Haematological investigations and interpretation of results.

Prof. Victor Mwanakasale

(BSc, MBChB, MSc, Dip, PhD)

MBS 240 (2024)

Objective of the lecture:

For the students to learn commonly requested haematological investigations in clinical practice and Interpretation of the results.

Format of the lecture.

1. The blood picture
2. Types of hematological investigations
3. Interpretation of results of specific haematological investigations.

The blood picture.

- An essential part of the **clinical description** of practically **every** disease.
- A **normal number** and **normal distribution** of blood cells and a **normal** hemoglobin concentration in the blood- **physiologic constants*.**
- Certain diseases **do not** produce **significant** changes*.

- **Most** hematologic changes a result of pathologic processes **secondarily** affecting the **blood** or **blood forming** tissues.
- **‘True blood diseases’** less common (e.g. blood cancers).
- Blood picture provides important **diagnostic information.**

- **Clinical hematology** is almost **coextensive** with **medical diagnosis**.
- **Hemorrhagic diseases** included in **clinical heamatology.**

Types of haematological examination.

- These can be:

1. **Routine/screening** examinations
2. **Special** examinations.

Routine/screening examinations.

- A **few** hematological tests in the examination of **every** patient.
- Selected based on the **most common** diseases and abnormalities.

➢ Decide **whether** or **not** detailed haematological investigations necessary.

- **Characteristics of the tests***:
- Simple
- Economical
- Time efficient

Tests*.

1. **Hemoglobin** concentration
2. Total **white blood cell count**
3. Differential **white blood cell count**
4. Total **red blood cell count***

Toto RBC ⇨ Requested only when there is hematology machine to do red cell count.

Special examinations.

- **Any** of the examinations on blood included in the **routine** or **ordered** from time to time.
- Requested as **Single** examination, or **groups** of examinations, indicated by the **nature** and **course** of the patient's condition.

Tests. C VEM BFF BS

1. Macroscopic blood examination.
2. Full blood count.
3. Basophil stippling.
4. Vitamin B_{12} and Folic Acid levels.
5. Ferritin (serum iron) levels
6. Coagulation tests
7. Sickling test (sickle cell test)
8. Electrophoresis
9. Bone marrow biopsy

Interpretation of results of special haematological investigations.

Macroscopic examination of blood:

Tests:

I. Erythrocyte Sedimentation Rate (ESR)

II. Plasma viscosity

ESR.

Defn* ⇨ Measures rate at which Red blood cells sediment or settle in a period of **one hour**.

- **Raised levels**: any cause or focus of **inflammation** and **infection**.
- **Raised levels**: In pregnancy, joint diseases, anemias other than ***sickle cell anaemia*.**
- **Decreased levels**: in polycythemia, sickle cell anemia, and congestive heart failure.

Normal values*:

Normal ESR values*:

AGE	ESR VALUE
MEN > 50 YRS	<20mm/hr
MEN < 50YRS	<15mm/hr
WOMEN > 50 YRS	<30mm/hr
WOMEN < 50 YRS	<20mm/hr
NEONATES TO PUBERTY	3-13mm/hr
NEWBORNS	0-2mm/hr

Plasma Viscosity*

- Measures level of activity in different diseases.
- **Raised levels** with disease activity.

Full Blood Count

-**automated (haematology analyser)** or **manually.**

Comprises:

1) Hemoglobin concentration*
2) Red blood cell count*
3) Reticulocyte count*
4) Red blood Cell indices
5) Platelet count
6) White blood cell count
7) Differential white blood count

Hemoglobin concentration*

	Females	Males
11- 18 years	11.9 g/dL – 15 g/dL	12.7 g/dL – 17.7 g/dL
Men	13 g/dL ⇧	
Women	12 g/dL ⇧	
1 – 5 years	10.9 g/dL – 15g/dL	
Neonates	13.4g/dL – 19.9g/dL	

Red Blood cell indices*.

