Erythrocyte sedimentation Rate
ESR

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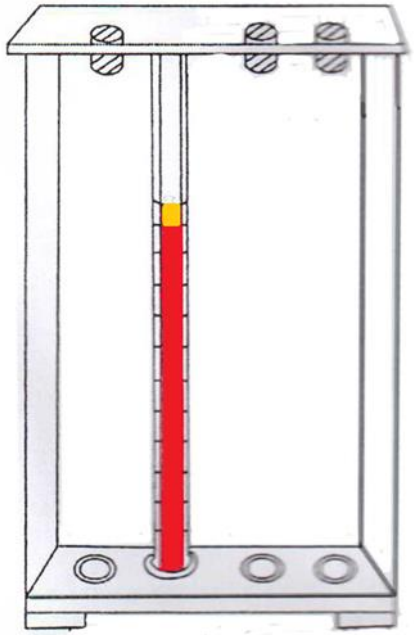
- The erythrocyte sedimentation rate (ESR), also called a sedimentation rate, it measures the rate of erythrocytes settling in diluted human plasma over a specified time period (1 hour).
- It is a relatively simple, inexpensive, non-specific test that has been used for many years to help detect inflammation associated with conditions such as infections, cancers, and autoimmune diseases.

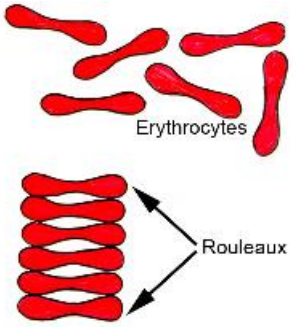
Principle

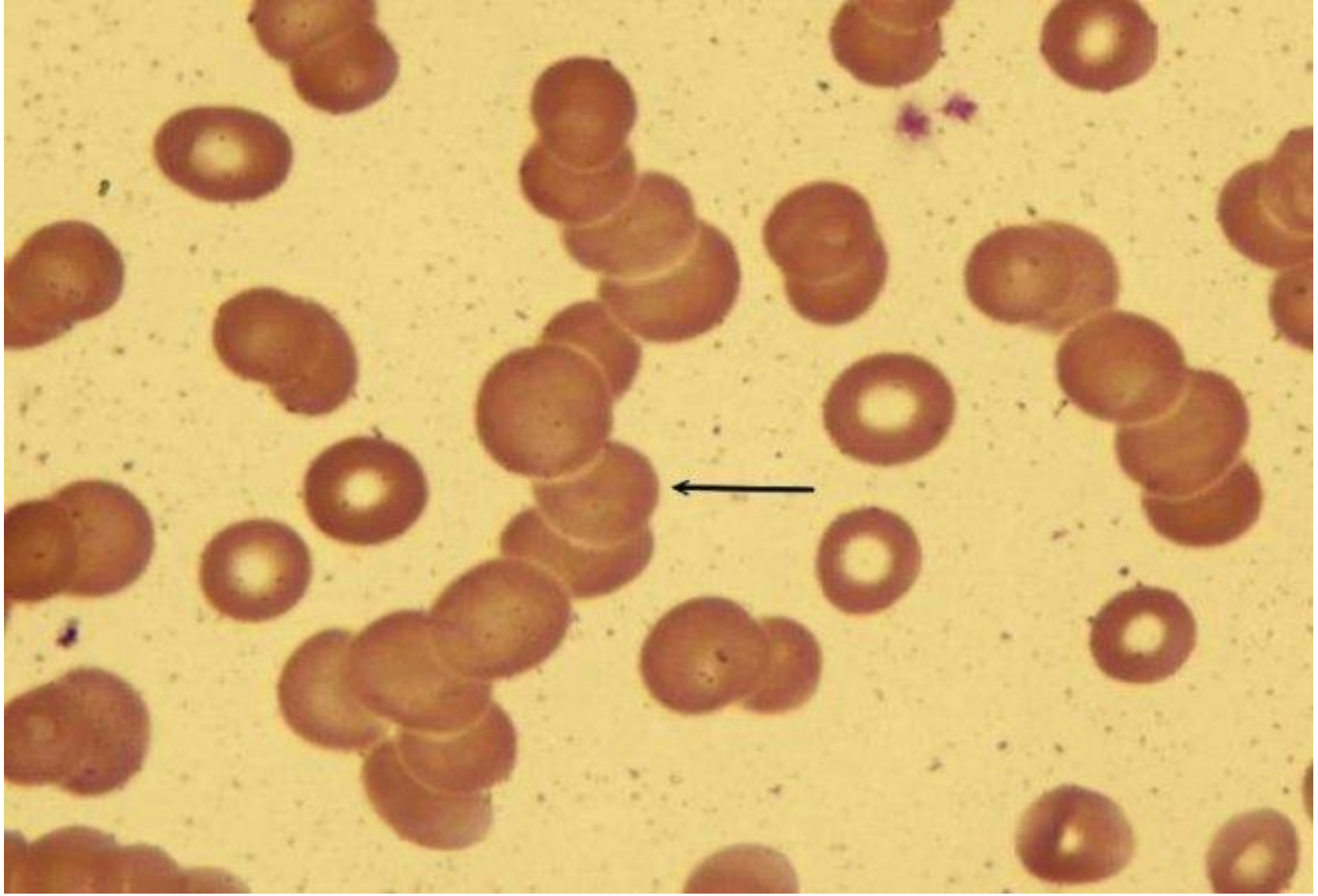
- When anticoagulated blood is allowed to stand in a narrow vertical glass tube, undisturbed for a period of time, the RBCs – under the influence of gravity- settle out from the plasma. The rate at which they settle is measured as the number of millimeters of clear plasma present at the top of the column after one hour (mm/hr)



