Measurement of Physiologic Health for Children

Anemia

Betsy Foxman, Kathleen N. Lohr, Robert H. Brook
The research reported herein was performed pursuant to Grant No. 016B-80 from the U.S. Department of Health and Human Services

The Rand Publication Series: The Report is the principal publication documenting and transmitting Rand's major research findings and final research results. The Rand Note reports other outputs of sponsored research for general distribution. Publications of The Rand Corporation do not necessarily reflect the opinions or policies of the sponsors of Rand research.

Copyright © 1983
The Rand Corporation

Published by The Rand Corporation
Measurement of Physiologic Health for Children

Volume 5: Anemia

Betsy Foxman, Kathleen N. Lohr, Robert H. Brook

January 1983

Prepared under a grant from the U.S. Department of Health and Human Services
PREFACE

The Rand Health Insurance Experiment (HIE), funded by a grant from the U.S. Department of Health and Human Services, is a large-scale social experiment designed to assess how varying a patient’s cost of health services affects his or her use of services, quality of care, patient satisfaction, and health status. It is also designed to study how the provision of services in either the fee-for-service system or a prepaid group practice affects those same variables.¹ This monograph describes the health status measurement methods and the enrollment results of the child health portion of the experiment, with particular attention to anemia and lead poisoning.

A total of 7706 people in 2756 families were enrolled in the experiment in six sites across the United States: Dayton, Ohio; Seattle, Washington; Fitchburg, Massachusetts; Franklin County, Massachusetts; Charleston, South Carolina; and Georgetown County, South Carolina. The sites were chosen to represent the four census regions of the country and an urban-rural mix, and to reflect variation in the amount of stress on the ambulatory medical care system (in terms of long or short delay for new and return appointments).

Families were enrolled in the HIE for either 3 or 5 years (approximately 70 and 30 percent, respectively). Low-income families were oversampled. Eligibility for participation in the HIE was broad; ineligible persons were mainly heads of households 61 years of age and older at the time of enrollment, members of the military, people confined to various institutions, and people eligible for Medicare. When families were enrolled, they agreed to assign their own health insurance benefits (if they were previously covered) to the HIE for the duration of their enrollment. Their policies were kept in force so that the families could return to them at the end of their participation. For persons who had not been previously insured, a policy was purchased during the HIE; it was assumable by the family at the end of the experiment.

The families were assigned to one of several insurance plans that differ either in the amount of cost sharing required each year or in the system from which medical services were obtained. For this purpose, an unbiased allocation model (described in Morris, 1979) was used to ensure that the assortment of families in each plan closely resembled

¹The experimental design for estimating the effects of insurance on the demand for medical or dental care was first described by Newhouse (1974a,b) and most recently by Newhouse et al. (1981). The structure of the experiment as it relates to covered services and rules of operation can be found in Clasquin and Brown (1977).
that in every other plan in terms of 24 different demographic and socioeconomic variables. The 16 experimental plans were as follows:

One plan in which care was free to the family (i.e., 0-percent coinsurance).

Three plans with 25-percent coinsurance (i.e., the family paid 25 percent of its medical bills).

Three plans with 50-percent coinsurance for dental and outpatient mental health services and 25-percent coinsurance for all other services (the "25/50" plans).

Three plans with 50-percent coinsurance.

Three plans with 95-percent coinsurance (which approximates an income-related catastrophic insurance plan).

One plan with 95-percent coinsurance on outpatient medical or dental expenditures up to a maximum out-of-pocket expenditure of $150 per individual ($450 per family) per year and no coinsurance above that; all inpatient care was free on this plan, which is referred to as the "individual deductible" plan.

One plan that assigned some Seattle participants to a prepaid medical group practice, Group Health Cooperative of Puget Sound, or GHC. Families were reimbursed 5 percent (95-percent coinsurance) for services required outside the GHC that were available (with no cost sharing) at the GHC.

An additional plan (a control group) that consisted of a random sample of people who were already members of the GHC at the time the HIE began in Seattle and who also met HIE eligibility requirements.

All plans except the first one and the last three had a ceiling on annual out-of-pocket expenditures by the family amounting to 5, 10, or 15 percent of annual family income. This maximum dollar expenditure (MDE) per year per family was $1000 for the 50- and 95-percent coinsurance plans ($750 for the 25-percent plans in some sites and years). All plans had an identical, very comprehensive benefits package that covered ambulatory and inpatient medical care, preventive services, all dental restorative and preventive services except orthodontia,
prescription drugs, certain over-the-counter drugs, most supplies and
durable medical equipment, psychiatric and psychological services,
and almost all other personal medical services, including those
delivered by chiropractors and Christian Science healers.

During the HIE, data were collected on demographic and socioeco-
omic variables, health status, use of health services, satisfaction with
and attitudes toward health care, and types of providers seen. The
sources of data included baseline interviews before enrollment, parent-
completed Medical History Questionnaires, medical screening
examinations,\(^4\) and claims submitted (chiefly by providers) for reim-
bursement for services rendered.

