

## Body fluids 2

### ❖ Key points :

- Severe bleeding
- IV fluids
- Body fluid compartments
- Effects of isotonic, hypotonic and hypertonic solutions on body fluids
- When to use isotonic, hypotonic and hypertonic solutions
- How to measure body fluids

**Note: the arrangement of information in this sheet is not exactly equivalent to its arrangement in the record.**

### ❖ Abbreviations :

- Bp :blood pressure
- Rxn :reaction
- Iv :intravenous
- Ivf :in vitro fertilization
- Ic :intracellular
- Ec :extracellular
- Mosm: milliosmolar
- RTA: road traffic accident

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### ❖ What should we do in severe bleeding cases?

-definitely, the patient needs blood to replace the lost one and it is the best substituent, because nothing is better than blood donation to replace the lost blood.

-but there are some points about blood we should take into consideration:

- I. Blood donation takes 15-30 minutes even in good hands to fully matched (cross matching).

❖ Dedications: bayram :)

II. Before you give blood to the patient you should be 100% sure that the patient will not get sick due to allergic rxns.

III. We conclude from the previous two points that blood donation takes a lot of time, meanwhile there are patients who cannot wait “they will die”

❖ **So, what should we do to save our patient’s life?**

-instead of blood we use other fluids until blood gets ready to be used from the lab so that you can give it to the patient.

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❖ **Clinical case 1: female who is delivering**

-nowadays the Ivf is very common and many couples get Ivf.

-woman gets pregnant with more than one fetus, so the uterus is huge and when she delivers the uterus fails to contract to stop bleeding. Therefore she might suffer l life threatening bleeding.

-fractures and injuries may occur and cause severe bleeding; also things may go wrong during the operation.

-We cannot control bleeding so you should act properly as mentioned previously in severe bleeding cases.

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## IV fluids

1. Crystalloids.
2. Colloids.
3. Blood products.

**-1) crystalloids:**

- The most commonly used in many hospitals and 95%-98% of patients are having it.

- They include three major types:

- a) Normal saline ("saline" a Latin word means "salt"): 0.9% NaCl, we give it in fluids-loss cases such as diarrhea and vomiting.
- b) Dextrose/glucose 5%: we give it to hungry patients

❖ Common features between a and b:

- Isotonic/isoosmotic
- safe and sterile
- both make no shifting of water from one compartment to another.
- most used IV fluids.
- The most common two types used all over the globe.

c) Hartmann solution (sodium lactate):

- contains many ions which are similar to those in body fluids.
- Not anyone uses it because it has some limitations and side effects, it contains lactate and acids, as well as, it is expensive.
- Be careful where to give it and to which person you give it!
- This type usually the surgeon loves it.

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## -2) Colloids:

- they are gelatinous materials that are called dextran.
- large protienous materials & mwt is (40-70) thousands that's why there are large.
- the fastest (life saving situations).
- they set in the vascular system and suck water to expand the volume of blood.

#dedications: mamoun :)

-the negative point of colloids that they make allergic rxns to certain sensitive people.

❖ **Clinical case 2:**

-if you have a patient who is severely bleeding to the extent and crystalloids need 5-10 minutes to work, so what do you use to elevate Bp?

-we use colloids.

❖ **Clinical case 3:**

-if your patient's Bp starts dropping 80 70 ~~60~~ ~~50~~ .....and you immediately gave him/her colloid then you expect Bp to rise but unexpectedly it drops to zero. Something went wrong what is it?

- At that time you should know that the patient started getting allergic rxns.

-signs of allergic rxns: severe vasodilatation, Bp goes to zero and you might lose the patient. Therefore, we only give colloids (dextran, gellatin) in hospitals and under direct supervision.

Dedications: zo3bi 😊

**-3) blood components:**

- we either give whole blood sample after matching it making sure that all subgroups are matching directly, or we give only some of blood components such as platelets, RBCs, WBCs and plasma.

-sometimes we give fresh frozen plasma after thawing it.

-a patient comes with diarrhea, vomiting, low BP and hypotension so you give him/her IV fluid after 5 minutes Bp rises he/she becomes good.

❖ How to prepare 1 L of normal saline solution?

