Review Article

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Erythrocyte Sedimentation Rate (with its inherent limitations) Remains a Useful Investigation in Contemporary Clinical Practice

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ABSTRACT

Erythrocyte Sedimentation Rate(ESR) determined by Westergren method is used in diagnosis and monitoring inflammatory activities. Extremely elevated ESR (>100mm/hr) is usually indicative of a serious underlying disease. ESR phenomenon occurs in three phases (Aggregation, Decantation & Packaging) and is related to certain laws of physics like Stokes's law. ESR by Westergren method is affected by RBC, Plasma and Technical factors and also by many physiological and clinical states. ESR by Westergren method is endorsed by International Council for Standardization in Haematology as a "Gold Standard" for ESR determination and provides recommendations to perform ESR by reference method. ESR by conventional Westergren method has many limitations necessitating technical innovations and alternate test methods in ESR determination.

Keywords: *ESR, Westergren, RBC factors, Plasma proteins, Technical limitation, Clinical use.*

Introduction

Erythrocyte Sedimentation Rate (ESR) estimation is a widely used laboratory test in clinical practice worldwide. ESR is performed in most laboratories because of its low cost, ease to perform and familiarity to assess acute phase inflammation response. ESR remains helpful in the specific diagnosis of few conditions including Polymyalgia rheumatica, Temporal arteritis and Rheumatoid arthritis. ESR determination by Westergren method is still the reference method despite availability of alternate methods for ESR estimation. However, there are many physiological and technical factors affecting the ESR determination by Westergren method.

This article reviews the Basics of ESR, history, physics involved in ESR phenomenon, Reference method as per International Council for Standardization in Haematology (ICSH), various factors affecting ESR by Westergren method, Clinical utility of ESR and limitations of ESR.

Discussion

Basics of erythrocyte sedimentation rate:

Erythrocyte Sedimentation Rate(ESR) is the sedimentation of red cells by observing the level to which the cells fall in a given time interval usually 1hr in a well described, specific pipette[1]. ESR is a test that may indicate and monitor an increase in inflammatory activity within the body caused by one or more conditions such as autoimmune disease, infections or tumors[2].

ESR is not specific for any disease but is used in combination with other tests to determine the presence of increased inflammatory activity. The ESR has been long used as a "sickness indicator" due to its reproducibility and low cost.

Standard-setting organizations, including International Council for Standardization in Hematology (ICSH) have repeatedly endorsed the Westergren method as the "gold standard" for determining the ESR[3]

The Westergren method measures the distance (in millimeters) at which red blood cells in anticoagulated whole blood fall to the bottom of a standardized, upright, elongated tube over one hour due to the influence of gravity. Three phases can be distinguished in the sedimentation process

The first phase, the lag or aggregation phase, reflects the period in which the individual erythrocytes from rouleaux, so there is little sedimentation. During the next decantation or precipitation phase, the plasma/ red cell interface falls more rapidly, which increases sedimentation. In the final or packing phase, the red cell aggregates pile up on the bottom of the tube or container; sedimentation slows down as a result of mutual interference of the closely packed aggregates.

Sedimentation can therefore be observed occurring in three stages: a preliminary stage of at least a few minutes during

which time rouleaux formation occurs and aggregates form; then a period in which the sinking of the aggregates takes place at approximately a constant speed; and finally, a phase during which rate of sedimentation slows as the aggregated calls pack at the bottom of the tube[4].

History of ESR[5]:

Edmund Biernacki (1866-1912), a Polish physician, first noted the increased sedimentation rate of blood from ill individuals and realized that it was due to the presence of fibrinogen. In 1918, Robin Fahraeus (1888-1968) furthered Biernacki's work. His initial motivation to study the ESR was as a pregnancy test but his interest expanded to the study of the ESR in disease states. Alf Westergren (1881-1968) refined the technique of performing the ESR and reported its usefulness in determining the prognosis of patients with tuberculosis. A variation of the methodology of the ESR was published by Windrode in 1935 and was at one time in wide use. In 1977, the International Committee for Standardization in Haematology recommended the adoption of the Westergren method worldwide.