Comprehensive assessment of each child’s health status occurred
upon enrolling and leaving the experiment. In addition, certain health
measures were collected annually during the enrollment period. As
noted, a major HIE objective is to assess the effects of varying the cost
of health services on the health status of individuals sampled from a
general population. To this end, reliable, valid, and understandable
measures were specially developed or adapted to enable us to detect
small but meaningful changes in the health status of enrollees.

HIE enrollment began in 1974, and the enrollment period ended for
the last site in 1982. Enrollment data concerning health status in all six
sites are available and reported herein, but longitudinal (experimental)
data are not available as of this writing.

This report series (R-2898-HHS) accompanies Rand report R-2262-
HHS, which has the series title Conceptualization and Measurement of
Physiologic Health for Adults. The volumes that constitute R-2262-
HHS cover a wide variety of diseases and organ system defects, such as
eyesight and hearing problems, cardiovascular and bronchopulmonary
diseases (e.g., hypertension, chronic obstructive pulmonary disease),
and surgery-related conditions (e.g., hernia, varicose veins). The sixth
volume of that series was concerned with anemia (Scott et al., 1980).
The R-2898-HHS series includes diverse conditions as well, such as
allergic diseases, middle ear disease and hearing loss, and seizure disor-
ders. These are all used to measure physiologic health, one of several
conceptually distinct dimensions of health status defined for the HIE.

These disease-specific volumes detail the suitability of these condi-
tions as health status measures for the HIE, discuss important
measurement issues, describe HIE techniques for determining the
prevalence and personal impact of the conditions, give HIE enrollment
results, and outline the disease-specific criteria for quality-of-care ana-
lyses for the HIE. These volumes report on enrollees aged 13 years and

\(^4\)Smith et al. (1978) give a detailed description of all aspects of tests and procedures
carried out in the enrollment and exit screening examination.
younger. They follow the general outline of the adult health status series (R-2262-HHS).

Three other dimensions of health status—physical, mental, and social health—have been defined for the HIE, as has an integrative measure—general health perceptions. These measures were initially described in the eight volumes of R-1987-HEW, which has the series title Conceptualization and Measurement of Health for Adults in the Health Insurance Study. More recent treatments of these health concepts can be found in R-2551-1-HHS and N-1706-1-HHS, Construction and Scoring of Aggregate Functional Status Indexes (Vols. I and II); R-2737-HHS, Refinements in the Measurement of Mental Health for Adults in the Health Insurance Study; R-2937-HHS, The Quantification of Social Contacts and Resources; and R-2711-HHS, Measuring Health Perceptions in the Health Insurance Experiment. Measurement of these same health status dimensions for children and youths (i.e., enrollees under age 14) was discussed in R-2313-HEW, Conceptualization and Measurement of Health for Children in the Health Insurance Study.

### Diseases and Conditions for Health Status and Quality-of-Care Measurement

<table>
<thead>
<tr>
<th>Diseases and Conditions</th>
<th>0-4 Years</th>
<th>5-13 Years</th>
<th>14+ Years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acne</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Anemia</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Angina pectoris and selected electrocardiographic abnormalities</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Asthma</td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Cancer</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Chronic airway obstruction and shortness of breath</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Colds</td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Congestive heart failure</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Convulsions</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Dental conditions</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Eczema</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Enuresis (bedwetting)</td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Growth and development disorders</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Hay fever</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Hearing disorders</td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Hemorrhoids</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hernia</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hypercholesterolemia (high cholesterol)</td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Hypertension</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hyperthyroidism and hypothyroidism</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Joint disorders</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Lead poisoning</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Otitis media (middle ear infection)</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Stomach pain and peptic ulcer disease</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Urinary tract infection</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Varicose veins</td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Vision disorders</td>
<td></td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>
SUMMARY

INTRODUCTION AND DEFINITION

The Rand Health Insurance Experiment (HIE) will use data on the presence and adverse effects of anemia to study the effect of different levels of health insurance on health status and the quality of medical care among children under 14 years of age. Anemia was selected as an appropriate indicator because (a) it is easy to diagnose, (b) it is responsive to treatment in most cases, (c) it is a common condition, and (d) it can affect a child’s overall well-being.

Anemia is not a disease in itself but, like fever, signals an underlying disease. It is usually defined as an abnormally low level of hemoglobin in the blood. Hemoglobin is the component of blood cells that contains iron, gives the blood its red color, and carries oxygen to all parts of the body through the bloodstream. A low level of hemoglobin can occur when blood is lost, when iron or other nutrients are insufficient to make new hemoglobin, when blood cells are destroyed within the body, or when disease prevents the body from making new hemoglobin.