- **Automated** or **calculated**
- **Information provided***

- **volume** of red blood cells
- **concentration** of haemoglobin in red blood cells
- **type** of anaemia being investigated

- **Types** and what is **measured*:**

1. **MCV** (Mean Cell Volume)
2. **MCH** (Mean Cell Haemoglobin).
3. **MCHC** (Mean Cell Haemoglobin Concentration).
4. **RDW** (Red Cell Distribution Width)

The Mean Cell Volume (MCV)*

✓ Measures the average volume of red blood cells.

- Normal value: **78- 104 μ^3**
- MCV=hematocrit (%) X 10/RBC count (million/mm^3 blood)

Decreased:(Microcytic RBC)

I. Anaemia of chronic disease
II. Iron deficiency anaemia

Increased: (Macrocytic RBC)

I. Vitamin B_{12} deficiency
II. Folate deficiency
III. Thyroid disorders
IV. Liver disorders
V. Marrow dysplasia /Aplastic anaemia

The Mean Cell Hemoglobin (MCH).

- ✓ Measures the weight of haemoglobin in a standard volume of blood.
- Normal value of MCH: **27-31 picograms/cell**
- MCH=(Hb X 10)/RBCs in volume of blood.
- **Decreased** in hypochromic anemias.
- Test **not** very useful.

The Mean Cell Hemoglobin Concentration (MCHC),

- Measure of the concentration of **hemoglobin** in a **given volume** of packed red blood cells.
- MCHC = (Hb ÷ PCV) x 100
- Normal values: **32 - 36 g/dl**
- **Most useful index.**
- **Decreased** MCHC: ("hypochromic") in **microcytic anemias,**

- **Normal** MCHC**:** ("normochromic") in **macrocytic anemias** (due to **larger cell** size, though the hemoglobin **amount** or MCH is **high**, the concentration remains normal).
- **Increased** MCHC: ("hyperchromic") in e.g. sickle cell disease.

Red blood cell distribution width.

(RDW or RCDW).

- Measure of the **variation** of red blood cell (RBC) **volume**.
- Usually red blood cells are a standard size of about **6–8** µm.

RDW =(Standard deviation of MCV ÷ mean MCV) × 100)

Normal range: **11-15%**.

High RDW=**Anisocytosis**.

Increased RDW observed in:

I. **Iron Deficiency Anemia**: usually presents with **high** RDW and **low** MCV
II. **Folate and vitamin B12 deficiency anemia**: usually presents with **high** RDW and **high** MCV
III. **Recent Hemorrhage**: typical presentation is **high** RDW and **normal** MCV

Platelet count*

a) **Thrombocytosis* (High Platelet count).**

- ✓ Inflammation

a) **Thrombocytopaenia* (Low Platelet count)**

- ✓ side effects to certain drugs
- ✓ some viral infections

Total White blood cell count*.

- Measures the **number** of white blood cells in blood.
- **High**: infection, exercise, stress, steroids.
- **Low**: immune deficiency, drugs, certain diseases.

Differential white cell count.

- "**Differential**"
- **Proportions** of neutrophils, basophils, eosinophils, lymphocytes, monocyte/macrophages among White blood cells.

➢ Information about the **immune system.**

- **Neutrophils** and **lymphocytes** most important to measure.
- Other three ***less significant*** (often measured together)

Neutrophil count*.

- Normal count: **40-60%** of total WBC
- **Neutrophilia (Increased %) e.g**

✓ steroids

✓Acute infection

✓ Inflammation

- **Neutropaenia (Decreased %) e.g**
- **“Negro” neutropaenia**

✓ Side effects to certain drugs

✓ Bacterial Infection

✓ Viral Infection

Eosinophil count*.

Normal count: **2 - 8%** of total WBC

- Eosinophilia (**Increased %**).:

❑ Side effects to some drugs

❑ Allergies

❑Worm infection

- Eosinopenia (**Decreased %**):

❑ Woman in pregnancy

❑ Eclampsia

❑ Electric shock therapy

Basophil count*.

- Normal count is **0 - 1%** of total WBC
- Basophilia (**Increased %**)

✓ Leukemia
✓ Haemolytic Anemia
✓ Polycythemia

- Basopenia(**Decreased %**)

✓ Inherently deficient
✓ thyroid Disease
✓ Side effects to steroids

Lymphocyte count*.