Physics related to red cell separation from the plasma, aggregation and sedimentation in a gravity field[6]

Stokes' law states that the rate of descent of a spherical particle in a medium is represented by the equation (Eq. 1): $v = 2/9\ r^2(\rho_1-\rho_2)\ G\eta^{-1}$(Eq. 1)

in which v is the velocity of descent, r the radius of the particle, ρ_1 and ρ_2 are the densities of the particle and the medium respectively, G the gravitational constant, and η the viscosity of the medium. With the application of certain modifying numerical factors, the same law can be used to study the rate of descent (erythrocyte sedimentation rate, ESR) of erythrocytes, normally biconcave discs, in a vertical tube of narrow bore filled with anticoagulated blood. Thus, at a given altitude the ESR depends on three main factors: the size of the erythrocytes, the density of the medium, and the viscosity of the medium (plasma).

Erythrocytes in suspension normally have a net negative surface charge resulting from negatively charged sialic acid groups on the erythrocytic membrane. Two adjacent erythrocytes would thus repel each other with a force represented by the equation (Eq.2): $F = Q_1\ Q_2\varepsilon^{-1}\ \iota^{-2}$(Eq. 2)

in which Q_1 and Q_2 are the net charges of the adjacent cells, ι the distance between them, and ε the dielectric coefficient of plasma. As the dielectric coefficient of plasma increases, the repulsive force between adjacent erythrocyte decreases, and it becomes easier for them to aggregate and form rouleaux.

Dissolved proteins form amphoteric ions which are electric dipoles of high electric moment, their presence in a solution increases its dielectric coefficient. As the dielectric coefficient of plasma increases, the repulsive force between adjacent erythrocytes is attenuated and rouleaux formation promoted (Eq.2). Because the effective radius of an aggregate is greater than that of a single erythrocyte, the numerator of Eq. 1 would be greatly increased, resulting in a high ESR.

From the above, it is evident that size of the aggregates formed in the lag phase is critical for the outcome of sedimentation. Fibrinogen, immunoglobulin M (IgM), and α2-macroglobulin all have agglomerin properties fibrinogen cleavage products show a sedimentation activity that decreases with decreasing molecular size.

Reference method for measurement of the erythrocyte sedimentation rate[7]

International Council for Standardization in Haematology(ICSH) in the year 1993, proposed reference and standardized methods, using undiluted EDTA anticoagulated samples, with haematocrit of 0.35 or less under standardized conditions in a Westergren open ended glass pipette.

This ICSH method required the test to be carried out on EDTA blood not diluted in citrate, using specified Westergren tubes and using an experimentally derived Formula [Diluted blood ESR mm = (undiluted blood ESR mm x 0.86) – 12] for correction.

Because of the misleading interpretations of the reference method and the confusion as to how to use the standardized method, the ICSH expert panel has established changes of the recommendations for the reference method and eliminated the standardized method.

Blood sample requirements for ESR estimation:

Blood should be obtained by clean venepuncture over a maximum period of 30 seconds. A manual or vacuum extraction venepuncture can be used, and the blood should be taken into EDTA (K_3 or K_2) anticoagulant (dilution<1%) or in sterile trisodium citrate dihydrate ($Na_3C_6H_5O_7.2H_2O$). Prior to testing, the EDTA samples should be diluted with sodium citrate ($Na_3C_6H_5O_7.2H_2O$) in the proportion of 4 volumes of blood to 1 volume of citrate. Blood samples may be drawn into sodium citrate directly, diluted in the proportion of rate of 4 volumes of blood 1 volume of citrate. Blood citrate samples can be stored for up to 2 h at ambient temperature or 4 h at 4°C prior to testing.

Mixing of blood sample:

For standard blood collection tubes, there should be a minimum of eight complete inversions with the air bubble travelling from end to end of the tube. Mixing should be continued until immediately before the ESR pipette is filled at the start of the test.