Opinions vary about how low hemoglobin must be before it is called anemia. A "normal" level of hemoglobin, as with "normal" height, varies widely with each individual. A person can be defined as anemic by monitoring his or her hemoglobin level over a period of time, by observing his or her response to treatment, or by comparing his or her level with the normal levels established in the general population. The last method is most useful in screening large populations for anemia.

PREVALENCE AND DISEASE IMPACT

The reported prevalence of anemia in children varies widely, depending upon the population studied and the hemoglobin and hematocrit values used to designate the diseased state. Using a hemoglobin concentration of less than 10.0 g/100 ml or a hematocrit of less than 31 percent as the definition of anemia, the reported prevalence of anemia in children 6 months to 10 years of age ranges from 0.1 to 15.2 percent.

The most common childhood anemias are those associated with having smaller-than-normal blood cells: iron-deficiency anemia or thalassemia minor. Anemia associated with infection or chronic disease is the next most common, followed by hemoglobinopathies (problems with the oxygen-conveying protein) and hemolytic disease of the newborn. Other types of anemia are relatively rare.
Anemia produces very few symptoms unless it is severe (hemoglobin levels below 8 to 10 g/100 ml). Above these levels, the body can compensate for a lack of hemoglobin by increasing the rate of blood circulation. The symptoms of anemia are symptoms of low oxygen to the body—fatigue, shortness of breath, dizziness, palpitations. They occur more frequently when the demand for oxygen is high, as during exercise, or when there is a sudden loss of blood and the body has not had time to adapt to the loss.

Although anemia itself is easily diagnosed by a simple blood test, its causes may not be obvious. If the cause of anemia is not diagnosed, not only will the underlying condition that is causing the anemia persist and progress, but the individual may experience worry or fear. As a general rule, anemia in children responds readily to therapy. Some causes of anemia, once detected, are not amenable to treatment; these include certain chronic diseases that prevent the body from making new hemoglobin regardless of how much iron is present.

HEALTH INSURANCE EXPERIMENT METHODS

At enrollment two sources provided data by which we would measure the prevalence and impact of anemia at enrollment among participating children under 14 years of age. First, we used a self-administered questionnaire to gather information on whether the child had had anemia in the past year (and whether the condition was cured or the child was still under care), on visits to a physician for anemia, and on types of treatments prescribed and used. This Medical History Questionnaire (MHQ) was answered by a parent (usually the mother) about any child 13 years of age or younger.

Second, we administered a medical screening examination at enrollment to all children from a random sample of families. Blood was drawn from children 6 months of age and older and analyzed for hemoglobin and other hematologic components.

A child is defined as having had anemia at some time during the HIE if at least one of the following conditions is met: (1) The child has a low hemoglobin level for his or her age and sex at the time of enrollment or exit screening, or (2) a diagnosis of anemia of any type appears on at least two claim forms. As noted earlier, this report concerns only enrollment results.

Adverse effects of anemia are measured by three questions on the MHQ about recent worry on the part of the parent about the child's anemia and about the child's activity restriction and days in bed attributed to anemia.

Generally, after 3 or 5 years, both the prevalence and impact of
anemia are expected to be lower among persons with generous health insurance. Such individuals are expected to have more frequent visits to physicians and better technical medical care that will detect anemia more often or more quickly, and treat it more effectively, than individuals with less generous health insurance. However, because a child (or his or her parent) may be adversely affected simply by being told that he or she has anemia, generous insurance could also increase the impact from anemia by causing the child or the family to worry excessively about the condition. Moreover, increased use of physicians might result in a “diagnosis” of anemia on the basis of borderline findings that might in turn lead to undue activity restriction or overuse of iron supplements or drugs.

HEALTH INSURANCE EXPERIMENT ENROLLMENT RESULTS

Among 2474 children who had a completed enrollment MHQ, 49 (2 percent) reportedly had anemia currently or had had it sometime in the past year. One percent of all children reportedly were currently taking some form of treatment for anemia, most often iron.

Of the 1535 children who received an enrollment screening examination and were found to have anemia (based on low hemoglobin values), 9.8 percent were girls and 10.3 percent were boys. These prevalence rates are comparable to those found in other large population surveys.

Only five children who were identified as anemic by hemoglobin level were reported to have anemia on the MHQ, and only one of these children was said to have some negative impact from the disease. Among the 22 children who were said to have anemia on the MHQ but did not currently qualify as anemic on the basis of the screening examination, 50 percent reported worry and 23 percent activity restriction from their anemia.

The MHQ identified only 3 percent of the children who were in fact anemic. The parents of the remaining 97 percent were evidently unaware that their children were currently anemic.

