

tuberculin test remains an important procedure to be done routinely to detect an early diagnosis. In this serie 28 (35%) affected meningitis out of which 8 died, 72 (90%) had malnutrition out of which 14

were severe malnutrition. Should the primary health services have suspected tuberculosis earlier, those cases would had been detected in the early stage.

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ORIGINAL ARTICLE

Capillary Microhematocrit Measurement as a Screening Test for Anemia in Children

by

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Abstract

The spectrophotometric measurement of hemoglobin performed with a well standardized instrument using venous blood is widely accepted as a reference standard for anemia. In developed countries automated electronic counters are used instead. However, this method of determining anemia is not practical for screening in developing countries as it requires special skill or expensive equipment to obtain the specimen or to perform the test.

The primary objective of this study was to determine the feasibility of using capillary microhematocrit measurement as a screening test for anemia.

The 104 patients examined ranged in age from 6 months to 6 years; 65 were males and 36 females. Sixty one of the 104 cases (58.7%) were below 2 years of age and the other 43 cases (41.5%) were older than 2 years. Hemoglobin values ranged from 2.7-13.5 g/dl and capillary microhematocrit ranged from 9-41%. Analysis of the result showed a significant correlation between the capillary microhematocrit values and the capillary hemoglobin values ($r = 0.99$ and $p < 0.001$). The sensitivity of the microhematocrit method for detecting anemia was 91.11% and the specificity was 89.83%. The predictive value for a normal (negative) microhematocrit was 92.98% and the predictive value for a low (positive) microhematocrit was 87.23%.

We conclude from this study that the capillary microhematocrit measurement method can be appropriately used as a screening test for anemia.

Introduction

Anemia is a reduction of red cell mass or hemoglobin concentration below normal values for age and sex. Anemia, especially due to iron deficiency, is very common in developing countries. For this reason screening for anemia is essential for early detection of the disorder. The choice of a simple and reliable method of screening for developing countries is very important.

The presence of anemia can be determined by measuring hemoglobin concentration or hematocrit. The spectrophotometric measurement of hemoglobin performed with a well standardized instrument using venous blood is widely accepted as a reference standard for anemia (Young et al., 1986). In developed countries automated electronic counters are nowadays used instead (Dallman, 1977; Dallman et al., 1981; Reeves et al., 1981; Thomas and Collins, 1982; Young et al., 1986). However, this method of determining anemia is not practical for screening in developing countries as it

requires special skills or expensive equipment to obtain the specimen or to perform the test.

The microhematocrit measurement of a capillary blood sample is widely used to screen children for anemia (Reeves et al., 1981; Young et al., 1986). The results are acceptable (Young et al., 1986), and its ease and economy is an advantage for developing countries.

Several studies have been done to compare capillary microhematocrit values with venous hematocrits measured by an electronic counter. Thomas and Collins (1982) obtained elevated microhematocrit values from fingerstick blood compared to venous hematocrit measured simultaneously in an electronic counter, while Moe (1970) and Young et al., (1986) found the opposite.

The primary objective of this study was to determine the feasibility of using capillary microhematocrit measurement as a screening test for anemia.

Materials and Methods

During a 3-month-period from March until May 1989 one hundred and four cases were studied at the Department of Child Health, Ujung Pandang General Hospital. The study group was selected to include all hospitalized children between 6 months and 6 years of age and comprised different levels of hemoglobin concentrations.

Capillary blood sampling was obtained from a medial or lateral heel prick in infants and from a finger prick in children. The sites were disinfected with 70% alcohol and let dry before being punctured with an autoclix device (puncture depth of 2-3 mm). The first drop of blood was wiped off with a filter paper. Hemoglobin pipettes were used to collect 0.02 ml of blood, which were put in test tubes each containing 5 ml of cyanmethemoglobin reagent. The pipettes

were then rinsed 3-5 times with the reagent and subsequently put in a rack for about 10 minutes before the hemoglobin concentrations were determined using a Perkin-Elmer Junior III Spectrophotometer with a wavelength of 540 nm.

Other blood samples were collected simultaneously into a 75 mm length heparinized microcapillary tubes (Terumo brand) until $\frac{2}{3}$ of the tubes was filled. The tubes were then spun at 11,700 rpm (13,700 RCF) for 5 minutes using a hematocrit centrifuge (Adams Auto-crit II). The results were read from a special reading device using a magnifying glass. No correction for trapped plasma were made. All measurements were done in duplo.

The name, age, sex and diagnosis of the patients were also recorded. The data

processed statistically using the linear regression analysis. Sensitivity, specificity, and positive and negative predictive values of the microhematocrit were also calculated. In this context, "sensitivity" refers to the percentage of patients with a low capillary hemoglobin value whose capillary hematocrit value was also low. "Specificity" refers to the percentage of patients with a normal capillary hemoglobin value whose capillary microhematocrit value was also

normal. The predictive value of a positive test, i.e. a low microhematocrit, refers to the percentage of patients with a low microhematocrit value whose capillary hemoglobin was also low, and the predictive value of a negative test designates the percentage of patients with a normal hematocrit value whose capillary hemoglobin value was also normal. The lower limits of normal for hemoglobin and hematocrit values are shown in table 1 (Dallman, 1977).

Table 1 : Lower limits of normal for hematocrit and hemoglobin values

Age (years)	Hematocrit (%)	Hemoglobin (gm/dl)
0.5 - 1	33	11.0
2 - 6	34	11.0

Results

The 104 patients ranged in age from 6 months to 6 years; 65 were males and 39 females. Sixty one of the 104 cases (58.7%) were below 2 years of age and the other 43 cases (41.5%) were older than 2 years. Hemoglobin values ranged from 2.7-13.5 g/dl and capillary microhematocrit values and the capillary hemoglobin concentration

is shown in figure 1.