Sedimentation pipette specifications

ESR pipettes must be disposable but, in special situations, glass pipettes can be reusable after washing and drying properly. Glass or plastic pipettes may be used but, if plastic, should not show adhesive properties towards blood cells and should not release plasticizers that affect blood or alter sedimentation. The pipettes should be colourless, circular and of sufficient length to give a 200-mm sedimentation scale. The pipette diameter must be not <2.55 mm (no upper limit is specified but the volume of blood required should be minimized). The bore has to be constant (within 5%) throughout its length.

The pipette should be filled with anticoagulated blood to a level of at least 200 mm. During the sedimentation period, and during subsequent disposal, the system must prevent blood spillage or aerosol generation.

Pipette holding device

The pipette should be held vertically, protected from direct sunlight, draughts and vibration and kept at a constant temperature (±1°C) within the range 18–25°C during the sedimentation period.

Expressing the result

The results should be recorded as sedimentation occurring at 60 min from the beginning of test and expressed as ESR = x mm.

Reference values

Reference values should be established locally and expressed in terms of results obtained with diluted blood.

In view of the progressive rise in ESR with age, separate values should be established for each decade of adult life in males and females.

The ICSH does not accept results obtained with undiluted blood samples as reference ESR values.

Table 1: Reference values for ESR by Westergren method as per literature:[8],[9],[10],[11]

New born	Child	< 50 year	>50 year
0-2 mm/hr	≤ 10 mm/hr	Male=0-15 mm/hr	Male=0-20 mm/hr
		Female=0-20 mm/hr	Female=0-30 mm/hr

Factors affecting ESR by Westergren method

Sedimentation of red cells in the Westergren tube is affected by forces both against and for sedimentation.

Forces opposing sedimentation are negative charges on the red cell surface [causing red cell to repel each other (zeta potential)], the up flow of plasma displaced by falling red cells and red cells. Forces favouring sedimentation are anaemia and plasma proteins.

I. RBC Factors:

Erythrocytes affect the sedimentation reaction primarily through changes in their number, size, shape, volume surface charge.

Macrocytic red cells with a smaller surface to volume ratio settle more rapidly increasing the ESR because of less charge in relation to mass[9].

A decreased ESR is associated with a number of blood diseases (sickle cell disease, Hereditary spherocytosis) in which red cells have an irregular or smaller shape retarding Rouleaux formation that causes slower settling. In thalassaemic RBC are broader and thinner than normal so they sediment less rapidly than normal normochromic and normocytic erythrocytes[9],[10].

II. Plasma Factors:

1) Plasma Protein:

Many plasma proteins have positive charges and can effectively neutralize the negative surface charges of the RBCs, which allows for the formation of the rouleaux.

Therefore, an increase in plasma proteins (present in inflammatory conditions) will propagate an increase in rouleaux formations, which settle more readily than single red blood cells and proteins include prothrombin, plasminogen, fibrinogen, C-reactive protein, alpha-1 antitrypsin, haptoglobin, complement proteins and immunoglobulins[2].

The effect of the proteins not only is proportional to the molecular weight but also is related to the asymmetry of the molecule. Fibrinogen is a needle-shaped molecule and the most asymmetric of the normal plasma proteins having significant influence on ESR[10].

2) Plasma viscosity :

ESR is directly proportional to the RBC mass and inversely proportional to plasma viscosity. Immunoglobulin IgM has higher intrinsic viscosity than the IgG molecule, a patient with macroglobulinemia is expected to have higher serum viscosity and, therefore, lower viscosity than the IgG molecule, a patient with macroglobulinemia is expected to have higher serum viscosity and therefore lower ESR than a patient with comparable levels of IgG immunoglobulin[6].

III. Technical factors:

1) Anticoagulant:

If the concentration is increased, the ESR will be falsely low as a result of sphering of the RBCs, which inhibits rouleaux formation[12].

