

Packed Cell Volume & Erythrocyte Sedimentation Rate

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- Packed cell volume (P.C.V) is the proportion of blood occupied by RBCs, expressed in percentage.
- It is the volume of RBCs packed at the bottom of a hematocrit tube when the blood is centrifuged. It is also called **hematocrit value** or **erythrocyte volume fraction (E.V.F)**.

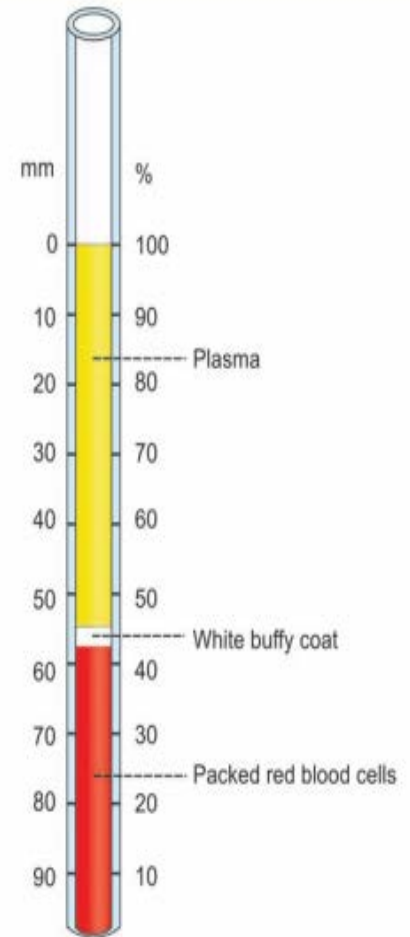


FIGURE 13.1: Packed cell volume

Method of Determination

- Blood is mixed with the anticoagulant ethylenediamine (EDTA) or heparin and filled in hematocrit or Wintrobe tube (110 mm long and 3 mm bore) up to 100 mark.
- The tube with the blood is centrifuged at a speed of 3000 revolutions per minute (rpm) for 30 minutes.
- RBCs packed at the bottom form the packed cell volume and the plasma remains above this. In between the RBCs and the plasma, there is a **white buffy coat**, which is formed by white blood cells and the platelets.

Diagram Showing The Method of P.C.V



- **Determination of P.C.V helps in:**
 1. Diagnosis and treatment of anemia
 2. Diagnosis and treatment of polycythemia
 3. Determination of extent of dehydration and recovery from dehydration after treatment
 4. Decision of blood transfusion.
- **Normal PCV:**
 - In males = 40% to 45%
 - In females = 38% to 42%

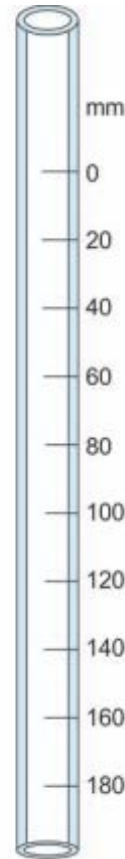
- **P.C.V increases in:**
 1. Polycythemia : Polycythemia means increased red blood cell volume.
 2. Dehydration
 3. Dengue fever
- **P.C.V decreases in:**
 1. Anemia : reduction in RBC count, hemoglobin content
 2. Cirrhosis of liver :Chronic liver damage from a variety of causes leading to scarring and liver failure.
 3. Pregnancy
 4. Haemorrhage due to **ectopic pregnancy** (pregnancy due to implantation of fertilized ovum in tissues other than uterine wall), which is characterized by vaginal bleeding.

Erythrocyte sedimentation rate (E.S.R)

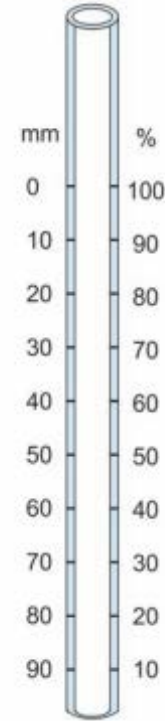
- Erythrocyte sedimentation rate (E.S.R) is the rate at which the erythrocytes settle down.
- Normally, the red blood cells (RBCs) remain suspended uniformly in circulation. This is called suspension stability of RBCs. If blood is mixed with an anticoagulant and allowed to stand on a vertical tube, the red cells settle down due to gravity with a supernatant layer of clear plasma.
- E.S.R is also called sedimentation rate, **Sed rate** or **Biernacki reaction**. It was first demonstrated by **Edmund Biernacki in 1897**.

