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I am submitting herewith a thesis written by Minda S. Lazarov entitled "An Evaluation of the Treatment for Pediatric Anemia in the Tennessee WIC Program." I have examined the final copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Nutrition.

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AN EVALUATION OF THE TREATMENT FOR PEDIATRIC ANEMIA IN THE TENNESSEE WIC PROGRAM

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ABSTRACT

The purpose of this investigation was to evaluate the treatment provided for pediatric anemia in three selected East Tennessee counties and to determine any differences between treatment responders and nonresponders which may be contributing to the relatively high rate of nonresponse found in the anemic pediatric WIC population in Tennessee. Of the 1507 children screened for anemia in the 3 clinics, 3.5% were found to be anemic (i.e., hematocrit less than 31% for children less than 24 months of age and less than 34% for children 24 to 54 months of age). The response rates among the anemic children in the three clinics varied from 29.5% in the urban WIC clinic to 64.3% and 66.7% in the two rural clinics. An evaluation of the distribution of initial hematocrits by county revealed that children with hematocrits of 32% or 33% are less likely to respond than the children with hematocrits less than 32%. This phenomenon also was evident when the treatment response rates by initial hematocrit were examined. A significantly higher response rate was noted among the children with initial hematocrits of less than 32% when compared to those children with initial hematocrits of 32% or 33% (81.8% versus 37.9%). This finding was confounded by the issuance of a greater dosage of supplemental iron to those children in the lower hematocrit range, however. Both an increased potential for false positive diagnoses common to the upper ranges of low hematocrit measures and the smaller dosages of supplemental iron were suggested as contributing to the lower response rate among those children with hematocrits of 32 or 33%. Other

demographic variables associated with response were sex, age, previous certification for WIC, educational level of father and growth centiles, although these differences were not significant.

Recommendations for a more effective program for the treatment of iron deficiency anemia in the Tennessee WIC Program were made, including the need for regional nursing and nutritionist training programs on the diagnosis and treatment of iron deficiency anemia, issuance of iron supplements by weight and the implementation of the hematocrit percentiles as a criterion for anemia.

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CHAPTER I

INTRODUCTION

Anemia attained national recognition as a major public health problem following a flurry of investigations of the late 1960's and early '70's . The Ten State Nutrition Survey was one of the first of many to reveal the alarmingly high prevalence of anemia in the United States particularly among low income infants, preschool children, adolescents and pregnant women (1, 2). There are a variety of conditions which have been identified as potential etiologic factors in the development of anemia. The principle cause, however, is dietary iron deficiency which continues to plague health professionals as the most common nutritional deficiency in the U.S. Lead intoxication, hookworm infestation, thalassemia, sickle cell trait, chronic infection, blood loss, and folic acid and B_{12} deficiencies are other, less common causes of anemia.

Extensive research has been conducted in the past three decades to define more clearly the effects of iron deficiency anemia. These studies have indicated a relationship between iron deficiency anemia and the less severe stages of iron deficiency without anemia and defective immunocompetency, impaired cognitive development, growth stunting, decreased work performance, lethargy and abnormalities in oxidative skeletal muscle function.

The Tennessee Department of Health and Environment (TDHE) provides screening and treatment for iron deficiency anemia for low

income pregnant and breastfeeding women and children under five through the Supplemental Food Program for Women, Infants, and Children (WIC). This food and nutrition program, sponsored by the United States Department of Agriculture, was established by Congress in 1972 through an amendment to the Child Nutrition Act to help meet the nutritional needs of the low income population during their most critical stages of development. Eligibility for WIC is based on income and nutritional risk. Nutritional risk is determined by a medical and dietary assessment and is defined as any medical condition which can be ameliorated through improved food practices. Anemia is one of the many health problems included in the nutritional risk criteria and is evaluated by the patient's hematocrit or hemoglobin level.

The standard protocol for the WIC participant with a "low" hematocrit is three-fold:

1. Issuance of food vouchers which can be redeemed for foods high in iron and other nutrients needed to help improve the patient's health status;

2. Nutrition education tailored to include instruction on sources of iron rich foods and foods which enhance or inhibit absorption of nonheme iron. The nutritionist also provides information on the use of the WIC foods and how to better utilize the family food dollars; and

3. Issuance of multi-vitamins with iron and/or iron supplements.

Follow-up visits, including nutrition counseling and issuance of the vouchers, are provided in intervals of three months or less until an adequate response to the treatment is demonstrated. Referrals to private physicians are made when necessary.

Although recent evaluations of the WIC program have reflected significant decreases in the incidence of anemia among the children enrolled in the program, many of the participants fail to respond to the treatment for iron deficiency provided through the WIC services.

The purpose of this study was to evaluate the treatment provided for and the response to anemia in the pediatric WIC population of the Tennessee Department of Health and Environment. Following observation of staff procedures and extensive training of nursing and nutrition staff on the proper procedures for the treatment of iron deficiency anemia, the study was implemented in one urban and two rural Tennessee WIC clinics. At the participant's 3 month follow-up visit, a questionnaire was administered to the parent or guardian of the anemic subject to obtain information on demographic, dietary, and compliance associated variables related to iron status. These data were evaluated by county and/or treatment response to help determine the possible reasons for nonresponse. It is intended that this information will be utilized to help establish a more effective intervention program for the treatment of anemia in the Tennessee WIC Program. A list of terms used frequently throughout this thesis have been defined below.

WIC. USDA Supplemental Food Program for Women, Infants and Children

Multivitamin with iron supplement. Poly-Vi-Sol with iron (Mead Johnson) issued to children less than 18 months old or Daily Dose Chewables (American Pharmaceuticals) issued to children 18 months or

older. Both contain 10 mg elemental iron/daily dose and both were issued to children with hematocrits of 33% or less.

Iron supplement. Fer-In-Sol (Mead Johnson); contains 15 mg elemental iron/0.6 ml; issued to children with hematocrits of 31% or less.

Initial visit. WIC certification examination which included screening for anemia and appropriate treatment.

Treatment. Services provided by WIC for anemia at the initial visit which included iron and/or multivitamin/iron supplements, individual nutrition counseling, and the WIC supplemental food package.

Follow-up visit. Hematocrit screening, nutrition counseling, administration of the questionnaire, and reissuance of the food package and supplements, when appropriate; given at approximately 3 months following the initial visit.

Responder. Any child whose hematocrit increased at least 3% by the follow-up visit and was greater than 30% for children less than 24 months or greater than 33% for children 24 months or older.

Nonresponder. Any child who did not meet the criterion for responder defined above.

CHAPTER II

REVIEW OF LITERATURE

With the advent of television, an increased awareness of health, and a more expansive public health system, "iron-poor" blood is a term that has become almost as familiar to the lay person as anemia is to the public health professional. Television and radio advertisements have been informing us for years of the potential risks of "iron-poor" blood or the anemia of iron deficiency. And yet despite the abundance and variety of foods available in the United States, dietary iron deficiency continues to be the major factor contributing to the high prevalence of anemia. While anemia is most common among indigent infants and preschoolers, adolescents, and pregnant women, it is evident in all age, racial and socioeconomic groups in the United States (1-5).

Prevalence of Anemia Among Infants and Preschool Children in the United States

Numerous investigations have been made to evaluate the prevalence of anemia among infants and preschoolers in the United States. One of the first and most familiar of these studies is the Ten-State Nutrition Survey of 1968-70, conducted by the U.S. Department of Health, Education and Welfare (HEW—currently the Department of Health and Human Services)(1). In this study, the subjects, primarily obtained from low socioeconomic census tracts, were classified for anemia as "low" or "deficient." The following criteria for hemoglobin (Hb) concentration in the children were:

Less than 2 years of age	Low: Hb 9.0-9.9 g/dl
	Deficient: Hb < 9.0 g/dl
2-5 years of age	Low: Hb 10.0-10.9 g/dl
	Deficient: Hb < 10.0 g/dl

The results disclosed a wide discrepancy in the percentage of "deficient" hemoglobin values between the black and white children less than 2 years of age. Whereas 19.8% of the black children in the low income states were "deficient," only 3.8% of the white children less than 2 years of age in the low income states had "deficient" hemoglobin values. The gap narrowed considerably in this age group when the "low" criterion was used, with 15.4% of the white and 15.6% of the black children in this group having "low" levels. Among the 2 to 5 year old children in the low income states, approximately 3% of the white children and 11% of the blacks were "deficient." In contrast to the younger children, the gap widened when the low criterion was used, with 9.9% of the whites and 22.8% of blacks falling within the low range. Similar gaps in the prevalence of low and deficient hemoglobin concentrations also were present among the black and white infants and preschoolers of the high income states in this survey, although the rates generally were lower.

The Preschool Nutrition Survey of 1968-70 revealed a 5% prevalence of anemia in a cross section of 2,000 children from 36 states (Hb < 10 g/dl for children 1 to 2 years and Hb < 11 g/dl for children 2 to 6 years) (6). The highest incidence of anemia in this sample (22%) occurred in the low income preschoolers aged 12 to 23 months.

The first Health and Nutrition Examination Survey (HANES I) was undertaken by HEW in 1971 to obtain a broader view of the nutrition status of the U.S. population than the Ten-State Survey provided (2). Among 1 year old infants in all socioeconomic classes, the data from the HANES I study revealed hemoglobin values of less than 11.0 g/dl in 42.1% of the blacks and 14.9% of the whites. The prevalence decreased with age in both the white and black preschoolers, with 18.7% of the 2 to 3 year old blacks and 6.4% of the blacks 4 to 5 years exhibiting low hemoglobin values. Among the white preschoolers, 7.4% of the 2 to 3 year olds and 0.9% of the 4 to 5 year olds had low hemoglobin concentrations. A significant discrepancy also was noted when comparing male infants 1 year of age to female infants, with 19.3% and 12.6%, respectively, having low hemoglobin concentrations. This variance was not evident in the older preschool males and females.

HANES II, conducted in 1976 through 1980, once again demonstrated the significantly higher hemoglobin as well as hematocrit values among white children when compared with black children of similar ages (5). This phenomenon was evident regardless of income status. In this survey, 7.4% of black male preschoolers aged 3 to 5 years had hemoglobin concentrations of less than 11 g/dl while 3.4% of the white males of this age had low hemoglobin levels. Over four times as many black female preschoolers (3 to 5 years) as white female preschoolers had low hemoglobin levels (12.3% vs. 2.9%). If a hematocrit of less than 34% is used as a criterion for abnormal hematologic status among these children, 16.7% of the males and 14.9%

of the females would be classified with low values. The specific findings according to income status have not been published to date.

Evidence of anemia in specific population samples in the United States has shown varying degrees of prevalence. In 1968, Hutcheson found hematocrits below 30% in 10% of 15,681 poor, rural Tennessee preschoolers less than 6 years of age (7). Approximately 40% of the nonwhite 1 year olds were anemic.

Over half (52%) of 168 "presumably" healthy, indigent children primarily of Mexican origin and aged 6 months to 9 years were identified with hemoglobin levels of less than 10 g/dl (8). The largest percentage of the anemic children in this study (23%) were 12 to 23.9 months old. An even higher prevalence of iron deficiency (88%) among these children was identified by the low serum iron levels and total iron binding capacities.

The effect of indigence on the nutritional status of 300 randomly selected black preschool children below the poverty level was evaluated in Memphis, Tennessee (9). The results indicated approximately one fourth of these children were anemic and that the lack of food was the primary reason contributing to the development of anemia.

Etiology of Anemia

Dietary iron deficiency is one of the most common nutrient deficiencies in the U.S., contributing to the relatively widespread prevalence of anemia, particularly among young children, adolescents and women of the childbearing years. Both the HANES I study and the

Ten-State Nutrition Survey showed a significant correlation between low intakes of iron and low hemoglobin values among young children 1 to 3 years of age (2, 10). Other smaller studies have shown similar results indicating a strong relationship between low dietary iron intakes and the prevalence of anemia (8, 9, 11).

When the iron content of the typical American diet is examined in relation to the Recommended Dietary Allowances (RDA), the reason for the prevalence of iron deficiency anemia in the U.S., particularly among the population groups mentioned above, becomes evident. Six mg of iron per 1000 kcal, the average amount of iron in the typical American diet, is insufficient to meet the RDA of 10-15 mg iron per day for many young children as well as the 18 mg iron per day for adolescents and premenopausal women who frequently consume less than 2000 kcal daily (12).

Although dietary iron deficiency is the most common culprit in the etiology of anemia, the maintenance of sufficient levels of circulating hemoglobin or erythrocytes can be impaired for a variety of other reasons. Blood loss (13, 14), thalassemia (14-16), sickle cell trait (17), hookworm infestation (18, 19), lead intoxication (20-22), and folic acid (23-25), and B_{12} deficiencies (24, 25) are among the less common causes of anemia. Cow's milk which has not been heat treated and excessive milk intake also have been cited as etiologic factors in the development of anemia in infants and young children (24, 26, 27). The remainder of this discussion will focus primarily on the more common anemias of iron deficiency and the less advanced, but noteworthy, stages of iron deficiency without anemia.

Iron Metabolism

Finch defines iron deficiency as "a state in which the iron supply is inadequate to permit normal synthesis of essential iron compounds" (28). After 4 to 6 months of age, this iron supply is provided almost solely through the diet. Dietary iron, however, is very poorly absorbed from the gastrointestinal tract and since there is minimal iron loss through sweat, urine, or endogenous fecal material in the healthy individual, the main physiological control for iron balance is through the absorptive mechanisms in the small intestine (29-31). There are three main factors which determine the bioavailability of dietary iron from the small intestine: (1) the type of iron ingested, i.e., heme versus nonheme iron, (2) the presence of dietary constituents which either enhance or inhibit the absorption of iron, and (3) the individual's iron status. Although all the mechanisms involved in the digestion, absorption, and utilization of iron are not fully understood, the general concepts of iron metabolism are as follows.

Following the ingestion of a meal, the dietary iron in the lumen of the gastrointestinal tract exists in one of two pools depending on the chemical form of the iron (32). The iron from the hemoglobin and myoglobin in beef, fish, poultry, pork, and lamb forms a heme pool and is immediately available for absorption from the lumen of the small intestine. Approximately 40% of the iron in meat, fish, or poultry is in the heme form. The absorption rate of the iron from the heme pool is unaffected by other dietary constituents. In an individual with sufficient iron stores, approximately 15-25% of the heme iron is

absorbed. The amount of heme iron absorbed in an iron-depleted individual can increase significantly up to 35% (32-35).

The iron in vegetables, fruits, breads, and cereals, the remaining 60% of the iron in meat, fish and poultry, and the iron in dairy products and eggs forms a second pool of iron in the lumen of the gut known as the nonheme pool. The absorption of nonheme iron is inhibited significantly by the presence of calcium and phosphate salts (36, 37), tannic acid in tea (38-40), phenols in coffee (40), phytates in high fiber foods (39, 41, 42), EDTA (43), and soy products (44).

Ascorbic acid has been shown to enhance dramatically the absorption of nonheme iron by forming a soluble iron chelate and/or by preventing the oxidation of ferrous iron (29, 45). Rossander (46) and Callender (47) described a three-fold increase in iron absorption with the addition of a glass of orange juice to a typical breakfast meal of eggs, bread, coffee or tea. Evidence also has been provided to indicate the amount of ascorbic acid added to the meal is directly proportional to the degree of improvement in iron absorption (48) and that the ascorbic acid can minimize the inhibitory effects of tea (41). Conversely, tea has been shown to decrease the enhancement properties of ascorbic acid by as much as 50% (49).

In addition to supplying a readily absorbable form of iron, animal tissue contains an unidentified compound which enhances the absorption of nonheme iron, known as the meat-fish-poultry (MFP) factor (37, 50). The MFP factor does not affect the absorption of heme iron and is not found in eggs or dairy products. In fact, eggs and dairy products can

be inhibitory to nonheme iron absorption due to the presence of phosphoproteins and calcium and phosphate salts, respectively (37, 50).

Approximately, 90-95% of our total dietary iron is obtained from nonheme sources (34). However, only 1 to 10% of the iron from the nonheme pool is absorbed (51). Consequently, even when considering the addition of the heme iron to the diet, one must consume 10 to 20 times the amount of iron actually needed by the body in order to maintain a healthy iron status.

The major site of iron absorption is the upper segment of the small intestine known as the duodenum. The nonheme iron in the food, the majority of which is in an organic ferric complex, is released in the stomach by the acidic gastric juices and is converted to a soluble, absorbable form (i.e., ferrous iron chelates) prior to entering the duodenum. The soluble nonheme iron and the heme iron, along with the partially digested food and the remaining unreduced nonheme ferric iron, then pass from the stomach into the duodenum. In the duodenum the elevated pH facilitates the incorporation of the nonheme ferric iron into insoluble and unabsorbable precipitates (29, 52, 53). It is also primarily in the duodenum where ascorbic acid and certain sugars and amino acids can prevent formation of the unabsorbable precipitates, while dietary constituents such as phylates and tannins can enhance precipitation of the iron (29, 53). Both the soluble ferrous iron and the intact heme molecules are absorbed by the intestinal mucosal cell (IMC), where ferrous iron is released from the protoporphyrin complex of the heme molecule. The ferrous iron from both the nonheme and

heme iron sources then is oxidized to the ferric state in the IMC and is stored either as ferritin in the intestinal mucosal cell or is transported to the serosal surface of the intestinal mucosa where the iron is released into the circulating plasma. The iron stored as ferritin in the IMC no longer is available for utilization by the body since the IMC cells are sloughed within 4 to 5 days after being synthesized. The iron entering the circulation binds to the carrier glycoprotein transferrin, which transports the iron to the respective tissues for the synthesis of hemoglobin, myoglobin, cytochromes and other iron-containing enzymes, such as succinate dehydrogenase, monoamine oxidase, and α-glycerophosphate oxidase (54). A minute, but essential amount of the iron, also is required as a co-factor for the activity of other enzymes (54).

The absorbed iron released into the plasma and not immediately utilized by the body is stored as ferritin and hemosiderin in the reticuloendothelial cells of the liver, bone marrow, and spleen (55). The ferritin iron in the reticuloendothelial cells can be readily mobilized as needed during periods of iron deficiency, while the hemosiderin is a more insoluble form of storage and is mobilized only as a last reserve.

The amount of iron crossing into the IMC and reaching the blood also is influenced by the iron status of the body (29, 52, 53), with the amount of dietary iron entering the blood circulation being inversely related to the iron stores. The most currently accepted theory is that the mucosal cells are responsible for this control (29, 56, 57). The mechanism by which the mucosal cells receive this information and

monitor the absorption rate and storage of ferritin in the IMC has not yet been elucidated, although many theories have been suggested (58-61). This responsiveness to the level of iron storage is not always sufficient to meet the body's needs for iron, however, particularly when there is chronic dietary iron deficiency, lack of heme iron or an excess of inhibitory factors or lack of enhancing factors in the diet.

Although the human body is extremely inefficient in the absorption of dietary iron, it partially makes up for this inefficiency through the recycling of iron made available from the degradation of red blood cells. Following hemolysis, two-thirds of the iron returned to the circulating blood is bound immediately to transferrin and is recycled (31). The majority of the remaining iron from hemolysis not returned to transferrin is stored as ferritin or hemosiderin so that almost all of the iron from the destruction of red blood cells eventually can be recycled. Because of this efficient recycling process, iron is often referred to as the "one way element."