b) Westergren tube on the rack

- The ESR is directly proportional to the RBC mass and inversely proportional to plasma viscosity
- In **normal** whole blood, RBCs do not form rouleaux; the RBC mass is small and therefore the ESR is decreased (cells settle out slowly),
- while in **abnormal** conditions when RBCs can form rouleaux, the RBC mass is greater, thus increasing the ESR (cells settle out faster).





The aggregated RBCs in the rouleaux formation have a higher ratio of 'mass to surface area' as compared to single RBCs and hence sink faster in plasma .

This mechanism involves three stages:

1. **Stage of aggregation**: The RBC aggregate to Rouleaux formation. It occurs in the first 10-15 minutes.
2. **Stage of sedimentation**: It is the stage of actual falling of RBCs in which sedimentation occurs at constant rate. This occurs in 30-40 minutes out of 1 hour
3. **Stage of packing**: This is the final stage and is also known as stationary phase. In this stage, there is a slower rate of falling because of packing and accumulation(packing) of RBCs in bottom of the tube. It occurs in final 10 minutes

- **Adults Normal values**

1. Children: 0-10 mm\hr
2. Women: 0-20 mm\hr
3. Men: 0-15 mm\hr

Above 50 years 0-30 mm/h

Above 50 years 0-20 mm/h

Factors affecting on the rate of RBC settling

1. **Biological factors**
    a. Hematologic factor
    b. Proteins factors (Rate of rouleaux formation)
    c. Miscellaneous factors
2. **Physical factor**: room temperature, tilted ESR tube, vibration, bubbles in ESR column.

Hematologic factors	Increases ESR	Decreases ESR
RBC count	anemia	polycythemia
RBC shape	Microcytosis	Macrocytosis, spherocytosis
WBC count		Extremely high WBC
Protein factors		
fibrinogen	hyperfibrinogenemia	Hyporfibrinogenemia, dysfibrinogenemia
Other serum proteins	Increased alpha-globulins , beta-globulins and gamma- globulins	hypogammaglobulinemia
Miscellaneous factors		
temperature	fever	hypothemia
Serum cholesterol	High serum cholesterol	
Gender of patient	Females specially during prignancy	
Age of patient	Advanced age	

- **Methods**
- **1- Westergren’s method**
- **2- Wintrobe’s method**
- **3- Automated method**

Westegren's method

- The Westergren's method is preferred by National Committee for Clinical Standards (NCCLS) because of its simplicity and greater distance of sedimentation measured in the longer Westergren tube. The straight tube is 30 cm long, 2.5 mm in internal diameter, and calibrated in millimeters from 0-200. Approximately 1 mL of blood is required.

Procedure

Westergren Method

1. Collect blood

- Draw blood into a **Westergren tube** or mix venous blood with **3.8% sodium citrate** (1 part citrate : 4 parts blood).
- Alternatively, use **EDTA blood**, then transfer to a citrate tube.

2. Fill the Westergren tube

- Fill the vertical Westergren tube up to the **0 mark** (top).