QUALITY OF CARE

Quality of care for anemia will be assessed at the end of the study by criteria that outline good medical outcomes and processes. The data to assess quality of care are from the MHQ and screening examinations at enrollment and exit and from the health insurance claim forms filed during the HIE. Medical records are not examined. Good outcomes
include absence of curable forms of anemia, little or no impact from anemia, and patient (parent) awareness of the diagnosis of anemia. Good treatment processes include use of appropriate diagnostic tests and appropriate therapy once the diagnosis has been made.
ACKNOWLEDGMENTS

We thank Harold M. Koenig, Chairman of the Department of Pediatrics at the Naval Regional Medical Center in Oakland, California, for a thoughtful and constructive review of an earlier draft of this monograph. Because much of this work is based on material from the monograph on anemia in adults, we would like to acknowledge a substantial debt to Bonnie Scott, who was the senior author of that volume; to George Goldberg, who compiled the quality-of-care criteria; and to William H. Crosby (now of the Department of Hematology of Walter Reed Army Institute of Research, Washington, D.C.), who was the very helpful reviewer of the adult volume. We also express our appreciation to Rand colleagues Joseph Newhouse, Caren Kamberg, Michael Kaufman, Thomas Calabro, Eanswythe Leicester, and Rand Rubenstein for support and assistance in the work reported here. Finally, we thank Barbara Eubank for bringing the manuscript into final form.
## CONTENTS

PREFACE .......................................................... iii
SUMMARY ....................................................... vii
ACKNOWLEDGMENTS ........................................... xi
TABLES .......................................................... xv

Chapter

1. INTRODUCTION ............................................. 1

2. DEFINITION AND MEASUREMENT ISSUES .............. 2

3. JUSTIFICATION FOR SELECTING ANEMIA FOR HEALTH INSURANCE EXPERIMENT
   - ANALYSES .............................................. 5
     - General Considerations .......................... 5
     - Prevalence ........................................ 5
     - Morbidity and Mortality ....................... 7
     - Effects of Medical Care ....................... 8
     - Summary .......................................... 9

4. HEALTH INSURANCE EXPERIMENT METHODS .......... 10
   - General Considerations .......................... 10
   - Prevalence ........................................ 11
   - Criteria for Classification .................... 13
   - Disease Impact .................................. 13
   - Potential Effects of Health Insurance ........ 14

5. HEALTH INSURANCE EXPERIMENT
   - ENROLLMENT RESULTS ............................... 15
     - Analytic Sample .................................. 15
     - Prevalence of Anemia According to the Medical History Questionnaire .... 15
     - Prevalence of Anemia According to Screening Examination Findings ..... 16
     - Disease Impact .................................. 20
     - Reliability of Hematology Measurements .... 23
     - Validity of the Medical History Questionnaire .... 25
     - Prevalence of Anemia According to the HIE Insurance Plans ............ 26

6. QUALITY-OF-CARE CRITERIA FOR ANEMIA IN CHILDREN .... 28
Appendix

A.  LEAD POISONING ................................... 29
B.  ANEMIA AND LEAD POISONING BATTERIES
    FROM THE MEDICAL HISTORY
    QUESTIONNAIRE ............................... 35
C.  DISTRIBUTION OF RESPONSES TO DISEASE
    IMPACT QUESTIONS ........................... 45
D.  QUALITY-OF-CARE CRITERIA FOR ANEMIA ...... 49

REFERENCES ........................................... 55
TABLES

1. Comparative Summary of Selected Studies Reporting the Prevalence of Anemia Among Children .................. 6
2. Distribution of Responses to Questions About Anemia from the MHQ: Treatments Prescribed by Physician and Followed ................................................. 17
3. Current Treatments for Anemia ............................. 18
4. Distribution of Hemoglobin Values According to Sex and Age Group .................................................... 19
5. Prevalence Rates of Anemia per 100 Children, by Age and Sex, Based on Hemoglobin Values .................. 20
6. Distribution of Cell Size in the HIE Population, by Anemia Status .......................................................... 21
7. Distribution of Responses to Questions About Anemia from the MHQ: Disease Impact ............................ 22
8. Percentage of Children with Worry, Activity Restriction, and Any Impact Owing to Anemia, by Anemia Status ............................................................ 23
9. Median Categories of Worry and Activity Restriction, by Anemia Status .................................................... 24
10. Number of Children With and Without Anemia, Based on MHQ Responses and Hemoglobin Values ......... 25
11. Prevalence of Anemia, by Experimental Health Insurance Plan ................................................................. 27
A.1. Distribution of Blood Levels Among Children 1 to 5 Years of Age, by Level ................................................ 33
C.1. Distribution of Responses to Disease Impact Questions from the MHQ, by Anemia Status: Children with Completed Battery .................................................. 46
C.2. Distribution of Responses to Disease Impact Questions from the MHQ, by Anemia Status: Children with Completed MHQs .................................................... 48
Chapter 1

INTRODUCTION

The Rand Health Insurance Experiment (HIE) will use data on the prevalence and adverse impact of anemia to investigate the effects of differing levels of health insurance on health status and quality of care for children. Anemia was selected as an appropriate indicator for three reasons: (1) It is easy to diagnose and responds to treatment in most cases; (2) it is a common condition (especially among young children); and (3) it affects a child’s overall well-being.

