

E.S.R. Red Blood Cell Synthesis Speed Test

Bandar.F.Alsubahi¹, Maha.S.Shthab², Saad.H.Aljadran³, Fayez.A.Algarni³,
Awadh.M.Al-Shahri³, Shaker.B.Alqarni³, Khalaf.A.Alhalafi⁴,
Mohammed.S.Albishi⁴, Saad.A.Albeshi⁵, Emad.S.Alghamdi⁶

Laboratory specialist – King Faisal hospital¹

Laboratory technician- Alkakiya PHC²

Medical laboratory Specialist- King Abdullah hospital Bisha³

Medical laboratory technician - King Abdullah hospital Bisha⁴

Medical laboratory technician - Bisha Maternity and children's hospital⁵

Medical laboratory technician- King Abdullah hospital Bisha⁶

Abstracts

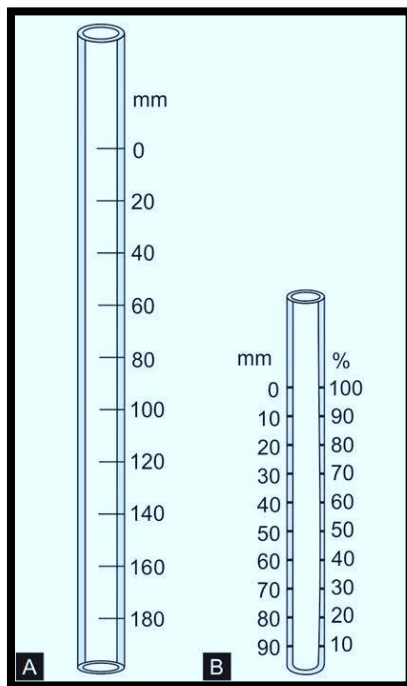
The ESR (erythrocyte sedimentation rate) is a century old and common test for detecting acute and chronic inflammation. This test has served as a nonspecific indicator of presence of disease. It also has been found useful in monitoring response to therapy, especially in rheumatologic disease. It reflects both plasma concentration of acute-phase proteins of large molecular size and anaemia. The ESR test is easy to perform and inexpensive, is used today as a routine test worldwide. However, the ESR has some demerits, in requiring large volume of sodium citrate or EDTA blood and at least 1 hr testing time. The minimum of 1 hr testing time is not practical for modernized laboratories. Present study evaluates the process, background, levels and other associated components of ESR.

Keywords: ESR test, Laboratory, History, process.

1. Introduction

Erythrocyte Sedimentation Rate (ESR) is a kind of test that can detect the fluctuation in inflammatory activity of the body, which is being generally caused by some of the conditions like disease of self-immune, some infections, tumors, etc. The test of ESR is not for the detection of unitary diseases but or unitary test but it is performed in combination with other tests that are performed to check the fluctuation in inflammatory activity in the body. In the recent past ESR was performed in a number of different ways but the history of the same is around 100 years or so when Westergren introduced the same in 1921, after this many of the individuals and agencies have reformed, renewed and revamped the test but still all of them were based on the findings as mentioned by Westergren. As of now the system of ESR has become automated as well where the mechanized readers and blood collection tubes are used, and even the test can be performed in minimum given time. This is a well-known fact that the RBCs use to travel with our blood

stream and the ESR test ought to measure this travel pattern of RBC (in mm), here the time lap is around 1 hour and the tube used to measure it is called Westergren tube.



Source: <https://www.pinterest.com/pin/768497123910530222/>

Figure 1: Westergren (A) and Wintrobe (B) Tubes

In 1918 Dr. Robert Fahraeus refined the state of ESR test and the same was taken to an advance level by Dr. Alf Vilhelm Albertsson Westergren in 1921, as he introduced the of ESR and the same are being followed till now. This is the reason that another name given to the test was Fahraeus-Westergren test or FW test.

The Westergren strategy for measuring the ESR proposed by the Worldwide Committee for Standardization in Hematology (ICSH) has permitted reproducibility for nearly a century. Over time, this same strategy has set up comparable reference values inside the same research facility and indeed between diverse offices over the globe. The ICSH received the Westergren strategy as the gold standard for ESR estimation in 1973. Indeed after the appearance of robotized machines utilized to analyze the ESR, the Westergren strategy was still affirmed as the gold standard in 2011 by both the ICSH and the Clinical and Research facility Guidelines Established (CLSI).

