Classifications of Anemia (table 2.2)

Anemia is a general name given to a group of circulating RBC deficiencies, both qualitativeand quantitative.

Anemia can be caused by decreased RBC production, excess destruction or both.

There are many classifications of anemia (here we mention 2 types), according to:

1. Morphology(shapeand size) of the cells

- Normocytic normochromic anemia : the size of the cell is normal, such is the content.the problem isin the number of RBC's.
- Hypochromic normocytic anemia: the problem is in the content.
- Hypochromic macrocytic: problem is in content and the size of the cells. Examples are iron deficiency anemia and sideroblastic anemia.

2. Etiology(cause):

- Decreased blood production, either nutritional or bone marrow failure.
- Increased blood loss is due to hemorrhage or hemolysis, either acute or chronic.

Hemolysis may be due to :

I. problem in the cell, Pyruvate kinase deficiency and G6PD deficiency given as examples
II. problem in the surrounding medium (plasma)

Remember: RBC's half-life (he must've meant life span) is 120 days on average.

Effects of anemia on the body

(the effects depend on the degree of the anemia)

- *Blood viscosity*in an anemic patient may fall to as low as (1.5-2) times the viscosity of water, while it's normally 3 times that of water.As a result the *resistance* to blood flow in the peripheral blood vessels decreases, so blood flows easily, increasing the amount of blood returning to the heart and consequently increasing the workload on the heart.

- *hypoxia* resulting from decreased oxygen transport by the blood causes the peripheral tissue blood vessels to *dilate*, allowing a further increase in the return of blood to the heart and increasing theworkload on the heart.

In conclusion, One of the major effects of anemia is increased pumping workload on the heart.

Erythrocytosis vs.Polycythemia

An increase in number of circulating RBC's (the opposite of anemia).It's called Erythrocytosis when it is transient (an increase just for short time and then comes back to normal) and we're referring to a benign situation, while in Polycythemiait may be referring to both a malignant or a benign situation.

- Fasting in Ramadan(dehydration) leads to *relative erythrocytosis*, increased Hct.
- True erythrocytosis with low r normal EPO this is a cancerous case such as Polycythemia Vera.

The effects of erythrocytosis/polycythemia on the body

Hematocrit(number one factor affected) increases greatly, sometimes reaching 50% and above indicating a great increase in viscosity (more than 3X water viscosity), increasing he work done by the heart. The blood flow through the peripheral blood vessels is often very sluggish, of course depending on the degree of polycythemia. Increasing blood viscosity decreases the rate of venous return to the heart. However, the blood volume is greatly increased (becomes about 7L or 8L) at the same time, and that tends to increase venous return, overcoming the effect of the increased viscosity and sluggish blood flow. At the end, the workload on the heart is increased, even more than that caused by anemia.

Erythrocyte Sedimentation Rate (ESR)(very important and famous test)

fresh anti-coagulatedblood is placed in a graduated cylinder, kept in lab conditions for around 1 hour, afterwards the clear plasma on the top is measured (the height).

Normally, clear plasma reaches *5mm in males*,it reaches up to *15mmin females*. When we say 5 and 15 mm, we're using the wintrobe method.

In this slide we have 3 methods(tubes). An additional method is the *Landau* method similar to the cutler method.

ESR varies according to the type of the tube (or method), as they have different parameters.

- ESR is *not* a *diagnostic*test, it indicates the presence of a disease but doesn't specify it.

ESR increases in:

- all infections(acute or chronic)
- connective tissue destructive diseases

Examples given: Rheumatoid arthritis, tuberculosis, hepatitis

ESR is highin old people (both males and females),and low in young people.
That's Because most old people suffer from connective tissue destructive diseases (or another problem in the connective tissue.

Osmotic fragility test

- is used to diagnose different types of anemia, especially *hemolytic*anemia.

The numbers on the x axis indicate different NaCl concentrations in different test tubes (0.1 in the first tube, 0.8 in the last one).
Equal drops of blood are added to each tube then they're incubated for an hour, and after that they're centrifuged.

- Normally, the blood begins to hemolyze in the test tube with 0.55/0.5 NaCl concentration and it is completed at 0.3 (all RBC's are hemolyzed at 0.3) and this is the normal case (curve).

- If RBC's begin to hemolyze in tubes that containNaCl concentration **higher** than 0.55,the osmotic fragility **increases** which means that RBC's are fragile, aren't intact and hemolyze easily. Occurs in: hemolytic anemia, spherocytosis.

- If RBC's begin to hemolyze at NaCl concentration=**0.45 or less**, the osmotic fragility **decreases** which means the membrane of RBC is solid, this is also abnormal, such as in sickle cell anemia, iron deficiency anemia, thalassemia. So the problem is in the shape of RBC's like in sickle cell anemia, or in the small size (microcytic) so the surface area exposed to NaCl is decreased.

The *main factor*which affects the osmotic fragility test is the *shape of RBC's,* which in turn is dependent on the *volume, surface area*, and the *functional state* of the RBC's.

The cause of abnormal osmotic fragility tests can be:

a. Corpuscular: G6PD deficiency, pyruvate kinase deficiency.

b. Extra corpuscular: such as in
   * ABO incompatibility
   *some drugs cause hemolysis, such as Penicillin
   *infections, such as Malaria

<u>Leukocytes</u>

They are nucleated, larger than RBCs (10-20 micrometer in diameter) but have shorter half-life (hours to days to months and even years in the case of monocytes)

They're very active as they move within the vessels and outside of them to reach tissues.

The WBC count is 5000-10000 cells/μL and there is no difference between males and females, but within the same individual the number can change from time to time: minimum in the morning; maximum in the evening; increase after meals, exercise, excitement and during pregnancy.

The count which we get at laboratory is actually half of the total WBCs in blood because the remaining 50% adhere to the inner the wall of blood vessels(especially neutorphils). They are called the *marginal WBCs*and released in*hemorrhage* or *hemolysis*.

Classification of Leukocytes

The *most common classification* is:

a. Granular leukocytes: have granules in cytoplasm, include: neutrophils,eosinophils and basophils

b. Agranularleukocytes: no granules in cytoplasm, include:monocytes and lymphocytes.

** old cells might have few granules.

Another classification is (no indication of the presence of granules)

a. granulocytes b. lymphocytes c. monocytes

Differential Count of Leukocytes

Normally, neutrophils have the highest count, but in very rare conditions lymphocytes have the highest count.

Leukopenia : low count of WBCs, Leukocytosis : high count of WBCs

Leukopoiesis

The production duration of WBC's is almost similar to that of the RBC's, but the *WBC's* need about *six* days to be released from the bone marrow to the circulation while in the *RBC's* the reticulocytes need *two* to three days to be released to circulation.

All WBCs are produced in the bone marrow, but lymphocytes have another source of production, in lymphoidtissue: spleen, lymph nodes and the thymus.

And we're done :]