Chapter 2 presents the HIE conceptualization of anemia in children and reviews pertinent measurement and diagnostic issues. Chapter 3 discusses the suitability of anemia as a measure of health status and quality of care for children in terms of its prevalence, associated morbidity, and response to medical care. Chapter 4 describes the HIE methods for determining the presence of anemia and assessing the effect of this disorder for HIE participants. The experiment’s results from enrollment procedures are presented in Chapter 5 for all six HIE sites (Dayton, Ohio; Seattle, Washington; Fitchburg, Massachusetts; Franklin County, Massachusetts; Charleston, South Carolina; and Georgetown County, South Carolina). Finally, Chapter 6 introduces the quality-of-care criteria for anemia that will be applied in later HIE analyses. Appendix A briefly reviews HIE findings pertinent to lead poisoning.

Readers are referred to the Preface for more information regarding the design of the HIE and the overall strategy to measure disease-specific effects on health as a function of the level of health insurance. The companion series (R-2262/6-HHS) includes a volume on anemia in adults (Scott et al., 1980).
Chapter 2

DEFINITION AND MEASUREMENT
ISSUES

Anemia is not a disease itself but, like fever, signals an underlying disease. It is usually defined as an abnormally low level of hemoglobin in the blood. Hemoglobin is the component of blood cells that contains iron, gives the blood its red color, and carries oxygen to all parts of the body through the bloodstream. A low level of hemoglobin can occur when blood is lost, when not enough iron or other nutrients are present to make sufficient amounts of new hemoglobin, when blood cells are destroyed within the body, or when a disease is present that prevents the body from making enough new hemoglobin.

A "normal" level of hemoglobin, as with "normal" height, includes a wide range of values. Normal hemoglobin can be defined by comparison to an individual's usual hemoglobin level, by response to treatment, or by comparison to levels in the general population. The last method is most useful in screening large populations for anemia. Opinions have varied about how low the hemoglobin must be before the individual is considered to have anemia. A more detailed discussion of the definition of anemia and of problems surrounding its measurement can be found in Scott et al. (1980); an extensive technical review of red blood cell evaluation has been done by Marsh and Koenig (1982).

Anemia is usually measured by analysis of the blood for hemoglobin or hematocrit. Although hemoglobin and hematocrit can be measured by visual comparisons with standards for hemoglobin concentration and by centrifuging the blood for hematocrit determination, these tests are generally performed by automated electronic equipment. The Coulter Model S, a widely used machine, combines automatic blood sample dilution with cell-counting apparatus and hemoglobinometry at the rate of two to three samples per minute. Since its introduction in the late 1960s, the accuracy, precision, and reproducibility of Coulter Model S determinations have been studied in detail and found to be a significant improvement over manual methods (Henry, 1979).

Measuring hemoglobin concentration in the blood is a good screening test for anemia because it is a direct measure of the oxygen-carrying capacity of the blood. In automated machines such as the Coulter Model S, hemoglobin is measured directly by a photoelectric cell that determines the optical density of the most stable hemoglobin pigment, cyanmethemoglobin. Repeated hemoglobin measures from the same
blood sample, when done by automated equipment, vary by only 1 to 2 percent (Koopke, 1977). The manual method is less reliable and gives consistently higher hemoglobin values than automated measures (by an average of 0.3 g/100 ml) (Koopke, 1977).

With automation, the hemoglobin test for anemia has replaced the hematocrit test. It is considered more reliable because hemoglobin measurements have a smaller range of error than hematocrit determinations when done on automated equipment. Hemoglobin has also been shown to be more sensitive in detecting anemia (Graitec et al., 1981).

Machines like the Coulter Model S do not measure hematocrit directly; rather, it is calculated by multiplying the red blood cell (RBC) count times the mean cell volume (MCV), each of which is measured by an impedance technique. Although the error in this technique is only about 1 to 2 percent (Henry, 1979), it is present in both the RBC and the MCV measurements and thus its effect is additive in the hematocrit calculation.

The proportion of anemia in the general population caused by iron deficiency greatly exceeds that caused by chronic disease (Dallman, 1981). Therefore, any low hemoglobin found in a general population survey such as the HIE screening examination is much more likely to be from iron-deficiency anemia than from chronic disease. The remainder of the discussion of measurement issues will therefore focus on iron-deficiency anemia.

Once anemia has been detected by a low hemoglobin level, other measures, such as the size of the red blood cells, sometimes help to determine the cause of the anemia. Before the introduction of automated laboratory equipment, manual microscopic examination of red cells was sometimes used to diagnose iron-deficiency anemia. This was possible because in cases of long-standing severe iron deficiency, the red blood cells contain very little hemoglobin and appear small and pale. However, the manual method was difficult and not very reliable, even in expert hands. Fairbanks (1971) reported that hematologists examining red cells under a microscope diagnosed 6 percent of normal people as iron deficient and anemic. Moreover, they identified only 49 percent of those who really were severely iron deficient and anemic (i.e., men with hemoglobin levels of 4.0 to 11.6 g/100 ml and women with levels of 6.8 to 11.6 g/100 ml; both with low serum iron concentration).

