Hematology

- Histology
- Biochemistry
- Pathology
- Pharmacology
- **Physiology**
- Microbiology

- Handout
- Slide
- Sheet 8+9

- Dr. name :
  Dr Salim Khresha
- lecture number :
  8 +9
- Done BY :
  Amani Al Halabi
  & Noor Hammad

By: Anas Abu Shanab

Blood, Fluids, & Lymphatics

• General notes :

- In dealing with phenotypes of Rhesus Ag; "Rh" indicates +ve, while "rh" indicates -ve.

- When talking about genotypes; A phenotype of "Rh" or "+ve" could have the genotype of a homozygote "RhRh" or a heterozygote "Rhrh".

- In cases where both parents are Homozygote the +ve gene, all children will carry it (are +ve).

- When one parent carries the +ve Ag (Heterozygote) and the another doesn't; -ve children would be born.

- In cases of –ve Mothers, a +ve baby during childbirth could send some RBCs from his +ve blood to the mother's circulation; the body of the mother responds by producing Abs for this "+ve", which will react with Ags in a new baby's blood in an agglutination reaction.

There are 3 conditions in which the mother forms the Abs and the agglutination with fetal Ags occurs;

1- **Pre-marital**; if the lady has received a "+ve" blood transfused from a +ve person, either she will produce Abs, or at least become sensitive to do so.

2- **During Pregnancy**; Leakage of some fetal blood to the mother's circulation; here again, either she will produce Abs directly, or later on. The fetus may become at risk.

3- **During Childbirth**; Fetal blood may diffuse back to mother's blood.

In these 3 conditions, one of the following may occur:

a. **Mild agglutination** in fetal blood "*Erythroblastic Fetalis",* and this can be corrected after birth by blood transfusion of "-veD" blood, without doing any change on the main blood group (ABO). (The blood transfused to the child is not from the mother who has the Abs already!)

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b. **Moderate agglutination** "*Icterus graves neonatorum*"; the infant is born on term, with Jaundice (or gets it within 24hrs) and severe neurological lesions where the pigments are deposited (basal ganglia of the brain).

c. **Severe** "*Hydrops Fetalis*"; severe hemolysis, the infant may die in uterus, or develop jaundice, edema, and sever anemia and die within few hours after birth.

→ Within 3 days after the delivery, -ve mothers of +ve fetuses should be given certain gamma-globulins (Abs) against the foreign +veD Ags on leaked fetal RBCs, these will fight the foreign Ags, then be eliminated from the body due to their limited half life, thus no normal agglutination or maternal normal Abs are formed.

Notice the compatible blood transfusions in the slides;

- O-RBCs blood can be given to any group, "General Donor".

- AB-RBCs blood receives blood from any group. "General Recipient".

- B-RBCs blood receives blood from B + O groups only.

- A-RBCs blood receives blood from A + O groups only.

But pay attention:

Limited volumes of blood should be transfused normally even for general donors and recipients, 3 bags maximally (1.5 L).

In cases of wars and emergencies, more blood (up to 4 bags) may be transfused.

→ The limited volume transfused is monitored due to the fact that Abs in the transfused plasma should be **diluted** when added to patient's blood, so they won't cause harm or agglutinations, thus 1-2 bags of blood with their Abs may be tolerated by the recipient blood, more (3-4bags, with more Abs) will put the patient in a new risk!

NOTE ALSO THAT

- "A" + "B" Ags don't produce similar agglutinatin reactions between an infant and his mother (as in Rhesus);

A women with "O" group has the Abs-A and Abs-B in her plasma. Any "A" or "B" transfused blood to her, will induce agglutination reactions. BUT, if she's pregnant, these Abs won't affect the baby, why?

→ "A" + "B" Ags are not much expressed on fetal RBCs. Also these Abs in mother's circulation are of "IgM" type → cannot cross the placenta easily!