Assessment of Iron Status

There is an extensive list of hematological biochemical tests available for the assessment of iron status. Hemoglobin concentration and packed cell volume (hematocrit) are the two most widely used hematological measurements for the detection of iron deficiency anemia. These tests are used interchangeably for the screening and diagnosis of anemia, although evidence has suggested the hematocrit is less sensitive (26, 62, 63). In the early stages of iron deficiency, the body may produce a sufficient number of microcytic red blood cells to maintain a

"normal" hematocrit reading. Also, the increased rigidity of the iron deficient erythrocyte has been cited as creating a false negative reading since these cells are not as easily compacted.

Graitcer et al. (62) examined the use of the hemoglobin versus the hematocrit in a review of data collected from seven surveys on a total of 13,040 children. The results indicated the hematocrit would misdiagnose 1 to 10% of children with normal hemoglobin levels (i.e., false positives) and 20 to 50% of the children with low hemoglobin values (i.e., false negatives). They concluded the hemoglobin would be preferable to the hematocrit during the earlier stages of iron-deficiency anemia since "it measures the first change in peripheral blood-hemoglobin volume."

Most clinical investigators concur that due to individual variations in the homeostatic controls of "normal" hemoglobin levels (63), and the inability of either the hematocrit or hemoglobin to detect the less severe stages of iron deficiency, that these measurements in themselves do not adequately assess iron status. Evidence indicates there is a significant overlap in the hemoglobin distribution curves of anemic and normal subjects, particularly in a population with a high prevalence of iron deficiency anemia (63, 64). Consequently, an alarmingly high number of false negative and false positive assessments can be made with the hemoglobin concentration measurements. Finch postulates that in some population groups, the use of the hemoglobin concentration as a measure of iron deficiency can result in as much as 50% inaccuracy, with one-half of the "apparent" anemic individuals being misdiagnosed, and one-half of the truly anemic subjects incorrectly labeled as normal (28).

Garby et al. investigated the accuracy of the hemoglobin concentration as a predictor of response to iron supplementation in adult women and found 17% of the responders had been identified as normal and 35% of the nonresponders were misclassified as iron-deficient (65). He also determined if a hematocrit of less than 36% was used to diagnose iron deficiency anemia in women, 53% of the responders would be misdiagnosed (i.e., false negatives) and 59% of the nonresponders would be treated (i.e., false positives) (66).

Similar degrees of inaccuracies in the hematocrit were disclosed in a study which ascertained 60% of the women with inadequate iron in the bone marrow would be misclassified as normal if the criterion of less than 36% was used while 39% of the women with adequate bone marrow iron would have been treated (67).

To avoid the potential for these inaccuracies, most clinicians obtain at least one biochemical assay in addition to the hematocrit or hemoglobin (or other hematological measures of anemia) when assessing iron status. This practice has been substantiated by increasing evidence indicating the importance of diagnosing iron deficiency prior to the development of anemia. The most commonly used tests are serum iron, total iron binding capacity, percent transferrin saturation, serum ferritin, free erythrocyte protoporphyrin (FEP), and the FEP/ hemoglobin ratio. The mean corpuscular volume and the mean corpuscular hemoglobin concentration are two additional tests used for the detection of anemia. The time and money available, the degree of accuracy desired, and the prevalence of anemia in the respective

population will determine the appropriate combination of hematologic or biochemical evaluations chosen.

The mean corpuscular volume (MCV) is the ratio of the hematocrit to the red blood cell count (RBC) and currently is measured by an electronic counter. Because the MCV via an electronic counter is a direct measure of cell volume, it gives a more accurate assessment of anemia than the hematocrit. Not unlike the hematocrit, however, it cannot serve as an indicator of the less advanced stages of iron deficiency (5, 52, 68-73). The mean corpuscular hemoglobin concentration, a ratio of the hemoglobin concentration to the RBC, is another relatively accurate measure of anemia (52, 68-73).

The serum iron is a technically complex procedure which is subject to diurnal changes. In conjunction with the total iron binding capacity (TIBC), however, a more precise picture of iron status can be drawn. This measure is called the transferrin saturation (TS) and is the ratio of serum iron to the TIBC, expressed as a percent. The TIBC is a measure of the quantity of iron that will bind to the free transferrin in a sample of plasma. As the serum iron concentration decreases, the TIBC increases to assure that any available iron will be transported where needed. Although the TS is about twice as accurate as the hemoglobin in the detection of iron deficiency, its usefulness is limited because of the extreme sensitivity of serum iron to mild infections (5, 52, 68, 71-75).

Serum ferritin is measured by radioimmunoassay and is the most sensitive measure of nonhematologic iron deficiency. A decrease in the serum ferritin level indicates a proportional decrease in the body's

stores of iron in the liver, spleen, and bone marrow. It is capable of distinguishing the anemia of true iron deficiency from anemia due to chronic infection. Unfortunately, it is also sensitive to acute inflammations (5, 52, 68, 71, 72, 75-77).

A relatively inexpensive, quick, and simple test of fluorescence has been developed recently for the measurement of the free erythrocyte protoporphyrin (FEP) or red blood cell zinc protoporphyrin (ZPP) concentration. The FEP or ZPP increases when insufficient quantities of iron are available to bind with the protoporphyrin IX complex in the final step of heme synthesis. Lead toxicity can also cause an elevation in free protoporphyrin by inhibiting the enzyme needed for the incorporation of iron into the protoporphyrin molecule. This assay is particularly important in population groups in which excess lead ingestion or inhalation via leaded paint, water, or air pollution is suspected. The elevated FEP or ZPP from the anemia of lead intoxication is significantly higher than the typical values of iron deficiency. The FEP or ZPP is preferred by some over the transferrin saturation since it is unaffected by acute infections. It is subject to changes in chronic inflammations, however (5, 52, 68, 71, 72, 75, 77-81).

The FEP is inversely related to the hemoglobin concentration; this relationship can be expressed as the FEP/hemoglobin ratio and provides a more sensitive, well-defined picture of iron deficiency anemia than the FEP alone or the percent transferrin saturation, particularly for small children (68, 75, 79).

These various measurements of iron status can be used to categorize the severity of iron deficiency into one of three stages (23, 28, 52). In the initial phases of iron deficiency, known as the iron depletion stage or prelatent iron deficiency, the only change in iron status is a decrease in iron stores, as demonstrated by falling serum ferritin levels. Iron deficiency in stage one is particularly common during rapid stages of growth such as infancy, early childhood, adolescence, and pregnancy and can sometimes be corrected with an improvement of diet only. In stage two, the increasing depletion of iron is manifested by an elevated total iron binding capacity and FEP and a decreasing percent transferrin saturation and serum iron. Hemoglobin synthesis begins to be impaired in this stage, although the levels are maintained within the normal range. Anemia is the last and final phase of iron deficiency and is documented with significantly lowered hemoglobin, hematocrit, MCV, or MCH levels (23, 82). It should be noted that there is some evidence in rats that these stages can overlap, further complicating an accurate diagnosis of the degree of iron deficiency (83).

Any combination of the various biochemical assays can be helpful in diagnosing iron deficiency. However, if all else fails in detecting a suspect case, the most accurate, infallible and inexpensive test is a therapeutic trial of iron supplementation with follow-up observations (68).

The Manifestations of Iron Deficiency Anemia and Nonhematologic Iron Deficiency

The basic laws and pathways of bioenergetics describe the vertebrate's dependence on a regular supply of oxygen to maintain normal metabolic processes. The hemoglobin molecule in the erythrocyte, of which iron is an essential element, carries the critical responsibility of delivering the oxygen to the appropriate tissues as needed. Iron also is contained in a diverse group of enzymes, including the cytochromes, and serves as a co-factor for many other enzymes (54). Consequently, there are multifarious effects of iron deficiency, many of which occur prior to the onset of anemia.

It is apparent from the literature that maximal performance capacity is significantly hindered by iron deficiency, presumably due to the decreased oxidative power of muscle tissue. Finch et al. clearly demonstrated this effect of iron deficiency without anemia in an experiment with four groups of treadmill trained rats with similar nonanemic hemoglobin concentrations (84). Group I received an iron-deficient diet for 4 weeks prior to a series of treadmill tests. The rats in group II were fed a normal diet. An iron deficient diet with weekly intraperitoneal iron injections was given to the group III rats during these 4 weeks and group IV was maintained on an iron deficient diet during the pretesting period but received iron supplements (intraperitoneal injections) from day 2 through the 4 week period of the treadmill examinations. The hemoglobin values of the four groups were maintained throughout the study by exchange transfusions (i.e.,

erythrocytes to increase and plasma to decrease the hemoglobin concentration). The results were dramatic. The maximum running time for the group I rats was 4 minutes, while the rats fed the normal diet and the iron supplemented diet prior to the test had mean running times of 17.2 and 20.1 minutes, respectively. Even more conclusive evidence was provided by the group IV rats whose running time increased proportionately with the number of days of iron supplementation administration until a maximum time was reached. By day 4, these rats were running 16 to 20 minutes. Upon further examination of the muscle tissue of the iron deficient rats, these investigators found the myoglobin concentration, oxidative cytochrome concentration, and the rate of oxidative phosphorylation had decreased.

The effect of iron deficiency on skeletal muscle oxidative capacity was evaluated in another study by comparing the muscle mitochondrial respiration and hemoglobin and myoglobin concentrations of male, weanling rats fed an iron-deficient diet and rats given a control diet (85). The hemoglobin, skeletal muscle myoglobin, and cytochrome concentrations were 35%, 20-37%, and 35% less, respectively, in the iron-deficient rats than the corresponding measures in the control rats. A broader picture provided by the skeletal muscle mitochondrial respiration showed a 17-20% difference in the two groups.

In a similar study, Davies et al. showed a 30% difference in mitochondrial content of skeletal muscle in anemic rats as compared to nonanemic controls (86). In addition, a 60-85% reduction in skeletal muscle oxidative power was demonstrated. A 90% difference in

endurance capacity was noted among the anemic and iron sufficient rats. Following the addition of adequate levels of iron to the diet of the iron deficient rats both hemoglobin concentration and VO_{2max} increased within 3 days, while endurance capacity significantly increased by the 5th day.

Koziol et al. demonstrated that the intensity of the effect of anemia on endurance is proportional to the severity of the anemia by examining running time in normal rats, in moderately iron-deficient anemic rats (MIDA) and in severely iron-deficient anemic rats (SIDA) (87). A 64% difference in exhaustive run time was noted among the normals and MIDA rats, while the SIDA rats had an 82% lower exhaustive run time than the controls. Also, blood lactic acid levels, a product of anaerobic metabolism and the principle cause of fatigue following exercise, were significantly lower in the controls than the MIDA rats or SIDA rats, regardless of the longer running time in the control rats.

In an experimental human study, Gardner et al. employed the Harvard step test on 29 anemic subjects infested with hookworms to ascertain the effect of anemia on maximum heart rate, oxygen consumption, and oxygen delivery rate (88). Blood lactic acid levels also were examined. Nineteen of the 29 subjects were given enough intramuscular iron supplementation to replete iron stores over an 80-day period. The remaining 10 subjects constituted the placebo group and were matched to the experimental subjects for age, sex, and degree of anemia. Following a step test, the variables mentioned above were measured on each of the subjects before and after the 80-day period. While the

placebo group showed no changes in heart rate at the end of the 80-day period, the heart rate of the iron treated men and women decreased from 155 to 113 beats per minute and 152 to 123 beats per minute, respectively. No differences in oxygen consumption between the two groups were reported. However, 15% more oxygen per beat was delivered in the iron treated group. Lactic acid levels were significantly higher in the subjects receiving the placebo.

Improved exercise performance was manifested in a group of agricultural laborers in Guatemala following iron supplementation (89). The scores on the Harvard step test rose directly with the hematocrit over a 60-day period in the supplemented subjects. No changes were demonstrated in the control group.

Many studies have implicated iron deficiency anemia as the principal cause of decreased worker productivity, probably as a result of lethargy or weakness. Data collected on workers on a tea plantation in Sri Lanka demonstrated this effect (90). Following iron supplementation, significantly more tea was picked by workers whose hemoglobin levels had risen. The degree of physical activity throughout the regular day also was recorded and found to increase following supplementation.

Similar results were obtained in a study of adult Indonesian workers on a rubber plantation whose wages were dependent on the work output (91). The hemoglobin levels were correlated directly with the wages. Following 60 days of iron supplementation, work output (i.e., amount of rubber tapped or weeds pulled per day), hemoglobin

concentration, and the Harvard step test were reported to have improved significantly. Conversely, no change was noted in the untreated subjects.

The effect of iron deficiency on cognitive development is of special interest to the pediatric physician and nutritionist, particularly since there is a high prevalence of iron deficiency among preschool children. Lethargy, apathy, and irritability, symptoms frequently associated with iron deficiency, have been suggested as etiologic factors, presumably resulting in decreased attentiveness and social interaction (54). These impairments of mental and behavioral development have been attributed to a decrease in the iron dependent enzymes affecting cerebral function, including monoamine oxidase, the controlling enzyme for the catabolism of the catecholamines (71, 92). Rat studies have suggested an impaired ability to metabolize the catecholamines could result in an inordinate level of these neurotransmitters, thus affecting the behavior and subsequent learning ability of the iron deficient child (93-95). Other studies suggest aldehyde oxidase, needed in the metabolism of serotonin, or phenylalanine hydroxylase, which is required for the conversion of phenylalanine to tyrosine, could be responsible for the effect of iron deficiency on behavioral development (96, 97).

A study to assess the effect of anemia on behavioral development by Oski and Honig evaluated the effect of intravenous iron supplementation on the developmental scores of 24 iron deficient infants and toddlers aged 9 months to 26 months (92). Twelve of these subjects were randomly assigned to a control group which received a

placebo of sterile saline solution. The control group and experimental group were matched for sex and race, and had similar ages, weights, initial hemoglobin concentrations, MCVs, serum iron concentrations, percent transferrin saturations and similar mean parental educational levels. Following 5 to 8 days of intravenous treatment, a significant increase in the Bailey Mental Development Index (MDI) was noted in the children receiving the intravenous iron preparation. No significant change in the Index was demonstrated in the control group receiving the placebo. The improvement in developmental scores in the treated children was inversely proportional to the hemoglobin concentration at the initial assessment (prior to treatment), indicating that the severity of the anemia affects the extent of the impairment in behavioral development. The categories within the index which contributed to the improvement were gross and fine motor coordination, alertness, and responsiveness. No change was noted in the attention span.

An assessment of the changes in the MDI following oral iron supplementation in 15-month old children with varying stages of iron status was made in a similar study by Walter et al. (98). The MDI was measured pre- and posttreatment in 12 nonanemic controls, 11 children with mild anemia (hemoglobin concentration less than 11 g/dl and greater than 8.5 g/dl), and 15 children with evidence of iron deficiency without anemia (hemoglobin concentration greater than 11 g/dl and at least one biochemical measure of iron deficiency). The children were identified as having similar cultural background, ethnicity, socio-economic status, and parental educational status. Also, all the children

were within acceptable National Center for Health Statistics (NCHS) percentiles for weight and height. The children in all three groups, including the iron replete group, received Fer-In-Sol for at least 10 to 15 days at which time the post-MDI tests were administered. Prior to treatment, the anemic children scored significantly lower on the MDI Index than the controls. There was no significant difference in the indexes of the nonanemic iron deficient subjects and the controls. A significant improvement in the MDI Index following the oral iron therapy was noted in both the anemic subjects and a subgroup of the nonanemic iron deficient children with at least two abnormal biochemical measures of iron deficiency. Improvements in both attention span and cooperativeness contributed to the improved Index. No change was noted in the treated non-iron deficient controls. These authors concluded that due to the relatively short duration of the treatment verses the time usually required to make a noteworthy impact on heme synthesis, these changes were a consequence of the iron deficiency rather than the reduction in red blood cells.

Lozoff et al. were unable to obtain similar results in a double blind study of 28 iron deficient anemic Guatemalan children 6 to 24 months of age (99). Prior to treatment with oral iron therapy the anemic subjects scored significantly lower on the MDI tests than did the 40 nonanemic controls. Of special concern was the deficit noted in the language skills of these anemic children. However, unlike Oski and Walter's iron-deficient anemic subjects, these children did not improve their scores following one week of treatment. The authors noted that the

lack of improvement is particularly alarming since the poor MDI scores were obtained on items which are associated with future IQ's. Some authors have suggested the differences in these studies may be explained by different rates of improvement following therapy, which was not addressed in any of these studies (100).

Deinhard et al. also found negative results in comparing the MDI indexes of 212 low-income nonanemic children 11-13 months old with varying degrees of iron deficiency (100). No significant differences were found among mildly iron deficient, severely iron deficient, and iron sufficient children. Some isolated differences in fearfulness and sensory areas were noted, however. The authors suggested that perhaps a longer duration and/or extent of iron deficiency as exhibited by anemia is required before behavioral effects can be demonstrated.

The relationship of hemoglobin concentration during infancy and mental development in later years was examined by Palti et al. (101). They showed a significant correlation of anemia at 9 months of age and developmental scores at 2 years and IQ scores at 3 years and 5 years, despite controlling for hemoglobin, educational status of mother, birth weight, sex, and social class. The developmental and IQ scores at 2, 3 and 5 years of age were positively correlated with the hemoglobin concentration measured at 9 months. These results correspond to Dallman's animal study in which iron deficiency early in the rat's life resulted in persistent iron deficiency in brain tissue following iron repletion in other tissues (102).

Growth stunting and underweight are two other manifestations of iron deficiency that have been reported among anemic children. Owen

et al. identified lower hemoglobin values among the "skinny" and "short" boys than the "tall" and "fat" male subjects (11). These data were obtained from the National Preschool Nutrition Survey in which the children were divided into four categories: short and skinny, short and fat, tall and skinny, and tall and fat. The hemoglobin values in these four groups were 12.7, 12.8, 12.9 and 13.0 g/dl, respectively. This correlation did not exist among the girls, however.

In a study of the nutritional deficiencies of disadvantaged school children, the taller children were found to have higher serum iron levels (103). The Ten-State Nutrition Survey ascertained similar results; the children with the higher hemoglobin values were taller on the average than the children with lower hemoglobin levels (1).

The most convincing data have been provided by an investigation of 156 iron-deficient infants and children less than 3 years of age (104). In a subsample of 88 of these children, 23% were below the 10th percentile for weight for age, 41% were between the 25th and 75th percentiles, and 6% fell above the 90th percentile prior to the iron therapy, indicating a distribution skewed in a highly negative direction. Following therapy, the distributions shifted, with 10%, 34% and 17% falling into the respective categories. The individual patterns of growth also reflected the possible effect of iron deficiency on weight. Before iron therapy, the weight for age was rapidly leveling off, whereas after treatment, the weight for age curve took a significant jump upward, creating a sigmoidal curve. The relationship of iron deficiency and an increased incidence of impaired growth and intellectual development is far from conclusive, however, since in the majority

of these studies it is difficult to distinguish between the effects of iron deficiency per se and a more general nutritional deficiency (105).

The effect of iron deficiency on immunocompetency and the incidence of infection remains a very controversial observation with many opposing viewpoints. While some investigators claim iron deficiency enhances the susceptibility to infection, others suggest abnormalities in iron status actually may serve a bacteriostatic function while iron therapy may enhance the growth of bacteria (106). Supporters of the latter theory claim that since apotransferrin can inhibit the growth of bacteria by sequestering a critical portion of the ionic iron needed by bacteria for growth and proliferation, that iron left over after the saturation of the transferrin with iron supplements can result in the availability of sufficient serum ionic iron to support the growth of bacteria (107, 108). However, the American Academy of Pediatrics Committee on Nutrition and others have noted that oral iron therapy is not sufficient to saturate transferrin in the normal individual (107, 109).