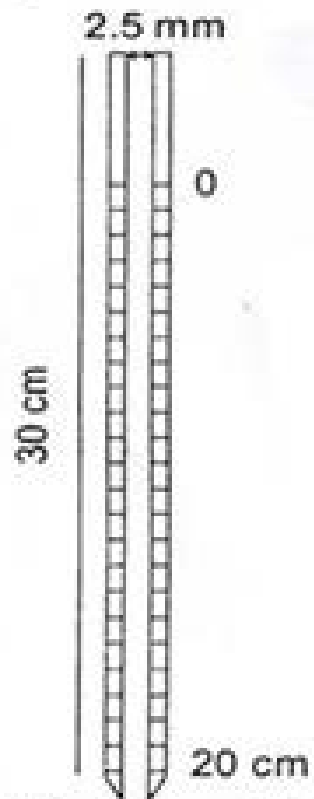
- There are two methods to determine ESR.
 1. Westergren method
 2. Wintrobe method

Westergren Tube

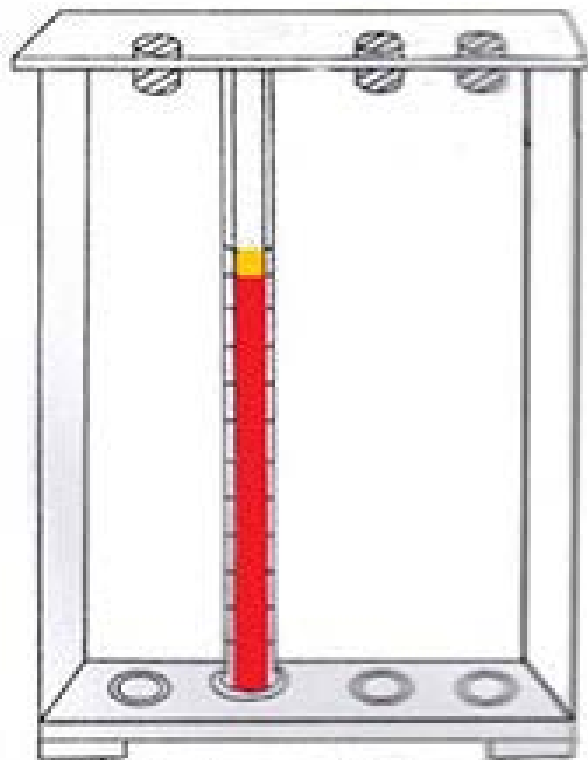


Wintrobe Tube

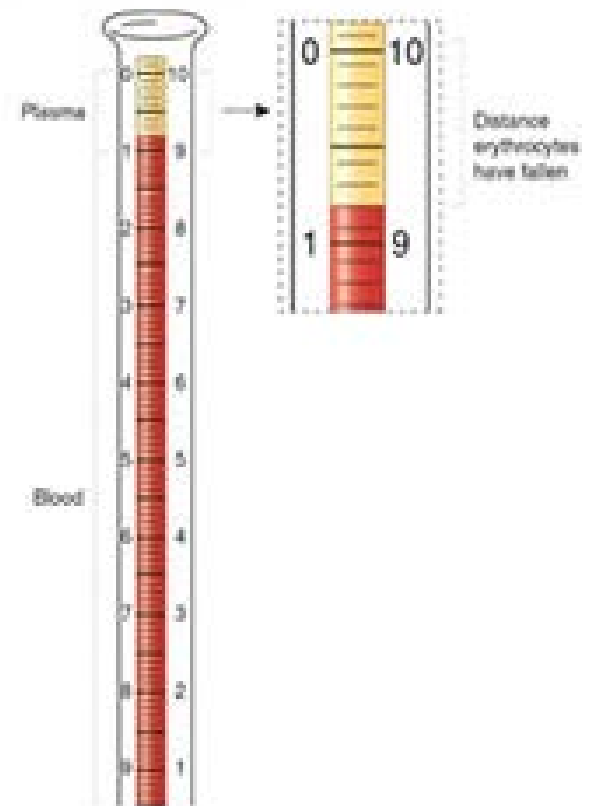




a) Westergren tube



b) Westergren tube on the rack



Wintrobe tube

Westergren Method

- In this method, Westergren tube is used to determine E.S.R. The tube is 300 mm long and opened on both ends.
- It is marked 0 to 200 mm from above downwards. Westergren tube is used only for determining E.S.R.
- 1.6 mL of blood is mixed with 0.4 mL of 3.8% sodium citrate (anticoagulant) and loaded in the Westergren tube.
- The ratio of blood and anticoagulant is 4:1. The is filled to stand vertically and left undisturbed. The reading is taken at the end of 1 hour.