Indications for blood transfusion;

1. Compensating lost blood or decreased blood volume in Hemorrhages.
2. Providing Blood cells.
3. Increasing blood coagulation in cases of Hemophilia.
4. Replacing blood (in infants) in cases of erythroblastosis foetalis.
5. Supplying Antibodies + Proteins.
6. Provide WBCs in cases of leucopenia.
7. Supply proteins in hypoproteinemia.

- Certain machines and laboratory techniques can separate different cells and components in blood; thus you can transfuse the plasma plasma, or only RBCs, etc.

Complications of blood transfusion;

A. EARLY:

Hemolytic reactions (immediate vs. Delayed) / Infections / Allergic reactions (in response to new WBCs, Platelets, Proteins, etc.) / Circulatory Overload / Air embolism/ citrate toxicity / Hyperkalemia / Clotting abnormalities (After massive transfusion).

B. LATE:

Transmission of serious diseases (Hepatitis, Malaria, Syphlis, AIDS) / Transfused Iron Overload / Immune Sensitization.

NOTES:

1. All cells contain More K inside and More Na outside.

Transfusion of stored blood:
When the cells become old, Na /K pump is weakened, therefore:
-K concentration increases in plasma
-Na concentration increases inside the cell
-cell swelling and hemolysis occur

(Na+/K+ pump is paralysed, and K+ leaves the cell while sodium enters it). **More than 2 weeks of storage**, potassium leaks progressively from the erythrocyte and the extracellular concentration increases.

During storage, red blood cells intended for transfusion undergo progressive changes affecting survival and function, therefore, we should avoid transfused blood that is stored for more than 2 weeks, and the best duration is below 2 weeks.

For example : transfusing blood that is stored for 2 weeks, and measuring the survival cells ,they will be around 80% of the donated cells and every day 1% of them undergo hemolysis

1- Sometimes the patient need blood transfusion, and we don't have the same blood type, so we give him **Orh**- .But In extreme emergency cases if the same blood type is not available not even **Orh**-, we transfuse **ORh**+

- Cross-matching test: refers to the test that is performed prior to a blood transfusion in order to determine if the donor's blood is compatible with the blood of an intended recipient.

- How is the cross matching done?

Cross matching is done by mixing a small sample of recipient blood with a small sample of the donor blood and it takes two steps,

- First step: we take plasma from the donor and RBCs from the recipient

- Second step: we take plasma from the recipient and RBCs from the donor

The mixed blood is looked under a microscope to see if there is any clumping of blood. If there is no clumping it indicates that it is safe to transfuse the donor blood

- **Note: We store the mixed blood at (4) degree Celsius by using anti-coagulant (Acid citrate dextrose)**
- Autoagglutination: represents clumping of an individual's red blood cells (RBCs or erythrocytes) by his or her own serum due to the RBCs being coated on their surface by antibodies.

Body fluids:

-Intracellular fluid (28L)

-Extracellular fluid (14L) ; >> Interstitial and plasma

There is no difference in the composition between both compartments (plasma and interstitial), except in proteins.

- Notes:

-Distribution of electrolytes is similar in both plasma and interstitial fluids..

-In the interstitial fluid, there are virtually no proteins. If there are any proteins (albumin for example), they pass to the lymphatic system.

-The major differences between intracellular and extracellular compartments: (this is very very important)

- o Potassium
- o Sulfate
- o Phosphate
- o Proteins

-Sodium maintains the positivity of the cell, and it is kept outside.

Water is distributed in:

- Blood 83%
- Kidneys 82.7%
- Adipose tissue 10% (least tissue containing water)
- Muscles 42%
- Skin
- Skeleton

Water in a 70 Kg Man:

- 5 liters in blood
- 22 liters in muscles
- 9 liters in skin

- There are differences between males and females. The prime difference is between the ages of **18-40** mainly due to differences in **estrogen levels**.
- Higher estrogen levels make the body fattier. Thus, women have more fat content and less water content (male: 61% fluids in comparison with female: 51%).
- This difference is **negligible** during childhood and in old age.
- The plasma has an osmolality of around 290 mosmol/Kg and the principle ions are Na/Cl/K.
  - ➢ How much of that count is for Sodium, potassium, and Chloride?
  - ✓ 280, and the rest (10 mosmol /kg) are for proteins, glucose and nonionic substances.