❖ 0.9% NaCl

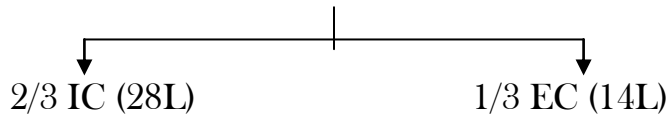
$$\begin{array}{l} 0.9 \text{ ————— } 100 \text{ ml} \\ X \text{ ————— } 1000 \text{ ml (1L)} \end{array}$$

X=9 grams we should dissolve in 1L of water.

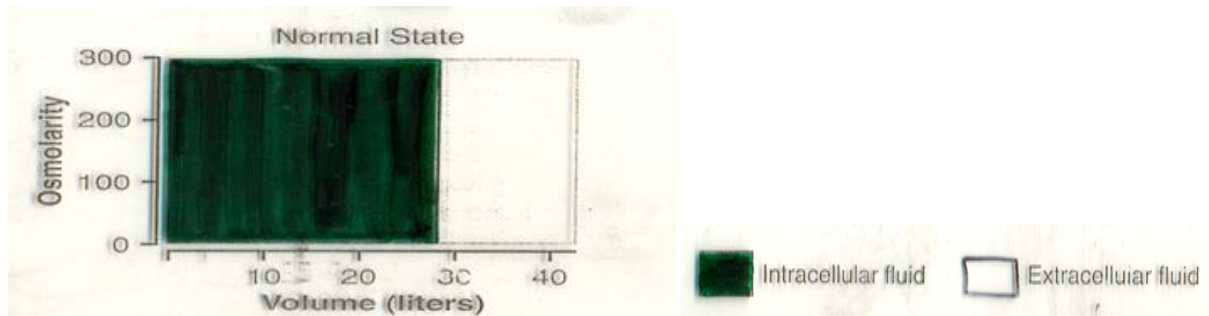
- We have two ways of measuring the fluids that we give to the patient either with Osmoles or with Percentage.

❖ Body fluid compartments of a 70 kg person:

60% of body weight is fluid



-Normal osmolarity of the body is approximately 300 mosm



❖ What will happen if we give the patient:

- 1) Normal saline (isotonic)?
- 2) Hypotonic solution?
- 3) Hypertonic solution?

1) Isotonic solution:

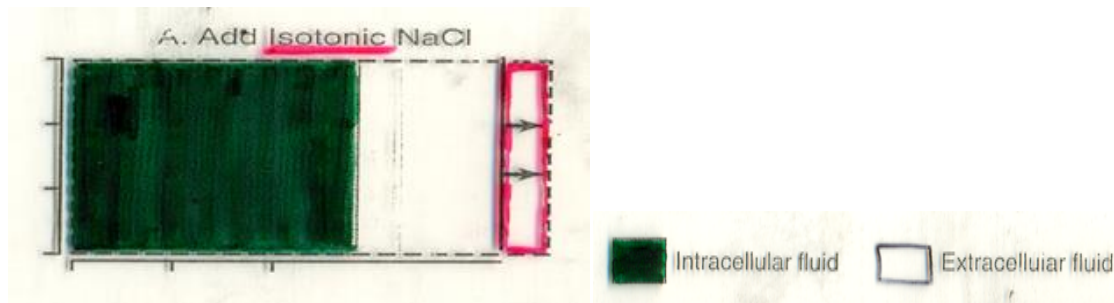
-Normal saline doesn't affect the osmolarity, because it contains salts that are similar to the body compartments salts.

Dedications: harith 😊

-Bp increases as the body fluid volume increases and this is the ultimate goal of normal saline.

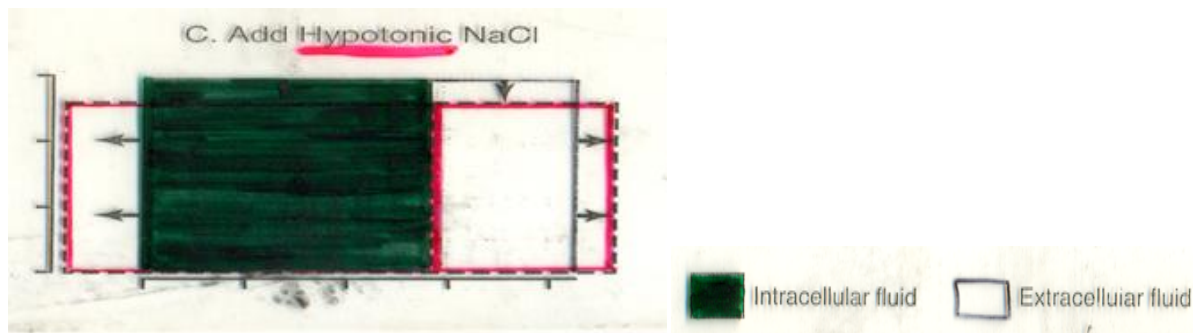
#Note: isotonic solutions are the best choice to raise Bp without disturbing body compartments. It is the most common fluid used when the patient loses fluids.