A number of clinical studies have implicated a significant relationship between iron deficiency and immunocompetency. Joynson et al. examined the lymphocyte transformation (measured by thymidine uptake for DNA synthesis) and dermal hypersensitivity reactions in response to Candida and purified protein derivative (PPD) antigens in 12 iron deficient anemic subjects and 12 controls (110). After 48 hours, only one-fourth of the anemic subjects displayed a significant

skin reaction, while all of the controls showed significant hypersensitivity reactions. In vitro lymphocytes from the subjects in both groups showed no significant impairment of cell-mediated response to candida via lymphocyte transformation. The PPD did stimulate a significant impairment in thymidine uptake in the anemic subjects, however. Ten out of 12 controls had sufficient cell-mediated PPD responses whereas only 5 out of the 12 anemic subjects responded adequately.

Similar results with delayed hypersensitivity reactions and lymphocyte transformations were obtained by MacDougall et al. on both iron deficient anemic children and iron deficient nonanemic children with mean ages of 13 to 14 months. These children were well-nourished with no evidence of calorie or protein deficiencies (111). No abnormalities were detected in humoral immunity, however, as indicated by normal levels of serum immunoglobulin concentrations and salivary IgA concentrations. The children then were given oral or intramuscular iron therapy and after 2 to 3 months exhibited normal functional cell mediated immunity.

These same impairments in cell mediated immunity were corrected following oral or parental iron therapy in a study of 20 anemic children (9 months to 9 years of age) with normal serum albumin levels and heights and weights within the acceptable range (112). Humoral immunological function did not appear to be impaired in these anemic subjects.

Srikantia et al. found bacteriacidal activity of leucocytes was directly correlated with hemoglobin concentration in children aged 2 to

14 years (113). Significant impairments occurred in the moderately deficient and severely deficient anemic children, but not in the mildly anemic group. Serum albumin and heights and weights also were measured in this study and showed no bearing on the immune status of these children. The data on the moderately and severely anemic subjects also support the studies previously discussed in which significant impairments in lymphocyte thymidine uptake were noted.

The evidence presented here appears to indicate iron deficiency can impair cell-mediated immunity, but has little effect on humoral immunocompetency. It is apparent from the literature, however, that more research is needed to elucidate the extent of this effect and the exact role of iron in preventing infection.

As a result of the diverse roles of iron in the normal metabolism of the human body, the effects of iron deficiency can be varied. Among these potential effects are decreased skeletal muscle oxidative capacity, decreased endurance and worker productivity, growth stunting, impaired cognitive development, and impaired immunocompetency. Although all of these effects have not been proven conclusively, any problem which can potentially impair the optimal physical and mental growth and development of the young child warrants special attention.

Diagnosis and Treatment for Iron Deficiency Anemia in Infants and Preschool Children

A variety of pediatric texts providing recommendations for the diagnosis and treatment of iron deficiency anemia are currently available (13, 14, 25, 114-116). A summary of these guidelines is outlined below:

1. The initial diagnosis of iron deficiency anemia should be distinguished from the anemia of chronic disease or infection. The profile of the anemia of iron deficiency includes a decreased MCV, percent TS, serum iron, serum ferritin, and an elevated FEP and TIBC. In contrast, the TIBC and MCV will be normal or depressed with an elevated FEP and low serum iron and normal or elevated serum ferritin with the anemia of chronic disease (14, 52, 114). As previously mentioned, oral iron therapy is the simplest, easiest, and least expensive diagnostic tool if there is any doubt about the diagnosis (114). With mild iron deficiency, the hemoglobin, MCV, or hematocrit may be slightly low or low normal (114).

2. Anemia is diagnosed in infants and young children by the following laboratory values (13, 52, 115):

Hemoglobin concentration: <11 g/dl
MCV: <70 fl

Various values are suggested for the appropriate hematocrit indicative of anemia. A measurement of less than 34% for children less than 2 years of age and less than 36% for children 2 to 12 years is recommended by Miller, while a hematocrit of less than 33% is suggested by the American Academy of Pediatrics for 9 to 12 month old infants and by Oski and McMillan for children 6 months to 2 years of age (115, 117, 118). The Centers for Disease Control (CDC) Nutrition Surveillance Program uses normal cut off values of 31% for children less than 2 years of age and 34% for children 2 through 5 years (62).

3. Oral iron therapy with a ferrous sulfate solution is recommended most often at a dosage of 3 to 6 mg iron/kg/day (13, 25,

114, 116). This amount should be divided into two to three doses and administered at different times during the day between meals to facilitate maximal absorption. The liquid form is more easily administered to young children than are the tablets. Gastrointestinal problems are uncommon with children but may be minimized by decreasing dosage or offering the ferrous sulfate solution with juice or with meals, if necessary.

4. The liquid therapy may temporarily stain the child's teeth but can be prevented by administering the iron supplement at the back of the mouth and by brushing the teeth following administration (29, 109).

5. Administration of vitamins with the iron therapy has not been shown to enhance the desired increase in hematologic status above that provided by the iron itself, although it is well known that ascorbic acid enhances nonheme iron absorption (25, 52, 116).

6. Intravenous iron supplementation does not produce a greater or more rapid response than does oral iron treatment and is only warranted in cases of malabsorption or other special conditions in which oral therapy is inappropriate (114, 116).

7. A response to the iron therapy should be detected by reticulocytosis within 3 to 10 days. Thereafter, a maximal increase of 0.25-0.5 g/dl/day in the hemoglobin and 1%/day in the hematocrit should occur until a normal level is achieved. The desired value should be obtained within 1 to 4 months (25, 52, 114).

8. Iron supplementation should be extended for a few weeks after a normal hematologic level is reached to assure replenishing of the iron

stores. Dallman recommends continual treatment for 3 to 5 months, while Nelson's Textbook of Pediatrics recommends 4 to 6 weeks (25, 114).

9. Nutrition education should be provided as an adjunct to iron supplementation to assure maintenance of adequate iron status (13, 25).

The WIC Program

The extensive evidence on the effects of iron and other nutritional deficiencies prevalent in the United States spurred legislation to help meet the nutritional needs of the indigent population during their most critical states of development (119). In 1972, an amendment to the Child Nutrition Act (of 1966) established the Supplemental Food Program for Women, Infants and Children (WIC) to provide nutrient rich foods, nutrition education, and referral into the health care system for persons at nutritional risk. WIC is administered by state and local nonprofit public health agencies and is regulated by the U.S. Department of Agriculture. Nutritional risk is determined by a medical screening which includes a medical and dietary history, anthropometric measurements, and determination of packed cell volume or hemoglobin. The current nutritional risk criteria in Tennessee are as follows (119):

Pregnant or breastfeeding women

—less than 18 years of age

—low hematocrit (33% or below)

—history of low birth weight infants and/or miscarriages

—complications of pregnancy

—underweight, obesity or inappropriate weight gain

—pregnancies in rapid succession

—no prenatal care by 4th month of pregnancy

—breastfeeding with infant at risk

—inadequate dietary intake

—smoking (one or more packs daily)

—danger of regression from a nutritional risk condition determined by a previous certification

Infants (less than 1 year of age)

—low birth weight (5.5 lbs. or less) or premature

—low hematocrit (33% or less)

—inadequate pattern of growth

—infant of a mother who was on the WIC Program during her pregnancy

—infant of a non-WIC mother who would have been eligible for WIC during pregnancy

—danger of regression from a nutritional risk condition determined by a previous certification

Children (1 to 5 years of age)

—low hematocrit (33% or less)

—inadequate pattern of growth

—danger of regression from a nutritional risk condition determined by a previous certification

Following the initial income and medical screening, individual nutrition counseling is provided to assess the participant's dietary

habits. The findings from both the medical and dietary screening are reviewed with the participant (or the parent or guardian). Instruction for improving the participant's health status through better eating practices and information on utilization of the WIC foods and family food dollars is discussed. Follow-up group and/or individual nutrition counseling usually is provided in 3 month intervals or less, depending on the severity of the nutritional risk criterion.

The WIC food package in Tennessee is obtained from any locally approved grocery store with a food voucher. The package includes the following foods:

Infant 0-6 months

—iron-fortified formula (if not breastfeeding)

Infant 6 months to 1 year

—iron-fortified formula

—infant cereal

—infant juice

Children and Women

—iron-fortified cereal

—100% juice containing at least 30 mg ascorbic per 100 ml juice

—evaporated milk

—fluid milk

—nonfat dried milk

—cheese

—eggs

—dried legumes (if hematocrit is 30% or less)

Vouchers usually are dispensed at 3-month intervals. At the 3 month reissuance visit, a follow-up examination is also provided, if needed. Referrals to other government assistance programs and private physicians are made when necessary. WIC participants are rescreened for eligibility every 6 months and remain enrolled in the program until an adequate response to the WIC services is demonstrated (119).

Many surveys in recent years have been conducted to assess the impact of the WIC Program on the population served. A consistent finding demonstrated in these studies is the reduction in the incidence of anemia among the infants, children, and pregnant women (120-123). In Tennessee, the Pediatric Nutrition Surveillance data from 1975 through 1981 reflect the long term impact of the WIC Program on the prevalence of anemia in the population served by the health department. In 1975, 25% of the children screened for health department services were anemic. A continual decline occurred over the next 6 years, with less than 15% of the children in 1981 demonstrating anemia (120). The rate of anemia has dropped even further over the most recent 2 years with a rate of 10% being reported in 1983 (124). It should be noted, however, that this most recent data is calculated from the recently developed hematocrit percentiles rather than the cutoffs of 30% for children less than 24 months of age and 33% for children older than 24 months. Prior parental participation has been suggested as the major factor contributing to this steady decline (120).

The effectiveness of the WIC Program in treating pediatric anemia has been documented in Tennessee by a randomly selected record

review of 461 anemic infants and preschoolers from 33 WIC clinics. This investigation indicted a 73% response rate within 6 months of treatment (125). Weiler et al. and Blunt obtained similar rates of improvement (70% and 73.3%, respectively) in evaluations of WIC infants and children (122, 123).

A much greater degree of response to the treatment for anemia should be expected in the WIC population, however, since there is little reason to suspect many cases of non-iron deficiency anemias and the WIC Program procedures are targeted for the treatment of iron deficiency anemia. Noncompliance by the parents or guardians of the anemic subjects in the administration of the iron supplements, as well as failure to modify the diet to include daily dietary sources of iron, are the most obvious explanations for these relatively high rates of nonresponse. Also, inaccurate laboratory procedures in measuring the hematocrit or the potential inherent error rate associated with the measurement of the packed cell volume may have resulted in a significant number of misdiagnoses (i.e., false positives) and hence, a larger number of nonresponders than might be expected.

In lieu of the possible manifestations of prolonged iron deficiencies, particularly among infants and young children, further investigation is needed to elucidate the problems in and improve the effectiveness of the WIC intervention program for anemia. This study was undertaken to assess the effectiveness of the Tennessee WIC procedures for the treatment of anemia and to determine the reasons for noncompliance and/or nonresponse.

CHAPTER III

PROCEDURES

Study Design

The specific objectives for this study were: (1) to evaluate the incidence of pediatric anemia and the rate of treatment response in one urban and two rural East Tennessee WIC clinics and (2) to determine differences in demographic and dietary characteristics between treatment responders and nonresponders. A pilot investigation was conducted in the Roane County Health Department WIC clinic to evaluate the preliminary study design and questionnaire. Following the pilot study, appropriate changes were made in the study procedures and data collection was begun in the WIC clinics of the Knox (Main), Monroe, and Sevier County Health Departments. The methods of procedure are summarized in the following four sections: (1) Pilot Investigation (2) Final Investigation (3) Record Review, and (4) Statistical Analysis.

Pilot Investigation

The pilot study for this investigation was conducted in the Roane County Health Department (RCHD) from May 1983 through August 1983 and in the Knox County Health Department (KCHD)—main clinic from June 1983 through August 1983. The RCHD and KCHD WIC nursing, clerical, and nutrition staff participated in two workshops on the study

methods and procedures (Appendix A). Subjects for the pilot study were selected from children aged 6 months to 4½ years who were certified for WIC because of anemia. The Centers for Disease Control criteria for anemia was utilized and are as follows:

Children 6 months through 23 months: Hematocrit ≤ 30%

Children 24 months through 54 months: Hematocrit ≤ 33%

Routine WIC clinic procedures were used throughout the study. Some additions were made, however, to facilitate the collection of the data. The procedures are outlined below.

I. Initial WIC Certification

A. Applicant was screened for income (Appendix B).

B. If income eligible, the parent or guardian signed an informed consent form (Appendix C).

C. The nurse performed a medical screening, including the medical history, hematocrit, and anthropometric measurements.

1. One finger-stick blood sample was drawn into a heparinized capillary tube for the hematocrit. The blood sample was sealed with clay and centrifuged for 5 minutes to obtain the packed cell volume.

2. The height/length and weight of children under 5 years of age were measured with minimal clothing and shoes removed. The weight of infants (less than 1 year) was measured on the table model beam scale and

was recorded to the nearest ounce.

3. The length of children under 24 months was obtained on the table model measuring board or pediatric table. The recumbent length was recorded to the nearest 1/4 inch.
4. The weight of a child who was able to stand was measured using the floor model beam scale to the nearest 1/4 pound.
5. The standard measuring board attached to the wall was used to measure the height of a child 24 months or older. The height was recorded to the nearest 1/4 inch.
6. All measurements were plotted on the National Center for Health Statistics weight for age, height/length for age, and weight for height/length growth charts for the appropriate age and sex.

D. Fer-In-Sol (15 mg elemental iron/0.6 ml, Mead Johnson) and/or Poly-Vi-Sol with Iron (10 mg elemental iron/ml, Mead Johnson) or Daily Dose-1 chewable multivitamins with iron (10 mg elemental iron/tablet, American Pharmaceutical Co.) were dispensed according to the Tennessee Department of Health and Environment Child Health Standards. The guidelines for supplement issuance are outlined in Table 1.

E. Following the medical screening, individual nutrition

TABLE 1

Tennessee Department of Health and Environment Child Health Standards Guidelines for vitamin and iron supplement issuance

	18 months or less		19 months or older	
Hematocrit (%)	Poly-Vi-Sol with Iron[1]	Fer-In-Sol[2]	Daily Dose I (Chewables)[3]	Fer-In-Sol
≥34	--	--	--	--
32-33	1 ml/day	--	1 tablet/day	--
30-31	1 ml/day	0.6 ml once/day	1 tablet/day	0.6 ml once/day
28-29	1 ml/day	0.6 ml twice/day	1 tablet/day	0.6 ml twice/day
≤27	1 ml/day	0.6 ml 4 times/day	1 tablet/day	0.6 ml 4 times/day

[1]Mead Johnson and Co.—10 mg elemental iron/ml

[2]Mead Johnson and Co.—15 mg elemental iron/0.6 ml

[3]American Pharmaceutical Co.—10 mg elemental iron/tablet

education on the sources of iron rich foods was provided by the public health nutritionist. Iron and/or multivitamins with iron were issued if not already done.

F. The appropriate number and type of WIC food vouchers were issued according to age and individual need of the child. In keeping with routine WIC clinic procedures, an appointment for a 2½-3 month follow-up visit was assigned. All anemic children certified within a 2 week period were scheduled to return on the same day to facilitate administration of the study questionnaire.

II. Three Month Follow-Up Visit

A. Participant registered at the front desk. The health record was pulled and the study questionnaire (Appendix D) was clipped to the front of the folder.

B. The nurse measured the hematocrit and erythrocyte protoporphyrin (FEP). One finger-stick blood sample was used for both the hematocrit and FEP measurements. The FEP level was obtained by placing a single drop of blood on a slide mounted in the hematofluorometer. The FEP was measured in µg/dl whole blood. The hematofluorometer was calibrated daily when in use. FEP values above 60 µg/dl were remeasured.

C. The anthrometric measurements were made on those children who had extreme or otherwise abnormal measurements at the initial visit.

D. The parent or guardian was referred to a trained interviewer for administration of the study questionnaire. The child's identity as a responder or nonresponder was contained within the folder, so the interviewer was not aware of the child's response status during the interview.

E. The parent or guardian received counseling from the interviewer/nutritionist on the effects of iron deficiency, sources of iron rich foods, and importance of ascorbic acid to iron absorption. Iron supplements were dispensed, as necessary, according to the Child Health Standards (Table 1).

F. WIC food vouchers were issued and a return appointment for the 6 month certification was scheduled.

Final Investigation

At the completion of the pilot investigation, a variety of changes needed in the design of the study were identified. The original procedures had been established under the assumption that public health personnel were familiar with the following health department procedures and concepts: (1) Child Health Standards for supplement issuance and follow-up care for anemic children, (2) proper instructions for administering the supplements, (3) effects of and appropriate treatment for iron deficiency. After 5 months of observation, however, it was determined that many health department procedural problems existed which could be associated with the

nonresponders lack of compliance, e.g., lack of familiarity with and the importance of the Child Health Standards for the treatment of anemia. Since the study was originally designed to follow usual health department procedures and to evaluate compliance associated variables of the WIC participant rather than the health department procedures, a revision in study methods was warranted. With the original procedures, the data analysis from the questionnaire at the 3 month follow-up visit would be partially a function of these procedural problems noted and thus would complicate accurate and logical analysis and discussion of the data.

As a result, study methods were altered to include public health procedures which would most effectively facilitate a high rate of compliance and thus the highest rate of response possible within the limitations of available public health time, staff, and equipment. The Knox County-Main clinic, Monroe County, and Sevier County were ultimately chosen for participation due to their proximity to the University and caseload of anemic children. Other WIC clinics in the East Tennessee Region with higher rates of anemia were available, but were unsuitable for various reasons. The Roane County Health Department was excluded since many of the potential subjects had participated in the pilot study. The study was initiated in the Knox and Monroe County clinics in September 1983; Sevier County was added in November 1983 when it became apparent that additional subjects were needed.

The revised procedures are outlined below.

1. Prior to implementing the study in each of the three clinics, an in-service training workshop on iron deficiency anemia, nonhematologic iron deficiency, and the study procedures was given to the WIC nurses and nutritionists. New nursing and nutrition staff were trained separately before participating in the study.

   Topics covered in the workshop were:

   a. iron digestion, absorption, and metabolism
   b. stages of iron deficiency
   c. laboratory measures for assessment of iron status
   d. effects of iron deficiency
   e. accurate procedures for measuring the hematocrit
   f. review of Child Health Standards for supplement issuance and follow-up care
   g. proper instructions for administering the supplement
   h. use of prescription labels (Appendix E)
   i. role of nurse in enhancing credibility of nutritionist
   j. suggestions for improving effectiveness of nutrition education in relation to iron deficiency
   k. study procedures

The packet of materials distributed in these training sessions can be found in Attachments 1-8, in Appendix F.

