



Erythrocyte Sedimentation Rate (ESR)

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INTRODUCTION



- Erythrocyte sedimentation rate (ESR) is a non-specific test for inflammation.
- It is easy to perform, widely available and inexpensive making it a widely used *screening test*
- It is also used a monitoring tool for response to treatment in conditions in which it is raised (Tuberculosis, Autoimmune diseases etc)

ESR

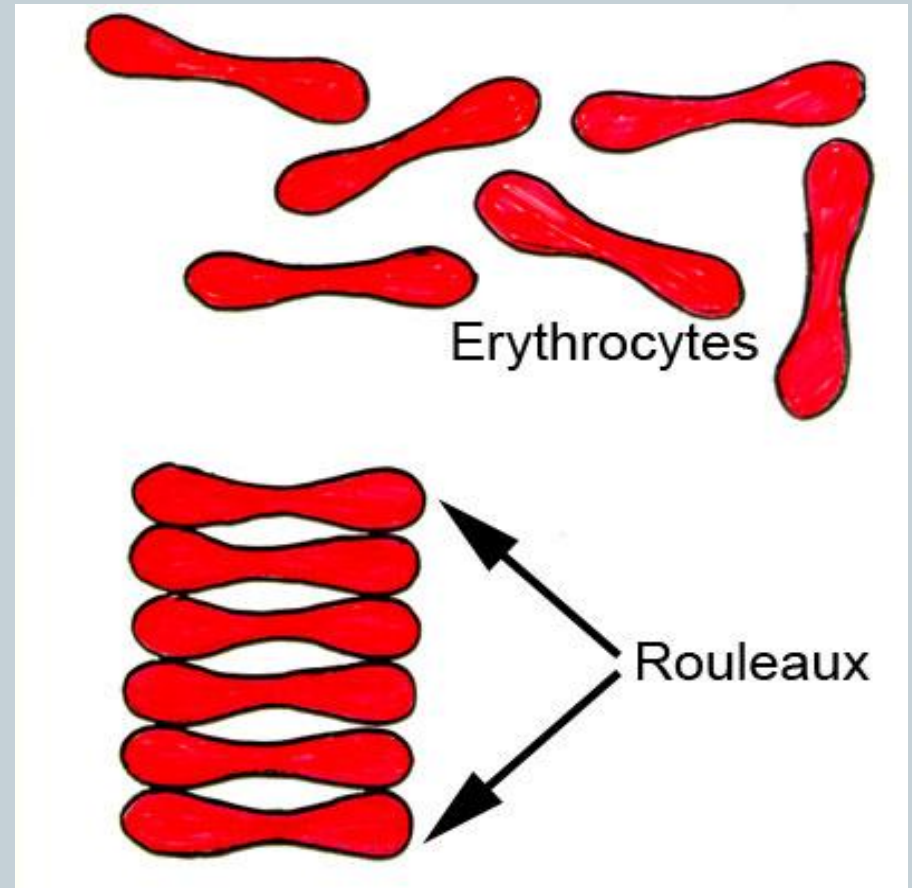


- Consist of allowing a specific amount of blood to sit in a vertical position for a period of time (usually one hour).
- The distance, in millimeters, that the red cells fall during this time period is the erythrocyte sedimentation rate and is reported in mm at one hour.

Stages of ESR

Three stages:

- **Rouleaux formation**
(10 minutes)
Red cells stack together
like pair of coins
- **Sinking of rouleaux**
(40 minutes)
- **Cell packing :**
(10 minutes)



The ESR is affected by three factors:

1. Erythrocytes
2. Plasma Composition
3. Mechanical/Technical Factors

Erythrocytes



- Macrocytes tend to sediment rapidly than microcytes
- Alterations of ratio of red cells to plasma
 - Decreased red cell mass in anaemia increases ESR
 - Increased red cell mass in polycythemia decreases ESR
- Sickle cells and spherocytes are unable to form rouleaux and therefore ESR is low.

Plasma Composition



- In normal blood, the RBCs remain more or less separated. They are negatively charged and, therefore repel each other. (Zeta Potential)
- Increased plasma protein concentration, most notable fibrinogen, immunoglobulins and acute phase proteins (C-reactive protein, ceruloplasmin, α -1 globulin) , cause a reduction in the negative charge of the RBCs and facilitates formation of rouleaux.
- Removal of fibrinogen by defibrination and increase in the albumin retard ESR

Mechanical/Technical factors



- It is important that the ESR tube be exactly perpendicular. A tilt of 30° can cause errors up to 30%.
- The rack, holding the tubes should not be subject to any movement or vibration.
- The sedimentation rate increases as the temperature increases.
- ESR tubes with a narrower than standard bore will generally yield lower sedimentation rates.