1. Pathophysiology:

As stated above the ESR test is performed to measure the speed of RBCs and this is done by measuring the speed at which single blood sample goes to the bottom of Westergren tube, this process is called as sedimentation, if the flow is fast then it can be established that a given patient is carrying conditions for the cause of infections, cancer, etc. as such conditions can increase the amount of proteins in the blood and clumps are formed at the bottom of the tube.

Ordinarily, RBCs have negative charges on the exterior of the cells, which cause them to repulse each other. Numerous plasma proteins have positive charges and can successfully neutralize the negative surface charges of the RBCs, which permits for the arrangement of the rouleaux. Subsequently, an increment in plasma proteins (show in provocative conditions) will engender an increment in rouleaux arrangements, which settle more promptly than single ruddy blood cells. The settling of the rouleaux totals within the Westergren tube happens at a consistent rate. The arrangement of rouleaux permits the RBCs to settle at a quicker rate, in this way expanding the ESR. Therefore, the ESR isn't the degree of a single marker but a physical handle. Rouleaux arrangement (and hence the ESR) is influenced by the sums of immunoglobulins and intense stage proteins (prothrombin, plasminogen, fibrinogen, C-reactive protein, alpha-1 antitrypsin, haptoglobin, complement proteins) that are show in a few provocative conditions. "Acute-phase proteins" (APP) is the title given to a course of roughly 30 unmistakable, chemically irrelevant plasma proteins that are naturally controlled in reaction to disease and aggravation. APPs are created by the liver and are practically controlled by the body in reaction to a few shapes of tissue harm or offended. These proteins act as inhibitors or go between the provocative reaction.

2. Specimen Requirements and Procedure:

The method of ESR requires a small amount of blood, then a phlebotomist will obtain the blood sample. The sample of blood is collected in a ESR vacuum tube which already contains 3.2% sodium citrate anticoagulant. Then in the laboratory sample is put in Westergren tube and after about one hour RBCs gradually settle at the bottom because of gravity and plasma along with other elements of blood remain at the top of the tube. The test result will depend on the amount of plasma at the top of the tube, measured after one hour. The result will be reported in millimeters per hour (mm/hr).

3. Diagnostic Tests:

ESR can be measured by different strategies, counting the Westergren, Wintrobe, micro-ESR, and mechanized machines. Truly, the Westergren was the foremost commonly utilized strategy of performing the ESR. Specialized variables, such as the sum of blood drawn into the tube, vibrations, temperature, time from example collection, the expansion of appropriate anticoagulants, and tube introduction, can influence the comes about. RBC measure, shape, and concentration can modify the ESR comes about. Plasma characteristics too have an affect on the esteem of the ESR. The Westergren strategy has classically been utilized to degree the ESR based on the separate RBCs settle to the foot of an stretched tube with a 2.5 cm inside bore. It is graduated descending in millimeters, from to 200, permitting the clear plasma to stay at the beat of the tube after the RBCs have settled toward the foot due to gravitational constrain after one hour of observation.

The micro-ESR could be a strategy of getting the ESR utilizing capillary tubes and speedier testing times. This strategy employs four drops of capillary blood drawn through fingerstick, at that point blended in a 4:1 proportion on a slide with a 3.8 percent sodium citrate arrangement. The test is at that point drawn into a 7.5-centimeter heparin-free microhematocrit capillary tube. The comes about are measured at fair 20 minutes and after that balanced to foresee routine ESR values from the micro-ESR esteem. Other computerized strategies for deciding the ESR have gotten to be accessible. One consider demonstrated that less labs utilize the unmodified Westergren method, and comes about utilizing mechanized machines might contrast from ordinary comes about by 142%.