2. Initial WIC Certification

   a. Applicant was screened for income (Appendix B)
   b. If income eligible, the parent or guardian signed an informed consent form (Appendix C)

c. The nurse conducted the WIC medical screening, including a medical history, the hematocrit, and anthropometric measurements according to the procedures described previously. Two capillary tubes of blood for the hematocrit were drawn according to the procedures outlined in Appendix F—Attachment 2. Both readings were recorded in the health record with the highest reading being utilized for the WIC eligibility screening. Many of the nurses objected to this latter procedure, suggesting that for the benefit of the client, the lowest reading should be used for the WIC screening. To determine the number of children who would not be eligible for WIC due to this procedure, a tally of all children with two hematocrit readings of 33% and 34% was kept by the nurses and nutritionists in Monroe and Sevier County for 4 WIC clinic days (33% is the cutoff for WIC anemia eligibility). This tally revealed that 4 out of 90 children in Monroe and 5 out of 90 children in Sevier would have been ineligible for WIC for low hematocrit, because of the second hematocrit measure of 34%. All nine of these children were eligible for another reason however—primarily inadequate dietary intake. Therefore, since the highest hematocrit measurement is generally considered to be the most accurate and since the WIC eligibility of few, if any, children would be affected by

this procedure, the highest reading of the two samples was used for both the WIC screening and the investigation.

d. If the hematocrit was 33% or below the nurse issued Fer-In-Sol and/or a multivitamin with iron supplement according to the Child Health Standards (Table 1, p. 42). The type and number of supplements issued were recorded in the health record. Prescription labels (Appendix E) were placed on the bottles prior to issuance. Since one bottle of the liquid multivitamin/iron supplement Poly-Vi-Sol lasted only 50 days, two bottles were issued in Knox and Monroe Counties to last until the 3 month follow-up visit. Sevier County issued only one bottle Poly-Vi-Sol at this initial visit, since their policy was to request all children issued supplements to return in 4 to 6 weeks.

The chewable multivitamins for children 18 months or older (in all three clinics) should have lasted 100 days; the Fer-In-Sol should have lasted 83 days if one dose per day was administered. For those children with hematocrits below 30%, however, two or more doses daily was suggested so that the parent or guardian and child was scheduled to return in 6 weeks for another hematocrit check and Fer-In-Sol reissuance.

e. The following potential effects of iron deficiency were discussed briefly by the nurse with the parent or guardian accompanying the participant: (1) irritability, (2) increased susceptibility to infection, (3) decreased potential for learning, (4) lethargy—mentioned only for severely anemic children.

f. The following instructions on the administration of the supplements also were discussed with the parent or guardian by the nurse: (1) the daily dosage, (2) encouraged to drop the liquid supplements in the back of the mouth to minimize temporary staining and potential for spitting supplement out, (3) encouraged to follow supplements, particularly the Fer-In-Sol, with high ascorbic acid drink to enhance iron absorption, (4) encouraged to give supplements between meals (i.e., on empty stomach), (5) encouraged to brush teeth after supplement administration, if appropriate, and (6) encouraged to call if they had any problems. An example of the discussion by the nurse with the parent on guardian is given in Appendix F—Attachment 4.

g. The nutritionist provided counseling following the nursing examination on the following topics: (1) explanation of the hematocrit, (2) effects of iron deficiency, (3) sources of iron rich foods, (4) importance of ascorbic acid to iron absorption, (5) detailed instructions on administering the dietary supplements, including establishing a regular time

for supplement administration, and (6) analysis of 24 hour recall/food frequency. An example of the discussion by the nutritionist with the parent or guardian is given in Appendix F—Attachment 5.

h. The nutritionist checked the health record to determine if the supplements were issued and recorded according to the study criteria; the growth charts were also checked for plotting accuracy. A colored sticker was placed on the record for future identification as a study participant.

i. The "Building Blood" pamphlet was given to the parent or guardian by the nutritionist with encouragement to read (Tennessee Department of Health and Environment, Division of Nutrition/WIC Services).

j. WIC food vouchers were issued by the WIC clerk and a return appointment scheduled for approximately 2½ to 3½ months. Children with hematocrits less than 30% were scheduled to return in 6 weeks. Sevier County clerks encouraged all WIC subjects certified because of low hematocrits (i.e., ≤33%) to return in 4 to 6 weeks, although the only appointment given was for the 3 month follow-up visit.

3. Three Month Follow-Up Visit

a. The nurse measured the hematocrit and height and weight according to the procedures previously described. Measurements were recorded in the health record and on

the growth charts. The erythrocyte protoporphyrin measurement, which was originally implemented as a second measure for iron deficiency and as a lead screening tool, was excluded from the final investigation. Over the 5 month period of the pilot study, little relationship was observed between the FEP and the levels of anemia observed in the sample as measured by the hematocrit; also, no elevated FEP measures were detected during the pilot study.

b. The nurse issued one bottle of Fer-In-Sol with a prescription label and instructions to all nonresponders. A nonresponder was defined as any child whose hematocrit either decreased, remained the same or had not increased at least 3% and was not greater than 30% for children less than 24 months or greater than 33% for children 24 months or older. The Child Health Standards were followed for vitamin issuance. Fer-In-Sol was not issued to those parents of nonresponders who still had at least one-half bottle of Fer-In-Sol remaining from the previous visit.

c. The study questionnaire (Appendix D) was administered by a trained interviewer/nutritionist who was unaware of the participant's response status. Nutrition education was provided as appropriate.

Record Review

A WIC health record review was conducted in the Sevier and Monroe WIC clinics to determine the attrition rates for the same time period of the study, but of the previous year. The records of all children certified with low hematocrits (i.e., 30% or less for children less than 24 months and 33% or less for children 24 to 54 months) during September 1982 to January 1983 and November 1982 to January 1983 in Monroe and Sevier, respectively, were reviewed. The CDC nutrition surveillance listings and the TDHE surveillance listings were used to identify those children with low hematocrits. A record review in Knox County was not completed since 3 month follow-up nursing visits were not standard protocol for anemic WIC children prior to the implementation of the study.

Statistical Analysis

The Statistical Analysis System (SAS) program PROC GLM (126), a test of least-squares analysis of variances, was used to compare the mean hematocrits, family incomes, ages of mothers, heights and weights at the initial visit by type of response and county. Tukey's method was used for multiple comparisons of anova.

The chi-square test was used to evaluate statistical differences in the response rates of the following variables: (1) supplement issuance, (2) age, (3) sex, (4) previous WIC certification for anemia, (5) number of children in the family, (6) weight for height centiles, (7) height for age centiles, (8) educational level of father figure,

(9) milk consumption, and (10) frequency of meat consumption. The correction test for continuity was utilized with the chi-square test when a single cell contained less than five observations.

A brief descriptive analysis by frequencies and percents was used to describe the remaining variables. Due to the small sample size of this study, the data did not lend itself to an extensive statistical analysis. Therefore, the chi-square test was limited to those comparisons containing a 2 x 2 cell structure. The probability level of $p \leq .05$ was used to indicate significant differences in all analyses.

CHAPTER IV

RESULTS AND DISCUSSION

Incidence of Anemia and Attrition Rate

The rates of anemia for the three county health departments participating in the investigation are shown in Table 2. Of the 1,507 children screened in this study, 2.7, 5.5 and 6.9% met the criteria for anemia in the Knox, Monroe, and Sevier County WIC clinics, respectively. The anemia rate for the three clinics combined was 3.5%, almost 1/3 of the most recent state rate of 10.3% (124).

Seventeen of the 57 children found to be anemic were excluded from the study because they did not meet the study criteria or failed to return for the 3-month follow-up visit. The reasons for not meeting the study criteria were as follows:

1. diagnosed as sickle cell or triple-X syndrome
2. transferred to another WIC clinic not included in the study
3. certified for an examination done in another clinic not included in the study
4. under physician's care; therefore, supplements were not issued or the child was given a different type of supplement prescribed by physician
5. seen by untrained nurse or nutritionist who did not issue supplements correctly
6. not scheduled to see the interviewer for administration of the questionnaire; the demographic variables obtainable from the

TABLE 2

Rate of anemia and treatment response by county in the WIC pediatric population in three selected East Tennessee counties

	Rate of anemia[1]			Children not meeting study criteria and dropouts	Rate of response		
County	Number screened	Number anemic	Percent	Number	Number subjects	Number responders[2]	Percent
Knox	1019	28	2.7	11	17	5	29.4
Monroe	329	18	5.5	4	14	9	64.3
Sevier	159	11	6.9	2	9	6	66.7
Total	1507	57	3.5	17	40	20	50.0

[1]Anemia is defined as a hematocrit less than 31% for infants and children 6 to 24 months of age and less than 34% for children 24 to 54 months of age.

[2]Responder defined as any child whose hematocrit increased at least 3% by the 3 month follow-up visit and was greater than 30% for children less than 24 months or greater than 33% for children 24 months or older.

health record of these 3 children were included in the analysis, however.

The attrition rate among the subjects initially screened and meeting the study criteria was very low when compared to the attrition rate of anemic WIC children certified during the same time period of the previous year. None of the 14 children in Monroe County and only 1 of the 10 anemic children in Sevier County failed to return for the follow-up visit. One of the 18 (5.5%) of the anemic children in Knox County did not return, bringing the attrition rate for the entire investigation to 4.8%. In contrast, the record review of anemic children certified for WIC during September 1982 through January 1983 in Monroe County revealed a 36.4% attrition rate (n = 11). The Sevier County record review of the previous year (November 1982 to January 1983) showed that 3 out of 12 (25%) of the anemic children failed to return. Failure of WIC clients to return for follow-up care is a recurring problem in many of the Tennessee WIC clinics. The low rate of attrition in this investigation may be attributed to three procedures: (1) greater emphasis by nurses and nutritionists during the examinations and counseling sessions of the potential effects of iron deficiency and the importance of treatment, (2) a phone call (if phone available) to the mother or guardian of subject within 24 hours prior to follow-up exam as a reminder of upcoming appointment, and (3) a postcard which was mailed following a missed appointment to remind participant's mother or guardian of the need to have the participant return to clinic to have the child's "blood checked and to pick up WIC vouchers."

Compliance of Supplement Administration

Table 3 shows the number of children issued multivitamins with iron only and the number issued both the Fer-In-Sol and multivitamins for each of the three counties. Compliance among the parents or guardians in the administration of these supplements was fair to excellent. Although the majority (89.7%) finished all or almost all of the bottle(s) of vitamins with iron and 92.1% administered the vitamin/iron supplement one time per day as instructed, four of the mothers gave a portion of the chewable supplement to a sibling. Two of the mothers of the children who had at least 1/2 bottle of the chewable vitamin/iron supplement remaining at the follow-up visit claimed the child refused or "spit up" the supplements. A third child who did not like the chewable multivitamin supplements was given Flintstone brand chewable vitamins with ferrous fumarate which contains 50% more iron than the brand used by the health department. No problems were noted among the liquid vitamin/iron supplement given to children less than 18 months of age.

Eleven children with a hematocrit of less than 32% were issued a liquid iron supplement (Fer-In-Sol) in addition to the vitamins with iron. The mothers of 10 of these 11 children completed the study questionnaire. Of these 10, 70% finished all or almost all of the Fer-In-Sol by the follow-up visit; 2 (20%) children consumed 1/2 bottle and 1 child consumed less than half. These latter 3 children who did not receive the Fer-In-Sol as often as instructed completed the multivitamin/iron supplements, however, so that the total dosage of

TABLE 3

Number of anemic WIC children issued dietary supplements in three selected East Tennessee counties

County	Multivitamins with iron[1]	Fer-In-Sol and Multi-vitamins with iron[2]
	---n---	---------n---------
Knox	14	3
Monroe	9	5
Sevier	6	3
Total	29	11

[1]Poly-Vi-Sol with iron (10 mg elemental iron/ml) issued to children less than 18 months of age with a hematocrit of 32 or 33%; Daily Dose 1-chewable multivitamins (10 mg elemental iron/tablet) issued to children 18 months or older with a hematocrit of 32 or 33%.

[2]Fer-In-Sol (15 mg elemental iron/0.6 ml) and multivitamins with iron issued to children with a hematocrit of less than 32%.

iron received by these children was greater than the children taking the multivitamin supplement only.

Despite counseling and instructions which were provided on the prescription label, only 30% of the children issued Fer-In-Sol received the supplement on an empty stomach. WIC juice (at least 30 mg ascorbic acid per 100 ml juice) was administered with the Fer-In-Sol, however, by 8 of the 10 mothers as instructed to enhance iron absorption. No gastrointestinal problems or difficulties administering the Fer-In-Sol were noted by any of the mothers.

Treatment Response Rates

The treatment response rates by county are presented in Table 2. Monroe and Sevier County had similar response rates of 64.3 and 66.7%, respectively, while the rate of treatment response in the anemic children enrolled in Knox County was only 29.4%. Variables distinguishing the Knox County subjects from the Sevier and Monroe County children which might account for this discrepancy are described in following sections on the distribution of the hematocrits and the discussion of the demographic and dietary characteristics.

Although previous WIC program reviews including the in-house Tennessee WIC record review of 1979-81 reveal similar response rates as those obtained in Monroe and Sevier, the comparison is somewhat misleading since less stringent response criteria were utilized in these previous WIC evaluations. In fact, when the less severe "cutoff" criteria are used to determine the response rate (i.e., response defined as a hematocrit above 30% by the follow-up visit for children

less than 24 months and above 33% for older children), the discrepancy in the urban and rural clinics no longer exists. The ranking in response rates in the three counties is shifted with this more lenient criteria, with Sevier County having a response rate of 88.9% and Knox and Monroe following closely behind with rates of 82.3% and 78.6%. The criteria utilized in this study were more stringent, however, since it was expected that with proper diagnosis and treatment, a child's hematocrit would be expected to improve at least 3% within 6 to 8 weeks (25, 52, 114)

When response rates were examined by the type of supplement issued a significant and noteworthy variance was identified ($p \leq .05$). Children issued vitamins with iron only (10 mg elemental iron daily) exhibited a 37.9% ($n = 29$) rate of response. In contrast, 81.8% ($n = 11$) of the children issued both Fer-In-Sol and vitamins with iron (at least 25 mg elemental iron daily) met the response criteria by the follow-up visit.

The amount of daily supplemental iron recommended to treat iron deficiency anemia is 3 to 6 mg iron/kg body weight. The mean weight of the children participating in the study was approximately 13 kg (range = 6.7 to 16.4 kg), indicating that the average dosage issued should have been at least 39 mg iron. The Tennessee Child Health standards for supplement issuance utilized in this study resulted in only 2 of the 40 subjects receiving this amount, however. These two children had hematocrits below 30% and were instructed to take Fer-In-Sol 2 times/day and the multivitamin 1 time/day for a total of 40 mg iron/day. Both children were responders. It is interesting to

note that for the majority of the other nine children issued both Fer-In-Sol 1 time/day and the multivitamins (i.e., total daily dosage of 25 mg/day), this standardized amount of iron given, regardless of weight, appeared to be sufficient for a response (7 out of 9 responded); the daily dosage of 10 mg iron issued to the children receiving the multivitamin/iron supplement only was not sufficient for an adequate response in most of these children (37.9% response rate).

Whether this disparity among the response rates of the two types of supplement issuance was due solely to the difference in daily dosages, is unclear, however, since not all the children took the supplements as instructed. A general description of the children who varied from the study protocol for supplement administration was discussed in the previous section. This information is broken down by response in the outline given below:

1. Children issued vitamins with iron only—nonresponders
   a. 10% (2/20) of the nonresponders had at least 1/2 bottle left
   b. Four of the mothers of the nonresponders gave a portion of the supplement to another child
   c. Two of the nonresponders were given Flintstones supplements instead (15 mg elemental iron/tablet)
2. Children issued vitamins with iron only—responders
   a. 5.5% of the responders (1/18) had at least 1/2 bottle left
3. Children issued both Fer-In-Sol and multivitamins with iron—nonresponders

a. The mother of one of the two nonresponders spilled approximately 1/4 bottle of the Fer-In-Sol

b. The second nonresponder was never issued a full bottle of Fer-In-Sol. Upon entry into the study, the mother of this child claimed she had 1/2 bottle of Fer-In-Sol remaining from a previous visit. Therefore, the multivitamin/iron supplement only was issued and a return appointment for 6 weeks later was scheduled to issue another bottle of Fer-In-Sol. (The nurse wanted to avoid two bottles of Fer-In-Sol being on hand in the home to help prevent potential overdose.) The mother and child did not return, however, until the 3 month follow-up visit; consequently only 1/2 bottle of Fer-In-Sol was administered to this nonresponder.

4. Children issued both Fer-In-Sol and multivitamins with iron—responders

a. Three of the children who were identified as responders had at least 1/2 bottle Fer-In-Sol left. These three children received the proper dosage of vitamins with iron, however.

Despite these variances in supplement administration from the original protocol, it should be noted that the majority of the children received the supplements as instructed and in every case the children issued both types of supplements ultimately received a greater dosage of iron than those children issued the multivitamins only.

A second factor which may have contributed to the large discrepancy in response rates by supplement issuance was the difference in the degree of anemia which determined the type of supplement(s) issued. Since the children issued only the multivitamin/iron supplement had higher hematocrits (i.e., 32 or 33%) a higher percentage of false positive diagnoses may be expected. This phenomenon of misdiagnosing a normal child as anemic is a confounding factor in the use of the hematocrit as a method of diagnosis for iron deficiency anemia (63, 64). This phenomenon is described further in the following section.

Distribution of Hematocrits

Figure 1 represents the distribution of hematocrits in the entire sample at the initial visit and at the follow-up visit. Although the sample size was small, the distribution of the hematocrits following treatment represents a normal distribution. If this bell-shaped distribution indicates normalcy, then many of these hematocrits may reflect false positive diagnoses, since 50% of these children were identified as nonresponders.

