

# Background on non-invasive blood rheology



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Background on Non-invasive Blood Rheology Introduction: Blood Rheology involves the study of flow of blood through the vascular system of the body. The physical principles involved in blood rheology provide the non-invasive means to ascertain the status of red blood cells in blood.

## 2. Background:

Blood can be classified in to two components plasma and red blood cells. Plasma makes up 55% of the volume of blood mainly consisting of water (50%), with plasma proteins (3-4%) and other solutes completing its constitution. Red blood cells constitute almost of the whole of the remaining part of blood by volume, with white blood cells and platelets present as minute constituents. (1)

In rheology the viscosity of a Newtonian fluid remains constant as shear rate is proportional to shear stress. However, in a non-Newtonian fluid viscosity is not constant as shear rate and shear stress are not proportional. The plasma constituent of blood is a Newtonian fluid, while whole blood is a non-Newtonian fluid, because orientation and deformation of red blood cells result in changes of apparent viscosity at different shear rates. It is this aspect of blood and its constituents that relevant to clinical investigations.

(1)

### a. Definitions:

Hematocrit:

Hematocrit may be taken as the proportion of blood by volume that is made up of red blood cells. The normal value is 40-50%. Lower values are significant marker for anemia.

Sedimentation Rate:

Sedimentation is the rate at which the red blood cells separate from the

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blood plasma over time in clinical testing of blood. It is better known as erythrocyte sedimentation rate (ESR), and high ESR is indicative of inflammation in the human body. Normal values are 5-15mm/hr, depending on the technique employed.

#### Viscosity:

Viscosity may be considered as the internal resistance of blood to shear forces. The normal values for blood viscosity vary depending upon the techniques employed in its evaluation. Higher blood viscosity is indicative of inflammation.

#### b. Relationship:

Blood viscosity for a given shear value is dependent on the hematocrit value, plasma viscosity, ESR and rheological properties. The higher these values over normal, the higher are the blood viscosity rates over normal. (1).

#### c. Clinical Significance:

Changes in blood composition occur due to several diseases and conditions, which include anemia, malnutrition and dehydration, leukemia, heart failure, kidney disease, rheumatoid arthritis, and blood loss due to trauma or surgery. Several blood tests play a role in the determination of these diseases and conditions and in tracking the efficiency of the intervention strategies. This is reason why blood tests are the normal experience during the initial clinical investigations and during the course of the treatment. (1).

Anemia is a common condition that results from the deficiency in red blood cells, which is reflected by a hemoglobin level that is less than 12g/dL in men and 13g/dL in women. According to the World Health Organization (WHO) nearly two billion people around the world are afflicted with anemia.

Untreated anemia can be a precursor for or part of several life threatening

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diseases (2).

The deformability of the red blood cells is determined by the nutritional status and the fluid balance of the body. This is the reason why blood rheology and malnutrition or dehydration has a relationship that is clinically important. (1).

During surgery blood loss is expected. Transfusions are an essential feature of surgery. The cues or triggers for the required transfusions come from the blood tests that indicate the status of the blood and the type and timing of transfusion. (2).

#### D. Current Test Methods:

Current test methods require the taking of a blood sample from the patient and employing a viscometer, centrifuge and Westergren glass pipette for the evaluation. The current testing methods have the advantages of accuracy and replication within the techniques employed. It is also the tried and tested traditional means of securing valid blood status and so commands clinical acceptance world wide. However it suffers from some disadvantages. The taking of the blood sample is painful, thereby causing discomfort to the patient. The more frequent the requirement of blood testing the more the discomfort. Current blood tests take time and proper intervention is likely delayed till it is completed and the values received. The addition of anti-coagulant could lead to changes in the actual values. There is the issue of biohazards as the blood and the disposables used in the taking of blood sample and the testing have to be suitably disposed. There are the elements of cost issues too involved in the current testing methods. Yet another disadvantage is the inability to conduct the blood tests at the site of requirement, like during surgeries and in the emergency department,

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making it inconvenient and time consuming. Blood samples have to be taken and rushed to the testing facilities and the results brought back to the required site. (2).

#### Works Cited

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