Significance of the ESR



- The ESR represents a nonspecific response to tissue damage and inflammation.
- It primarily reflects changes in the plasma proteins that accompany most the acute and chronic infections, tumors, and degenerative diseases.
- It may be used to follow the progress of certain diseases such as tuberculosis and rheumatoid arthritis.
- Important criterion in establishing the diagnosis of temporal arteritis and polymyalgia rheumatica.

- **An elevated ESR may be found in**

1. Pregnancy (after the third month).
2. Acute and chronic infections.
3. Rheumatic fever.
4. Rheumatoid arthritis.
5. Myocardial infection.
6. Nephrosis.
7. Acute hepatitis.
8. Menstruation.
9. Tuberculosis.
10. Hypothyroidism.
11. Hyperthyroidism.

- Adults over 60 years of age frequently have a slightly higher ESR value due primarily to decreased concentrations of plasma albumin.

- **A decreased ESR will be present in:**
 1. Polycythemia.
 2. Congestive heart failure.
 3. Hypofibrinogenemia.
 4. The presence of red blood cell abnormalities (poikilocytosis, spherocytes, and sickle cells).

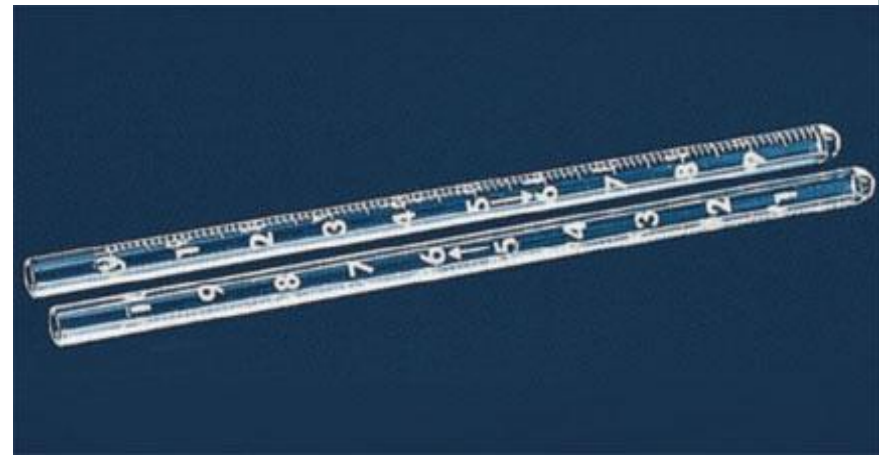
Methods for estimation of ESR



- **MANUAL** - Wintrobe's Method
Westergen's Method
Zeta Sedimentation ratio
Micro ESR Method
- **AUTOMATED** – Monitor 100
Ves-matic 60
Sedimatic
Sediscan

WINTROBE METHOD

Wintrobe tube:



- 110 mm long, narrow, thick walled tube with 3mm internal bore.
- Graduated from 0-10 cm with graduation both in ascending and descending order on 2 sides of tube.
- The scale with the markings from 0-10 from above downwards is used in ESR determination and from below upward is used for Hematocrit (PCV) determination.

WINTROBE TUBE WITH STAND

110mm long

Internal diameter 2.5 mm

Calibrated both sides

0- 10

10 -0



60-106



 **dolphin**

Procedure

- Mix the anti coagulated blood thoroughly.
- Fill the wintrobe tube by using Pasteur pipette upto mark 0.
- Place the tube vertically in a stand.
- Note the ESR at the end of 1 hour.

Westergren's Method

- Westergren rack.
- Leveling plate for holding the Westergren rack
- Timer.



Westergren's Method

Recommended by ICSH

1. Westergren pipette

- 30 cm in length
- 2.5 mm internal diameter,
- Marking on the tube is 0 - 200 mm.
- Clean and dry
- Anticoagulant used 3.8% trisodium-citrate dihydrate solution (1:4)



Specimen



- Venous blood collected in trisodium citrate solution in 4:1 proportion
- Test should be carried out within four hours of blood collection if specimen is kept at room temperature
- Mix the blood and anticoagulant thoroughly
- There should be no clots and air bubbles in the blood.