1Briefly, the impedance technique involves passing uniformly suspended cells through an opening of fixed volume and fixed electrical condition. As the cells go through the opening, they produce a measurable change in impedance that is proportional to their individual volumes. In this way, the cells are counted and their individual volumes are measured (Henry, 1979).
Automated measures of cell size (mean corpuscular volume or MCV) and color (mean cell hemoglobin concentration or MCHC) are more reliable than the manual methods for detecting the small, pale red cells of iron-deficiency anemia (Henry, 1979). Except in severe cases, however, the MCV and MCHC measures may be only mildly abnormal. Of the two measures, the MCV is considered the more sensitive, but even the MCV fails to detect one-third of the adults with uncomplicated iron-deficiency anemia (hemoglobin below 10 g/100 ml in men and 9 g/100 ml in women) (Bainton and Finch, 1964; Klee et al., 1976).

Transferrin saturation (blood saturation level of a protein that carries iron) is the test most commonly used to establish the presence of iron-deficiency anemia. It is calculated by dividing serum iron by total iron binding capacity (SI/TIBC). Normal values can range from 20 to 55 percent; SI is normally 60 to 160 μg/100 ml and TIBC, 250 to 350 μg/100 ml. Transferrin saturation cannot be used in place of a hemoglobin test in the first screening for iron-deficiency anemia because the SI reliability is much lower than that of the hemoglobin test. Its coefficient of variation is 10 to 15 percent (Eastham, 1975) and its diurnal variation is as high as 40 percent (Bowie et al., 1963). Once the presence of anemia has been determined by a low hemoglobin concentration, however, transferrin saturation is very useful for determining whether the anemia is caused by iron deficiency.
Chapter 3

JUSTIFICATION FOR SELECTING ANEMIA FOR HEALTH INSURANCE EXPERIMENT ANALYSES

GENERAL CONSIDERATIONS

As noted in Chapter 1, we selected anemia for intensive investigation of the health status of children in the HIE for several reasons. First, anemia is widely prevalent throughout the infant/pediatric/adolescent age range. Second, it is easy to diagnose and responsive to treatment in most cases. Finally, it affects a child’s overall well-being. These topics are taken up in turn in the remainder of this chapter.

PREVALENCE

The reported prevalence of anemia in children varies widely, depending upon the population studied (see Table 1). Using a concentration of hemoglobin of less than 10.0 g/100 ml or a hematocrit of less than 31 percent as the definition of anemia, investigators have reported prevalence rates for anemia as low as 0.1 percent (white youngsters 6 to 10 years old) and as high as 7.7 percent (Head Start children 4 to 6 years old). Dutton (1979), using a more conservative cutoff for hematocrit, reported anemia prevalence rates of 32.9 percent among black children in blue-collar families in Washington, D.C., and of 19.2 percent among black children in white-collar families. Kessner and his colleagues and Dutton and her associates reported the percentages of children with anemia according to a variety of studies over the previous two decades (see Kessner and Kalk, 1973, or Dutton and Silber, 1980). Generally, anemia is more prevalent in pediatric age groups (age 6-24 months), in blacks, and in children from the lower socioeconomic class.

A large part of the variation can be ascribed to the age composition of the study populations. Hemoglobin and hematocrit values vary with age. The values are initially high at birth and then fall, reaching a low at 3 to 6 months; they subsequently rise gradually until adulthood (Dallman, 1981). For example, the Center for Disease Control (CDC) Nutrition Surveillance study (1981) (Table 1) shows how the same cutoff (less than 10.0 g/100 ml hemoglobin) yields different prevalence rates in different age and racial groups.
### Table 1