This concept which describes a potential for false positives in the upper range of low values is graphically represented in Figure 2, in which Knox County displayed a higher proportion of initial hemocrits in the 32 to 33% range than did the other two clinics--the range in which the greatest risk for a false positive diagnosis could occur. Thus, this discrepancy in the distribution of initial hematocrits between the Knox County clinic and the two rural clinics could

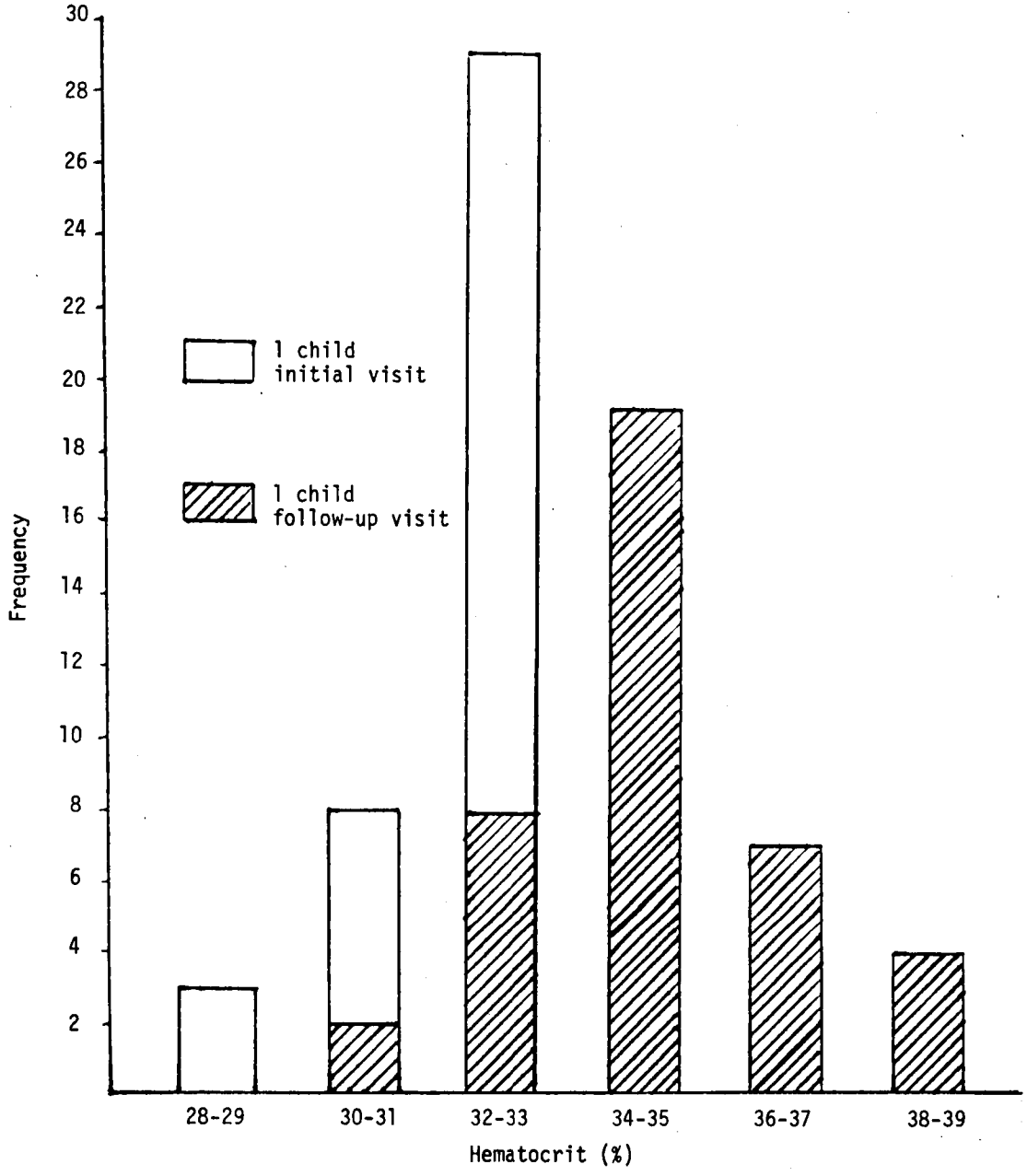

Figure 1. Distribution of hematocrits at the initial and follow-up visits in the WIC anemic pediatric population in three selected East Tennessee counties.

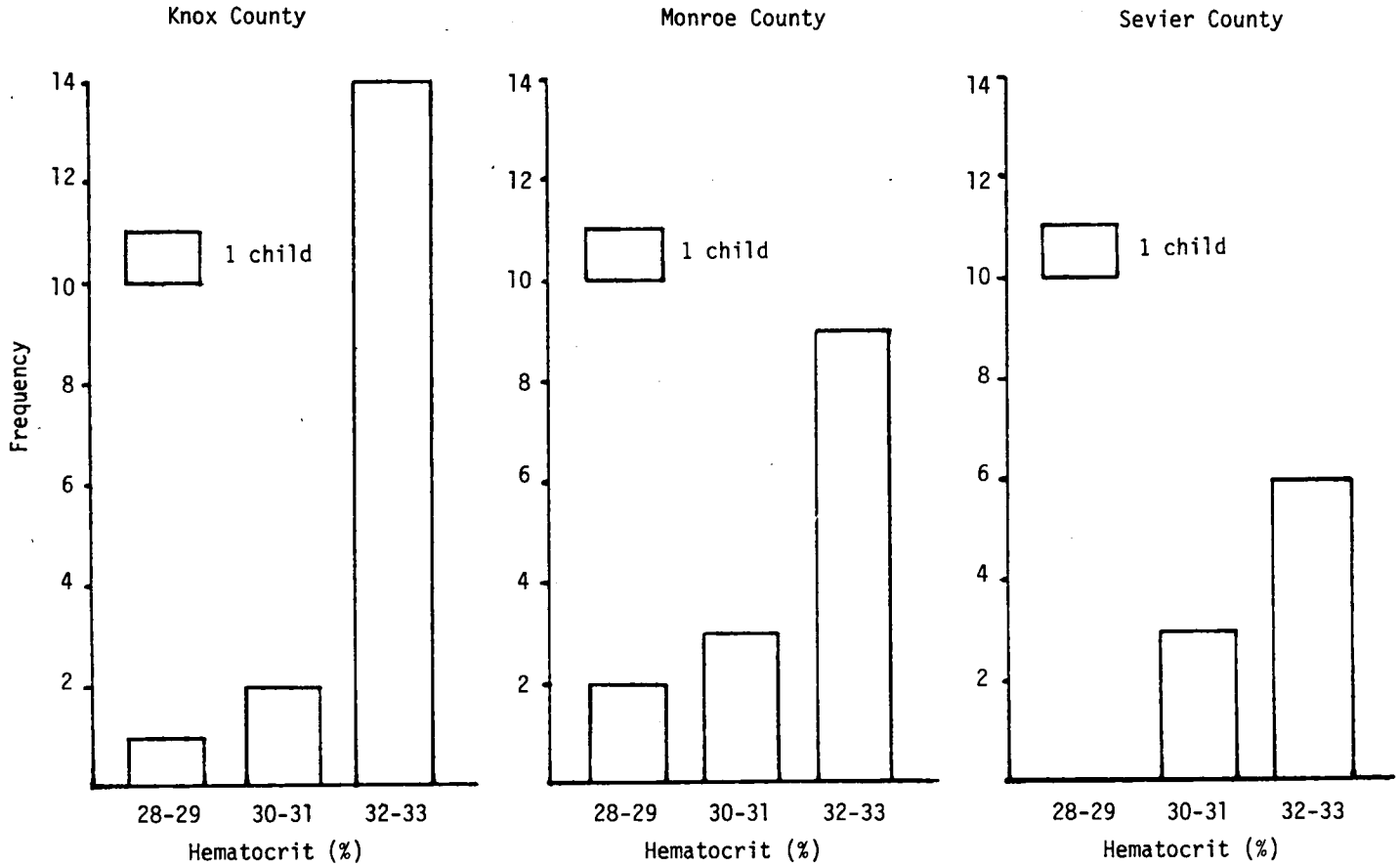

Figure 2. Distribution of initial hematocrits by county in the WIC anemic pediatric population in three selected East Tennessee counties.

contribute to the lower rate of response in Knox County, not only because of the greater potential for false positive diagnoses, but also because of the lower dosage of iron administered to the children with initial hematocrits of 32 or 33%.

Figure 3 and Table 4 reflect these two concepts once again. In Figure 3, the distribution of initial hematocrits in responders is shown in comparison to the distribution of initial hematocrits in non-responders. Eighteen out of 20 (90%) of the nonresponders were within the 32-33% range, while only 55% of the responders were within this higher range. This difference is significant at the $p \leq .05$ level of significance. The mean initial hematocrits, as shown in Table 4, are significantly lower for the responders than for the nonresponders ($p \leq .01$). When the initial hematocrits for the responders versus the nonresponders are examined by county, this consistent difference is evident once again, although it is not significant. (The lack of significance can be attributed partially to the small subsample sizes.)

Description of Selected Demographic Characteristics by Response

The mean age and age distribution of the sample by county and response is shown in Table 5. The mean age of children from each county is consistently, but not significantly, lower for the responders than for the nonresponders. This consistent variation may be an artifact of the difference in the anemia criterion for children of different ages (i.e., a hematocrit of less than 31% for children less than 24 months and less than 34% for children 24 months or older);

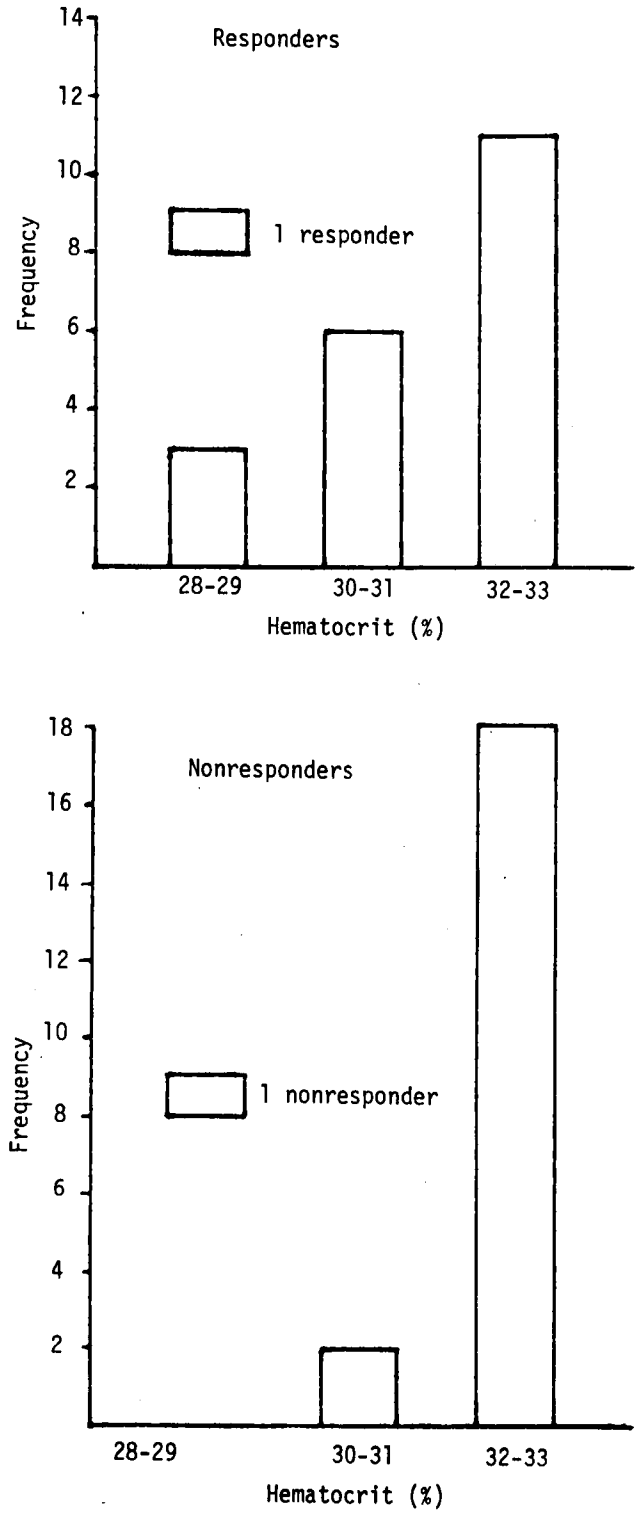

Figure 3. Distribution of initial hematocrits by response in the WIC anemic pediatric population in three selected East Tennessee counties.

TABLE 4

Mean initial and follow-up hematocrits by county and treatment response in WIC anemic pediatric population in three selected East Tennessee counties[1],[2]

County	Responders	Nonresponders
	Mean ± SD (n)	
Initial visit		
Knox	31.8 ± 1.79[a] (5)	32.5 ± .9[a] (12)
Monroe	31.1 ± 1.9[a] (9)	32.4 ± 1.3[a] (5)
Sevier	31.3 ± 1.5[a] (6)	33.0 ± 0.0[a] (3)
Total	31.3 ± 1.69[a] (20)	32.5 ± .94[b] (20)
Follow-up visit		
Knox	35.8 ± 1.8[c] (5)	33.8 ± 1.2[c] (5)
Monroe	35.3 ± 1.4[c] (9)	32.6 ± 1.5[c] (9)
Sevier	36.7 ± 1.9[c] (6)	34.0 ± 1.0[c] (6)
Total	35.9 ± 1.66[c] (20)	33.5 ± 1.32[d] (20)

[1]Means within the same row with different superscripts differ at the $p \leq .01$ level of significance.

[2]Responder defined as any child whose hematocrit increased at least 3% by the 3 month follow-up visit and was greater than 30% for children less than 24 months or greater than 33% for children 24 months or older.

TABLE 5

Mean age and age distribution by county and treatment response in the WIC anemic population in three selected East Tennessee counties[1,2]

County/Response	Age (months)	6-11 months	12-23 months	24-35 months	36-54 months	Total
	--Mean ± SD--			Percent		
Knox						
Responders (n = 5)	25.8 ± 11.6	20.0	0.0	80.0	0.0	100.0
Nonresponders (n = 12)	33.8 ± 9.6	0.0	8.3	41.7	50.0	100.0
Total (n = 17)	31.5 ± 10.5	5.9	5.9	52.9	35.3	100.0
Monroe						
Responders (n = 9)	27.0 ± 13.4	22.2	11.1	44.4	22.2	100.0
Nonresponders (n = 5)	28.6 ± 10.6	0.0	40.0	20.0	40.0	100.0
Total (n = 14)	27.6 ± 12.0	14.3	21.4	35.7	28.6	100.0
Sevier						
Responders (n = 6)	28.7 ± 13.9	16.7	0.0	50.0	33.3	100.0
Nonresponders (n = 3)	34.0 ± 10.6	0.0	0.0	66.7	33.3	100.0
Total (n = 9)	30.4 ± 12.5	11.1	0.0	55.5	33.3	100.0
Total						
Responders (n = 20)	27.2 ± 12.5	20.0	5.0	55.0	20.0	100.0
Nonresponders (n = 20)	32.5 ± 9.6	0.0	15.0	40.0	45.0	100.0
Total (n = 40)	29.9 ± 11.3	10.0	10.0	47.5	32.5	100.0

[1]Responder defined as any child whose hematocrit increased at least 3% by the 3 month follow-up visit and was greater than 30% for children less than 24 months or greater than 33% for children 24 months or older.

[2]Means are not significantly different ($p \leq 0.05$) as tested by analysis of variance.

that is, a higher response rate may be expected for children less than 24 months of age if it is assumed that children with hematocrits in the lower range would experience a higher rate of response for reasons previously discussed. The response rate for the children less than 24 months of age is, in fact, higher than the rate for the older children (66.7% vs. 47.0%). There were only six children in the younger age range, however, and the difference was not significant as analyzed by the chi-square test.

Other selected demographic characteristics of the responders are delineated in Table 6. An examination of these factors reveals that sex appears to be the demographic characteristic most closely associated with response. The ratio of males to females in the entire population screened and in the total anemic sample was approximately 1:1 (47.5% male and 52.5% female in the anemic sample and 48.7% male and 51.3% female in the entire population screened). An analysis of the proportion of males to females in the nonresponders and responders, however, indicates that males are more likely to respond to the treatment than females. The ratio of males to females in the responders was approximately 2:1 (65% male and 35% female). This difference is not significant, however.

There was a similar proportion of whites in the anemic subjects (85%) as in the entire population screened (81.2%). Of the 6 anemic subjects who were black (all from Knox County), 2 (33.3%) responded, while 18 of the 34 white subjects responded (52.9%).

The WIC records of the study subjects were reviewed to determine if a previous certification for anemia was associated with

TABLE 6

Selected demographic characteristics by treatment response of the WIC pediatric anemic population in three selected East Tennessee counties[1]

Characteristic	Responders (n = 20)	Nonresponders (n = 20)	Total (n = 40)
	----------Percent----------		
Gender			
Male	65	35	47.5
Female	35	65	52.5
Ethnic Group			
White	90	80	85.0
Black	10	20	15.0
Previously certified for WIC for anemia			
Yes	70	90	80.0
No	30	10	20.0
Mother on WIC during pregnancy			
Yes	70	70	70.0
No	30	30	30.0
Sibling previously on WIC			
Yes	35	55	45.0
No	30	25	27.5
Does not apply (no siblings)	35	15	25.0
Unknown	0	5	2.5
Number of children in family			
1	40	20	30.0
2	30	60	45.0
3-4	25	20	22.5
5 or more	5	0	2.5

[1]Responder defined as any child whose hematocrit increased at least 3% by the 3 month follow-up visit and was greater than 30% for children less than 24 months or greater than 33% for children 24 months or older.

response. Children previously placed on the WIC program because of a low hematocrit (33% or less) were less likely to respond although the difference was not significant. Ninety percent of the nonresponders and 70% of the responders had been certified previously for WIC because of a low hematocrit. It is interesting to note that 80% of all of the anemic children previously had been through the WIC Program for anemia, reflecting a high rate of nonresponse, noncompliance, and/or recurring anemias.

Whether or not the mothers of the subjects were enrolled in WIC during their pregnancies with the subject appeared to have no bearing on the likelihood of response. Seventy percent of the mothers of both the responders and nonresponders were enrolled in the WIC Program while pregnant. The mean age of the mothers also was not significantly different among the responders and nonresponders (23.9 ± 3.3 yrs. versus 23.9 ± 3.3 yrs., respectively).

The majority of both the responders and nonresponders had only one or two children in the family (70% and 80%, respectively). However, while 40% of the responders were from single child families, 20% of the nonresponders were only children. This difference was not significant.

The growth chart percentiles at the initial visit for weight for age, height for age and weight for height, are presented in Table 7 by treatment response. While no difference was noted between the mean initial weights of the nonresponders (12.7 ± 2.1 kg) and that of the responders (12.6 ± 2.7 kg), 21% of the nonresponders and 5% of the responders were below the 5th percentile for weight for age. A

TABLE 7

Growth chart percentiles at the initial visit by treatment response of the WIC anemic pediatric population in three selected East Tennessee counties[1]

Percentile	Responders (n = 20)	Nonresponders (n = 19)
--Weight for age--	----------Percent----------	
≦5	5.0	21.0
5.1 to 25	25.0	31.6
25.1 to 75	40.0	42.1
75.1 to 95	30.0	5.3
>95	0.0	0.0
--Weight for height--		
≦5	0.0	15.8
5.1 to 25	20.0	26.3
25.1 to 75	50.0	26.3
75.1 to 95	15.0	26.3
>95	15.0	5.3
--Height for age--		
≦5	10.0	31.6
5.1 to 25	30.0	26.3
25.1 to 75	45.0	36.8
75.1 to 95	15.0	5.3
>95	0.0	0.0

[1]Responder defined as any child whose hematocrit increased at least 3% by the 3 month follow-up visit and was greater than 30% for children less than 24 months or greater than 33% for children 24 months or older.

more meaningful measure of weight status, however, is reflected by the weight for height growth chart in which weight is measured in relation to stature. None of the 20 responders fell at or below the 5th centile on the weight for height chart, whereas 15.8% of the non-responders were in the underweight range. On the other end of the scale, 15% of the responders and 5.3% of the nonresponders were over-weight or above the 95th centile for weight for height. The non-responders also generally were shorter for their age as reflected by the centiles for height for age. While only 10% of the responders were at or below the 5th percentile, almost 1/3 (31.6%) of the nonresponders were in this low range for height for age. The greater percentage of nonresponders than responders falling below the 5th centile for height for age and weight for height could be indicative of a more extensive degree of an inadequate diet. None of these differences in growth chart centiles were significant, however.

The mean monthly incomes of families of the responders and non-responders as shown in Table 8 were similar and therefore, probably were not associated with response in this sample. Most all of the subjects (87.5%) were below the poverty level. These mean family incomes included wages, AFDC, disability, unemployment and/or Food Stamps of the mother, father (if living in the child's household), and children. It did not include the income of other household members who were not in the immediate family.

