compartments

Volume overload

CLINICAL MANIFESTATIONS

FLUID VOLUME EXCESS



How do we manage fluid therapy ?

Review Article

Fluid Therapy: Double-Edged Sword during Critical Care?

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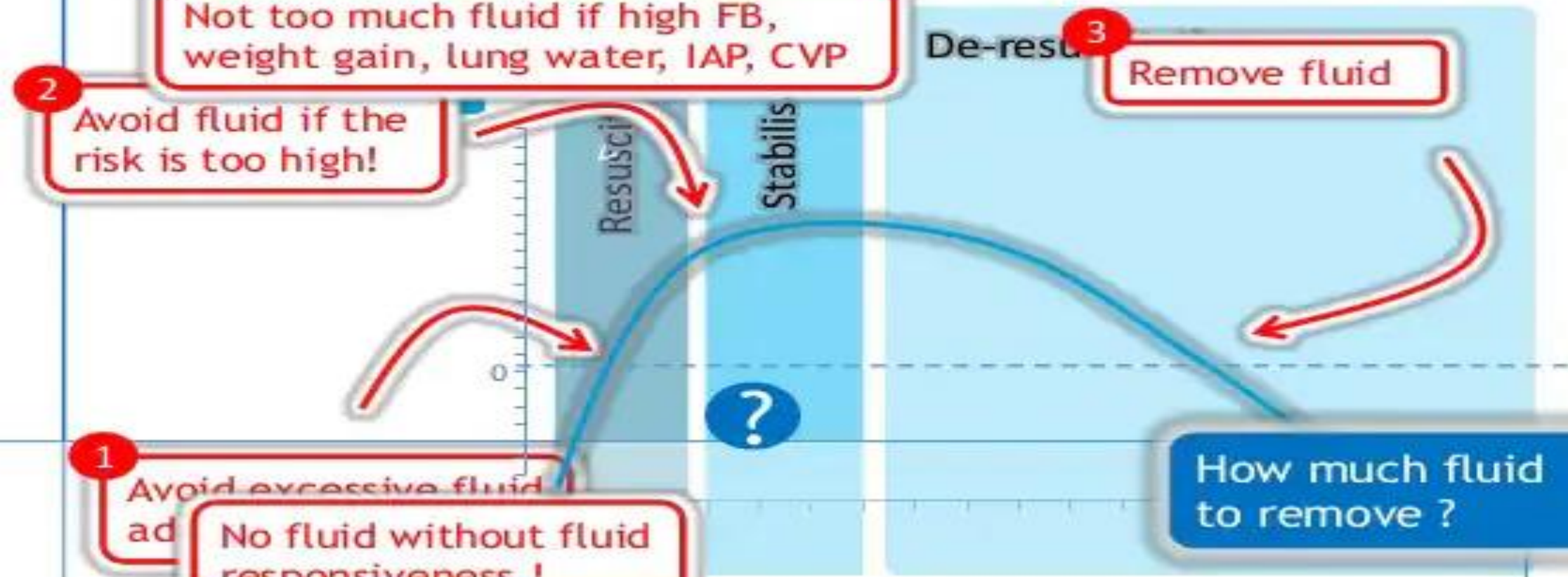
Jan Benes,[1] Mikhail Kirov,[2] Vsevolod Kuzkov,[2] Mitja Lainscak,[3,4] Zsolt Molnar,[5] Gorazd Voga,[6] and Xavier Monnet[7]

How do we reduce fluid overload ?

Not too much fluid if high FB, weight gain, lung water, IAP, CVP

2 Avoid fluid if the risk is too high!

3 Remove fluid



1 Avoid excessive fluid ad

No fluid without fluid responsiveness !

How much fluid to remove ?