Procedure



- Fill the Westergren pipette by inserting in a vacutainer tube containing 1.6 ml blood and 0.4ml anticoagulant
- Keep the pipette upright in the ESR stand lying on the leveled surface
- Read the upper level of RBC column exactly after one hour
- N.R. Adult Males : 0 to 10 mm in 1 hour &
Adult Females : 0 to 20 mm in 1 hour

Modified Westergren Method

- EDTA blood is used instead of citrate.
- 2ml of EDTA blood is diluted with 0.5 ml of 3.8% TSC or 0.85% NaCl
- Undiluted blood gives poor precision.

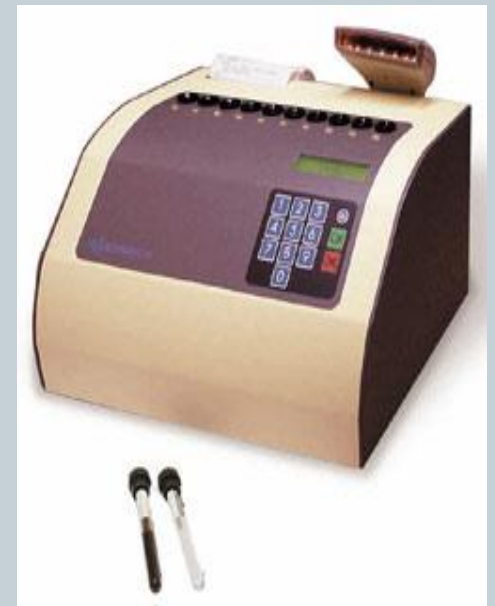
Source of error

- Improper ratio of blood and anticoagulant.
- Hemolysed sample.
- Clotted blood.
- Presence of air bubbles.
- Error due to sunlight, vibration, small bore size, dirty and wet tube.
- Delay in performing the test.

Automated ESR method



Automated ESR analyzers



VES-MATIC 20 instrument

- It is designed to measure 20 blood sample.
- Result are comparable to Westergren method
- results are available in approximately 22 minutes.



Vasmatic 20

WORKING PRINCIPLE

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graph TD; A[WORKING PRINCIPLE] --> B[Blood is collected in a special cuvette]; B --> C[Sample is mixed by instrument]; C --> D[Sample is allowed to stand at 18° slant from vertical]; D --> E[Opto-electrical sensor measure ESR]; E --> F[Data are elaborated and printed];
```

Blood is collected in a special cuvette

Sample is mixed by instrument

**Sample is allowed to stand at 18° slant
from vertical**

Opto-electrical sensor measure ESR

Data are elaborated and printed

ESR STAT PLUS

- It is centrifugation based method.
- Provides results in 5 minutes.



ESR STAT PLUS

centrifugation
based method

Provides result
in 5 minutes

WORKING PRINCIPLE

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graph TD; A[WORKING PRINCIPLE] --> B[Sample is placed in centrifuge]; B --> C[Infrared laser tracks the erythrocytes plasma interface & takes multiple measurements]; C --> D[Linear portion of sedimentation is identified]; D --> E[Software algorithm to determine ESR result];
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Sample is placed in centrifuge

Infrared laser tracks the erythrocytes plasma interface & takes multiple measurements

Linear portion of sedimentation is identified

Software algorithm to determine ESR result

SEDIMAT

- The filled Sediplast Westergren pipet is placed into the SEDIMAT automated ESR reader, which accelerates sedimentation under controlled conditions.
- The reader displays the results of each sample on an LCD display after 15 minutes.
- The results are also stored in memory and can be printed out.



Sedimat 15

Zeta Sedimentation Ratio

- The ZSR is performed using a special, small-bore capillary tube that is filled with blood and spun for 3 to 4 minutes in a special centrifuge called the Zetafuge
- Centrifuge alternately compacts and disperses the RBCs under standardized centrifugal force
- Tube is then read on a special reader to obtain a value called the zetacrit
- It is rapid, corrects for anemia, and requires only a small blood sample, which is desirable for pediatric patients

ZETA FUGE

ZETA SEDIMENTATION RATIO

553



Fig. 2. Photograph of Zetafuge, the centrifugal device that produces the repetitive cycles of compaction and dispersion.

Advantages of automated method



- Automated ESR analyzer is designed to accurately and precisely measure the sedimentation rate of erythrocytes in ESR tubes
- Less sample volume.
- Barcode Scanner
- Results in 20-30 minutes
- Built-in Printer
- No external influence of temperature, tilting of tubes.
- Higher number of samples can be processed simultaneously

Automated ESR method



- On comparing manual and automated methods for measuring ESR, discrepancy was noted for HIGH ESR values.
- This was however, not evident for normal ESR values.
- Hence it is recommended that a correction factor be applied while using automated equipment.



THANK YOU