Anticoagulants, sodium or potassium oxalate and heparin cause the RBCs to shrink and falsely elevate the ESR.K_3EDTA enhances blood cell stability, thus favouring rouleaux formation, preserving morphologic features, and obviating unphysiologic effects on the cells, and this is of crucial importance in the ESR reaction[13].

2) Time taken to set up the test (Age of the sample):

Blood specimens must be analysed within 4 hours of collection if kept at room temperature (18° to 25° C). If the specimen is allowed to sit at room temperature for more than 4 hours, the RBCs start to become spherical, which may inhibit the formation of rouleaux. Blood specimens may be stored at 4° C up to 24 hours before testing, but must be rewarmed by holding the specimen at ambient room temperature for at least 15 minutes before testing.

A blood sample that is allowed to sit too long before starting the test will cause RBC sphering and a decrease in the ESR[14].

3) Procedural errors:

Even a slight tilt of the pipette causes the ESR to increase[14]. An angle of 3 degrees from vertical can increase the ESR[2]. A significant change in the temperature of the room alters the ESR reading. Thus obtained is at or above 25^{0}C the observed result should be corrected for temperature using the chart or nomogram as shown below in Table: 2 and Fig.1.

Table 2: A sample of the correction chart for ESR reading according to room temperature

Room Temperature ^{0}C	Observed ESR	Corrected ESR
34	100	68
33	24	14
25	40	32
25	80	68

Bubbles in the column of blood or inadequate filling of ESR pipette invalid the test because it can increase the ESR[2].

The tubes must not be subjected to vibration on the laboratory bench, which can falsely increase the ESR. Clotted sample cannot be used as it can decrease in ESR because clotting of the blood sample will consume fibrinogen.

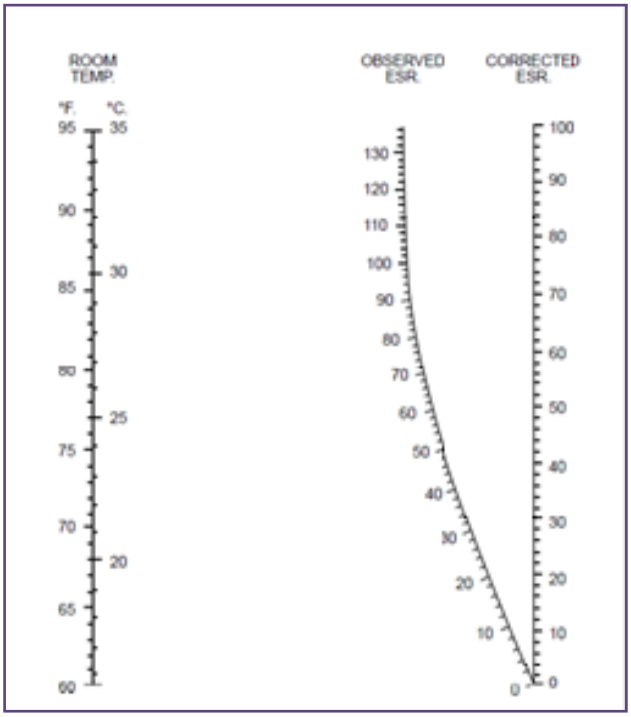

Fig. :1 A sample of nomogram for correction in ESR reading according to room temperature.

Higher room temperature decreases blood viscosity and may increase the ESR[15].

Icteric & haemolysed samples make plasma yellow or red respectively and make it difficult to differentiate from sedimented RBC[2].

VI. Physiological and Clinical factors affecting ESR

1) Physiological and clinical factors that increase the ESR

ESR values are higher for women than for men and increase progressively with age. Pregnancy also increases the ESR. During acute phase reactions, macromolecular plasma proteins, particularly fibrinogen, are produced and decrease the negative charges of red blood cells and the repellence between them, thereby encouraging rouleaux formation. Paraproteins are positively charged molecules that are abundantly present in patients with multiple myeloma and Waldenstrom's macroglobulinaemia. Like fibrinogen, paraproteins decrease the negative charges of red blood cells and the repellence between them, which increases rouleaux formation.