**Comparative Summary of Selected Studies Reporting the Prevalence of Anemia Among Children**

<table>
<thead>
<tr>
<th>Population Characteristics</th>
<th>Sample Size</th>
<th>Percent Anemic&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Location</strong></td>
<td>Age</td>
<td>Race</td>
<td></td>
</tr>
<tr>
<td>Head Start</td>
<td>4-6 years</td>
<td>--</td>
<td>7,000</td>
</tr>
<tr>
<td>Houston</td>
<td></td>
<td></td>
<td>0.6</td>
</tr>
<tr>
<td>Jacksonville</td>
<td></td>
<td></td>
<td>1.7</td>
</tr>
<tr>
<td>Gainesville</td>
<td></td>
<td></td>
<td>2.8</td>
</tr>
<tr>
<td>Chicago</td>
<td></td>
<td></td>
<td>4.5</td>
</tr>
<tr>
<td>Augusta</td>
<td></td>
<td></td>
<td>7.7</td>
</tr>
<tr>
<td>Mississippi</td>
<td>1-5 years</td>
<td>--</td>
<td>210</td>
</tr>
<tr>
<td>Low income</td>
<td></td>
<td></td>
<td>24.0</td>
</tr>
<tr>
<td>High income</td>
<td></td>
<td>342</td>
<td>12.0</td>
</tr>
<tr>
<td>Cross-sectional sample of</td>
<td>1-6 years</td>
<td>--</td>
<td>725</td>
</tr>
<tr>
<td>in 15 states</td>
<td></td>
<td></td>
<td>6.0</td>
</tr>
<tr>
<td>Washington, D.C.</td>
<td>16-18 months</td>
<td>--</td>
<td>109</td>
</tr>
<tr>
<td>United States</td>
<td></td>
<td></td>
<td>6.5</td>
</tr>
<tr>
<td>(Coordinated Surveillance)</td>
<td>6-11 months</td>
<td>White</td>
<td>5,387</td>
</tr>
<tr>
<td>Program of the Center for</td>
<td></td>
<td>White</td>
<td>5,465</td>
</tr>
<tr>
<td>Disease (Control)</td>
<td>2-5 years</td>
<td>White</td>
<td>15,805</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Black</td>
<td>9,919</td>
</tr>
<tr>
<td></td>
<td>6-10 years</td>
<td>White</td>
<td>1,109</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Black</td>
<td>1,514</td>
</tr>
</tbody>
</table>

<sup>a</sup>Hemoglobin <10g/100 ml or hematocrit <31 percent.

In addition, the same study demonstrated a variation in anemia prevalence by geographic location, income, and race. Other investigators have also marshaled data to show that hematocrit levels (i.e., anemia) are strongly associated with a variety of environmental and family characteristics reflecting socioeconomic status and poverty (Dutton, 1979; Dutton and Silber, 1980).

The prevalence of iron-deficiency anemia in children depends on many factors. Infants of low birth weight (less than 5.5 pounds), of multiple births, and perhaps those born to mothers with several recent pregnancies are prone to develop iron-deficiency anemia during the
first year of life (Fomon, 1970; Lundstrom et al., 1977). Age, socioeconomic factors, dietary habits and, in females, menstruation also play a part in the prevalence of iron-deficiency anemia (Lanzkowsky, 1974).

The most common childhood anemias are those associated with having smaller-than-normal red blood cells: iron-deficiency anemia and thalassemia minor (Rudolph, 1977). Anemia associated with infection or chronic disease is the next most common, followed by hemoglobinopathies (abnormalities of the oxygen-carrying protein) and hemolytic disease of the newborn. Other types of anemia (folate, vitamin B12 and other nutritional anemias, aplastic anemia, malignancy, and inherited disease of red cell membrane or metabolism) are relatively rare.

An additional cause of low hemoglobin in children is lead poisoning. Lead-induced anemia in children is difficult to distinguish from iron-deficiency anemia. Lead inhibits enzymes concerned with heme synthesis thereby causing anemia (Cohen et al., 1981). The effects of lead and the prevalence of lead poisoning in the HIE are discussed in Appendix A.

MORBIDITY AND MORTALITY

A complete discussion of the adverse effects of anemia can be found in Scott et al. (1980). Briefly, anemia produces very few symptoms unless it is severe (hemoglobin levels below 8 to 10 g/100 ml). Above these levels the body can compensate for a lack of hemoglobin by increasing the rate of circulation of the blood. The symptoms of anemia are those of low oxygen in the body—fatigue, breathlessness, dizziness, palpitations. They occur more frequently with high demand for oxygen, as in exercise, and also with sudden blood loss before the body has had time to adapt to the loss (Crosby, 1980).

Although anemia itself is easily diagnosed by a simple blood test, its cause may not be obvious. Failure to diagnose the cause of anemia may produce worry and fear, as well as allow an underlying condition to persist and progress. However, some causes of anemia, even when detected, are not amenable to treatment. These include certain chronic diseases that prevent the body from making sufficient quantities of new hemoglobin, regardless of how much iron is present.

Whether low levels of iron in children increase their levels of illness or decrease their ability to play is much disputed (Dallman, 1981; Van Heerden et al., 1981). When anemia is severe, a child’s capacity for physical activity and play may be diminished (Gardner et al., 1975, 1977), and an infant may show signs of lethargy and irritability (Hughes, 1980). Dallman et al. (1978) reported immune function abnormalities and decreased work performance related to iron deficiency.
In contrast, Burman (1972) followed infants from ages 3 to 24 months and found no relationship between hemoglobin levels and illness. Van Heerden et al. (1981) were unable to find differences in lymphocyte and neutrophil function between children with and without deficiency anemia. Gandra and Bradfield (1971) studied energy expenditures among Brazilian children 8 to 13 years of age and detected no significant differences in energy expenditure patterns between anemic and nonanemic children. They did find significant differences in oxygen-handling efficiency following iron therapy. Climate was thought to be a greater determinant of energy expenditure than hemoglobin levels in this study.