Analysis of the result showed a significant correlation between the capillary microhematocrit values and the capillary hemoglobin values ($r = 0.99$ and $p < 0.001$); the higher the hemoglobin concentrations, the higher the capillary hematocrit values.

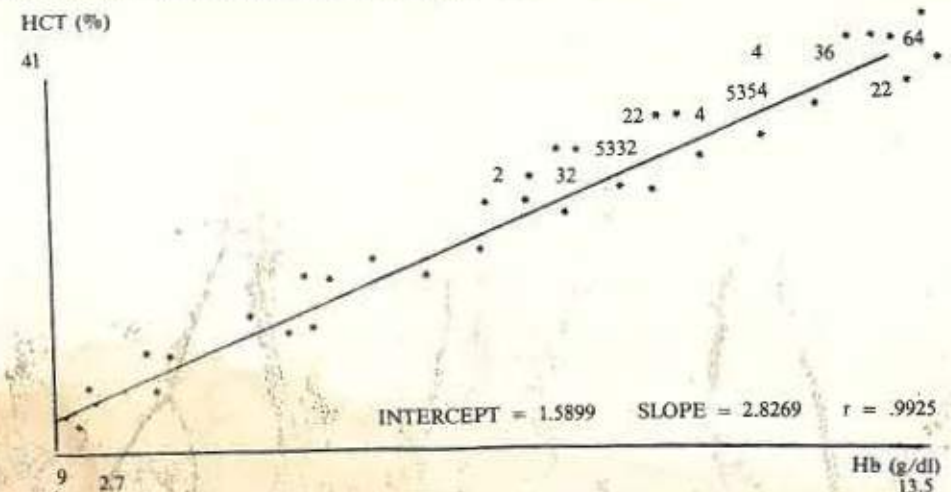


Figure 1 : Relationship between capillary microhematocrit values and capillary hemoglobin values for all cases

Discussion

Anemia, especially due to iron deficiency, is one of the most common symptoms accompanying several diseases at the Ujung Pandang General Hospital (Daud and Tranggana, 1983). Therefore, screening for anemia is very important to detect the disease in its early stage so that treatment can be started promptly to prevent its effects on neurological and intellectual functions (Pearson, 1987).

Several different methods have been described for the screening for anemia (Dallman, 1977; Dallman et al., 1981; Reeves et al., 1981; Thomas and Collins, 1982; Van Lerberghe et al., 1983; Young et al., 1986). The ones still used to day are either the determination of capillary microhematocrit or the venipuncture Coulter S hematocrit. It is realized that the venipuncture Coulter S hematocrit is the most accurate method for screening the anemia. However, Coulter S hematocrit are not commonly available in Indonesia, even in some big cities. On the other hand microhematocrit centrifuges are widely available even in Kabupaten hospitals. Therefore, the only other method left for choice is the capillary microhematocrit determination.

The capillary microhematocrit test is widely used to screen pediatric patients for anemia (Young et al., 1986). However, Thomas and Collins (1982) have suggested that this method gives values that are signi-

ficantly higher than simultaneously obtained venous hematocrits using an electronic counter. The difference, which varies from 3 to 12%, is caused by plasma trapped in the red cell layer in the microhematocrit, while the Coulter S calculates a value for the hematocrit from the direct measurement of red cell numbers and red cell size, and thus is not affected by trapped plasma. Since increased plasma trapping occurs in hypochromic, microcytic anemias, they therefore hypothesized that the use of the microhematocrit in screening iron deficiency anemia in children might be unreliable.

On the other hand, Moe (1970) found higher mean hematocrit values in venous blood than in capillary blood, particularly in children. Young et al., (1986) in a study of 66 patients comparing the venipuncture Coulter S values with the capillary microhematocrit values, concluded that the microhematocrit method using capillary blood will miss very few patients with significantly low venous hemoglobin values and is thus an acceptable screening test for anemia.

Evaluating the capillary microhematocrit as a screening test for anemia requires careful reflection upon the goals of such a screening program: What is the reference standard for anemia? How well does the capillary microhematocrit identify children who are anemic or not anemic when com-

pared with that standard: Are the numbers of false-positive results and false-negative results acceptable? (Young et al., 1986).

In this study, hemoglobin values determined by spectrophotometer measurements of capillary blood were used as standard. Linear regression analysis of the results showed a positive correlation between capillary microhematocrit and capillary hemoglobin values (see Fig 1 & 2) which means that changes in hemoglobin concentrations will affect the hematocrit values in the same direction. Therefore, the hemoglobin concentration of a person can be predicted from the known capillary microhematocrit values using the regression line

$$\text{equation: } Y = 2.83 X + 1.59.$$

In screening the anemia, the predictive value of a negative test is probably the most important criteria to consider. In this study the negative predictive value was excellent (92.98%), which is in accordance with that found by Young et al., in 1986 (90.1%). Moreover, a good positive predictive value was found in this study, which means that capillary microhematocrit determination can replace hemoglobin measurement as a screening test for anemia.

From analysis of the data in Table 2 and Figures 1, 2, and 3, it can be concluded that capillary microhematocrit can be appropriately used for screening the anemia.

Conclusion

- (1) There is a positive correlation between hemoglobin concentrations and capillary microhematocrit values.
- (2) Using the capillary microhematocrit method for the detection of anemia yields a sensitivity of 91.11%, a specificity of 89.83%, a positive predictive value of 87.23% and a negative predictive value of 92.98%.
- (3) The capillary microhematocrit method can be appropriately used for screening the anemia.

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