Iron Deficiency Anemia in Tennessee Among Rural Poor Children

ROBERT H. HUTCHESON, Jr., M.D., M.P.H.

STUDIES of the incidence of iron deficiency anemia among infants in rural areas of the United States have not been reported (*1*). This paper describes an anemia survey among rural children of Tennessee and a program of primary and secondary prevention.

The widespread cause of iron deficiency anemia in infancy include (*a*) deficient stores of iron at birth, (*b*) relatively rapid increase in weight after birth, (*c*) a deficient intake of iron, and (*d*) blood loss. Although 10 gm. of hemoglobin per 100 cc. of blood (*3*) is often selected as the critical level (*4*), iron depletion exists in many children who are "normal" by currently accepted hematologic standards (*5*). Experts who accept the hemoglobin and hematocrit values found among exceptionally favored children as the desirable levels set the optimum hematocrit value for children from 3 months to adolescence at more than 36 percent of the packed cell volume (*5*, *6*). Such a high level is obtainable with either a good diet or iron supplementation. The averages and the ranges of hemoglobin given in some texts include values which are far from desirable when viewed as indices of nutrition (*6*). Since experts disagree about the precise dividing line for anemia in children, the tables in this paper have been constructed to show the proportion of children falling under different dividing lines.

Anemia of infection is probably rare in infants, but many infants with iron deficiency anemia develop infection (*5*). Probably most infants diagnosed as having anemia of infection have had anemia first and infection second.

Although the incidence of iron deficiency anemia of infants varies from one group to another, the illness may reach alarming proportions in underprivileged groups (*7*). Thirty percent of the year-old children were anemic in one population of ill babies (*2*) and more than 24 percent in another (*8*). According to studies done in the 30's, 40's, and 60's, the incidence of iron deficiency anemia in low economic groups has differed little over the years.

Apparently, iron deficiency anemia predisposes to infection. Andelman has shown that infants who do not become anemic have fewer respiratory infections than those who do (*3*). He quotes several authors, including McKay, Salmi, Shaw, Moe, and Helmendinger, who observe that prevention of anemia prevents illness in infants. Sturgeon is quoted as showing that infants from low-income families clearly benefited from iron supplementation (*7*). Many physicians argue that iron therapy is not needed in mild anemia. However, against this view and in favor of prophylactic and therapeutic iron, are the observations of Guest (*6*) that (*a*) mild anemia followed by infection often results in a precipitous fall in hemoglobin to a severe degree of anemia, (*b*) anemic infants are less resistant to infection, (*c*) pica is often associated with iron deficiency anemia, and (*d*) infection in anemic babies often follows a stormy course with complications. Al-

Dr. Hutcheson is director of maternal and child health for the Tennessee Department of Public Health, Nashville.

though "expert" opinion is changing, iron deficiency anemia is still not always identified as the major public health problem that it is (7).

Survey in Tennessee

Suspecting that iron deficiency anemia was widespread in Tennessee, I directed four public health nurses to perform a microhematocrit upon every child between the ages of 3 and 24 months who was brought to the Robertson County Health Department for immunizations between June 1 and August 11, 1965. Every child in this age group was tested, including even the few children who were receiving well-baby care from a physician.

A compact microhematocrit machine (*A*) was used, and capillary blood was obtained from the great toe. The children tested were presumably well since most mothers know that public health nurses do not give injections to sick children, and children are not treated for illness in county health department clinics.

Of 244 children tested, 24 percent had hematocrit readings of 31 percent or less. The large percentage of anemic youngsters found at this one public health clinic prompted the Tennessee Department of Public Health to supply the rest of the 91 rural health departments in Tennessee with equipment to perform microhematocrits. By the end of 1966 this equipment had been delivered, and the public health nurses had learned the technique used in the preliminary survey in Robertson County.

During 1967, a total of 15,681 different children under age 6 were tested for anemia in 91 rural health departments. The rural health departments included all the health departments in the State except those in Shelby, Davidson, Knox, and Hamilton Counties. Thus, the departments in Memphis, Nashville, Knoxville, and Chattanooga were excluded.

