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UCLA Family Health Center for consultation. The majority of the patients come because they desire continuity of comprehensive health care.

A significant increase in the compliance of physicians performing sigmoidoscopy on their patients was noted after the flexible sigmoidoscope was introduced to the practice. Some of the patients in this report might have been diagnosed earlier, and thus not counted in this study, if residents and faculty had previously been as diligent to colorectal symptomatology. (This is probably not a major factor, however, as the three patients with cancer were all new to the practice and diagnosed early.) Early diagnosis of these patients reinforces the belief that significant findings await the primary care physician who uses the flexible sigmoidoscope in routine examinations.

The role of flexible sigmoidoscopy in colorectal disease is evolving. This study validates the use of this sophisticated instrument by family physicians who have the opportunity to receive appropriate training in the use of the instrument.

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Screening One-Year-Old Infants for Iron Deficiency

David A. Driggers, MD, and Jerry D. Reeves, MD
Casper, Wyoming, and Travis Air Force Base, California

Primary care physicians should screen infants for iron deficiency anemia when they are approximately one year of age, a time when the cumulative effects of rapid growth and relatively decreased iron intake commonly result in iron deficiency.[1] Suggested screening methods from the literature have included determination of capillary or venous hematocrit, hemoglobin concentration, transferrin saturation, free erythrocyte protoporphyrin (FEP), and serum ferritin.[2-7] A survey was conducted which revealed that 84 percent of 142 prac-

From the Department of Pediatrics, David Grant Medical Center, Travis Air Force Base, California. Requests for reprints should be addressed to Dr. David A. Driggers, University of Wyoming Family Practice Residency, 1522 East "A" Street, Casper, WY 82601.

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ticing family physicians and pediatricians screened their one-year-old infants with either a capillary blood spun microhematocrit or a capillary hematocrit calculated by the Coulter Model S electronic counter (Coulter Electronics, Hialeah, Florida). Forty-four percent used the spun hematocrit alone. This study compares and evaluates these two most common screening methods. Implications regarding their similarity and application to office practice can then be made.

Methods

As part of their routine well-baby examination, 274 consecutive infants had capillary blood samples obtained by a single 3-mm lancet puncture. The blood was then placed in two heparinized microcapillary tubes and into three capillary pipettes. Hemoglobin and red cell indices were measured by a Coulter Model S electronic counter using Coulter 4C Tripack quality controls and manufacturer calibration recommendations according to standard laboratory practice.[8,9] Spun hematocrits were performed on a microcentrifuge at 11,000 rpm for 4 minutes. The hematocrit readings obtained by both methods were then averaged on each patient. This was done incidental to other studies of laboratory and demographic variables as predictors of response to iron treatment.[4,7] Infants with a birth weight less than 2,500 g were excluded from this study. All infants who had a capillary hemoglobin less than 11.5 g/100 mL or a mean corpuscular volume (MCV) less than 72 fL (10th percentile for a normal reference population)[3] were designated screen positive and had venous blood studies drawn. A three-month course of oral ferrous sulfate was then given to these screen-positive infants at a dose of 3 mg/kg/d (of elemental iron) 30 minutes before breakfast. Repeat venous blood studies were again obtained after three months of oral iron therapy, and compliance was estimated. Those infants with less than 50 percent compliance were excluded. No significant side effects were noted. A comparison of the pretreatment and posttreatment venous hemoglobin (Coulter Model S) was used to determine response to therapy. Although a rise in hemoglobin by at least 0.6 g/100 mL would be statistically significant,[4] the definition of iron response (iron deficiency) for this study was a rise in hemoglobin concentration by at least 1 g/100 mL over the three months of therapy. This change in hemoglobin seemed more physiologically relevant and might be more generally accepted as warranting therapeutic intervention.

Results

Comparison of hematocrit values obtained by the two methods demonstrated a statistically significant difference ($P < .001$) between mean spun hematocrit (35.64) and mean Coulter hematocrit (35.15). However, there is a significant correlation between these two methods which give a similar hematocrit within 0.5 points ($r = .862$).

The slightly higher spun hematocrit could be a result of plasma trapping between red blood cells or inadequate packing during centrifugation.[10] Therefore, the manufacturers of Coulter Model S program a 3-percent correction factor into the calculated Coulter hematocrit to offset some of this difference.[9] It is also recognized that increased plasma trapping occurs in hypochromic anemias, falsely elevating the spun hematocrit.[10] Thus, the practicing physician can use the spun microhematocrit in his office and obtain values reasonably similar to the Coulter hematocrit. However, he must realize that the spun hematocrit is slightly higher than the Coulter hematocrit and that these differences may increase with hypochromic anemias.