In this pic: Expansion to the extracellular compartment and no change in osmolartiy.



## 2) Hypotonic solutions:

- we are giving the patient water more than the salt so the water will go from the EC to IC so there will be expansion of the volume of the IC compartment and expansion of the volume of EC compartment at the expense of osmolarity which will decrease in both compartments as a dilution happens.



## 3) Hypertonic solutions:

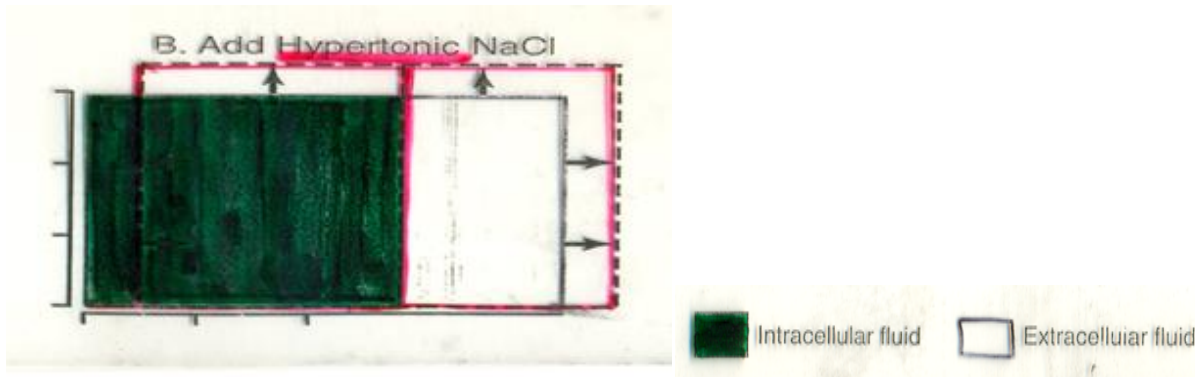
Dedications: issa 😊

- We are adding salts more than water so water will be sucked from the cells to EC to dilute everything {explanation: that is due to osmosis of free water molecules down their concentration gradient from IC to EC}.

-Due to the previous point IC volume will decrease but EC volume will increase.

-Osmolarity will increase in both compartments.

-We use hypertonic solutions to suck water in swelling (edema) cases.



#Notes:-As physicians we cannot play directly with IC compartment.

-We can affect EC compartment especially plasma where we give IV fluids.

#summary:

Solution	Volume	Osmolarity
Isotonic	+ EC	No effect
Hypotonic	+ in IC & EC	- in IC & EC
Hypertonic	- IC/+EC	+ in IC & EC

Dedications: khreisat  
😊

- Do we have any cases that we need to give the patient otherwise solutions than isotonic solution?

In life threatening cases when the patient is between life and death such

❖ **Clinical case 4:**

-if you hit your arm with a hard object or an insect stung you there will be swelling but it is not dangerous because there is enough space.

-If a patient suffers from a head injury due to sport or car accidents (RTA), what will happen? -The brain is very soft so when it hits the skull or there was a direct injury to the brain it starts swelling.

#Note: sutures (fibrous joints in the skull) close at 18 months of age, and we are left with only 10% space to the brain to expand. The same thing is applicable to the vertebral column.

#Study: scientists found that only 10% of brain damage is caused by direct trauma and 90% is due to cerebral edema, because when neurons swell they will block blood vessels by hypoxia/anoxia as a result there will be cell death and it is known that neurons never recover after death.

❖ **In some cases of cerebral edema the patient is between life and death, bleeding occurs in the brain (so-called space occupying lesion):**

-If you give the patient normal saline and hydrate him, the brain stem will immediately enter the vertebral column and presses on respiratory and cardiovascular centers, the patient will **DIE IN FRONT OF YOUR EYES.**

-What is the best indication in this case?