Not every child coming to the rural health centers could be tested, as had been done in the preliminary survey. Instead, the nurses tested children as time permitted. The nurses exhibited only a slight tendency to emphasize the testing of children who appeared anemic; therefore, the results parallel those in the preliminary survey. The results are shown in table 1.

Conventional wisdom holds that nutritional deficiencies are no longer a problem in the

Table 1. Hematocrit readings of rural Tennessee children by age and race, 1967

Age (years) and race	Total children	Percent of packed red cells in a blood column									
		Under 30		30 and 31		32 and 33		34 and 35		36 and over	
		Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent
All children	15,681	1,560	9.9	1,718	11.0	2,822	18.0	3,971	25.3	5,610	35.8
Under 1	6,697	747	11.2	877	13.1	1,338	20.0	1,710	25.5	2,025	30.2
1	2,464	443	18.0	289	11.7	472	19.2	567	23.0	693	28.1
2	1,394	151	10.8	166	11.9	289	20.7	362	26.0	426	30.6
3	1,250	90	7.2	153	12.2	218	17.4	312	25.0	477	38.2
4	1,210	54	4.5	90	7.4	172	14.2	352	29.1	542	44.8
5	2,666	75	2.8	143	5.4	333	12.5	668	25.1	1,447	54.3
White children	12,572	1,140	9.1	1,281	10.2	2,195	17.4	3,219	25.6	4,737	37.7
Under 1	5,506	548	10.0	677	12.3	1,086	19.7	1,454	26.4	1,741	31.6
1	2,010	327	16.3	224	11.1	383	19.1	464	23.1	612	30.4
2	1,088	104	9.6	116	10.7	214	19.7	285	26.2	369	33.9
3	927	60	6.5	101	10.9	147	15.9	225	24.3	394	42.5
4	901	40	4.4	46	5.1	110	12.2	253	28.1	452	50.2
5	2,140	61	2.9	117	5.5	255	11.9	538	25.1	1,169	54.6
Nonwhite children	3,109	420	13.5	437	14.1	627	20.2	752	24.2	873	28.1
Under 1	1,191	199	16.7	200	16.8	252	21.2	256	21.5	284	23.8
1	454	116	25.5	65	14.3	89	19.6	103	22.7	81	17.8
2	306	47	15.4	50	16.3	75	24.5	77	25.2	57	18.6
3	323	30	9.3	52	16.1	71	22.0	87	26.9	83	25.7
4	309	14	4.5	44	14.2	62	20.1	99	32.0	90	29.1
5	526	14	2.7	26	4.9	78	14.8	130	24.7	278	52.9

Table 2. Daily schedule of iron treatment provided anemic children in Tennessee with hematocrit readings of 31 percent or less

Hematocrit value	Ferrous sulfate solution (*B*) in mg. of elemental iron	Vitamins with iron (*C*) in cc.	Total supplemental iron in mg.
30 or 31	15	0.6	25
28 or 29	30	.6	40
27 or lower	60	.6	70

United States, but the table clearly indicates that a significant percentage of Tennessee's rural poor children are anemic. Most physicians will accept hematocrits of 31 percent or less as anemia. If so, a shocking 40 percent of the nonwhite 1-year-old poor children in the State were anemic. Even if the criterion is 29 percent or less, fully one-fourth of the nonwhite 1-year-olds were in trouble. The dietary histories of these children with these low readings left little doubt that most of them had iron deficiency anemia. Tennessee had an epidemic of an easily preventable disease.

The maternal and child health service of the Tennessee Department of Public Health next attempted to find out if the anemia observed in the children was responsive to iron treatment when managed by the public health nurses. Children with a hematocrit of 31 percent or less were referred to a private physician whenever the parents were willing to go to one. These referred children are not evaluated in this paper; they usually responded to treatment with iron. Those who would or could not go to private physicians because of poverty or ignorance were managed by the public health nurses, who delivered their services in rural health centers or on home visits according to the schedule in table 2.