Wintrobe Method

- In this method, Wintrobe tube is used to determine ESR.
- Wintrobe tube is a short tube opened on only one end. It is 110 mm long with 3 mm **bore**. Wintrobe tube is used for determining E.S.R and P.C.V.
- It is marked on both sides. On one side the marking is from 0 to 100 (for E.S.R) and on other side from 100 to 0 (for P.C.V).

Normal Values of ESR

- **By Westergren Method**

In males : 3 to 7 mm in 1 hour

In females : 5 to 9 mm in 1 hour

Infants : 0 to 2 mm in 1 hour

- **By Wintrobe Method**

In males : 0 to 9 mm in 1 hour

In females : 0 to 15 mm in 1 hour

Infants : 0 to 5 mm in 1 hour

Significance of Determining E.S.R

- Erythrocyte sedimentation rate (E.S.R) is an easy, inexpensive non specific test which help in diagnosis and prognosis.
- Determination of E.S.R is especially helpful in assessing the progress of patients treated for certain chronic inflammatory disorders such as
 1. **Pulmonary tuberculosis** -
 2. **Rheumatoid arthritis**- a chronic progressive disease causing inflammation in the joints and resulting in painful deformity and immobility, especially in the fingers, wrists, feet, and ankles.
 3. **Temporal arteritis**- is inflammation of arteries of head.

Physiological Variation

1. *Age*: ESR is less in children and infants because of more number of RBCs.
2. *Sex*: It is more in females than in males because of less number of RBCs.
3. *Menstruation*: The E.S.R increases during menstruation because of loss of blood and RBCs.
4. *Pregnancy*: From 3rd month to parturition, ESR increases up to 35 mm in 1 hour because of hemodilution.

Factors Increasing E.S.R

1. Specific gravity of RBC

when Specific gravity of RBC increases cells become heavier and sedimentation is fast. So E.S.R increases.

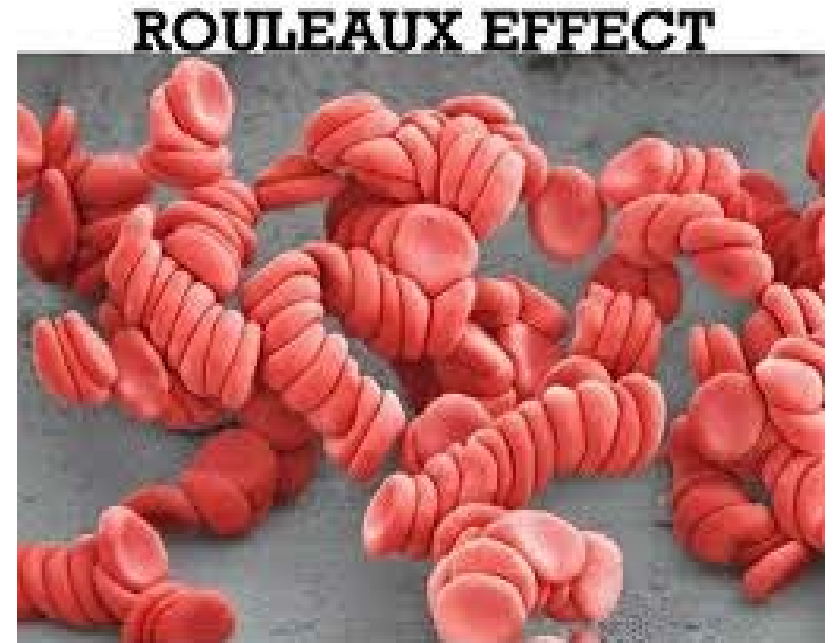
2. *Rouleaux Formation*

Rouleaux formation increases the E.S.R. Globulin and fibrinogen accelerates the rouleaux formation.

3. Increase in Size of RBC

When the size of RBC increases (macrocyte), ESR also increases

Morphology of Rouleaux Effect



Stacking of Red Blood Cells

Factors Decreasing E.S.R

1. *Viscosity of Blood*

Viscosity offers more resistance for settling of RBCs. So when the viscosity of blood increases, the ESR decreases.

2. *RBC count*

When RBC count increases, the viscosity of blood is increased and E.S.R decreases. And when the RBC count decreases, E.S.R increases.

- E.S.R increases in diseases such as the following conditions:
 1. Tuberculosis
 2. All types of anemia except sickle cell anemia
 3. Malignant tumors
 4. Rheumatoid arthritis
 5. Rheumatic fever: Rheumatic fever causes inflammation, especially of the heart, blood vessels, skin , brain and joints.
 6. Liver diseases

- ESR decreases in the following conditions:
 1. Allergic conditions
 2. Sickle cell anemia
 3. Polycythemia
 4. Severe leukocytosis.