High protein concentrations increase plasma viscosity, which slows down the sedimentation rate and thus the ESR. However, the effects of fibrinogen and paraproteins on the negative charges of red blood cells, reducing repellence between them and promoting rouleaux formation, far outweigh the effect of increased plasma viscosity, resulting in a strong net increase of the ESR.

In anaemia, red blood cell counts are reduced, which increases rouleaux formation. In addition, the reduced haematocrit (HCT) affects the velocity of the upward plasma current so that red blood cell aggregates sediment faster. In macrocytosis, red blood cells are changed into a shape with a small surface-to-volume ratio, which leads to a higher sedimentation rate[16].

2) Physiological and clinical factors that decrease the ESR

Polycythaemia is characterised by an increased proportion of red blood cells in the blood, which artificially lowers the ESR. Polycythaemia can be caused by increased numbers of red blood cells or by a decrease in plasma volume. Red blood cell abnormalities can affect aggregation, rouleaux formation and sedimentation rate. Red blood cells with irregular or small shapes tend to settle slower and decrease the ESR. A decrease in plasma proteins, especially of fibrinogen and paraproteins, decreases the ESR.

Clinical use of ESR: [8],[12],[17]

ESR has inherent limitations in clinical utility, as it is a nonspecific test. However, ESR is a sensitive, non-specific marker of inflammation and is, in combination with clinical history and physical examination, being used as a marker of the general physical condition. There is linear correlation between fibrinogen levels in blood and ESR readings, so any condition that increases fibrinogen levels, increases the ESR.

I. Screening for disease:

ESR is neither very sensitive nor very specific as a general screening test, so ESR hasno role in screening asymptomatic individuals.

Asymptomatic conditions: ESR is not an appropriate screening test in asymptomatic persons and is of little value in screening for serious disease in patients with nonspecific symptoms.

Most unexplained ESR elevations are short-lived and not associated with significant underlying disease.

Non specific symptoms: An elevated ESR in the presence of nonspecific symptoms may help justify or direct further evaluation because moderate elevation of the ESR are common in infection, inflammatory diseases and neoplastic.

A normal ESR, however dose not exclude active disease.

II. Diagnosis of disease:

ESR is useful aid in establishing the diagnosis of several diseases

A) Temporal Arteritis and Giant Cell Arteritis

In patients with temporal arteritis, the average ESR is >90 mm/h (Westergren method) and exceeds 30 mm/h in 99%. When symptoms of temporal arteritis are present, an elevated ESR—particularly a highly elevated ESR—indicates that corticosteroid therapy should be started immediately.

Thus, when clinical evidence of temporal arteritis is weak, the finding of a normal ESR value reduces the probability of the disease to less than 1%.

Giant cell arteritis may affect a variety of arteries other than the temporal artery, often with vague symptoms. A very high ESR may be an important clue to the diagnosis.

B) Polymyalgia Rheumatica

ESR is an important diagnostic criterion for two diseases: polymyalgia rheumatica and temporal arteritis. It has very few laboratory markers other than ESR elevation.

C) Rheumatoid Arthritis

American Rheumatism Association criteria use an increased ESR only in classification of possible rheumatoid arthritis, and it is 1 of 20 findings that may be present.

D) Other Inflammatory Diseases

The ESR is used in the emergency department setting in the evaluation of suspected appendicitis, pelvic inflammatory disease, septic arthritis, and other inflammatory diseases.

E) Multiple myeloma and other paraproteinemia

Increased ESR is helpful in suspecting these conditions and the importance of ESR parallels that of plasma viscosity in these conditions.

III. Monitoring of disease :

ESR continues to be used as an aid in monitoring the activity of selected inflammatory diseases.

(A) Temporal Arteritis and Polymyalgia Rheumatica :- A significant decrease in the ESR, in combination with improved clinical status, is indicative of a therapeutic response. Sustained elevation of the ESR, even with symptomatic improvement, suggests a poor response to therapy.