An examination of the educational levels obtained by the mothers (Table 9) reveals a similar distribution among the responders and

TABLE 8

Mean monthly income by county and treatment response of the families of the WIC pediatric anemic population in three selected East Tennessee counties[1] [2]

County	Income
	------Mean ± SD------
Knox (n = 16)	316.25 ± 246.25[a]
Monroe (n = 14)	608.71 ± 340.89[b]
Sevier (n = 9)	582.11 ± 373.04[a,b]
Total	
Responders (n = 20)	490.00 ± 324.46[a,b]
Nonresponders (n = 19)	506.37 ± 368.44[a,b]

[1]Means with different superscripts differ at the $p \leq .01$ level of significance.

[2]Responders defined as any child whose hematocrit increased at least 3% by the 3 month follow-up visit and was greater than 30% for children less than 24 months or greater than 33% for children 24 months or older.

TABLE 9

Educational level of parents or guardians by treatment response of the WIC anemic pediatric population in three selected East Tennessee counties[1]

Level of Education	Responders (n = 20)	Nonresponders (n = 20)
--Mother--	----------Percent----------	
<8 years	10.0	10.0
8-11 years	50.0	45.0
12 years (high school graduate)	35.0	30.0
13 or more years (school beyond high school)	5.0	15.0
Father or male --guardian living at home--		
<8 years	5.0	20.0
8-11 years	25.0	20.0
12 years (high school graduate)	35.0	15.0
13 or more years (school beyond high school)	0.0	10.0
Does not apply (father or male guardian did not live at home)	35.0	35.0

[1]Responders defined as any child whose hematocrit increased at least 3% by the 3 month follow-up visit and was greater than 30% for children less than 24 months or greater than 33% for children 24 months or older.

nonresponders. Contrary to what might be expected, however, 10% more of the nonresponders than the responders had mothers with post-high school education.

An analysis of the educational level of the father or male guardian living at home, also shown in Table 9, displays a different profile than that of the mothers. Only those mothers who had a husband or male friend living at home (i.e., father or father figure) responded to this question. Seven out of 20 of both the responders and nonresponders had no father figure living in the subject's home. Twenty-three percent more of the fathers or male guardians (living in the home) of the nonresponders than the responders had less than 8 years of education, while 15% more of the responders' fathers living at home had at least a high school education. These differences were not significant.

Demographic variables not statistically analyzed from the questionnaire were the number of months the participant was enrolled in WIC, number of breastfeeding infants and children and questions II-1 and III-5, which were attempts to obtain information on social compliance and knowledge associated variables.

Since most of the subjects were enrolled in WIC at birth the number of months participating in WIC reflected the age of the participant rather than the time period exposed to the WIC procedures and nutrition education.

The social compliance question was a brief and subjective attempt to determine if lack of social compliance was contributing to the rate of

nonresponse. There was only one case (a nonresponder) in which social deprivation was obvious from the time the interviewer spent with the subject and his/her parent or guardian.

The breastfeeding questions were omitted from the analysis since none of the subjects were breastfeeding and only 1 of the 3 children less than 1 year of age had breastfed.

A variety of answers were obtained to the question III-5, "What did you learn from the health department about how to help cure the iron poor blood?" Unfortunately, these answers did not reflect fully the actual knowledge the mother had retained about the appropriate dietary treatment for iron deficiency. After the questionnaire had been completed and the nutrition counseling session had begun, the mother often revealed additional facts she knew were important but had failed to conceptualize in responding to the question. Of the answers given to the question, 49% of the mothers were able to list at least two iron rich foods, one of which was usually liver. Misconceptions most commonly noted were that all nutritious foods, especially all the foods contained in the WIC food package, contain iron, and that vitamins (not minerals or iron) were the cure for iron deficiency or anemia. This latter misconception is easily understandable in light of the issuance of a vitamin supplement for anemia. The importance of the iron as the essential component in the multivitamin/iron supplement was emphasized by the nutritionist, however, in the initial counseling session.

Description of Selected Demographic Characteristics by County

The demographic characteristics of the subjects also were analyzed by county to isolate any factors which may have contributed to the variance in response rates between the urban WIC clinic of Knox County and the two rural WIC clinics, Monroe and Sevier. The demographic variables are outlined in Tables 8, 10, 11 and 12. The variables which were similar in the two rural clinics but notably different in the Knox County subjects were ethnic group, the number of children in the family, income, growth chart centiles, and the educational levels of both parents or guardians.

As previously mentioned, no blacks participated in the study in Monroe and Sevier, while approximately 1/3 (35.3%) of the Knox County subjects were black (Table 10). This difference in ethnicity did not appear to contribute to the variance in response rates, however, since the rate of responses among the blacks and whites in the Knox clinic were similar (27.2% for whites and 33.3% for blacks).

The Knox County families generally were smaller with only 11.8% of the subjects having families with three or more children; 42.9% and 22.2% of the Monroe and Sevier County subjects, respectively, were from families with three or more children.

The mean monthly family income of the Knox County subjects was significantly lower than their rural counterparts in the Monroe clinic ($p \leq .01$) as shown in Table 8. The mean monthly income in Knox was $316.25 \pm 246.25, in Monroe was $608.71 \pm 340.89 and $582.11 \pm 373.04

TABLE 10

Selected demographic characteristics of the WIC anemic pediatric population in three selected East Tennessee counties

Characteristic	Knox (n = 17)	Monroe (n = 14)	Sevier (n = 9)
	----------Percent----------		
Gender			
Male	47.1	42.9	55.5
Female	52.9	57.1	44.4
Ethnic Group			
White	64.7	100.0	100.0
Black	35.3	0.0	0.0
Previously certified for WIC for anemia			
Yes	82.3	85.7	66.7
No	17.6	14.3	33.3
Mother on WIC during pregnancy			
Yes	64.7	78.6	66.7
No	35.3	21.4	33.3
Sibling previously on WIC			
Yes	35.3	50.0	55.5
No	23.5	35.7	22.2
Does not apply (no siblings)	35.3	14.3	22.2
Unknown	5.9	0.0	0.0
Number of children in family			
1	35.3	28.6	22.2
2	52.9	28.6	55.5
3-4	5.9	42.9	22.2
5 or more	5.9	0.0	0.0

TABLE 11

Growth chart percentiles at the initial visit by county of the WIC anemic pediatric population in three selected East Tennessee counties

Percentile	Knox (n = 17)	Monroe (n = 13)	Sevier (n = 9)
--Weight for age--	----------Percent----------		
≦5	29.4	0.0	0.0
5.1 to 25	17.6	35.7	33.3
25.1 to 75	47.1	42.8	33.3
/5.1 to 95	5.9	21.4	33.3
>95	0.0	0.0	0.0
--Weight for height--			
≦5	17.6	0.0	0.0
5.1 to 25	29.4	15.4	22.2
25.1 to 75	35.3	38.5	44.4
/5.1 to 95	5.9	30.8	33.3
>95	11.8	15.4	0.0
--Height for age--			
≦5	23.5	30.8	0.0
5.1 to 25	41.2	23.1	11.1
25.1 to 75	29.4	38.5	66.7
/5.1 to 95	5.9	7.7	22.2
>95	0.0	0.0	0.0

TABLE 12

Educational level of parents or guardians by county of the WIC anemic pediatric population in three selected East Tennessee counties

Level of Education	Knox (n = 17)	Monroe (n = 14)	Sevier (n = 9)
--Mother--	----------Percent----------		
<8 years	0.0	14.3	22.2
8-11 years	35.3	64.3	44.4
12 years (high school graduate)	52.9	14.3	22.2
13 or more years (school beyond high school)	11.8	7.1	11.1
Father or male --living in household--			
<8 years	5.9	21.4	11.1
8-11 years	29.4	14.3	22.2
12 years (high school graduate)	5.9	35.7	44.4
13 or more years (school beyond high school)	5.9	7.1	0.0
Does not apply (father or male guardian did not live at home)	52.9	21.4	11.1
Unknown	0.0	0.0	11.1

in Sevier. Although a $265.86 difference was noted among the mean incomes of the Knox and Sevier County families, the difference was not significant at the $p \leq .05$ level due to the large standard deviations.

The children in Knox County as a group weighed less both in relation to age and stature at the initial visit when compared to the rural anemic children (Table 11). None of the anemic children in Monroe and Sevier were at or less than the 5th centile for weight for age and weight for height. In contrast, 29.4% of the Knox County anemic children were in this low range for weight for age and 17.6% were in this range for weight for height. Another 29.4% of the children in Knox were between the 5th and 25th centiles, while 15.4% and 22.2% of the children were in this range in Monroe and Sevier, respectively.

As one might anticipate in comparing educational levels of parents or guardians living in an urban setting to adults in a rural setting, the mothers of the Knox County subjects were better educated that the mothers of the Monroe and Sevier children. Over one-half (64.7%) of the Knox County mothers were high school graduates. Only 21.4% of the Monroe mothers and 33.3% of the Sevier mothers completed their high school education (Table 12).

The opposite was true when the educational levels of the father or male guardians living at home were examined (Table 12). Whereas 12.5% of the Knox County subjects had a father or father figure living in the home with a high school degree, over half of the Monroe and Sevier County fathers or male guardians living in the home had graduated from high school (54.5% and 57.1%, respectively). Also,

while 9 out of 17 (52.9%) of the Knox County subjects had no male guardian, only 1 out of 9 (11.1%) in Sevier and 3 out of 14 in Monroe (21.4%) had no father figure living in the home. This striking difference in the percentage of one parent families in the urban and rural clinics could have contributed to the significantly lower mean monthly income among the Knox County subjects.

Description of Selected Dietary Characteristics by Response

A few selected dietary questions associated with iron status were included in the questionnaire. Although this method of obtaining dietary information is not one of the most accurate procedures for dietary analysis, because of the time and staff limitations and the limited impact of dietary factors on a 3 month treatment response, the brief food frequency questions were chosen to obtain a general overview of dietary factors associated with iron deficiency in this sample. These dietary characteristics have been outlined in Table 13 by response and correspond to Questions III 19, 21, 22, 26 and 28 in the questionnaire (Appendix D).

Excessive milk intake is a dietary factor which has been correlated with iron deficiency in young children. A young child 1 to 5 years of age should be drinking 12 to 24 ounces of milk daily, while an infant may drink approximately 26 to 32 ounces of formula or breastmilk daily; 20% of the nonresponders consumed more than 32 ounces of milk whereas 10.5% of the responders consumed this excessive amount. This difference in milk consumption was not significant, however.

TABLE 13

Selected dietary characteristics by treatment response of the WIC pediatric anemic population in three selected East Tennessee counties[1,2]

Characteristic	Responders (n = 19)	Nonresponders (n = 20)
	----------Percent----------	
Ounces of fluid milk or formula consumed daily		
None	0.0	0.0
1-24 oz.	47.4	60.0
25-32 oz.	42.1	20.0
>32 oz.	10.5	20.0
Time of day WIC juice consumed[3]		
With meals	0.0	25.0
With snacks	0.0	10.0
Between meals and snacks (alone)	31.6	20.0
Throughout the day	68.4	40.0
Does not drink juice	0.0	5.0
Frequency of meat consumption		
Less than 3 times/week	26.3	0.0
3-6 times/week	10.5	30.0
1-2 times daily	57.9	55.0
3 or more times daily	0.0	5.0
Does not eat meat	5.3	10.0
Consumption of WIC cereal for breakfast or snacks[4]		
Yes	94.7	90.0
No	5.3	10.0

[1]Responder defined as any child whose hematocrit increased at least 3% by the 3 month follow-up visit and was greater than 30% for children less than 24 months or greater than 33% for children 24 months or older.

[2]Data compiled from answers to questions III-19, III-22, III-26 and III-28 of questionnaire (Appendix D).

[3]WIC juices are any juices with 100% natural fruit juice and at least 30 mg ascorbic acid per 100 ml juice.

[4]WIC cereals for children and women are any fortified dry cereals with at least 28 mg iron per 100 g dry cereal; infant cereals must contain at least 45 mg iron per 100 g dry cereal.

Ascorbic acid has been reported by a number of investigators to enhance dietary iron absorption (29, 45). At the initial visit, the patients were encouraged to consume the WIC juice with iron rich sources of food. (No distinction of heme and nonheme iron was made to minimize confusion.) A distinction in juice consumption by treatment response was difficult to make since many of the subjects drank juice throughout the day. The majority (68.4%) of the responders drank juice throughout the day (i.e., with meals, snacks and alone). Seventy-five percent of the nonresponders drank juice either throughout the day or with meals or snacks.

Meat consumption was significantly related to response ($p \leq .05$). This relationship was contrary to what might be expected, however, i.e., infrequent meat consumption was more common among responders than nonresponders. Whereas 26.3% of the responders ate meat less than three times per week, none of the nonresponders ate meat this infrequently.

WIC cereal consumption is encouraged by all WIC nutritionists as an important source of iron in the diets of these young children. The WIC regulations require that cereals in the WIC food package contain no more than 6 g sucrose/ounce of dry cereal and at least 45% of the U.S. RDA for iron per ounce of dry cereal. These cereals were found to be well liked and regularly consumed by most of both the responders and nonresponders (94.7 and 90%, respectively). Two of the three most popular cereals consumed contained 100% of the U.S. RDA for iron.

These same dietary variables were examined by county also and are shown in Table 14. The only striking difference noted between subjects enrolled in the urban clinic and the two rural clinics was in meat consumption, with none of the Knox County children consuming meat less than three times per week while 21.4% of the Monroe County children and 22.2% of the Sevier County children ate meat this infrequently. This difference in meat consumption among the children in the rural and urban clinics is contrary to what might be expected, given the monthly income differences of the subjects families.

Limitations of the Study

Methods of analysis were limited due to the small number of subjects meeting the criteria within the time span of the investigation. Although approximately 1,500 children were screened, only 57 were identified as anemic. Of these 57 anemic children initially certified, only 40 met the criteria or were not lost to follow-up (drop-outs). Consequently an extensive statistical analysis of the data was not applicable in many of the comparisons. In particular, statistical analyses of the demographic and dietary characteristics by county was not possible with the small subsample sizes. Also, differences between groups frequently were not significant perhaps because of small sample size.

A second limitation in this investigation was the limited amount of control over the study procedures. Due to the large number of staff involved in the study, frequent reminders of study procedures were

TABLE 14

Selected dietary characteristics by county of the WIC anemic pediatric population in three selected East Tennessee counties[1]

Characteristic	Knox (n = 16)	Monroe (n = 14)	Sevier (n = 9)
	----------Percent----------		
Ounces of fluid milk or formula consumed daily			
None	0.0	0.0	0.0
1-24 oz.	62.5	35.7	66.7
25-32 oz.	25.0	42.9	22.2
>32 oz.	12.5	21.4	11.1
Time of day WIC juice consumed[2]			
With meals	25.0	0.0	11.1
With snacks	12.5	0.0	0.0
Between meals and snacks (alone)	18.7	42.9	11.1
Throughout the day	37.5	57.1	77.8
Does not drink juice	6.3	0.0	0.0
Frequency of meat consumption			
Less than 3 times/week	0.0	21.4	22.2
3-6 times/week	25.0	28.6	0.0
1-2 times daily	56.3	50.0	66.7
3 or more times daily	6.3	0.0	0.0
Does not eat meat	12.5	0.0	11.1
Consumption of WIC cereal for breakfast or snacks[3]			
Yes	93.7	92.9	88.9
No	6.3	7.1	11.1

[1]Data compiled from answers to questions III-19, III-22, III-26 and III-28 of questionnaire (Appendix D)

[2]WIC juices are any juices with 100% natural fruit juice and at least 30 mg ascorbic acid per 100 ml juice.

[3]WIC cereals for children and women are any fortified dry cereals with at least 28 mg iron per 100 g dry cereal; infant cereals must contain at least 45 mg iron per 100 g dry cereal.

made, but the occasional chaos of the WIC clinics does not always lend itself to a carefully controlled study setting. This lack of control was particularly evident in the Knox County clinic where five nutritionists (as opposed to one in the rural clinics) were responsible for the counseling at the initial visit; in addition, there was a high turnover of nutrition staff in the Knox County WIC clinic during the study. This additional lack of control in Knox County as compared to the two rural clinics may have contributed to the lower rate of response in Knox County.

CHAPTER V

SUMMARY AND IMPLICATIONS

The purpose of this investigation was to evaluate the treatment provided for pediatric anemia in three selected East Tennessee WIC clinics and to determine any differences between treatment responders and nonresponders which may be contributing to the relatively high rate of nonresponse commonly found in the anemic pediatric WIC population in Tennessee. In this study, anemia was defined as a hematocrit less than 31% for children less than 24 months of age and less than 34% for children 24 to 54 months of age. Responders were classified as children whose hematocrit increased at least 3% by the 3 month follow-up visit and was greater than 30% for children less than 24 months or greater than 33% for children 24 months or older. Due to the lack of familiarity of some of the WIC staff with the proper procedures for the treatment of iron deficiency and the effects of iron deficiency, extensive in-service training sessions were conducted with all nurses and nutritionists participating in the study. Topics covered in these sessions which were found to be unfamiliar to many of the staff involved were the proper procedures for measuring the hematocrit, effects of iron deficiency, review of the Child Health Standards for supplement issuance, appropriate instructions for administration of the supplements, and suggestions for more effective counseling for iron deficiency.

During the investigation, 1,507 children were screened for anemia in the Knox, Monroe, and Sevier County WIC clinics. Of the 3.5% of

these children found to be anemic and meeting the study criteria, 29.4%, 64.3% and 66.7% responded to the treatment provided in the Knox, Monroe, and Sevier County WIC clinics, respectively.

Differences isolated among demographic variables in the children enrolled in the urban clinic (Knox) versus the subjects in the two rural clinics (Monroe and Sevier) which may have contributed to the large discrepancy in response rates in the urban and rural children were mean family income, family size, growth chart centiles, percentage of the children without a father figure living in the home, and distribution of the initial hematocrits. Due to the small number of subjects in each subsample, these associations with the exception of income were strictly observational (via percentages) and were not statistically evaluated.

Both family size and mean monthly income were markedly lower among the Knox County subjects as compared to their rural counterparts. Fatherless families were much more common to the Knox County subjects which could have contributed to the lower income.

The Knox County children tended to weigh less as a group than the Monroe and Sevier County subjects, with over one-fourth of the Knox County children being below the 5th percentile for weight for age while none of the rural children fell in this lower range. This difference was evident among the children falling below the 5th percentile for the weight for height growth chart, also, although the difference was not quite as dramatic.

An analysis of the distribution of initial hematocrits among the urban and rural children revealed that the initial hematocrits in Knox

County generally were higher than the hematocrits of the children in the rural clinics, with a larger percentage of the hematocrits being in the upper range of anemia (i.e., 32 to 33%) in the Knox clinic. This variance among the urban and rural children in relation to the response rates is particularly important in lieu of the inherent potential for false positive diagnoses in the measurement of the hematocrit. The potential for making an inaccurate diagnosis of anemia in a nonanemic individual increases with an increasing hematocrit.

Although race varied in the urban and rural children, with one-third of the Knox County subjects being black while all of the rural children were white, this variance did not appear to contribute to the lower rate of response in Knox County.

When the demographic variables were examined by response for all three clinics combined, the following discrepancies (none of which were significant) were noted between the responders and nonresponders:

1. Males are more likely to respond than females.
2. Mean age of responders was lower than the mean age of the nonresponders. Although this difference was not significant, it was consistent when analyzed by county.
3. Children previously certified for the WIC Program because of anemia were less likely to respond.
4. The fathers of the responders generally were better educated than the fathers of the nonresponders.
5. Nonresponders were more likely to be below the 5th centile for weight for height and height for age than the responders,

while the responders were more likely to fall above the 95th percentile for weight for height.

