Detecting Iron Deficiency Anemia in Type C Hospital: Role of RDW and MCV Parameters

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ABSTRACT

Iron deficiency anemia remains a global health problem, which is also a prominent cause of morbidity and mortality of all range of ages. There are three stages of anemia development, and there are some parameters to detect bodily iron status. Transferrin saturation is one of the reliable parameters. Among all hematology parameters, Red Cell Distribution Width (RDW) and Mean Corpuscular Volume (MCV) are two of the most often studied. MCV and RDW are relatively affordable and accessible, most importantly for rural areas with lower socioeconomic status. This was an analytical observational study with a cross-sectional design aimed to determine the correlation between RDW and MCV values with iron deficiency anemia, which was measured by transferrin saturation. A significant correlation was found between RDW, MCV values, and iron deficiency anemia in patients of Mitra Keluarga Cikarang Hospital and Permata Keluarga Hospital, Jakarta with a p-value of <0.05. Sensitivity and specificity for MCV were 75% and 100%, for RDW were 55.45% and 80%, respectively. In conclusion, RDW and MCV parameters can be used as screening instruments for iron deficiency anemia.

Keywords: Transferrin saturation, iron deficiency status, screening parameter

INTRODUCTION

Anemia, a condition where hemoglobin level or erythrocyte count in the body is below the reference range adjusted for age and gender, is one of the most encountered health problems worldwide.¹ Data from RISKESDAS in 2018 showed that 20.3% of males, 27.2% of females, and 26.8% of school-aged children suffer from anemia.²

Iron Deficiency Anemia (IDA) is the most frequent type of anemia that makes up 30% world’s population. Iron deficiency anemia is mostly found in developing countries including Indonesia and has a detrimental effect on work productivity and learning capacity, which become a burden for a country’s economy.³,⁴ Comprehensive detection of IDA is critical for its prevention and treatment. Diagnosis involves complete blood count, peripheral blood evaluation, reticulocyte count, and iron status. Iron deficiency anemia is characterized by microcytic hypochromic erythrocytes and low iron storage.⁴

Mean Corpuscular Volume (MCV) is the average of erythrocyte volume, whereas Red Cell Distribution Width (RDW) is a calculation to evaluate the variation of erythrocyte sizes, which may reveal anisocytosis in the peripheral blood evaluation. A low MCV shows small, pale erythrocytes, whereas a high RDW shows anisocytosis; both together indicate microcytic hypochromic anemia. RDW is a more sensitive indicator to determine the possible cases of microcytic hypochromic anemia. In the era of increasing medical expenses, an efficient, accurate, sensitive, and specific diagnostic method is needed to determine IDA. Gold standard tests such as bone marrow evaluation, serum ferritin, transferrin, and iron are relatively costly. Contrastingly, RDW and MCV are a part of routine hematology examinations using a hematology analyzer.⁵ This study aimed to evaluate the role of RDW and MCV as parameters to detect IDA in type C hospitals.

METHODS

This was observational cross-sectional analytical research using a total sampling collection of medical records and laboratory results from 122 patients with IDA from two type C hospitals (Mitra Keluarga Cikarang Hospital and Permata Keluarga Jababeka Hospital) from January to November 2022. The inclusion criteria used were: Patients diagnosed with anemia; Patients whose complete data of serum iron and total iron binding capacity (TIBC) and; Patients whose complete blood count data, including MCV and RDW. Pediatric patients (<18 years old),
hemoglobinopathy/thalassemia patients, and patients whose incomplete medical records were excluded from the study.

The diagnosis of anemia was made using hemoglobin parameters of <13 g/dl for males, and <12 g/dl for females. MCV with a cut-off point < 80 fl and RDW-CV with a cut-off point 15% were used as parameters of IDA. A complete blood count test was carried out using a hematology analyzer such as Symex XN-1000 in Mita Keluarga Cikarang Hospital and Symex XN-350 in Permata Keluarga Jababeka Hospital. Anemic patients were then separated from the non-anemic patients, and transferrin saturation was determined by using serum iron divided by TIBC and multiplied by 100%. The data were analyzed using SPSS version 27. Research permission was obtained from the health research ethics committee of both hospitals, with registration numbers 228/CRK-DIR/EKS/XII/2022 and 044/5K-DIR/RSPJKB/XII/2022.

RESULTS AND DISCUSSIONS

A total of 122 subjects were evaluated during the study period, with the characteristics as shown in Table 1.

The number of male subjects (56%) was slightly higher compared to female subjects (44%) in this study. World Health Organization shows that anemia is more frequently found in females of reproductive age and during pregnancy. Females of reproductive age experience menstruation and child labor, which increases the risk of experiencing IDA. A study by Jimenez found that the cause of iron loss in productive-aged females is mostly menstruation, especially those experiencing heavy flow. Another factor contributing to this is the low consumption of iron from food.

This study uses transferrin saturation instead of ferritin because ferritin is one of the acute phase reactants that increase in people undergoing inflammation. Zarate et al. reported that ferritin levels increase in people undergoing infection and/or surgery. To avoid false positive results, this study use transferrin saturation that was not inflicted with inflammation was used in this study to diagnose IDA.

Most of these study subjects had low MCV values, which correlates with the high prevalence of IDA in Indonesia, and the intention of including anemic subjects in our study. A study performed in Thailand by Karoopongse et al. found that low MCV correlates with increased mortality in the elderly. Honda et al. in Japan also found that low MCV correlates positively with mortality in patients undergoing hemodialysis. This emphasizes the importance of IDA treatment in Indonesia.