(B) Rheumatoid Arthritis :- ESR generally parallels disease activity and mirrors other symptoms. A sustained elevation of the ESR is associated with a poor prognosis.

(C) Other Collagen Vascular Diseases :- As with rheumatoid arthritis, the ESR generally parallels disease activity with other collagen vascular diseases.

(D) Neoplastic Diseases : - A high ESR has been found to correlate with an overall poor prognosis for various types of cancer, including Hodgkin's disease, gastric carcinoma, renal cell carcinoma, chronic lymphocytic leukaemia, breast cancer, colorectal cancer and prostate cancer. In patients with solid tumours, an ESR >100 mm/h usually indicates metastatic disease, but for most tumours this relatively nonspecific finding has been supplanted by more precise diagnostic tests

Clinical Usefulness of the Erythrocyte Sedimentation Rate[18]

Diagnosis of

Temporal arteritis

Rheumatoid arthritis

Multiple Myeloma*

Monitoring disease activity or response to treatment

Temporal arteritis

Rheumatoid arthritis

Systemic lupus erythematosus

Acute hematogenous osteomyelitis in children

Possible value for prognosis or prediction of outcome in

Bacterial otitis media

Sickle cell disease

AIDS

Pelvic inflammatory disease

Stroke severity

Coronary artery disease

Febrile intravenous drug users

Prostate cancer

Controversial

General screen especially in asymptomatic patients

Elderly patients

CONDITIONS IN WHICH ESR IS ELEVATED IN PEDIATRIC POPULATION[19]

Infectious

Oncological

Renal

Glomerulonephritis

Renal failure

Rheumatological

Acute rheumatic fever

Chronic recurrent non-infectious multifocal

Osteomyelitis*

Juvenile dermatomyositis

Juvenile idiopathic arthritis (polyarticular, systemic)

Periodic fever syndromes

Sarcoid disease

Some vasculitides:

> **Small vessel vasculitis:**
  - Granulomatosis with polyangiitis
  - Isolated childhood primary angiography-negative central nervous system vasculitis†
  - Henoch–Schönlein purpura

> **Medium vessel vasculitis:**
  - Polyarteritis nodosa
  - Kawasaki disease

> Other vasculitides:

> Behçet disease

Systemic lupus erythematosus

Other

Congestive heart failure

Inflammatory bowel disease/Coeliac disease

Interstitial lung disease

Obesity

Post-transplantation

ASSESSING PATIENTS WITH EXTREMELY ELEVATED ESR :[17],[20]

An extreme elevation of the ESR, defined as >100 mm/hr, is indicative of a serious underlying disease, most notably

infection, collagen vascular disease, metastatic malignant tumours or renal disease.

In most cases, the underlying condition is clinically apparent. In < 2% of patients with an extremely elevated ESR, no obvious cause can be found, but the underlying cause can usually be found in combination with the clinical history, physical examination and other standard laboratory tests.

QUALTY CONTROL FOR CONVENTIONAL WESTERGREN METHOD FOR ESR DETERMINATION[4]

As ESR procedure cannot be calibrated but it is inherently quite stable. Therefore, unless some change is made in specimen collection equipment or procedure an ESR method that is in control to start with is likely to remain in control.

Verification of any working routine ESR method against the reference method should be performed at a frequency determined by the laboratory's standard operating procedure, and particularly when any changes in pipettes, personal or other variables are introduced.

Verification against the reference method detects errors in the volume or quality of the diluent and in the adequacy of mixing the diluent with blood in the working method.

As per specific criteria for Accreditation of Medical Laboratories published by National Accreditation Board for Testing and Calibration Laboratories (NABL Document 112), Monitoring of Coefficient of variation % is not mandatory except for the automated method (due to algorithmic extrapolation). Split testing or exchange of samples between laboratories for ESR is also not required.[21]

As regards Automated systems, most of the manufacturers supply instrument and method specific control material for Internal Quality Control (IQC) with prescribed ranges for the ESR values. For e.g., Celltacα+ Hematology analyser, Nihon Kohden with automated ESR facility, MEK 3D L and MEK 3D N dedicated control materials are used for IQC purposes.

