A simplified computer and mobile based application for screening of thalassemia carrier

Mr. Somen Mondal*, Dr. Gopeswar Mukherjee

*Assistant Professor, Department of Computer Science & Engineering
Elitte College of Engineering, West Bengal, India

*Pathologist, M.D(Path), Ph.D(cal),
Barasat District Hospital, North 24 Parganas, West Bengal, India

Abstract — Underreported adverse events can be detected by computer based systems very effectively. We developed a computer based screening technique that detect thalassemia carrier (minor). We use erythrocyte indices to identify thalassemia carrier and it have been studied in different countries with a high prevalence of thalassemia. Each erythrocyte indices has well defined threshold value to indicate thalassemia carrier. In our approach we build computer and mobile based application to calculate several erythrocyte indices, and based on the result we can identify thalassemia carriers.

Keywords — thalassemia carrier, thalassemia minor, thalassemia carrier screen test, thalassemia carrier screen test application.

I. INTRODUCTION

The need for a reliable method of screening for thalassemia carrier (minor) is becoming apparent in today’s society. Most people who are carrying thalassemia carrier [1] does not know that they have it, unless they have a special blood test carried out [2, 3], because carrying thalassemia minor does not cause any illness. Possessing the thalassemia minor gives a chance of having a thalassemia major towards the successor. Thalassemia minor are the most common causes of hypochromic microcytic are almost universally found in this heterogeneous group and based on readily available erythrocyte results in a routine blood count [4]. Several computational indices have been proposed to identify the thalassemia carrier [5].

These indices include the Mentzer index, the Shine and Lal index, the England and Fraser index, the Green and King index, the RDW (red blood cell distribution width) index, the RDW (red blood cell distribution width), the RBC (red blood cell count) and the ratio of RDW (red blood cell distribution width) and RBC (red blood cell count) [6]. All computational indices have been tested with different threshold values to indicate the thalassemia carrier. These indices can be quickly evaluated [6] via parameters obtained from automated blood counters.

Our computer and mobile application based screening procedure mainly based on computational functions derived from these indices. In this application user can easily evaluate these computational indices using haematological data. Every health care centre possess automated blood counter machine [7], that can provide this haematological information, includes red blood cell count (RBC), haemoglobin (Hb), mean corpuscular volume (MCV), mean cell haemoglobin concentration (MCH), red blood cell distribution width (RDW). The result of these computational function provides indication of positive or negative towards thalassemia carrier [6], with potentially important and cost effective. Computer and mobile based application is one of its kind to alert the risk of effective thalassemia carrier.

II. MATERIALS AND METHODS

This application consists of several computational functions based on erythrocyte indices shown in table – 1 using the haematological data red blood cell count (RBC), haemoglobin (Hb), mean corpuscular volume (MCV), mean cell haemoglobin concentration (MCH), red blood cell distribution width (RDW).

Our screening procedure takes user information name, gender, age, location and the haematological data to store in a database after validating those information. The computational functions to evaluate the erythrocyte indices based on the given valid haematological data. The computational value of erythrocyte indices compared with their respective threshold values shown in the table - 2, to get the final result.

If the final result shows negative for all these erythrocyte indices concludes the person not a thalassemia carrier. On the other side if one of these erythrocyte indices indicates positive result then it is suspicious or doubtful towards thalassemia.
Indices | Calculations | Threshold values
--- | --- | ---
Mentzer index | (MCV) / (RBC) | 13
Shine and Lal index | ((MCV)^2 x MCH) / 100 | 1530
England and Fraser index | MCV – (5 x Hb) – RBC – 3.4 | 0
Green and King index | ((MCV)^2 x RDW) / (Hb x 100) | 65
RDW index | (MCV x RDW) / RBC | 220
RDW | RDW | 14
RBC | RBC | 5 \times 10^{12}
RDW and RBC Ratio | RDW / RBC | 3.3

Table 1: Threshold values used for the different erythrocyte indices.

