Final Med

Fluids and Electrolytes

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Overview

Fluids and electrolytes are very interesting

- Common important treatment of patients in hospital
- Common job for intern
- Common question for examiners to ask students

Fluids and electrolytes

- Milieu Interieur
- Normal volumes, fluid compartments
- Normal compositions
- Volume of secretions into the gastrointestinal tract
- Composition of secretions into the gastrointestinal tract
- Clinical assessement of fluid status
- Types of fluids available for administration
- Normal fluid and electrolyte requirements

Milieu Interieur. . . Amoeba

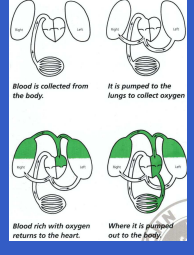
Simple unicellular organism in sea

- Nutritional needs supplied
- Waste products removed

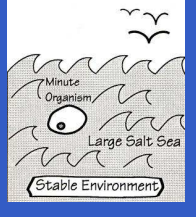
Milieu Interieur. . . Humans

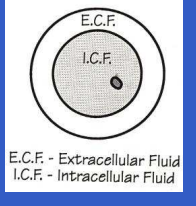
Complex multicellular organism

- Needs circulatory system
- Needs special organs

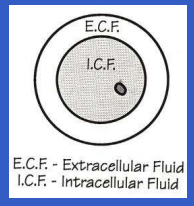


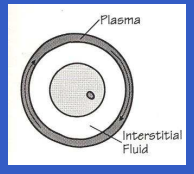
Fluid compartments . . . Amoeba



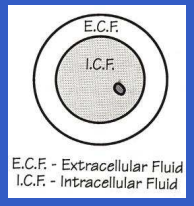


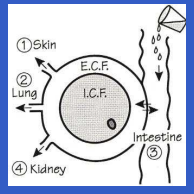
Fluid compartments . . . Humans





Fluid compartments . . . In-Out

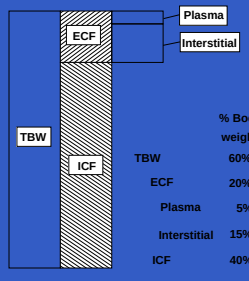




Fluid compartments

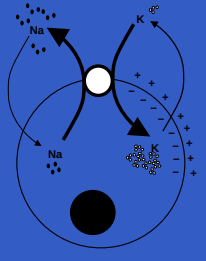
$$70 \times 0.6 = 42\,Litres \ldots Total\ body\ water$$
$$42 \times 0.66 = 28\,Litres \ldots ICF$$
$$42 - 28 = 14\,Litres \ldots ECF$$
$$14 \times 0.25 = 3.5\,Litres \ldots Plasma$$

Normal volumes



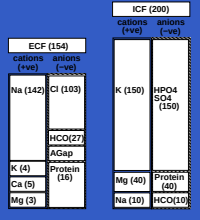
	% Body weight	70 Kg adult
TBW	60%	42 L
ECF	20%	14 L
Plasma	5%	3.5 L
Interstitial	15%	10.5 L
ICF	40%	28 L

The pump



- Na out K in
- ATP dependent
- Gradient of 140 mmol
- K leaks out faster than Na leaks in

Normal composition

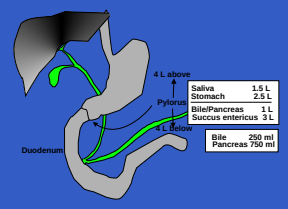


- Anode is positive
- Anions go to the anode
- Negative ions are anions
- Positive balanced by negative

Anion gap: sodium - (chloride + bicarbonate)

- Unmeasured anion contribution of phosphate and sulphate
- Calculated as sodium - (chloride + bicarbonate)
- If AG is increased - more acid in blood
- If normal then - bicarbonate loss, renal tubule dysfunction or acid loading

Secretions into GI tract

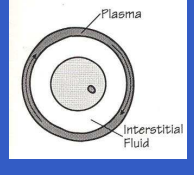


- 4 L above 4 L below
- Spit is 1.5 L
- Succus enterius is 3 L
- Bile 250 ml

Composition of GI secretions

	Plasma	Saliva	Stomach	Pancreas	Bile
Na^+	140	10	**60**	140	145
K^+	4	**26**	10	5	5
Cl^-	110	10	130	75	100
HCO_3^-	30	30	**0**	**115**	**35**

Clinical assessment of fluid status



- Body water up or down
- Which compartments
- Changes in ICF hardest to detect (hidden by the ECF)
- In ECF changes in plasma easier to detect than changes in interstitium

Symptoms of low body water

- Thirst
- Confusion
- Altered level of conciousness

Signs of low body water

- Dry mucous membranes
- Decreased skin elasticity
- Decreased intraocular pressure
- Cardiovascular decompenstation

