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Evaluation of Iron Status Using Methods Based on the Features of Red Blood Cells and Reticulocytes

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ABSTRACT

Iron is an essential element in the hemoglobin (Hb), which carry oxygen into the tissues. A shortage of iron causes not only anemia but also disturbances in children's development. Furthermore, iron overload and high iron stores have been associated with a variety of diseases such as hemochromatosis, Type II diabetes mellitus, gestational diabetes mellitus, gestational hypertension and increased risk of acute myocardial infarction. Erythropoietin (EPO) is the principal hormonal stimulator of red blood cell (RBC) production, and EPO synthesis is stimulated in a response to tissue hypoxia.

Laboratory measurements of iron status include both RBC indices reflecting the hematological iron compartment, and biochemical measurements reflecting the store and transferring iron compartments. The development of flow cytometric technique has produced more accurate cell indices reflecting the Hb content of RBCs and reticulocytes.

In the present series of studies, the aims were to investigate the diagnostic markers of iron status, especially the parameters reflecting the features of RBC and reticulocytes, in a cross-sectional population of pregnant women at term and their newborn infants (n = 220). Additionally, a new quantitative flow cytometric method for transferrin receptor (TfR) expression on reticulocytes (reflecting the iron requirement of cells) was developed and tested in a selectively chosen patient group (n = 46). The relationships between markers of hypoxia (EPO and pH), RBC and reticulocyte indices, and serum iron status measurements were also investigated.

On the basis of these studies, cell indices reflecting lower amounts of cellular Hb are the most practical way to evaluate iron deficiency in pregnant women at term, and they have the highest potential diagnostic accuracy. In cord blood, both accelerated erythropoiesis and the magnitude of iron stores contribute to the RBC and reticulocyte indices, thus impairing their value as specific indicators of iron deficiency. TfR expression on reticulocytes can be measured using a quantitative flow cytometric method, and it was shown that in patients with increased demand for iron, TfR expression is higher on reticulocytes than in controls. While the state of anemia is a contributor to the reduced oxygen-carrying capacity, the decreased amount of cellular Hb was also associated with suboptimal tissue oxygenation (higher EPO concentration and lower pH level) in pregnant women and in cord blood at birth.

These studies show that parameters reflecting the properties of the cells in the hematological iron compartment can be used as diagnostic markers for iron deficiency, using techniques that are available in modern hematological cell counters. More clinical studies are needed to confirm these findings but it seems possible that the RBC and reticulocyte indices may allow us to move from screening iron deficiency by Hb to more sensitive and rapid indicators of iron deficiency.

National Library of Medicine Classification: QV 183, WQ 252, WH 150, WH 155, WH 400
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