INTERNATIONAL JOURNAL OF RESEARCHES IN BIOSCIENCES, AGRICULTURE AND TECHNOLOGY
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www.vmsindia.org

A NOVEL METHOD FOR MEASUREMENT OF HEMOGLOBIN USING CAPACITANCE OF BLOOD

Arpita Gupta[1] and G.U.Kharat[2]
[1]EC Dept, Krishna Engineering College, Ghaziabad, India
[2]EC Dept, Sharadchandra Pawar College of Engineering, Pune, India,
arpita_gupta15@yahoo.co.in

Abstract:
The purpose of hemoglobin in our body is to bind oxygen. When there is a lack of hemoglobin one feels tired, suffers from headaches, dizziness, fatigue, inability to concentrate, shortness of breath, etc. Low hemoglobin causes anemia. It is suggested to get the hemoglobin level tested at regular interval. The common method to measure hemoglobin is by observing the chemical reactions in labs and estimating the hemoglobin level. In the present study it is observed that the hemoglobin can be accurately measured by measuring the capacitance of the blood sample. This study investigates the viability of measuring hemoglobin concentration by evaluating the performance of dielectric property of blood samples. In this paper the authors tried to establish a relationship between the hemoglobin and blood capacitance. It is observed that the blood capacitance decreases with increase in hemoglobin level in blood. Using this method hemoglobin level can be measured easily, accurately and quickly. By measuring the capacitance of the blood we can also predict the value of hemoglobin. The result has been verified by using data mining software, DTREG. Data mining is a computational process of determining data pattern. The paper includes the result of data mining which distinguishes the normal and abnormal hemoglobin value of blood by measuring the capacitance of blood.
Keywords: Hemoglobin, Blood Capacitance, Di-electric of blood, anemia, measurement of hemoglobin level, RBC, DTREG, Data mining.

Introduction:

The protein in red blood cells is called hemoglobin. Its main function is to carry oxygen from the lungs to the other parts of body tissues and extract carbon dioxide from the tissues back to the lungs. The main role of hemoglobin is to bind the oxygen. The low hemoglobin results in feeling tired, headaches, dizziness, fatigue, etc. Anemia is also the consequences of low hemoglobin [1-4]. A low hemoglobin range is as less than 13.5 grams of hemoglobin per deciliter of blood for men and less than 12 grams per deciliter for women. The hemoglobin is measured in grams (g) of hemoglobin (Hb) per deciliter of blood (g/dL). In case of females the normal range of hemoglobin is 12.3 to 15.3 g/dL while in case of males the normal range is 14.0 to 17.5 g/dL. Increased levels of hemoglobin in the sample blood serum generally indicate hemolytic anemia which can cause red blood cells to break down abnormally [5]. It may lead to sickle cell anemia (which is a genetic disorder that causes the RBC to be rigid and unusually shapes. It may also lead to hemoglobin C disease (which is a genetic disorder that causes the production of abnormal hemoglobin. Another disease like thalassemia may also be caused (which is a disorder that affects the body's ability to produce normal hemoglobin). It may result in congenital spherocytic anemia (which is a disorder of the red blood cell membranes) [6].

Blood is a valuable fluid in diagnosis of diseases. The precise knowledge of its contents, its biological, physical, electrical and chemical properties is of great importance. Most important is its dielectric parameters which are relevant for various medical applications [7-8]. The present method focuses on the measurement of hemoglobin by measuring the capacitance of the blood sample. It is based on the truth that the dielectric property of blood varies with the variation in its constituents. As the dielectric property changes the blood capacitance will change [9-10]. Many sensors which are used for diagnosis purposes are using this feature of the blood.

Data Mining:

Data mining is a process which includes sorting through data to identify certain patterns and establish relationships between the physical quantities. In this paper a pattern has been established between the capacitance of blood and normal and abnormal range of hemoglobin level using single tree in data mining (DTREG). It estimates the normal and abnormal ranges of hemoglobin [11].

Methodology:

Step 1: Blood samples were collected from various pathology laboratories of different patients and preserved as shown in fig 1. 225 samples of blood samples were collected. Out of

which 80 samples were of female patients and 145 were of male patients of different age group.
Step 2: The value of hemoglobin level of the samples were also taken from the respective labs.
Step 3: The capacitance of the blood is measured with the shown experimental setup in fig 2. It should be noted that a fixed amount of blood should be used for measuring purpose.
Step 4: The measured value of the capacitance is then co-related with its value of hemoglobin levels.
Step 5: In this step we verified our observation. We took blood samples randomly (5 male and 5 female samples) and measured the capacitance of it. Then the hemoglobin was checked. The measured values got fit into the curve which was obtained earlier.
Step 6: The measured value has been used for data mining to obtain the hidden pattern in the findings of the experiment.