6. A significantly greater number of the nonresponders had initial hematocrits in the upper range of anemia (32-33%) than the responders (90% versus 55%, respectively).

This latter discrepancy once again suggests the potential for an inaccurate diagnosis of iron deficiency anemia with the hematocrit measure.

An evaluation of the response rates by supplement issuance revealed a significantly higher response rate among those children issued both Fer-In-Sol and a multivitamin with iron supplement (i.e., hematocrit < 32%) when compared to the subjects issued the multivitamin/iron supplement only (i.e., hematocrit 32 or 33%). While 81.8% of the children issued both types of supplements responded, only 37.9% of the children receiving the multivitamin/iron supplement only were classified as responders, suggesting the higher dose of iron issued to the children in the former group is much more likely to elicit an adequate degree of improvement in the child's iron status. This finding parallels the recommendations by most pediatricians for iron supplementation, in which a daily dosage of 3 to 6 mg iron/kg body weight is suggested. The dosage of iron issued to the children receiving both Fer-In-Sol and the multivitamin/iron supplement comes closer to meeting this recommendation than the dosage issued when multivitamin/iron supplement only is given.

It should be noted that the high degree of response in the children issued both types of supplements also reflects a greater potential

for a false positive diagnosis among the children with the high hematocrit readings since the degree of anemia determined the type of supplement(s) issued (i.e., children with low hematocrits were issued more iron). Therefore, since the guidelines for supplement issuance utilized in the Tennessee Department of Health and Environment specify a lower dosage of iron to be issued to children with hematocrits in the upper range of "low," a lower response rate would be expected for two reasons: (1) greater potential for inaccurate diagnosis of iron deficiency, and (2) in most cases, these children are receiving one-third to one-fourth of the dosage of iron recommended for the treatment of iron deficiency anemia.

In general, no striking differences in the dietary variables which might have contributed to the likelihood of response were noted between the responders and nonresponders or between the children in the urban clinic versus their rural counterparts. A significant difference contrary to what might be expected was identified in meat consumption, however, with a significantly larger number of responders consuming no meat.

Another important finding in this investigation was the extremely low attrition rate among the study subjects. A phone call and/or postcard was utilized to remind the parent/guardian of the upcoming appointment. This procedure, in conjunction with extensive counseling on the potential effects of iron deficiency and the importance of a speedy recovery, resulted in a 4.8% dropout rate. (All of the children labeled as "dropouts" were terminated from the WIC Program.)

In evaluating the findings of this investigation, a variety of recommendations are suggested to help improve the effectiveness of the WIC Program in treating iron deficiency anemia. These suggestions are outlined below.

1. Implementation of the hematocrit for age percentiles as the criterion of anemia diagnosis; this recently developed method for the detection of anemia could help minimize false positive diagnoses.
2. Issue iron supplements by weight (3-6 mg iron/kg body weight) as recommended by most pediatricians and hematologists. A low dose of iron usually requires continued administration over prolonged periods of time before the desired level of improvement is obtained. Consequently, the parent/guardian will fail to understand the importance of an immediate improvement and will lose his/her motivation to remedy the problem. Also, in light of the potential effects of iron deficiency, particularly on cognitive development, a more rapid improvement should be encouraged. It should be noted, however, that an increased incidence of gastrointestinal problems may occur with the increased dosage.
3. Periodic in-service training sessions for nursing staff to review the following concepts:
   a. proper procedures for measuring the hematocrit, including the use of two blood samples; correct laboratory

procedures can minimize the potential for an inaccurate diagnosis.

b. review of Child Health Standards for supplement issuance and follow-up appointments; the importance of a 3 month check-up, and preferably a 4- to 6-week check-up should be emphasized. A specific appointment for the 6-week check-up should be given rather than just a verbal reminder.

c. appropriate instructions for administering the supplements (e.g., on empty stomach between meals, etc.).

d. effects of iron deficiency anemia and iron deficiency without anemia; this discussion will help the nurses understand the importance of implementing the procedures described in the rest of the in-service program.

e. encourage nurses to briefly discuss effects of iron deficiency with the parent or guardian; this procedure can improve the credibility of the more extensive counseling provided by the nutritionist on iron deficiency.

4. Use prescription labels on the bottle of all supplements issued; labels emphasize the importance of the iron supplement and provide instructions after the box has been discarded.

5. Periodic in-service training sessions for the nutrition staff to review the following concepts:

a. how to briefly but simply describe to the parent/guardian what the hematocrit measures; most parents are sincerely interested in what is being done to their child during the examination and will be more motivated to follow through with the instructions and return for the follow-up appointment if they understand what the problem is.

b. effects of iron deficiency.

c. correct instructions for administration of the supplements.

d. encourage parent/guardian to establish regular time for supplement issuance; this procedure will help the parent to remember to administer the supplement on a daily basis.

e. encourage the parent/guardian not to give the supplement to a sibling of the anemic child.

6. Develop a pamphlet for pediatric anemia including specific suggestions for the iron deficient infant, more extensive but brief information on the effects of iron deficiency than is discussed in the pamphlets currently used, and instructions for administering the supplements.

7. Develop a poster on iron deficiency to be displayed in health departments which briefly describes effects of iron deficiency, sources of iron rich foods, etc. (or utilize existing poster, if one is available).

8. Send postcard to anemic and perhaps other high risk patients to remind them of upcoming appointment which may help minimize attrition rate.

9. Include "danger of regression" as a reason for certification for infants being certified at one year of age regardless of the reason for the 6-month certification. Currently infants certified at 6 months for danger of regression must be terminated at 1 year if there is no other reason for certification. These postinfancy months are a very common period for iron deficiency to develop among WIC children since they are no longer receiving the iron-fortified formula and may still be consuming large quantities of milk. Further follow-up and encouragement in this postinfancy period could help decrease the rate of anemia.
10. Encourage both nursing and nutrition staff to re-stress effects of iron deficiency in follow-up visits regardless of the status of improvement. Regression is common among the WIC population and the parent/guardian should be motivated to maintain the improved status.

A major implication suggested from the findings of this study is the need for a more accurate test for anemia. Because of the potential effect of iron deficiency without anemia, a more sensitive test which detects the less severe cases of iron deficiency may be warranted. Due to the financial limitations of the health departments, however, other hematologic tests may not be feasible. A cost/benefit analysis of the use of other laboratory measurements of iron deficiency in the health department setting may be helpful, including a review of the measurements utilized in other state WIC Programs.

A cost/benefit analysis of the issuance of iron supplements by weight for children below the 5th percentile for hematocrit for age versus the current system of supplement issuance would be useful in planning revised program procedures to improve the health department's effectiveness for the treatment of iron deficiency.

Also, due to the small number of anemic subjects obtained in this investigation, and, hence, the limited statistical analysis applicable, further research similar to this investigation is needed to document more conclusively the findings of this study, including the differences in demographic variables.

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LITERATURE CITED

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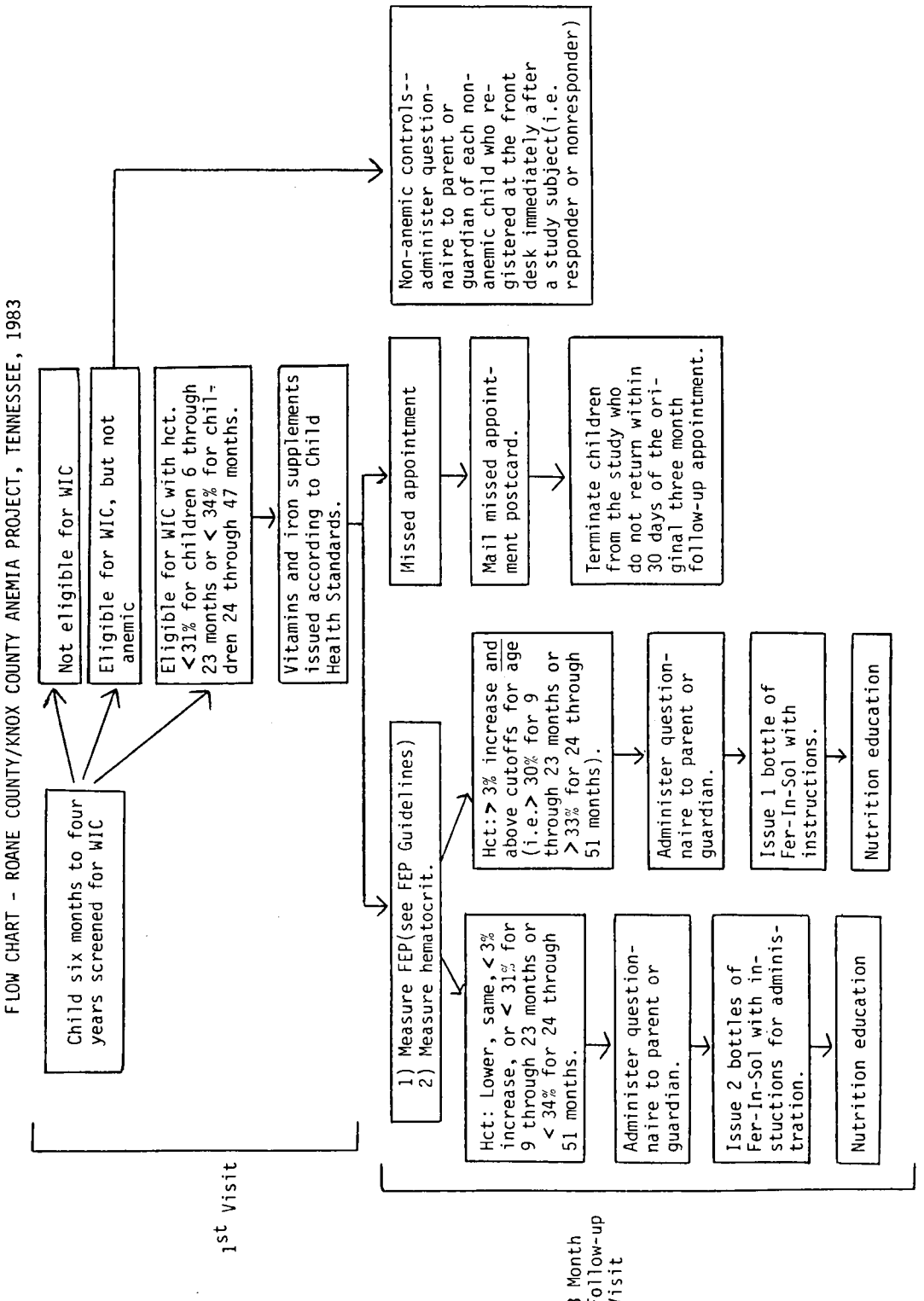
APPENDICES

APPENDIX A

FLOW CHART FOR STUDY PROCEDURES



APPENDIX B

WIC INCOME GUIDELINES

INCOME ELIGIBILITY CRITERIA

Income eligibility is uniform statewide and is determined at the local level by the clerk in the WIC clinic.* The participant's household income** must be no more than the WIC income guidelines (175% of the USDA income poverty guidelines). No person shall be removed from the program due to changes in income during a certification period.

WIC INCOME ELIGIBILITY GUIDELINES

1982-83

Family Size	Per Year	Per Month	Per Week
1	8,190	683	158
2	10,885	907	209
3	13,580	1,131	261
4	16,275	1,356	313
5	18,970	1,581	365
6	21,665	1,805	417
7	24,360	2,030	468
8	27,055	2,254	520
each additional family member	+2,695	+225	+52

Note: Do not allow hardship deductions from the above income poverty guidelines. A standard deduction has been included in all of the above income levels.

*At each certification the gross income is determined and filled in on the blue consent form. The clerk and the participant must sign the income certification at each certification.

**(gross income)

APPENDIX C

WIC INFORMED CONSENT FORM

PH-1530A
NS

INFORMED CONSENT FOR WIC PROGRAM

Name _____ Participant # _____ Date of Application _____

PROOF OF IDENTITY (enter type of identity supplied) _____

1. I understand the Special Supplemental Food Program for Women, Infants and Children (WIC Program) is to provide nutritious supplemental food and to collect medical data. I hereby authorize the Public Health Nurse and/or other health professionals to do the screening procedure, including height, weight, hematocrit, physical, and medical history.

2. It is of my own free will that I participate in this program. As parent or guardian I agree to the medical screening and evaluation procedures that will be performed on myself or my child named above and authorize the use of medical data collected.

3. I understand that this certification form is being made in connection with the receipt of federal funds. Program officials may verify information on this form. Deliberate misrepresentation may subject me to prosecution under Tennessee and Federal statutes.

4. I have been advised of my rights and obligations under the Program. I certify the information I have provided for my eligibility determination is correct to the best of my knowledge. There are _____ persons in my family and the family income is above _____. below

Date _____ Signature of parent or guardian _____ Signature and Title of Authorized Personnel _____

I certify that there are _____ persons in my family and the family income is above _____. below

Date _____ Signature of parent or guardian _____ Signature and Title of Authorized Personnel _____

I certify that there are _____ persons in my family and the family income is above _____. below

Date _____ Signature of parent or guardian _____ Signature and Title of Authorized Personnel _____

I certify that there are _____ persons in my family and the family income is above _____. below

Date _____ Signature of parent or guardian _____ Signature and Title of Authorized Personnel _____

I certify that there are _____ persons in my family and the family income is above _____. below

Date _____ Signature of parent or guardian _____ Signature and Title of Authorized Personnel _____

I certify that there are _____ persons in my family and the family income is above _____. below

8/82

APPENDIX D

STUDY QUESTIONNAIRE

TENNESSEE WIC ANEMIA EVALUATION QUESTIONNAIRE--THREE MONTH FOLLOW-UP VISIT

1. Identifying Information

State (1 2) County (3 4) Clinic (5 6) Participant No. (7 8 9 10 11 12)

Sex (13): 1=male, 2=female

Ethnic Group (14): 1=white, 2=black, 8=other

Birthdate: Mo. (15 16) Day (17 18) Year (19 20)

Child brought by (21): 1=mother, 2=guardian, 8=other

Previous certified for anemia (22): 1=yes, 2=no

Mother's age at last birthday: (23 24)

Census Tract (Knox County Only): (25 26).(27 28)

Initial Hct: (29 30)

Hct at Follow-up: (31 32)

FEP: (33 34 35)

Date of Medical Data: Mo. (36 37) Day (38 39) Year (40 41)

Mother's Hct at last prenatal visit (if less than one year): (42 43)

Number in Household: (44 45)

Number Months on WIC: (46 47)

At Initial Certification: Weight (48 49 lb. 50 51 oz.) Height (52 53 54 in.)

II. Questions for Nutritionist

1. Do you feel this family has any social problems related to poor compliance? (1=unlikely, 5=highly likely, 9=don't know) (55)

2. If siblings have been on the program prior to this child, were they anemic?
   1=Yes
   2=No
   8=Does not apply
   (56)

III. Questions for Mother-Guardian

1. How many children do you have other than _____ (Name)?
   1=None
   2=One
   3=2-3
   4=4 or more
   (57)

2. Were you on WIC when you were pregnant with _____ (Name)?
   1=Yes
   2=No
   9=Unknown
   (58)

3. Were any of your other children on the WIC Program before _____ (Name)?

If yes, how many? ☐ (59)

1=None
2=One or more
8=No other children--does not apply
9=Unknown

4. Has any one in this clinic talked you about iron-poor blood or anemia?

☐ (60)

1=Yes
2=No
9=Unknown

5. What did you learn from the health department about how to help "cure"the iron poor blood or anemia?

☐☐☐ (61 62 63)

1=Take iron medicine
2=Take vitamins
3=Eat iron rich foods (must give at least two correct examples)
4=Eat or drink vitamin C rich foods with nonheme iron rich foods
5=Eat vegetables (thinks any vegetable will help)
6=Other
7=Nothing
9=Uncertain

Is there anything else?

6. Have you been giving _____ (name) any of these supplements?(snow bottles) Which ones?

☐ (64)

1=Neither
2=Vitamins with iron
3=Iron supplements
4=Both
8=Does not apply (control)
9=Unknown

Have you been giving any other supplements?(Ask before completing block 64)

7. Where did you get the iron medicine and/or vitamins with iron?

☐ (65)

1=Health Department
2=Physician (prescription)
3=Store (off the shelf)
8=Does not apply
9=Unknown

8. How much of the vitamins you received at the last WIC certification is left in the bottle? Please point to the bottle.

☐ (66)

1=None
2=Less than half left (most gone)
3=About half left
4=More than half left
5=All or nearly all left
8=Does not apply (no to question 6)
9=Unknown

9. How often do you usually give _____ the vitamins?
name

1=Less than one/week
2=One-Six times/week
3=One time/day
4=Two or more times/day
5=Varies
8=Does not apply
9=Unknown

67

10. How much of the iron medicine you received at the last WIC certification is left in the bottle? (please point to the bottle)

1=None
2=Less than half left (most gone)
3=About half left
4=More than half left
5=All or nearly all left
8=Does not apply (No to question 6)
9=Unknown

68

11. How often do you usually give _____ the iron medicine?
name

1=Less than 1 time/week
2=One-Six times/week
3=One time/day
4=Two or more times/day
5=Varies
6=Other _____
8=Does not apply
9=Unknown/uncertain

69

12. How much of the iron medicine dropper do you usually give _____?
name
Please point to the dropper.

1=0.3 ml or less
2=0.3 ml - 0.6 ml
3=More than 0.6 ml
8=Does not apply
9=Unknown

70

13. Sometimes mothers of children with iron-poor blood or anemia worry about other family members being anemic. Have you given any of the iron medicine you received in this clinic to your other children or other family members including yourself?

1=Yes
2=No
8=Does not apply
9=Unknown

71

14. How often do you give the iron medicine to yourself or other family members?

1=Daily
2=Three-Six times/week
3=Less than One time/week
8=Does not apply
9-Unknown

72

15. What time of day do you usually give _____ the iron medicine?
name

73

1=Around mealtime
2=Between meals
3=Varies
8=Does not apply
9=Unknown

16. Sometimes mothers have a hard time giving their children the iron medicine as often as they should. Why was _____ not able to take his/her iron medicine?
name

74

1=Forgot
2=He/she doesn't need it
3=He/she doesn't like it
4=It upsets his/her stomach (constipation, diarrhea, nausea)
5=Thought the vitamins were enough
8=Does not apply
9=Unknown

17. Are you breastfeeding _____? (Children less than 3 years of age)
name

75

1=Yes
2=No
8=Does not apply

18. Did you ever breastfeed _____? If so, how long? (children less than one year of age)
name

76

77 78
MOS.