Whether the small differences in hematocrit measured by these methods altered their ability to predict subsequent response to iron therapy was then evaluated. Nineteen percent (52/274) of the one-year-old infants had a capillary hemoglobin less than 11.5 g/100 mL or an MCV less than 72 fL and were designated as screen positive. Fifty percent (26/52) of the screen-positive group responded to iron therapy with a rise in hemoglobin by at least 1.0 g/100 mL, resulting in an overall iron deficiency rate of at least 9 percent (26/274). The screening values of the spun and Coulter hematocrit of less than or equal to 33 percent and less than or equal to 31 percent were then compared. These two hematocrit values are commonly used for identifying infants with anemia.[1,3,11]

As seen in Figure 1, approximately one half of the infants with either spun or Coulter hematocrit less than or equal to 33 percent responded to iron

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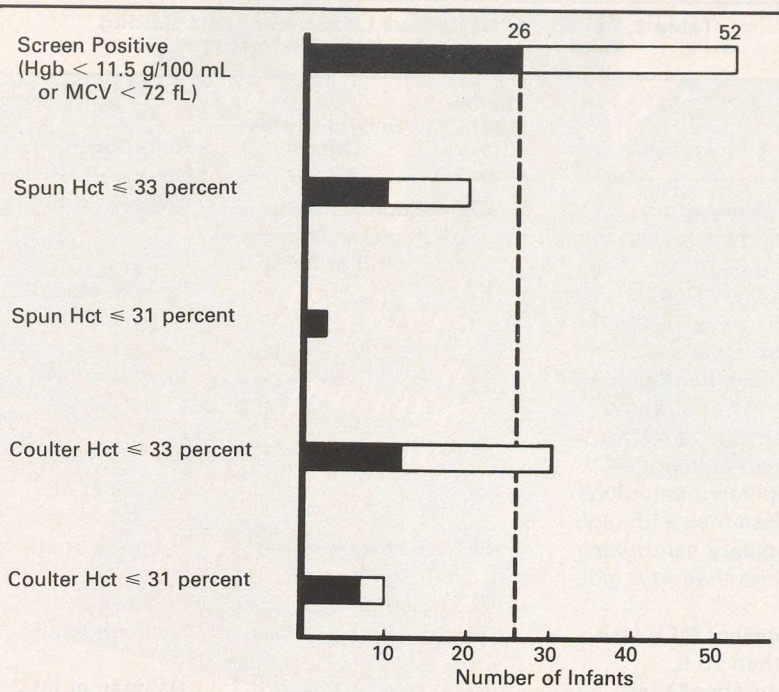

Figure 1. A comparison of several screening capillary hematocrits as predictors of response to iron therapy. The total length of each bar represents the number of one-year-old infants having the abnormal initial blood count specified on the left. The darkened portion represents the number of infants who responded to iron therapy (rise in hemoglobin by at least 1 g/100 mL). The hashed vertical line indicates the total number of iron-responsive (iron deficient) infants identified

therapy (predictive value, 42 percent and 45 percent, respectively). But about one half of the total number of iron-responsive infants were missed using these criteria (sensitivity, 43 percent and 53 percent, respectively). More than three fourths of the infants with either spun or Coulter hematocrit less than or equal to 31 percent responded to iron therapy (predictive value, 100 percent and 75 percent, respectively). But restricting therapy to those meeting these criteria would have meant more than two thirds of the potentially iron-responsive infants would have been missed (sensitivity, 13 percent and 23 percent, respectively). Thus capillary spun and Coulter hematocrits give equivalent results as screening tests for iron deficiency (iron responsiveness) in one-year-old infants.

Comments

The ideal screening test for a treatable disorder is the readily available one that with minimal cost or risk can accurately identify the majority of a population who would benefit from therapy.

Table 1 compares the sensitivities of various laboratory tests in prospectively identifying the subset of screen-positive infants who responded to iron therapy among the study population of healthy-appearing one-year-old infants. Capillary hematocrit less than or equal to 33 percent has sensitivity approximately equivalent to that of other commonly used laboratory tests of iron status when used as a single screening test for iron deficiency.

Spun and Coulter hematocrits are of equivalent utility as screening tests for iron deficiency in infants. Simultaneous values show close correlation, and each test shows approximately equal sensitivity and predictive value for subsequent response to a therapeutic trial of iron. As with any single screening test for iron deficiency in infants, the hematocrit by either method has only a moderate sensitivity for identifying infants who will respond to iron therapy.

Table 1. Sensitivity of Various Laboratory Tests Among Screen-Positive One-Year-Old Infants

Test	Sensitivity* (%)	Screen-Positive Criteria	Reference
Capillary spun hematocrit less than or equal to 33	43	Capillary hemoglobin less than 11.5 or MCV 72	Present study
Capillary Coulter hematocrit less than or equal to 33	53		Present study
Venous hemoglobin MCV confirming screening capillary hemoglobin, MCV	78		Reeves et al[6]
Capillary hemoglobin less than 11.5 g/dL	78		Reeves et al[6]
Capillary hemoglobin less than 11.0 g/dL	52	Capillary hemoglobin less than 11.5	Driggers et al[4]
Capillary MCV less than 70 fL	38		Dallman et al[5]
Saturation** less than 10 percent	52		Dallman et al[5]
Ferritin less than 10 μg/L	29		Dallman et al[5]
Erythrocyte protoporphyrin less than 3 μg/g hemoglobin	40		Dallman et al[5]

*Sensitivity here represents the proportion of the total number of iron-responsive infants prospectively identified by the single abnormal screening test listed on the left
**Saturation—Transferrin saturation (serum iron/iron binding capacity)

In terms of cost, simplicity, and sensitivity, the office spun hematocrit may be as good as any other single screening test. Regardless of which test is used, if a low or borderline low value is found, an empiric trial of iron therapy seems warranted. More elaborate diagnostic evaluation can then be reserved for those who remain anemic after iron therapy.

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