Water balance:

There is a balance between water input and water output.

-Fluid intake: (2.6 liter)

- ✓ 1 liter by drinking
- ✓ 1.2 liters from food
- ✓ 400 ml from other sources

-Fluid output (2.6 L)

- ✓ Urine 1.5 L
- ✓ lungs 500 ml
- ✓ skin 450 ml
- ✓ 150 ml through feces.

➢ The water intake should equal the water output. How is this maintained?

✓ Through mechanisms that the body employs in cases of hyper and hypovolemia.

- In the case of **hypervolemia**, the body needs to excrete water. In this condition, ADH is inhibited. We don't need to retain water. We also need to excrete sodium. This is mediated through the effects of **ANP** (atrial natriuretic peptide). This is how we maintain the blood volume.

- In case of hypovolemia, low pressure is detected by cells in kidneys. In the kidneys, rennin is produced. Renin is eventually transformed into angiotensin 2, the famous hormone. It maintains normal blood pressure.

➢ Angiotensin 2 functions:

- Stimulates thirst
- Constricts blood vessels
- Stimulates ADH to absorb water
- Stimulates aldosterone to absorb sodium

✓ Increases blood volume and it returns back to normal. If this system doesn't work, we take medications.

✓ -Mechanisms of the body in **HYPOVOLEMIA** , sometimes, fail to operate properly so **dehydration** occurs.

Dehydration

➢ -There are three types of dehydration: (extra note, depending on how it affects the *tonicity* of the extracellular fluids)/ (http://www.ehealthstar.com/dehydration/types-pathophysiology)

- -Equal loss of fluids and electrolytes: **isotonic dehydration**

- Excessive fluid loss, less electrolyte loss: **hypertonic dehydration**
- Excessive electrolyte loss, less water loss: **hypotonic dehydration**

➢ -Dehydration occurs because of:

- failure of absorption of water through GIT
- Excessive loss from copious sweating, prolonged vomiting, diarrhea and excessive diuresis
- Drainage from wounds or burns

-Charecterstics of dehydration:

- ✓ shrunken appearance of the face and body
- ✓ The skin loses its elasticity and becomes hard and leathery
- ✓ There is a rapid loss of body weight
- ✓ When the deficiency reaches such a degree that the water is no longer sufficient for removal of heat of metabolism, fever may occur.
- ✓ As the condition worsens, circulatory failure develops
- ✓ Anuria results (means nonpassage of urine, often caused by failure in the function of kidneys)
- ✓ Acid products are retained leading to **acidosis**
- ✓ Cerebral disturbances, excitement, **delirium** and coma terminate the episode

➢ Water intoxication:

Excessive water intake, decrease loss of water, or increase of absorption.

Alcoholics, when they become short on alcohol, they drink too much water to get drunk (wuuutt..?).

The problem here is in the distribution. The water starts **flooding the cells, and this causes disorientation.**

➢ Excessive water intake may produce the syndrome of water intoxication in which cellular function is disturbed by the **<u>dilution of the cellular electrolytes</u>**.

- Disorientation
- Convulsions
- coma may result
- gastrointestinal dysfunction
- Muscular weakness
- Abnormal cardiac rhythms.

❖ Lymphatic system:

- The pressure inside the blood vessels at the **arterial** end is 32, and the plasma proteins pressure is about 28.
- While at the **Venous** end, the blood pressure is 16; protein pressure does not change.