The public health nurses supplied mothers with iron and vitamins once a month. When the nurse was worried about the mother's ability to carry out instructions, return appointments were made more frequently. The quantity given the mother was calculated to last until the next appointment.

In addition to the iron and vitamins, a good diet with emphasis upon dry baby cereal was suggested by the public health nurses to the mothers. Fortified dry baby cereal has more iron per penny than liver (*10*). Diet alone was not used since a diet of good solid food does not correct iron deficiency anemia (*3*). Actually, only the well-endowed, full-term infant can meet his iron needs from dietary sources alone (*7*). Giving away free formula containing iron prevented anemia in one study (*3*), but such a free food program could not be financed in Tennessee.

Lahey suggests 60–70 mg. of elemental iron as satisfactory treatment (*5*). The Tennessee health department used somewhat smaller doses except in severe anemia.

The program of the maternal and child health service consisted of a simple trade with public health nurses. The State health department supplied vitamins and iron, and also ferrous sulfate solution, to county health department nurses in exchange for serial hematocrit and other data on each child they managed.

To learn if the treatment program was effective, the staff of the maternal and child health service prospectively selected children who fulfilled the following criteria: (*a*) the child's initial hematocrit had been taken by the rural health department between January and July 1967 and was found to be 29 percent or less, (*b*) the child had been placed on iron and vitamins by the public health nurses because they believed that his family was too poor or too uncooperative to purchase medical care.

In December 1967, the staff of the State health department evaluated this population of anemic, poor children to see what had happened to the hematocrit values. The following table clearly shows that these values significantly increased in nearly all the 576 children fulfilling criteria *a* and *b*.

Status of children	*Number*	*Percent*
Total	[1] 576	100
Hematocrit value increased to 32 percent or more	533	93
Hematocrit value remained below 32 percent	18	3
Had moved or could not be located	21	4
Under private medical care or had left the study	4	1

[1] Except for 18 children over age 5, these children are also included in table 1.

According to the hematocrit values for children 5 years and under shown in table 1, the age groups under 3 years deserve the highest priority in treatment for anemia, although the 4-year-olds and 5-year-olds should not be neglected. Of the 576 children studied (children 9 years and under with hematocrit values of 29 percent or less who were not under medical care), the largest proportion—43 percent—were 1-year-olds; the next highest proportion—29 percent—were under 1 year.

Age (years)	*Number*	*Percent*
Total children studied	576	100.0
Under 1	166	28.8
1	245	42.5
2	68	11.8
3	42	7.3
4	22	3.8
5	15	2.6
6	10	1.7
7	5	.8
8	0	0
9	3	.5

The program for the anemic children cost only $27,120 in 1967, including equipment and supplies; there were no additional personnel costs.

Durable equipment	$15,000
Testing supplies	930
Vitamins with iron	7,992
Iron	3,198
Total program cost	$27,120

A total of 3,278 anemic children were discovered, and about 2,000 were treated at these costs.

Comment

We considered an increase in the hematocrit level to 32 percent satisfactory, but the level of most of the children studied increased to 36 percent. This increase was achieved in a prospectively selected population, poor and lacking in education, with health behavior that was difficult to change. Not only did the anemia of the children in this population respond to iron treatment, but also the public health nurses were happy to find that they could bring about that response. As the hematocrit level rose, the children's appetites improved markedly, and they became less irritable. An unexpected side effect was improved rapport between the parents and the public health nurses. The nurses reported that the mothers attributed their infants' increased cheerfulness to the medication. The pleased mothers then tended to follow better than before the nurses' advice about feeding; they also were more inclined to complete their children's immunizations.

Once hematocrit machines, iron supplements, and vitamins became available in Tennessee, the public health staffs discovered that anemia was more widespread in the population served by their agencies than they had believed. Physicians in the counties studied also became more aware of the extent of iron deficiency anemia and often altered their feeding advice to mothers to help prevent the condition.

Lahey's observation that anemic babies frequently are not pale (*5*) is true. The public health nurses learned rapidly that their observation of the amount of a child's paleness did not negatively correlate with the hematocrit values.