3. Place tube upright

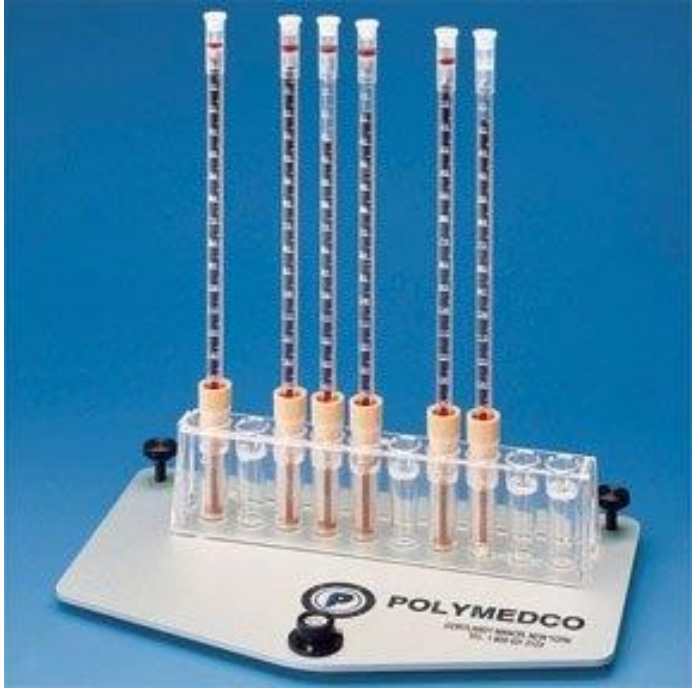
- Put the tube in an **ESR stand vertically** and on a **level surface**.
- Avoid vibration or tilting.

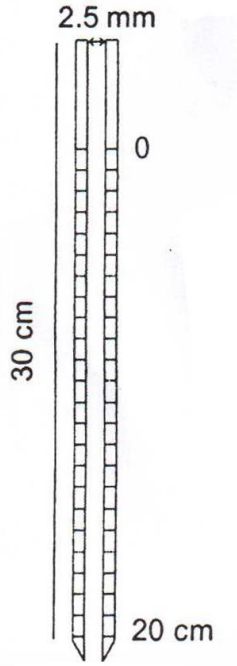
4. Wait for 1 hour

- Let the tube stand undisturbed at room temperature for **60 minutes**.

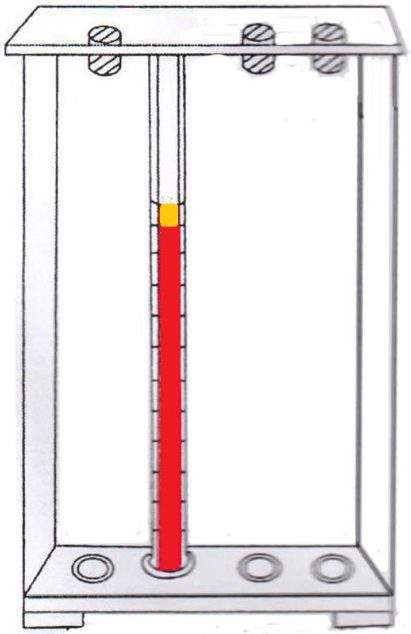
5. Read the result

- After 1 hour, measure the **distance (in mm)** between:
  - **top of the plasma** and the **top of the RBC column**
- This value = **ESR in mm/hour**.





a) Westergren tube



b) Westergren tube on the rack

Sources of error

1. Specimen older than specified time after collection and before testing
2. Incorrect proportion of anticoagulant
3. Incorrect type of anticoagulant
4. Haemolysed sample
5. Contaminated sedimentation tubes
6. Tubes tilted during sedimentation
7. Test set up near central heating or direct sunshine
8. Test set up adjacent to centrifuge or other instrument causing vibration Failure to read at exactly one hour.

Causes of a significantly raised ESR :

- All types of anemias except sickle cell anemia
- Acute and chronic inflammatory conditions and infections including:
  - HIV disease
  - Tuberculosis
  - Acute viral hepatitis
  - Arthritis
  - Bacterial endocarditis
  - Pelvic inflammatory disease
  - systemic infection
- Pregnancy
- Myocardial infarction
- Systeic lupus erythematosus
- Myelomatosis, lymphoma, multiple myeloma Hodgkins disease, some tumours

Causes of Reduced ESR

- Polycythaemia
- Poikilocytosis
- Congestive heart failure
- Newborn infants
- Dehydration
- Sickle cell anemia

- ESR and C-reactive protein (CRP) are both markers of inflammation
- Generally, ESR does not change as rapidly as does CRP, either at the start of inflammation or as it goes away.
- CRP is not affected by as many other factors as is ESR, making it a better marker of inflammation.
- However, because ESR is an easily performed test, many doctors still use ESR as an initial test when they think a patient has inflammation .