Result:

The authors observed a relationship between hemoglobin and the age of the subject. An interesting curve is obtained between the blood capacitance and hemoglobin of the blood sample.

It is observed in Fig 3 and fig 4 that the variation of hemoglobin is related with age. The value of hemoglobin is low at early age and increases as age progress. It gets saturated in normal condition and again starts decreasing after 50's.

The measured blood capacitance value changes with hemoglobin level as shown in fig 5. It is observed that the capacitance decreases with increase in hemoglobin level.

The result of date mining is also very interesting. It is seen that the normal range of hemoglobin for male patient is between 14g/dL to 17 g/dL and the variation of capacitance is between 2.5 pF to 1.01 pF. The abnormal range of hemoglobin is less than 14 g/dL or more than 17 g/dL. The value of capacitance is varying from 2.6pF to 7.4Pf corresponding to low hemoglobin. For high hemoglobin level the capacitance value decreases from 1.01pF to 0.9pF. The decision tree is as shown in fig 6. Lets check the node 11 in the tree. It indicates that if the blood capacitance is measured 2.55pF the hemoglobin of the patient is 13.5g/dL.

Figure 1: Collected and preserved blood samples

Figure 2: Experimental set up

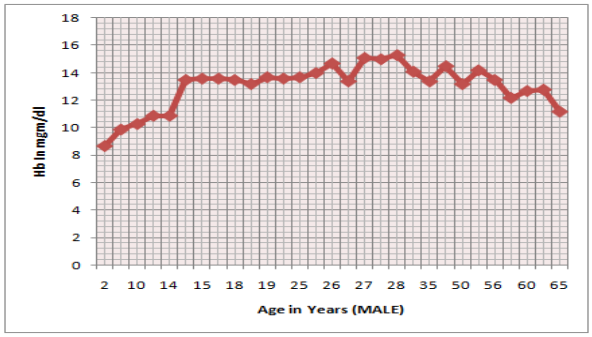

Figure 3: Age Vs Hb curve for male

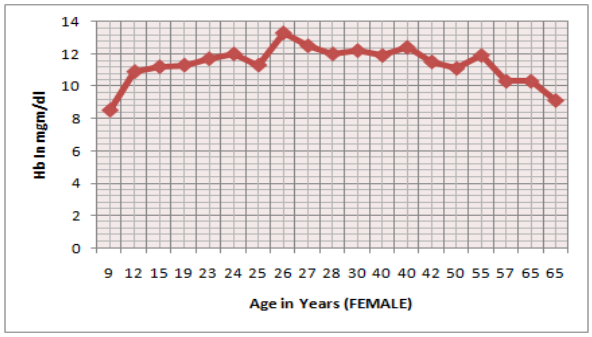

Figure 4: Age Vs Hb curve in Female

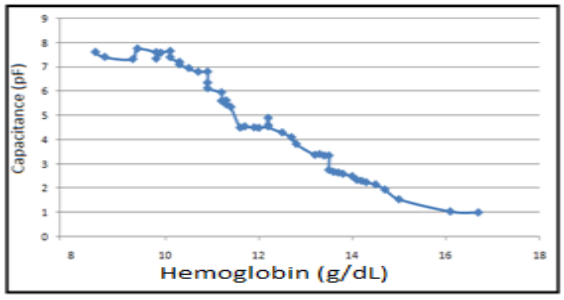

Figure 5: Hb vs capacitance curve

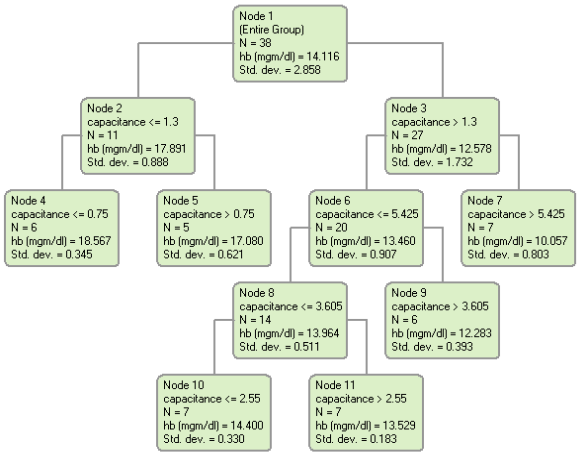

Figure 6: Decision Tree for Blood samples of Male Patients

Conclusion:

By measuring the blood capacitance the hemoglobin of the blood can be easily measured. It can be accurately bifurcated between normal, high or low levels of hemoglobin which can prove to be very helpful for doctor to take decision regarding treatment without putting much effort.

Acknowledgment:

The authors are very thankful to Krishna Engineering College, Ghaziabad for its valuable support. We thank all our friends and family for their encouragement and help. The experiments could not be completed without the help of careplus pathology labs. The authors also want to extend their heartfelt thanks to Mr Vikas for his technical support to carry out the experiments.

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