- Normal movement of fluids through the capillary wall into the tissues depends on two forces: **hydrostatic pressure** (exerted by pumping of the heart) and **oncotic pressure** (exerted by non-diffusible plasma proteins, primarily **albumin**). At the arterial end of the capillary, fluids are filtered through its wall by a hydrostatic pressure that exceeds the oncotic pressure exerted by plasma proteins. in contrast, because oncotic pressure is greater than hydrostatic pressure in the venous end of the capillary, fluids re-enter the capillary here

- Plasma and some protein pass into the interstitial spaces. At the arterial end, there is osmosis and return of proteins. But, sometimes, some of the plasma proteins remain in the interstitial fluid and become lymph which is part of the lymphatic system. This is the mechanism of forming lymph in the lymphatic system

- The lymphatic system is an accessory route, through which fluids can pass from the interstitial space to the blood. Lymph is a tissue fluid. Lymphatic vessels drain into venous blood via the thoracic and right lymphatic ducts.
    - It contains clotting factors and clots on standing in vitro.
    - In most locations, there are lymphocytes. The lymphocytes screen the blood and remove any bacteria or foreign bodies
    - The fats are absorbed through the lymphatic system
    - Lymphocytes enter the circulation, principally, through the lymphatics

The lymphatic system consists of

- Lymphatic capillaries, lymphatic vessels, lymphatic ducts, and lymphatic nodes.

- Related organs:

    - Spleen
    - Tonsils
    - Thymus

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-Tissues that lack lymphatic capillaries:

- ✓ Avascular tissues
- ✓ Central nervous system
- ✓ Bone marrow
- ✓ A portion of the spleen

- How does the lymph flow?

There are forces which include 1-contraction of skeletal muscles, 2-pressure changes due to the action of breathing muscles, and 3-contraction of smooth muscles in the walls of larger lymphatic vessels.

-Functions:

- Return of excess filtered fluid
- Defense against diseases through lymphocytes
- Transport of absorbed fat
- Return of filtered proteins
-

- Sometimes, fluids accumulate in the interstitial spaces and this is called edema.
  -Causes of edema: (the doctor read some random numbers from the slides about this topic, mixed up with some weird info that I couldn't understand, so please refer to them.)
  - High capillary pressure
  - Low protein pressure
  - Lymphatic vessels blockage
  - Increased capillary permeability
  - Increased blood pressure

Problems on blood grouping:

1- A phenotype of: BMNRh+

Possible genotypes: BBMNRh+/ BOMNRh+/ BBMNRhRh/BOMNRhRh/BOMNRhrh

2- A phenotype of: ABMMrh-

Possible genotypes: ABMMrhrh

3- A phenotype of: OMNRh+

Possible genotypes: OOMNRhRh/ OOMNRhrh

4- A Mother with phenotype of: AMNRh+, her child is: ONNRh-.

Is the putative father with: ANNRh+ really the father of the child?

Possible genotypes of mother: AAMNRhRh/ AAMNRhrh/ AOMNRhRh/ AOMNRhrh

Possible genotypes of the putative father: AANNRhRh/ AANNRhrh/ AONNRhRh/ AONNRhrh

→ Yes, this father could be the true father of the child; (AOMNRhrh (mother) * AONNRhrh (father))

5- The following are general statements about blood transfusion and blood groups:

a*) Donor blood is usually collected into heparin as anticoagulant*. (FALSE, ACD in used)

b) *Most ABO incompatible blood transfusions are due to failure in checking identity.* (TRUE)

c) *Anti-A and Anti-B are often absent from the serum of babies with group "O".* (TRUE)

Done by: Amani and Noor
Thanks to Tasneim Suhail

ثق تماما أن المنظورالضيق للأمور ومن زاوية واحدة ألا وهي "زاوية الانتماء أو التحزب " لن يجعلك تفهم من الحقيقة غير ما أقنعت نفسك به وبذلك فأنت قد تعلم الكثير ولكنه أبعد ما يكون عما تريده او عما هو صائب، اجعل للنظرة الموضوعية جزيئة من تفكيرك وستُقاد للصواب .