Purnamasidhi et al. also found increased RDW in IDA patients and stated that RDW has good sensitivity as a screening for microcytic hypochromic anemia, a characteristic of IDA.

Table 2. Iron status of subjects

<table>
<thead>
<tr>
<th>Median (Min; Max)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Serum iron (ug/dl)</td>
</tr>
<tr>
<td>Total iron binding capacity(ug/dl)</td>
</tr>
<tr>
<td>Transferrin saturation (%)</td>
</tr>
</tbody>
</table>

Serum Iron (SI) and Total Iron Binding Capacity (TIBC) were found within the normal range. Transferrin saturation was found in 112 subjects with IDA (transferrin saturation <15%), and the total average of transferrin saturation was 13.8%. A study by Faruqi stated that the total of saturated transferrin in the blood is only 33%, and every apo-transferrin molecule can bind two ferric ions. The transferrin saturation drops below 16% in iron deficiency, because there is only one ferric ion. Bouri et al. also state that during IDA, serum iron decreases, TIBC may be normal or increased, and transferrin saturation decreases.

During the iron deficiency state, transferrin saturation relative to iron increases, causing high TIBC values. During the early stages of iron deficiency, transferrin saturation changes are still minimal. During iron depletion, serum ferritin is a

Table 1. Characteristics of research subjects

<table>
<thead>
<tr>
<th>N (%)</th>
<th>Mean±SD</th>
<th>Median (Min;Max)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>26.0 (18;74)</td>
<td></td>
</tr>
<tr>
<td>Hemoglobin levels (g/dl)</td>
<td>9.79±2.0</td>
<td></td>
</tr>
<tr>
<td>MCV (fl)</td>
<td>69.5 (27;100)</td>
<td></td>
</tr>
<tr>
<td>Low MCV</td>
<td>84 (69%)</td>
<td></td>
</tr>
<tr>
<td>Normal to high MCV</td>
<td>38 (31%)</td>
<td></td>
</tr>
<tr>
<td>RDW (%)</td>
<td>15.2 (11.7;26.1)</td>
<td></td>
</tr>
<tr>
<td>Normal RDW</td>
<td>58 (48%)</td>
<td></td>
</tr>
<tr>
<td>High RDW</td>
<td>64 (52%)</td>
<td></td>
</tr>
</tbody>
</table>
Table 3. Combined diagnostic evaluation of MCV and RDW in iron deficiency anemia

<table>
<thead>
<tr>
<th>Combined RDW and MCV</th>
<th>Iron Deficiency Anemia</th>
<th>Non-Iron Deficiency Anemia</th>
<th>Total</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>High RDW and low MCV</td>
<td>55</td>
<td>0</td>
<td>55</td>
<td>p &lt; 0.005</td>
</tr>
<tr>
<td>Normal/low RDW and/or normal/high MCV</td>
<td>57</td>
<td>10</td>
<td>67</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>112</td>
<td>10</td>
<td>122</td>
<td></td>
</tr>
</tbody>
</table>

more sensitive marker of iron deficiency. The body then strives to maintain effective erythropoiesis, using up the iron pools. If this negative balance continues, ferritin serum drastically decreases, causing iron depletion. Iron levels in the blood also decrease and transferrin synthesis increases (marked by increased TIBC), causing a drastic decrease in transferrin levels. When transferrin saturation decreases together with ferritin, a condition of absolute iron deficiency has been reached. This ineffective erythropoiesis causes a low hemoglobin level, marking iron deficiency anemia.1

Analysis of the 2x2 table found a statistically significant correlation between iron deficiency anemia and the combined value of RDW and MCV with a p-value of 0.001. The sensitivity and specificity of RDW and MCV to diagnose IDA based on transferrin saturation values are 49.1% and 100%, respectively. It was reported that RDW and MCV analysis had a Positive Predictive Value (PPV) of 100% and a Negative Predictive Value (NPV) of 16.4%.

A study by Omuse et al., in Kenya found that among 528 adult (18-65 years old) patients, female subjects had significantly higher RDW. The anemic male subjects also had higher RDW and lower MCV although does not reach statistical significance.11 Sazawal et al. found that RDW can be used to identify children with iron deficiency, with hemoglobin value ≤ 10.0 g/dL, which helps decrease the cost of iron status tests and reduce blood sample usage, especially in developing countries.12

RDW measures the average erythrocyte size, which is similar in usage to other indexes like MCV, MCH, and MCHC. These factors cannot measure the minute change during the beginning of the iron depletion stage. Other parameters like hemoglobin are not feasible to be used, because hemoglobin only decreases when the body is in an absolute depletion state. Peripheral blood evaluation is also challenging to use during pregnancy, even during moderate iron deficiency. Means et al. stated that decreased transferrin saturation (especially with normal or increased transferrin/TIBC) correlates with iron deficiency in pregnancy and can detect iron deficiency even when the ferritin is normal.12

This study has several limitations, including subjects with anemia mostly having IDA, therefore the results may not fully indicate the effectiveness of the parameter to detect IDA due to the limited number of non-IDA subjects. Another limitation of the study was data extraction was only carried out in two hospitals, making generalization hard to consider. However, the study has its strengths by including many varieties of diagnoses of the patients in the study, which made the study inclusive of many patient conditions. Secondly, this study used a sample from a type C hospital. It is expected that the results can be used to detect IDA at a more affordable cost in many type C hospitals.

CONCLUSIONS AND SUGGESTIONS

The RDW and the MCV can be used in type C hospitals for the screening of ADB in adult patients admitted for suspect of anemia. It is recommended to perform another follow-up study on other iron parameters with bigger scale and including subjects from other hospitals with different ages group to complete the result of the study.

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REFERENCES