-Answer: we give him/her hypertonic solution to suck water from neurons then send it leave it to the vascular system to go the kidneys to be secreted.

#Notes: - this indication disturbs homeostasis **BUT** it is a life or death situation.

-maximum limit of osmolarity (as a medication) is 320 mosm which is abnormal but to save the life of patient.



**❖ Examples of hypertonic solutions:**

- Mannitol: alcoholic derivative of sugar that is usually with large molecules that tends to suck water. According to body weight and the condition of the patient we give the dose every 4-6 hours, and immediately the patient will open his/her eyes provided that the consciousness area is not damaged.

- Hypertonic saline solutions: - 2%....20 gram nacl in 1 L.

- 3%....30 gram nacl in 1 L

-7.5%....75 gram nacl in 1 L.

-10%.....100 gram nacl in 1 L.

-diuretics (مدر بول)

-Corticosteroids: hormone released from the cortex of the adrenal gland.

# They prevent swelling by sucking water from cells.

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**❖ Clinical case 4:**

-Sometimes cerebral edema is so huge so that we open a burr hole on the sides of the skull if it is not effective we use partial craniotomy in which we elevate the skull to let the brain expand.

-If the patient survives cerebral edema four or five days, he/she will recover properly, we use titanium (artificial prosthetic) to repair him.

# Story: three years ago an American-football player was hit strongly and directly on the spinal cord, then he fell on the ground and he was quadriplegic (paralyzed) but conscious. His doctor

diagnosed the injury in the upper cervical nerves, so he gave him iced normal saline to vasoconstrict blood vessels as a result edema was reduced properly. Now this is a certified way.

#Note: the very first minutes after injury are the most important even in stroke (جلطة دماغية) patient, the instant management is very important. If the doctor treated the patient immediately the outcome will be very better but if the patient was left one or two days without treatment the outcome will be very bad.

Dedications: my Malaysian friends 😊

### ❖ How to measure body fluids?

-how to calculate the total body water of a small animal?

#### ❖ there are two ways :

1) Long time ago there was a cruel way which is :

-weigh the animal then sacrifice it

-dry it (either by oven or burning him)

-weigh it again and find the difference which is the total body water weight.

2) Indicator dilution method:

-we use chemical materials with radioactive elements and with well-known volume ( $V_1$ ) and concentration ( $C_1$ ). We can also use a substance like antiburine (not sure from the name) which is a highly lipid soluble and can cross all the membranes.

-then we inject it into the compartment we want to measure.

-after 30 minutes it is evenly distributed.

-then we take a sample from plasma to get  $C_2$ .

-Finally, we use this equation:  $C_1V_1=C_2V_2$  to calculate  $V_2$ .

❖ **EC compartment:** major ions  $Na^+$ ,  $Cl^-$  so we prepare radioactive  $Na^+$  or  $Cl^-$  then we use the previous method. Although there are a little  $Na^+$  inside the cell but it is ok because it is a rough measure so we will have a 99% correct measurement to the extracellular compartment.

-plasma volume: major substance is protein so we use radioactive proteins such as radioactive albumin.

-total body water we use radioactive RBCs.

-interstitial fluid: we don't have a method to insert a substance in the interstitial fluid without affecting the other compartments so it is calculated by this equation:

$$\text{Interstitial fluid} = \text{ECF} - \text{plasma volume}$$

❖ **IC compartment:** it is difficult to be measured so it is calculated by this equation:  $IC \text{ fluid} = \text{total body fluid} - \text{EC fluid}$

-when we use radioactive  $K^+$  the error percentage will be too high.

❖ **Introduction to the next lecture:**

-abnormalities in body fluids are 4 types caused by the disturbance of two things

Water and salts either they both increase (Hyper-osmotic overhydration) or they both decrease (Hypo-osmotic dehydration) or one of them may increase and the another one decrease.

-Two important hormones: 1.ADH: -secreted from posterior pituitary gland  
-reabsorbs only water in collecting duct in kidneys (prevents urination).

2. Aldosterone: -secreted from adrenal cortex.  
-reabsorbs salts and water  
Follows salts always.

Finally, I hope that you enjoyed studying the sheet and benefited as much as possible cuz it is important in the final exam.

After you got your physiology marks today I'd like to share this wisdom with you:

"الحُسن في الإجتهداد و ليس في النتيجة"

**Your friend Khaled AL-Smadi**