Several unused mechanized and semi-automated procedures have ended up accessible for deciding the ESR; these strategies are more secure and speedier with higher precision. The Universal Board for Standardization in Hematology (ICSH) has surveyed the exactness and consistency of over a dozen strategies. Suggestions have been made for the producers for the approval of unused ESR strategies. Later thinks about demonstrate that automated estimations of the ESR have tall comparability with the Westergren strategy. Numerous computerized machines don't degree sedimentation but rather calculate a scientifically inferred rate based on total estimations within the early stages of RBC clumping (rouleaux arrangement). It'll be up to the producers and healthcare offices to guarantee the unused methods are approved and confirmed.

<i>Factors that increase ESR</i>	<i>Factors that decrease ESR</i>	<i>Factors with no clinically significant effect or questionable effect</i>
Old age Female Pregnancy Anemia Red blood cell abnormalities Macrycytosis Technical factors Dilution problem Increased temperature of specimen Tilted ESR tube Elevated fibrinogen level Infection Inflammation Malignancy	Extreme leukocytosis Polycythemia Red blood cell abnormalities Spherocytosis Acanthocytosis Microcytosis Technical factors Dilution problem Inadequate mixing Clotting of blood sample Short ESR tube Vibration during testing Protein abnormalities Hypofibrinogenemia Hypogammaglobulinemia Dysproteinemia with hyperviscosity state	Obesity Body temperature Recent meal Aspirin NSAIDs



Source: http://www.medical-labs.net/factors-that-may-influence-esr-867/#google_vignette

Figure 2: Factors Influencing ESR

Factors, such as regular varieties in room temperature, time from example collection, tube introduction and slant, and vibration, can influence the comes about. The next room temperature diminishes blood thickness and may increment the ESR. Coordinate daylight can increment the ESR. A tilted ESR tube and vibrations may also cause an increment within the ESR esteem. A point of three degrees from vertical can increment the ESR by 30 percent. Dishonorable filling of the ESR tube may cause bubble arrangement and increment the ESR esteem. A blood sample allowed to sit too long before starting the test will cause RBC sphering and decrease the ESR value. The test should be run within two hours of collection. A clotted blood sample will inhibit rouleaux formation and decrease the ESR.

4. Report formation:

The reference range of the ESR test is given by the laboratory testing it and this is a mandatory condition. as a matter fact the ESR is typically higher in females as compared to males and increases gradually with age. Values of the test as given by Westergren were:

- ❖ Male <50 years old: ≤ 15 mm/hr
- ❖ Female <50 years old: ≤ 20 mm/hr
- ❖ Male >50 years old: ≤ 20 mm/hr
- ❖ Female >50 years old: ≤ 30 mm/hr
- ❖ Child: ≤ 10 mm/hr

5. Medical Interpretation:

There are a number of factors that can influence the state of ESR, as the Females do have increased ESRs compared to males. Pregnancy and aging may also increase the ESR. Anemia, RBC abnormalities, technical factors such as tilted ESR tubes, increased specimen temperature, and dilution errors may increase the ESR.

An Increased level of ESR refers to some of the below given diseases:

- ❖ Anemia
- ❖ Arteritis
- ❖ Infections (including bone and joint)
- ❖ Kidney disease
- ❖ Low serum albumin
- ❖ Systemic lupus erythematosus
- ❖ Lymphoma, including lymphoplasmacytic lymphoma
- ❖ Multiple myeloma
- ❖ Polymyalgia rheumatica

- ❖ Red blood cell abnormalities
- ❖ Rheumatoid arthritis
- ❖ Systemic vasculitis
- ❖ Thyroid disease

Increased ESR	Decreased ESR
<ul style="list-style-type: none"> • Pregnancy • Anemia • Macrocytosis • Inflammatory disease • Acute and chronic infection • Multiple myeloma • Rheumatic fever • Rheumatoid arthritis • Anemia • Tuberculosis • Systemic lupus erythematosus 	<ul style="list-style-type: none"> • Hyperviscosity • Decreased fibrinogen levels • Polycythemia • Sickle cell anemia • Spherocytosis • Microcytosis

Source: <https://www.slideshare.net/slideshow/erythrocyte-sedimentation-rate/46654718>

Figure 3: Medical Significance of ESR Levels

The test must be performed using blood drawn within two hours of testing. In standing blood, erythrocytes tend to become spherical, which impedes rouleaux formation. Anisocytosis and poikilocytosis also interfere with erythrocyte stacking, thus decreasing the ESR. Certain medications (valproic acid, statins, nonsteroidal anti-inflammatory drugs) may lower the ESR value.