- Normal count: **20 - 40**% of WBC.
- **Lymphocytosis*** :

a) High Number b) High %

Absolute lymphocytosis (High number).

- ✓ Speen removal surgery
- ✓ Acute viral infections
- ✓ Parasite infections
- ✓ Chronic bacterial infection like T.B

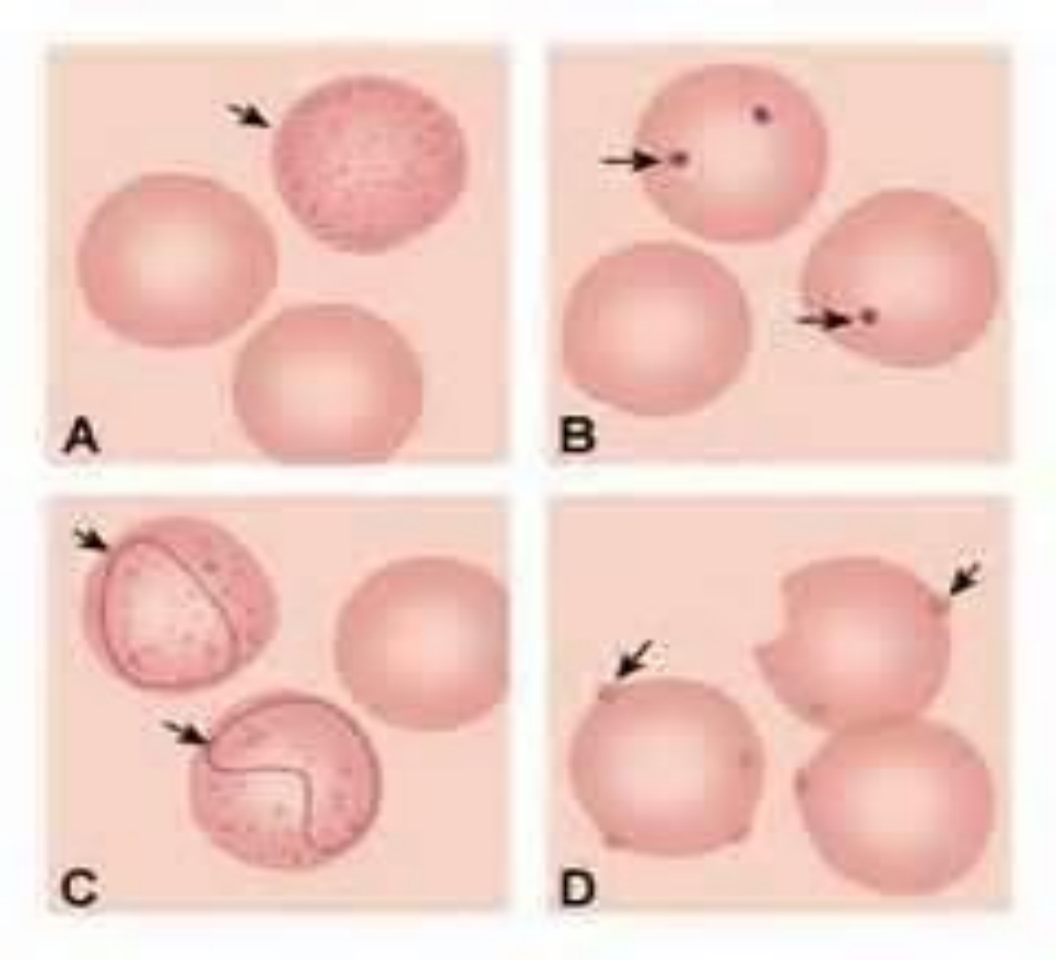
Lymphocytopenia or lymphopenia (Low number)

- ✓ Immunodeficiency like HIV and other viral and bacterial infections,
- ✓ Malnutrition and severe stress
- ✓ intense or prolonged physical exercise.

Basophil stippling.

- Also known as **Punctate basophilia**.
- RBC demonstrate **small dots** at the periphery.
- **rRNA**.
- **Always** pathological:

1) Lead poisoning
2) Anaemias


A
B
C
D

Vitamin B12 and Folic acid levels.