Limitations of conventional Westergren ESR method necessitating technical innovation and alternate test (automated) methods for ESR estimation[2],[12],[22]

Long analytical time (60 minutes sedimentation time plus setup and reading times) requirements for relatively large specimen volumes (1.0 – 2.0 ml a limiting factor especially in neonates & infants), need for diluting specimens, biohazards and elevation of ESR by anaemic primarily drive desire for alternate methods. Automated systems needing less sample volumes are a good alternative for scant sample from neonates and infants with difficult collections and short draws.

Technical factors such as variations in room temperature, time from specimen collection to test setup, tilting of vibrating, exposure to direct sunlight, improper filling inconsistent internal boreholes of Westergren tubes inaccuracy in reading meniscus line in hazy samples. ESR test results & further necessitate the use of alternate test methods.

A Kratz et al[3] in their survey have reported that 72% of labs are using modified or alternate for ESR estimation.

Modified Westergren methods use no diluent or different diluents them recommended by ICSH and have shorter assay time.

Alternate ESR methods use novel approaches such as centrifugation, multiple optical readings of the erythrocyte-plasma interface, capillary photometric-kinetic technology or photometric rheology.[3]

Table 3: Partial listing of ESR instruments and their methodologies[23]

METHOD	INSTRUMENT	MANUFACTURER	METHODOLOGY
Classic method of result adjustment to 60th min	ESR STAT PLUS	HemaTechnologies	Multiple optical readings of the erythrocyte plasma interface are used to determine the ESR.
	Excyte M	Vital Diagnostics	Measurement of sedimentation at 30 min, mathematically adjusted to a 1- h Westergren ESR.
	iSED	Alcor Scientific Inc.	Photometric rheology is used to measure the aggregation of red blood cells. Results are correlated with the Westergren method.
	Sedisystem	B.D.	Seditainer ESR tubes are put into a system rack, samples are homogenized. A camera records the initial cell layer height and the final sedimentation level reading after 20 min. Results are converted by polynomial extrapolation to correlated with conventional Westergren method.

METHOD	INSTRUMENT	MANUFACTURER	METHODOLOGY
Classic method of result adjustment to 60th min	Starrsed	MECHATRONICS	Measures ESR in dedicated tubes using whole blood diluted with citrate. Fully closed, automated system. Sedimentation is measured after 30 min and extrapolated to 60 min values.
	Streck ESR Auto Plus	STRECK	Measurement of sedimentation at 30 min, mathematically adjusted to a result that is comparable to a 1- h Westergren ESR.
	Vesmatic Cube 200	DIESSE	Samples are allowed to settle for 20 min, and results are converted to Westergren units.
Capillary Photometric Kinetic Technology	Test 1	ALIFAX	Utilizes capillary photometric kinetic technology. Sample is delivered into a capillary tube where it is accelerated via a "stopped-flow" circuit, which causes sedimentation of erythrocytes. Results are transformed to Westergren values and are available within 20 s.
	Microtest 1	ALIFAX	
	Roller 20LC	ALIFAX	

Conclusion

ESR is a simple, inexpensive, familiar, low cost, time tested and commonly performed laboratory investigation for assessing the inflammatory or acute response. ESR test despite its inherent limitations (technical and physiological variables) remains helpful in specific diagnosis of few conditions including temporal arteritis polymyalgia rheumatic and possibly rheumatoid arthritis.

An extreme elevation of ESR is strongly associated with serious underlying disease, most often infection, collagen vascular disease or metastatic malignancy.

ESR test in combination with patients clinical history and physical examination, can serve to aid diagnosis, management and follow up of different autoimmune disease, acute & chronic infection and tumours.

Modern and fully automated instruments have made the ESR test even more accurate and obviating many limitations of manual ESR technique safe in comparison with the manual Westergren version.

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Reference

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