Indices | Threshold Condition | Conclusion
--- | --- | ---
Mentzer index | < 13 | Positive (Thalassemia Carrier )
Shine and Lal index | < 1530 | Positive (Thalassemia Carrier )
England and Fraser index | < 0 | Positive (Thalassemia Carrier )
Green and King index | < 65 | Positive (Thalassemia Carrier )
RDW index | < 220 | Positive (Thalassemia Carrier )
RDW | < 14 | Positive (Thalassemia Carrier )
RBC | > 5 \times 10^{12} | Positive (Thalassemia Carrier )
RDW and RBC Ratio | < 3.3 | Positive (Thalassemia Carrier )

Table 2: Erythrocyte indices with Threshold condition used for the thalassemia carrier detection.

The user interface of the mobile based android application shown in the Fig. 2.

Fig. 2: Flow chart of thalassemia carrier screening test application.

Fig. 2: Screen short of android application.

III. RESULTS

All the cases were investigated to find the thalassemia carrier using the value of erythrocyte indices. With particular emphasis on red blood cell count (RBC), haemoglobin (Hb), and red blood cell indices as mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH) and red blood cell distribution width (RDW). Table -3 shows the mean and standard deviation (SD) values obtained from the full blood count with in two hundred and fifty known cases. It was observed that with in two hundred and fifty known cases thalassemia carrier (minor) detection rate 100%. The success rate of the individual erythrocyte indices are shown in table – 4.
blood test to avoid the false data. This type of computerized simple and cost effective technique is probably the first time available in this part of the country which can be also performed by an android mobile set.

This computerized method has been standardized after using large number of data of two hundred and fifty cases. There will be no need to calculate the values using the data by scientific calculator where there may be a chance of human error, this error can be avoided by simple application of this computerized technique even in android mobile phone. The results can be simultaneously stored which may be used in future if needed.

V. CONCLUSION

This study is helpful for early and quick screening of thalassemia carrier which is also cost effective. This screening method is especially helpful for the developing countries with higher thalassemia incidences [11–12]. It can be effective on the peripheral locations where this screening process can be done by using mobile devices. This screening methodology is highly specific rather than sensitive.

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REFERENCES


Table. 3 Distribution of cases by blood count.

<table>
<thead>
<tr>
<th>Indices</th>
<th>Threshold values</th>
<th>Thalasemia carrier (minor)</th>
<th>No. of cases</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mentzer index</td>
<td>&lt; 13</td>
<td>158</td>
<td>63.2</td>
<td></td>
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<tr>
<td>Shine and Lal index</td>
<td>&lt; 1530</td>
<td>250</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>England and Fraser index</td>
<td>&lt; 0</td>
<td>106</td>
<td>42.4</td>
<td></td>
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<tr>
<td>Green and King index</td>
<td>&lt; 65</td>
<td>151</td>
<td>60.4</td>
<td></td>
</tr>
<tr>
<td>RDW index</td>
<td>&lt; 220</td>
<td>171</td>
<td>68.4</td>
<td></td>
</tr>
<tr>
<td>RDW</td>
<td>&lt; 14</td>
<td>35</td>
<td>14.0</td>
<td></td>
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<tr>
<td>RBC</td>
<td>&gt; 5 x 10¹²/L</td>
<td>166</td>
<td>66.4</td>
<td></td>
</tr>
<tr>
<td>RDW and RBC Ratio</td>
<td>&lt; 3.3</td>
<td>160</td>
<td>64.0</td>
<td></td>
</tr>
</tbody>
</table>

Table. 4 Haematology results of thalassemia carrier using threshold values for erythrocyte indices.

IV. DISCUSSION

This computer based technique has immense public health importance and it is cost effective which is specifically important for developing country [11–12] like India. This screening method will be possible to perform in a computer according to version given as well as android mobile phone, after installing the specific application. This procedure can be perform simply for which no trained lab technician required as the result can be obtain by simply putting the data respectively as discussed above. The different data should be obtained from a well calibrated automated blood cell counter [7] and a standard should run before the