6. Safety Measures at Laboratory:

For non-waived tests, laboratory regulations require, at the minimum, analysis of at least two levels of control materials once every 24 hours. Research facilities can measure QC tests more habitually to guarantee precise comes about. Quality control tests ought to be measured after calibration or upkeep of an analyzer to confirm the proper strategy execution. To play down QC when performing tests for which manufacturer's proposals are less than those required by the administrative organization (such as once per month), the labs can create an individualized quality control arrange (IQCP) that includes performing a hazard appraisal of potential sources of mistake in all stages of testing and putting in put a QC arrange to reduce the probability of mistakes. Westgard multi-rules are utilized to assess the quality control runs. In case of any run the show infringement, appropriate corrective and preventive activity ought to be taken some time recently persistent testing.

The research facility must participate within the outside quality control or capability testing (PT) program because it may be a administrative prerequisite distributed by the Centers for Medicare and Medicaid Administrations (CMS) within the Clinical Research facility Enhancement Revisions (CLIA) controls. It is supportive to guarantee the precision and unwavering quality of the research facility with respect to other research facilities performing the same or comparable measures. Required cooperation and scored comes about are checked by CMS and deliberate accreditation organizations. The PT arrange ought to be included as an perspective of the quality appraisal (QA) arrange and the by and large quality program of the research facility.

Consider all examples, control materials, and calibrator materials as possibly irresistible. Work out the regular safeguards required for dealing with all research facility reagents. Transfer of all squander fabric ought to be in agreement with neighborhood rules. Wear gloves, a lab coat, and security glasses when taking care of human blood examples. Put all plastic tips, test mugs, and gloves that come into contact with blood in a biohazard squander holder. Dispose of all expendable crystal into sharps squander holders. Ensure all work surfaces with expendable retentive seat best paper, disposed of into biohazard squander holder's week by week or at whatever point blood defilement happens.

2. Conclusion:

Individuals with elevated ESR values may not always have a medical condition that requires treatment. A result outside the usual range is not necessarily a cause for concern. Slightly higher levels can occur due to laboratory errors, pregnancy, menstruation, or advancing age. The ESR result may establish the presence of an inflammatory condition within the body, but the test is not specific to any disease process. It must be combined with other modalities to define an underlying ailment. The use of the ESR as a screening test in asymptomatic patients is limited due to the low sensitivity and specificity. In the event that there exists a doubt of malady, the ESR may have a few levels as a sickness index. In case the level is greatly hoisted (>100 mm/hr), an clear cause is ordinarily display (threat, contamination, worldly arteritis). On the off chance that the level is mellow to modestly hoisted without self-evident causes, extra testing may be included in a broad explore for the basic malady prepare. There's no prove to recommend that a lifted ESR not upheld by a disturbing history, physical, or other modalities ought to provoke an broad workup or advance obtrusive methods. Rehashing the ESR testing in an asymptomatic persistent after a few months may be shown in case a patient's condition is stable. A continuously raised ESR may provoke a more broad and costly rummage around for covered up illnesses.

WORKS CITED

-
- Grzybowski A, Sak J. Edmund Biernacki (1866-1911): Discoverer of the erythrocyte sedimentation rate. On the 100th anniversary of his death. *Clin Dermatol*. 2011 Nov-Dec;29(6):697-703.
- Harrison M. Erythrocyte sedimentation rate and C-reactive protein. *Aust Prescr*. 2015 Jun;38(3):93-4.
- Narang V, Grover S, Kang AK, Garg A, Sood N. Comparative Analysis of Erythrocyte Sedimentation Rate Measured by Automated and Manual Methods in Anaemic Patients. *J Lab Physicians*. 2020 Dec;12(4):239-243.