Although vitamins are probably unnecessary in the treatment of iron deficiency anemia, some nurses and physicians will accept them more readily than iron alone. Contrary to Lahey (*5*), the Tennessee maternal and child health service found that when 10 mg. of elemental iron is the only iron given, hematocrits as low as 27 percent could be corrected within a few months. This low dose of iron was given whenever the public health nurses were fearful of giving ferrous sulfate solution because they knew that certain local physicians looked upon the giving of plain iron as "treatment" (and therefore not to be administered by nurses) but regarded iron with vitamins as a dietary "supplement" proper for a nurse to supply.

Both public health nurses and physicians were surprised at the rapidity of the hematocrit increase. Unlike Lahey, who quotes a much slower rise in hematocrit, most infants studied in Tennessee increased 2 or 3 percentage units in 2 weeks—from 30 percent of packed cell volume to 32 or 33 percent.

The high incidence of iron deficiency anemia among the nonwhite children may be partly due to proverty, but it is also partly due to the feeding of large amounts of milk, gravy, and pota-

toes while excluding low-cost enriched baby cereal. The staff of the maternal and child health service is now encouraging public health nurses to start all infants from poor families on vitamins with iron and dry baby cereal soon after birth in an effort to prevent iron deficiency anemia. Other workers report that such a plan works.

Even among the infants who are likely to develop iron deficiency anemia, prophylactic iron maintains high levels of hemoglobin and hematocrit throughout the ages when these values are most likely to fall (*6*). Lahey suggests 10–15 mg. of elemental iron in such prophylaxis (*5*). We use 10 mg. and have found that this dose prevents anemia in seriously disadvantaged children.

The cost of the Tennessee program is small, especially when both the illness averted and the effects on the attitude of the mothers are considered. No costs for additional personnel were incurred in the program.

Summary

Of 15,681 children under age 6 brought to 87 rural immunization clinics in Tennessee in 1967, a large number—at least 10 percent—were anemic. The 1-year-olds were more likely to be anemic than the other age groups under 6. At least one-fourth of the nonwhite 1-year-olds were anemic.

A group of 576 children 1–9 years old who had been screened during a 6-month period and found to have hematocrit values of 29 gm. or less of hemaglobin per 100 cc. of blood were selected for treatment with iron. The treatment program in 1967 cost $27,120, including $15,000 for durable equipment. The State health department supplied public health nurses in the rural health department clinics with vitamins and iron and with ferrous sulfate solution to treat these children in exchange for supplying the department with the serial hematocrit value and other data on each child treated. Each nurse in turn distributed the supplies to the mother of the anemic child and instructed her on the daily dosage. She also suggested a good diet with emphasis upon dry baby cereal.

Ninety-three percent of the 576 children responded to iron treatment. The hematocrit level of most infants increased 2 or 3 percentage units within 2 weeks—from 30 percent of packed cell volume at the beginning of treatment to 32 or 33 percent. The levels of most children finally increased to 32 percent. The children's appetites and dispositions also improved. The mothers were pleased and thus more inclined to complete their children's immunizations and to follow the public health nurses' advice about feeding. In view of these results, the cost of the program was small.

REFERENCES

(*1*) Foman, S. J.: Infant nutrition. W. B. Saunders Company, Philadelphia, 1967, pp. 166–180.

(*2*) Woodruff, C. W.: Multiple causes of iron deficiency in infants. JAMA 167: 715–719, June 7, 1958.

(*3*) Andelman, M. D., and Sered, B. R.: Utilization of dietary iron by term infants. Amer J Dis Child 3: 45–55 (1966).

(*4*) U.S. Children's Bureau: Prevention of iron-deficiency anemia in children of preschool age. U.S. Government Printing Office, Washington, D.C., 1967.

(*5*) Lahey, M. E.: Iron deficiency anemia. Pediat Clin N Amer 4: 481–496, May 1957.

(*6*) Guest, G. M., et al.: Normal blood values in infancy and childhood. Pediat Clin N Amer 4: 357–369, May 1957.