- Measured in patients with **macrocytosis** i.e. **increased MCV.**
- **Decreased** levels of **Vit B12** and **FA** occur in:

1) Nutritional deficiency anaemia,
2) Aplastic anaemia
3) Side effects of certain drugs.

Ferritin*.

- Serum ferritin (Iron) is an **acute phase protein**.
- **High levels** with inflammation.

Use:

R/o **Iron Deficiency Anaemia** (cases of **low** Hb + **low** MCV).

Coagulation (clotting) tests.

- Abnormal results in diseases of clotting e.g. hemophilia.

Sickle cell test *

(Sickling test).

- **Positive** in: Sickle cell trait (**AS**) or sickle cell disease (**SS)**.
- **Hemoglobin S**, instead of the normal hemoglobin, hemoglobin A.
- HbS ($\alpha_2\beta^{S2}$)

Hb Electrophoresis*.

- **Type** and **size** of haemoglobin molecules determined.

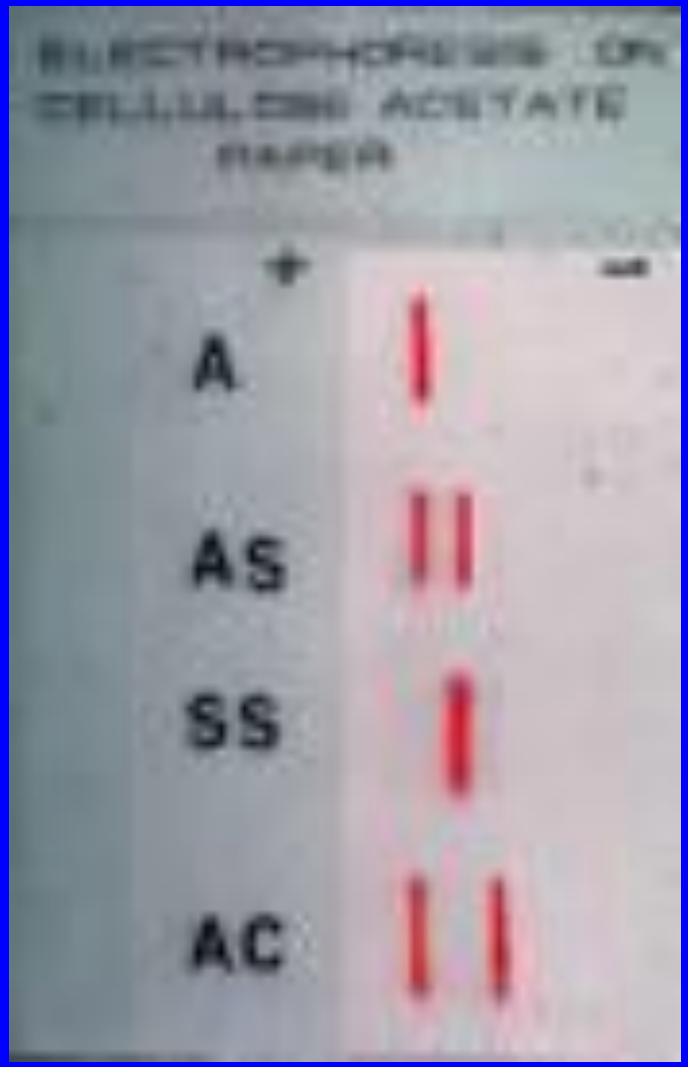
Use:

1. Diagnose **haemoglobinopathies (Quantify** the proportions of different **variants** of haemoglobin)-**mild anaemia**.
2. Detect **abnormal** haemoglobins e.g **HbS**

- differentiate **Trait** from **Disease**.

Hb Electrophoresis*.

- Haemoglobin electrophoresis is a method of determining the **type** and **size** of haemoglobin molecules in a persons blood by observing the rates of transit of these negatively charged proteins in an electric field medium.
- It is used to diagnose **haemoglobinopathies,** conditions with an unusual combination of haemoglobin types which usually result in **mild anaemia.**


ELECTROPHORESIS ON
CELLULOSE ACETATE
PAPER
+
A
AS
SS
AC

FIN