1=Yes
2=No
8=Does not apply

19. How many cups of milk or formula does _____ usually drink per day?
name

79

1=None
2=Less than 3 cups (less than 24 ounces)
3=Three-Four cups (24-32 ounces)
4=More than 4 cups (more than 32 ounces)
9=Unknown

20. Does _____ drink juice?
name

80

1=Yes
2=No
9-Unknown

21. What kind of juice does _____ usually drink?
name

[ ] 81

1=Adequate vitamin C content
2=Inadequate vitamin C content
8=Does not apply (does not drink juice)
9=unknown

22. When does _____ usually drink the juice?
name

[ ] 82

1=With meals
2=With snacks
3=Between meals and snacks (alone)
4=Throughout the day
8=Does not apply
9=Unknown

23. Does _____ usually drink anything when he/she takes the iron medicine? If so, what and how much? (Only indicate how much if he/she drinks a high ascorbic acid drink with the iron)
name

[ ] 83

[ ][ ] oz.
84 85

1=Yes--high ascorbic acid drink
2=Other
3=No
8=Does not apply
9=Unknown

24. How often does _____ drink juice when he/she takes the iron medicine?
name

[ ] 86

1=Most of the time
2=Sometimes
8=Does not apply

25. Does _____ eat meat, fish or chicken?
name

[ ] 87

1=Yes
2=No
9=Unknown

26. How many times per day or week does _____ eat meat?
name

[ ] 88

1=Less than 3 times/week
2=Three-Six times/week
3=One-Two times/day
4=Three or more times/day
8=Does not apply
9-Unknown

27. When _____ (name) eats meat how much does he/she usually eat at a time?

[ ][ ] oz. (89 90) [ ] (91)

1=Varies
8=Does not apply
9=Unknown

28. Does _____ (name) eat WIC cereal for breakfast or snacks?

If so, which one does he/she usually eat?

[ ] (92)

1=Yes
2=No
9=Unknown

_____

29. How many grades of school have you completed?

[ ] (93)

1=Less than 8 years
2=8-11 years
3=12 years (high school graduate)
4=13 or more (beyond high school)

30. Does your husband or boyfriend live at home?

[ ] (94)

1=Yes
2=No
3=Other

31. How many grades of school has he completed?

[ ] (95)

1=Less than 8 years
2=8-11 years
3=12 years (high school graduate)
4=13 or more (school beyond high school)
8=Does not apply
9=Unknown

32. What is your monthly income?

Wages _____
Welfare/AFDC _____
Disability _____
Unemployment _____
Food Stamps _____
Other _____

Total [ ][ ][ ][ ] (use leading zeros)
96 97 98 99

(Figure total and indicate below)

[ ]
100

1=Below poverty level
2=Between poverty level and 175% of poverty
3=Greater than 175% of poverty (should not be on WIC)
9=Unknown

Go Back and Complete Section II

APPENDIX E

PRESCRIPTION LABELS

SEVIER COUNTY HEALTH DEPARTMENT
P.O. BOX 112 SEVIERVILLE, TN 453-1032

Dr. M.C. Carver, Clinical Director

Poly-Vi-Sol with Iron
Give 1.0 ml (1 dropperful) one time
a day *between meals.*
Vitamins w/10 mg. elemental iron
KEEP OUT OF CHILDREN'S REACH.

CAUTION: Federal law prohibits transfer of this drug to any person other than the patient for whom it was prescribed.

SEVIER COUNTY HEALTH DEPARTMENT
P.O. BOX 112 SEVIERVILLE, TN 453-1032

Dr. M.C. Carver, Clinical Director

One tablet in mouth—may be chewed, dissolved or swallowed. Give one time a day *between meals.*
Vitamins w/10 mg. elemental iron
KEEP OUT OF CHILDREN'S REACH.

CAUTION: Federal law prohibits transfer of this drug to any person other than the patient for whom it was prescribed.

SEVIER COUNTY HEALTH DEPARTMENT
P.O. BOX 112 SEVIERVILLE, TN 453-1032

Dr. M.C. Carver, Clinical Director

Give 0.6 ml (1 dropperful) _____ times
a day *between meals.*
15 mg. elemental iron
KEEP OUT OF CHILDREN'S REACH.

CAUTION: Federal law prohibits transfer of this drug to any person other than the patient for whom it was prescribed.

APPENDIX F

NUTRITIONIST AND NURSING TRAINING PACKET

Attachment 1

KNOX COUNTY WIC ANEMIA STUDY

Certification Visit

1. RN draws 2 samples of blood for the hematocrit according to the procedures on Attachment 1. Both readings should be recorded with the highest one being utilized for the WIC eligibility screening.
2. If the hematocrit is 33% or below, the nurse issues supplements according to the Child Health Standards (Attachment 2) and briefly discusses iron deficiency and instructions for administration of the supplements (Attachment 3). Two bottles of Poly-Vi-Sol should be given if they are scheduled to return for 2½-3 months (i.e., hct. ≧30%). Labels with instructions for administration are placed on all bottles.
3. Record type and number of bottles of supplements dispensed in the health record.
4. Nutritionist provides counseling, including the topics listed on Attachment 4.
5. Nutritionist places purple triangle on health record.
6. Nutritionist gives "Building Blood" pamphlet to parent or guardian.

7. Follow-up appointment is scheduled for the appropriate Monday as follows:
   a. Children with a hematocrit of 29% or less should be brought back in six weeks.
   b. Children with a hematocrit of 30% or greater should be brought back in 2½ to 3 months.
8. Nutritionist makes note in record if the person accompanying the child is not the person who usually cares for the child.

Three Month Follow-Up Visit

1. RN draws 2 samples of blood for the hematocrit according to the procedures on Attachment 1. Both readings should be recorded with the highest one being utilized for the WIC eligibility screening.
2. Nonresponders are issued one bottle of Fer-In-Sol (see Attachment 5). Child Health Standards are followed for vitamin issuance.
3. Interviewer administers questionnaire and provides counseling.

Attachment 2

Checklist for Measuring the Hematocrit*

1. Wipe area with alcohol.
2. Dry area with gauze cotton.
3. Make firm puncture.
4. Wipe away first drop of blood.
5. Fill two tubes.
6. Check for exact filling to line prior to seal.
7. Make flat seal on tube by perpendicular entry into clay.
8. Spin samples for five minutes.
9. Use magnification and good lighting to read both tubes.
10. Record both readings in record and/or on daily data log.

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*Adapted from: Epidemiological Investigation of Different Frequencies of Anemia Among Counties in the Northwest Region of Tennessee, Tennessee Department of Health and Environment, Division of Nutrition/WIC Services and Division of Nutrition, Center for Health Promotion and Education, Centers for Disease Control.

TABLE F-1

Supplement issuance guidelines

18 months or less			19 months or older	
Hematocrit (%)	Poly-Vi-Sol with Iron[1]	Fer-In-Sol[2]	Daily Dose I (Chewables)[3]	Fer-In-Sol
≥34	--	--	--	--
32-33	1 ml/day	--	1 tablet/day	--
30-31	1 ml/day	0.6 ml once/day	1 tablet/day	0.6 ml once/day
28-29	1 ml/day	0.6 ml twice/day	1 tablet/day	0.6 ml twice/day
≤27	1 ml/day	0.6 ml 4 times/day	1 tablet/day	0.6 ml 4 times/day

[1]Mead Johnson and Co.—10 mg elemental iron/ml

[2]Mead Johnson and Co.—15 mg elemental iron/0.6 ml

[3]American Pharmaceutical Co.—10 mg elemental iron/tablet

Attachment 4

Topics To Be Discussed by Nurse at Certification Visit

1. Briefly discuss effects of iron deficiency
   a. Irritability
   b. Increased susceptibility to infection
   c. Decreased potential for learning
   d. Lethargy (mention only if appropriate)
2. Give instructions on administering supplements:
   a. Point to the dropper and tell the amount to be given.
   b. Encourage to drop the Poly-Vi-Sol or Fer-In-Sol in the back of the mouth and follow up immediately with high ascorbic acid drink (WIC or infant juice).
   c. Encourage to give between meals.
   d. Encourage to brush teeth after administration, if appropriate.
   e. Establish a regular daily time when the supplements will be administered.
   f. Encourage to call if they have any problems.

For example:

"Sally has a low hct. now which means she probably does not get enough iron. It is very important to make sure Sally has enough iron because if she does not get enough iron she may not learn as well as she could—she may be learning "this" much but she could be learning "this" much. Also, sometimes children that don't get enough iron and who don't make enough red blood cells get irritable a lot and are more likely to get sick.

Since Sally's hct. is low we are going to give you this iron supplement (if appropriate) and/or this vitamin supplement with iron. You should give ___ ml—up to this line—between meals with a little bit of WIC/infant juice. The juice will help Sally's body use the iron. It is usually easiest to drop the supplement in the back of the mouth and follow immediately with the WIC juice. The instructions are on the bottle. Be sure to call us if you have any problem. It is also good if you can set aside the same time every day to give the supplements so you won't forget. "What time is best for you?"

[The nutritionist will go into more detail about the juice and importance of giving the supplement in between meals.]

Attachment 5

Topics To Be Discussed by Nutritionist at Certification Visit

1. Explain what the hematocrit measures.
2. Discuss effects of iron-deficiency:
   a. Irritability
   b. Increased susceptibility to infection
   c. Decreased potential for learning
   d. Lethargy (only if appropriate)
3. Review sources of iron rich foods.
4. Review importance of ascorbic acid to iron absorption.
5. Review instructions on administering supplements:
   a. Give between meals—explain why.
   b. For drops, give in back of mouth and follow immediately with juice.
   c. Encourage to call if he/she has any problem.
   d. Note that the amount they are supposed to give is written on the bottle.

For example:

"Sally has a hematocrit of 32%. Do you know what this means? Well, the nurse stuck Sally's finger and put the blood in the glass tube. Then she put the tube in the machine that made a lot of noise! This machine spun the blood around real fast so the red blood cells were separated from the rest of the blood. That lets us know if Sally has enough red blood cells. Her hct. is 32% which means she was 32%

red blood cells which is not enough. And you need iron to make red blood cells, so Sally probably has not been getting enough iron. Now it's real important to get enough iron and make enough red blood cells because children who don't get enough iron may not learn as much as they could—she's learning alright, but she possibly could learn a lot more and we certainly want her to be as smart as she can be. Also, children who don't have enough iron in their blood may be more irritable and may get sick more often.

"The nurse gave you some supplements with iron. It is important to get some iron from your food, also. Foods that have a lot of iron are ..... Unfortunately most of the iron we eat, whether it be from the supplements or from food, comes right back out the other end! However, if we drink juice with a lot of Vitamin C—like your WIC juices (or the infant juices)— then the Vitamin C helps grab the iron and keep it in the body [this statement is not truly accurate since ascorbic acid does not really "grab" the iron, but it gets the point across]. So whenever you serve foods you know have iron, like turnip greens, pinto or navy beans, or WIC cereals, give some juice also.* That way your body will use more of the iron. And that's why it is also important to give some juice with the supplements. Also, it is important to give the supplements between meals—when you give the supplements between meals the body will keep a lot more of the iron. And as the nurse said, give the drops in the back of the mouth and follow

immediately with juice. The amount is written on the bottle and you should call us if you have any problems. Have any questions?

*It may confuse the mother if you try to distinguish between heme and nonheme sources of iron—also, the iron in meat is 60% nonheme so Vitamin C can aid in iron absorption with meat, also.

Attachment 6

KNOX COUNTY HEALTH DEPARTMENT

TENNESSEE DEPARTMENT OF PUBLIC HEALTH COOPERATING
CLEVELAND PLACE
KNOXVILLE, TENNESSEE 37917

TO: WIC Clinic Nurses

FROM: Mary B. Duffy, M.D., M.P.H., Director

SUBJECT: WIC Anemia Study

DATE: August 15, 1983

One bottle of Fer-In-Sol with instructions should be dispensed to all those children participating in the anemia study who do not respond by the three month follow-up visit. A non-responder is any child whose hematocrit:

1) decreases,

2) remains the same, or

3) has not increased at least 3% and is not greater than or equal to 31% for children less than 24 months or greater than or equal to 34% for children 24 months or older.

The Child Health Standards should be followed for vitamin issuance for these children. Fer-In-Sol should not be issued to parents of non-responders who still have the bottle they were issued at the last WIC visit.

This procedure would help improve the child's iron status, if, in fact, he/she is experiencing iron-deficiency anemia and could help determine more effective procedures for treating our classic WIC anemia child who fails to improve time and time again. Administration of iron and supplements has been shown to be the ultimate test for iron-deficiency anemia.

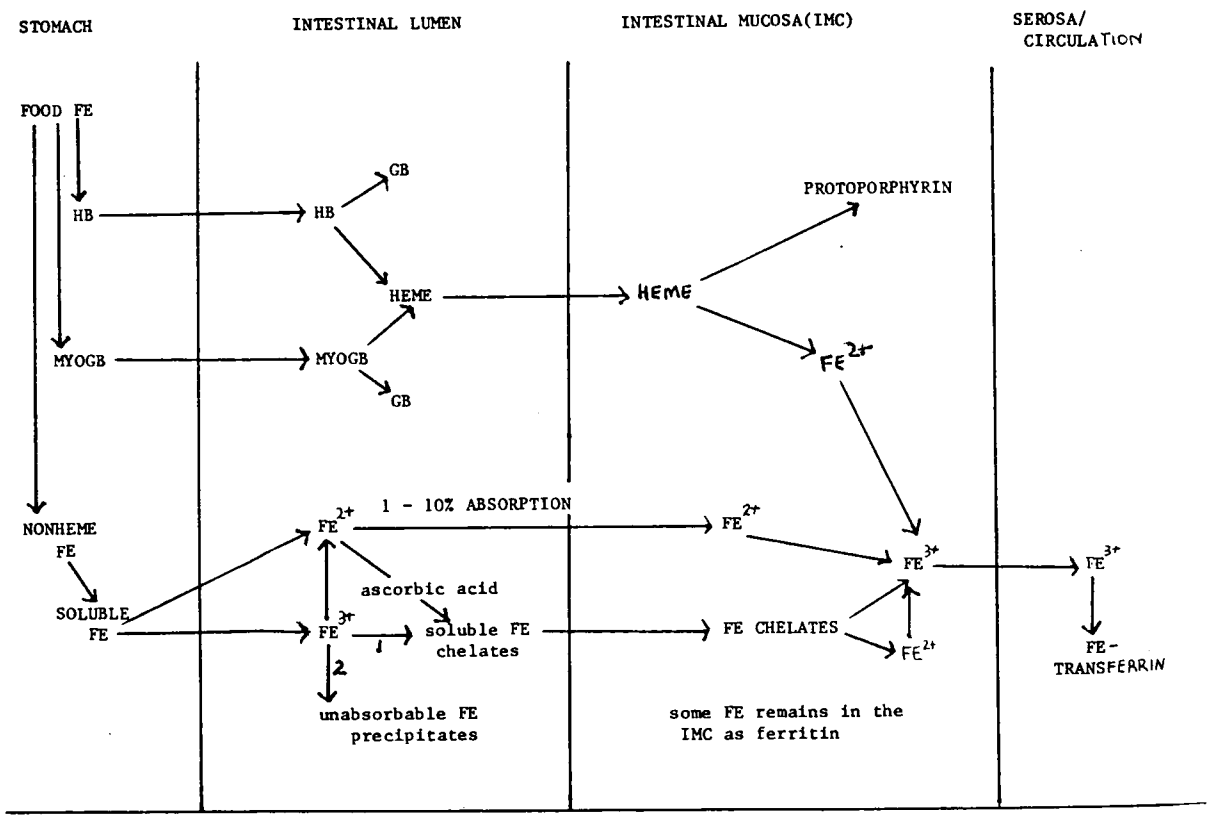

Figure F-1. Iron Digestion and Absorption.

[1]Ascorbic acid, certain sugars and amino acids will facilitate the incorporation of ferric Fe into soluble chelates and hence, prohibit a formation of the unabsorbable precipitates.

[2]Calcium and phosphate salts, oxalates, tannins and phytates will cause the formation of unabsorbable precipitates. Ferrous iron (Fe^{2+}) is not readily precipitated.

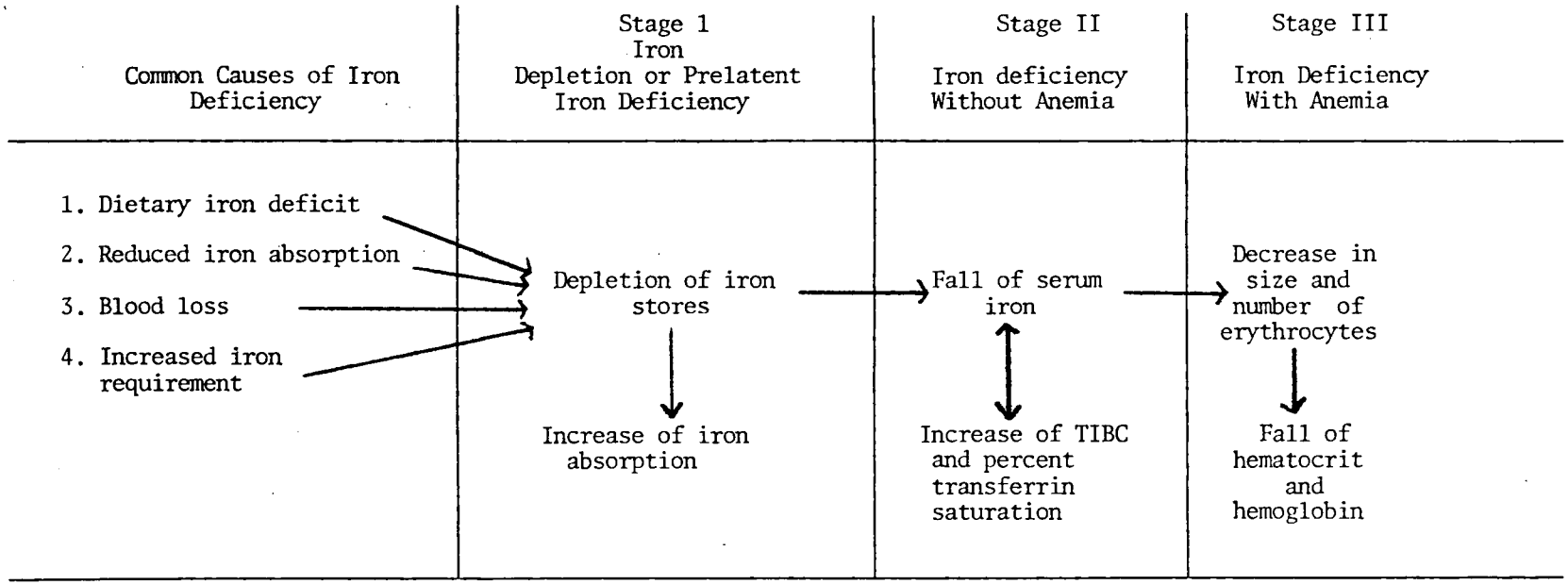

Figure F-2. Stages of Iron Deficiency.

Source: Adapted from Hallberg, L., et al. (1970) Iron Deficiency. Academic Press, New York.

VITA

Minda S. Lazarov was born on July 15, 1955 in Memphis, Tennessee. She graduated from White Station High School in Memphis in 1973. After attending one year at Indiana University, she transferred to the University of Tennessee, Knoxville, where she received a Bachelor of Science in Nutrition in June, 1977. She was employed by the Tennessee Department of Health and Environment as a Health Administrator and Nutritionist from August 1977 until September 1982, at which time she reentered the University of Tennessee, Knoxville to pursue a Master's Degree in Nutrition Science. Minda held two assistantships while in graduate school as coordinator of the Stokely-Van Camp Symposium during the 1982-83 school year and as a Graduate Teaching Assistant in 1983-84. She was recognized as an Outstanding Graduate Student for the UT Department of Nutrition and Food Sciences in May 1984.

Minda is a member of the American Public Health Association, Women in International Development and Omicron Nu, Alpha Lambda Delta and Phi Kappa Phi Honor societies.

In December 1984, she received the Master of Science Degree with a major in nutrition.