(*7*) Schulman, I.: Iron requirements in infancy. JAMA 175: 118–123, Jan. 14, 1961.

(*8*) Shaw, R., and Roberston, W. D.: Anemia among hospitalized infants. Ohio Med J 60: 45–47 (1964).

(*9*) Stewart, W. H.: Assessing the effectiveness of child health services. Paper presented at 56th Ross Conferenee. Ross Laboratories, Columbus, Ohio, Mar. 16–17, 1967, p. 13.

(*10*) Heinz nutritional data. H. J. Heinz Company, Pittsburgh, 1956.

EQUIPMENT REFERENCES

(*A*) Clay-Adams Read-a-crit centrifuge, catalog No. CT–3400, Clay-Adams, Inc., New York.

(*B*) Fer-in-sol, catalog No. 63250, Mead-Johnson Laboratory, Atlanta, Ga.

(*C*) Tri-vi-sol with iron, catalog No. 63237, Mead-Johnson Laboratory, Atlanta, Ga.

Increase in Outpatient Visits

A marked change in the public's demand for services has been experienced by the nation's hospitals in the past 2 years, according to the American Hospital Association's 1967 annual survey of all registered hospitals. Survey findings show that from 1965 through 1967 hospital outpatient visits across the nation have been steadily increasing, reaching a national average last year of 749 visits per 1,000 population. The total of such visits in 1967 was 148,229,113.

Inpatient admissions per 1,000 population have remained relatively stable, averaging 148 per 1,000 population. There was an 8 percent increase in outpatient visits while the number of inpatient admissions increased by only about 1 percent, to a total of 29,361,424.

Dr. Edwin L. Crosby, executive vice president and director of AHA, pointed out that the 1967 annual survey provided the first full-year profile of the nation's hospitals since the start of Medicare on July 1, 1966.

In comparing hospital utilization in 1967 with 1965, it was found that in the 2-year period, the average length of a hospital stay increased from 7.8 to 8.2 days. As a result of this longer stay, the number of admissions per bed in community hospitals declined slightly from 35.7 to 34.2 admissions. The average occupancy rate increased by 1.6 percent, from 76 to 77.6 percent.

Two factors—more hospital employees and higher wages for those employees—contributed significantly to a 21.6 percent increase in total hospital expense per patient-day.

Increased workloads in both inpatient and outpatient services resulted in a 7.7 percent increase in the number of persons employed by community hospitals. Some 246 employees were needed for every 100 patients in 1965, but by 1967 that number had risen to 265 employees per 100 patients. In all, the nation's 7,172 registered hospitals employed 2,202,930 persons in 1967, of which 1,618,887 were working in 5,850 community (short term, nongovernmental) hospitals.

Wages paid to hospital workers have steadily increased in recent years. Between 1965–67 the average annual salary of these workers rose 9.9 percent, from $4,071 to $4,476. Total payroll expense for all hospitals last year was $10,460,572,000. Despite substantial salary increases, hospital workers remain among the lower paid groups in the national economy. For example, they receive only 75 percent as much in wages as their counterparts in manufacturing, where the average annual wage was $5,975 in 1967.

The combination of increased wages and more employees boosted the hospitals' payroll expense per patient-day by 18.2 percent, from $27.44 to $32.43; nonpayroll expense per patient-day rose from $17.04 to $21.65; and the total expense per patient day climbed from $44.48 to $54.08 on September 30, 1967, the end of the 1-year annual survey period. By December 31, 1967, the total expense per patient-day had inched upward to $58.06.

The report on the annual survey, published in the August 1 Guide Issue of *Hospitals*, Journal of the American Hospital Association, pointed out that, in addition to the services reported through the survey, an unknown volume of hospital services is being provided because all registered hospitals do not respond to the questionnaire. While admissions for nonresponding hospitals are estimated, outpatient visits are not estimated, therefore, the actual number of outpatient visits is greater than the total reported in the survey.

In addition, more than 1,200 community hospitals provide hospital-based extended care services, but data on these services are not available. Another 572 hospitals conduct home care programs, but data on the services provided by these programs are also lacking.