Dehydration

Symptom or sign	Deficit	Volume (70Kg man)
Thirst	3%	1.5 L
Dry Mucosae	5%	2 L
Decreased skin elasticity	8%	3.5 L
Fall in intraocular pressure	10%	4.5 L
Tachycardia Hypotension	$>$ 15 %	6.5 L

Changes in plasma volume

Forward compartment

- Pulse (ECG)
- Blood pressure (Arterial Line)
- Tissue perfusion (Urinary output, ABG)

Backward compartment

- Change in venous pressure (CVP)

ATLS Classes of Haemmorhage

	Class I	Class II	Class III	Class IV
Blood loss (ml)	Up to 750	750-1500	1500-2000	$>$2000
Blood loss (% blood volume)	Up to 15%	15-30%	30-40%	$>$40%
Pulse Rate (beats per minute)	$<$100	$>$100	$>$120	$>$140
Blood Pressure	Normal	Normal	Decreased	Decreased
Pulse Pressure	Normal or ↑	Decreased	Decreased	Decreased
Respiratory Rate (breaths per minute)	14–20	20–30	30–40	$>$35
Urine Output (ml/hr)	$>$30	20–30	5–15	Negligible
CNS/Mental Status	Slightly anxious	Mildly anxious	Anxious confused	Confused, lethargic
Fluid Replacement (3:1 rule)	Crystalloid	Crystalloid	Crystalloid and blood	Crystalloid and blood

Changes in interstitium

- Expansion - oedema (check dependent part, ausculatate lungs, CXR)
- Contraction - dry mucosae, decreased skin elasticity, decreased intra-ocular pressure

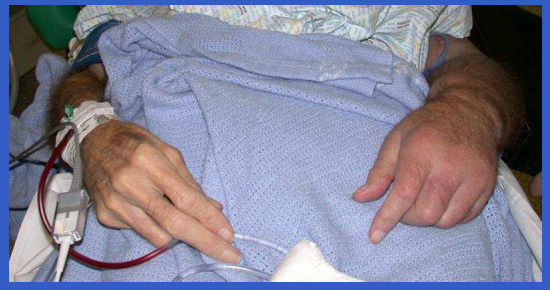
Changes in ICF

- Difficult to assess
- Brain is main organ affected
- Headaches and confusion due to contraction or expansion of ICF
- Expansion dangerous due to limited space in skull
- Contraction dangerous as it may cause bleeding

Examine patients fluid status

- History - thirst, losses, confusion
- Examination - pulse, blood pressure, central venous pressure, mucosae, skin elasticity, intraocular pressure, gallop rhythm, mitral incompetence, cardiomegally, fine bibasal creps, oedema of dependent parts
- Inspect input - output chart, weights

Oedema



Fluids available for therapy

- Crystalloids
- Colloids

- Crystalloids are in solution
- Colloids are in suspension
- Tindel effect

Crystalloids

Name	Na^+	K^+	Cl^-	HCO_3^-	Ca^{2+}	Glucose
Normal Saline	150	0	150	0	0	0
Hartman's	131	5	111	29	2	0
Dextrose Saline	30	0	30	0	0	43 g/L
Dextrose 5%	0	0	0	0	0	50 g/L

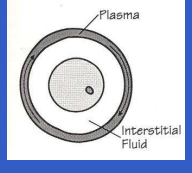
Colloids in common use

- Gelofusin
- Whole blood
- Packed red blood cells
- Fresh frozen plasma

Why these fluids?

- Must not be toxic
- Must not cause haemolysis (to much water)
- Must not damage vein too much (too little water)

Where do the fluids go?



- Colloids into plasma
- Saline and Hartmans into ECF
- Dextrose 5% into total body water

Normal volume requirements - Holliday-Segar regimen

Volume of fluid (ml) /(kg body weight) per hour	
Up to 10 kg	4 mls/kg
From 10 – 20 kg	2 mls/kg
In excess of 20 kg	1 ml/kg for every kg after

$$10\,kg\,@4\,mls/kg = 40\,ml/hr$$
$$10\,kg@2\,mls/kg = 20\,ml/hr$$
$$50\,kg@1\,ml/kg = 50\,ml/hr$$

Normal volume requirements - alternative

35 ml per kg per day

Electrolyte requirements

Sodium (Na^+)	1 mmol/kg/24 hours
Potassium (K^+)	0.5 mmol/kg/24hours

Normal fluid and volume requirements

- 3 litre H_2O / 24 hr
- 80-100 mmol Na^+ / 24hr
- 60 mmol K^+ / 24hr

eg. 1L Soln 18 with 20mmol K^+over 8 hours (repeat times 3)

Fluid prescription

- Existing deficit (Based upon your clinical assessment)
- Maintenance (See above)
- Ongoing loss, (Fluid for fluid, eg NaCl 0.9% for NG loss)

Monitor clinical status, weight, input output and urea and electrolytes