- Hashemi R, Majidi A, Motamed H, Amini A, Najari F, Tabatabaey A. Erythrocyte Sedimentation Rate Measurement Using as a Rapid Alternative to the Westergren Method. *Emerg (Tehran)*. 2015 Spring;3(2):50-3.
- Litao MK, Kamat D. Erythrocyte sedimentation rate and C-reactive protein: how best to use them in clinical practice. *Pediatr Ann*. 2014 Oct;43(10):417-20.
- Bray C, Bell LN, Liang H, Haykal R, Kaikow F, Mazza JJ, Yale SH. Erythrocyte Sedimentation Rate and C-reactive Protein Measurements and Their Relevance in Clinical Medicine. *WMJ*. 2016 Dec;115(6):317-21.
- Harr KE. Sample Collection. *Vet Clin North Am Exot Anim Pract*. 2018 Sep;21(3):579-592.
- Alende-Castro V, Alonso-Sampedro M, Vazquez-Temprano N, Tuñez C, Rey D, García-Iglesias C, Sopena B, Gude F, Gonzalez-Quintela A. Factors influencing erythrocyte sedimentation rate in adults: New evidence for an old test. *Medicine (Baltimore)*. 2019 Aug;98(34):e16816.
- Ramsay ES, Lerman MA. How to use the erythrocyte sedimentation rate in paediatrics. *Arch Dis Child Educ Pract Ed*. 2015 Feb;100(1):30-6.
- Kratz A, Plebani M, Peng M, Lee YK, McCafferty R, Machin SJ., International Council for Standardization in Haematology (ICSH). ICSH recommendations for modified and alternate methods measuring the erythrocyte sedimentation rate. *Int J Lab Hematol*. 2017 Oct;39(5):448-457.
- Lapić I, Piva E, Spolaore F, Tosato F, Pelloso M, Plebani M. Automated measurement of the erythrocyte sedimentation rate: method validation and comparison. *Clin Chem Lab Med*. 2019 Aug 27;57(9):1364-1373.
- Yayan J. Erythrocyte sedimentation rate as a marker for coronary heart disease. *Vasc Health Risk Manag*. 2012;8:219-23.
- Singh AS, Atam V, Yathish BE, Das L, Koonwar S. Role of erythrocyte sedimentation rate in ischemic stroke as an inflammatory marker of carotid atherosclerosis. *J Neurosci Rural Pract*. 2014 Jan;5(1):40-5.
- Cheema MR, Ismaeel SM. Temporal arteritis with erythrocyte sedimentation rate <50 mm/h: a clinical reminder. *Clin Interv Aging*. 2016; 11:185-8.
- Orr CK, Najm A, Young F, McGarry T, Biniecka M, Fearon U, Veale DJ. The Utility and Limitations of CRP, ESR and DAS28-CRP in Appraising Disease Activity in Rheumatoid Arthritis. *Front Med (Lausanne)*. 2018; 5:185.
- Saleh A, George J, Faour M, Klika AK, Higuera CA. Serum biomarkers in periprosthetic joint infections. *Bone Joint Res*. 2018 Jan;7(1):85-93.
- Lavery LA, Ahn J, Ryan EC, Bhavan K, Oz OK, La Fontaine J, Wukich DK. What are the Optimal Cutoff Values for ESR and CRP to Diagnose Osteomyelitis in Patients with Diabetes-related Foot Infections? *Clin Orthop Relat Res*. 2019 Jul;477(7):1594-1602.
- Tas F, Erturk K. Elevated erythrocyte sedimentation rate is associated with metastatic disease and worse survival in patients with cutaneous malignant melanoma. *Mol Clin Oncol*. 2017 Dec;7(6):1142-1146.
- Yago M, Pla C. Reference-mean-centered statistical quality control. *Clin Chem Lab Med*. 2020 Aug 27;58(9):1517-1523.
- Bruno LC. IQCP: Guideline and Helpful Tools for Implementation. *Lab Med*. 2016 Nov;47(4):e42-e46.
- Poh DKH, Lim CY, Tan RZ, Markus C, Loh TP. Internal quality control: Moving average algorithms outperform Westgard rules. *Clin Biochem*. 2021 Dec; 98:63-69.
- Badrick T. Integrating quality control and external quality assurance. *Clin Biochem*. 2021 Sep; 95:15-27.