Iron-deficient children have been said to grow normally unless the deficiency is severe (Kessner and Kalk, 1973). Nevertheless, children of below normal height and weight have a higher prevalence of anemia. Owen et al. (1971) found that U.S. children whose current heights were below the 25th percentile had lower hemoglobin levels and transferrin saturation than children in higher percentiles. However, this study does not rule out the possibility that poor nutrition caused both stunted growth and anemia.

Mild iron deficiency has also been associated with decreased attentiveness and learning ability (Kessner and Kalk, 1973; Dallman, 1981). However, the deficiency may be merely an indicator of an underlying nutritional or environmental problem.

**EFFECTS OF MEDICAL CARE**

Medical care for anemia varies in its effectiveness, depending on the cause of the anemia. Nutritional anemias are quite responsive to treatment. Others, such as anemias of chronic disease, may be very unresponsive to treatment.

Once the cause of a nutritional anemia has been determined, initial therapy with supplements of the missing nutrients usually corrects the problem. The need for continuing supplements may be eliminated by adjusting dietary habits or supplying the nutrient in a form usable by the body. For example, oral iron therapy raises hemoglobin levels from 2 to 4 g/100 ml after 3 or 4 weeks, provided the recommended dose of elemental iron (maximum of 60 mg) is tolerated; therapy may need to be continued for 2 to 3 months. Stomach upset is a frequent side effect of iron pills, and occasionally the dose must be adjusted downward to be tolerated. Although perhaps providing a more rapid correction of the anemia, intramuscular or intravenous iron therapy is rarely indicated because of the risk of serious side effects and the proven efficacy of oral therapy (Rudolph, 1977; Medical Letter, 1978; Hughes, 1980).
For nonnutritional anemias, therapy is directed at the underlying cause, and its effectiveness varies with the nature of the condition. For example, some chronic diseases such as rheumatoid arthritis are inherently more treatable than sickle cell anemia or leukemia. When dietary deficiency cannot be established as a cause of iron deficiency anemia, chronic blood loss (for example, secondary to problems in the gastrointestinal tract) should be suspected; if detected, the underlying cause of the blood loss must be promptly treated.

The medical treatment of anemia can contribute to morbidity and mortality in excess of the morbidity associated with anemia itself. In particular, underlying causes of anemia may be overlooked because of omissions in the diagnostic process. For example, lead poisoning may go undetected if the resulting anemia is treated as iron deficiency and the cause is not sought. Also, inappropriate treatment can have serious consequences, such as iron overload in a child who is not truly iron deficient (Matthews and Casey, 1973; Kingston, 1978).

**SUMMARY**

Anemia is a widely prevalent condition in the infant and pediatric age group. The most common anemia found in children is caused by iron deficiency. Even in mild forms, iron-deficiency anemia has been associated with increased levels of illness and decreased attention span and learning ability. Hemoglobin is the most sensitive indicator of anemia, but because hemoglobin levels vary with age, age-specific criteria should be used for diagnosis. In addition, anemia is easily diagnosed and treated, making it an appropriate condition for evaluating the effects of different levels of health insurance on health status.
Chapter 4

HEALTH INSURANCE EXPERIMENT
METHODS

GENERAL CONSIDERATIONS

For study design purposes in the HIE, we classified the nonadult population into two age groups—0 to 4 years of age (i.e., infants and small children) and 5 to 13 years of age (i.e., children and adolescents). Diseases and symptom complexes selected for intensive study in the HIE differed somewhat for the two age groups. Some problems were studied in both age groups, others in only one or the other, depending chiefly on whether the problem was likely to be observed (or measurable) in either or both groups.

Although including many conditions of infancy and childhood in the HIE analyses would have been desirable, several constraints limited our analyses. First, children typically are healthy individuals, and it should be remembered that the HIE sample is by design representative of a general population. Thus, for conditions that are not widespread in a pediatric age group, our sample sizes might have been too small for reliable or valid analyses. Second, considerations of respondent burden dictated that questionnaires about children not be too lengthy. This factor arose because questionnaires about health and health-related topics for children were completed by parents (or other responsible adult proxies). Generally, this respondent was the child’s mother, and for families with more than one child, multiple questionnaires might begin to pose a substantial burden on her.¹ (Moreover, parents had their own questionnaires to complete.) Third, overall time and other resource constraints limited the extensiveness of the disease studied for the pediatric age groups. However, anemia was considered sufficiently frequent and important to be measured in all children under 14 years of age.

¹Because the mother was the person who most often completed the children’s Medical History Questionnaires (MHQ), we will use “she” or “her” to refer to any proxy respondent in the remainder of this monograph. Because answers to MHQ questions reflect a parent’s perception of the presence and harmful effects of illness on the child, the proxy approach unavoidably introduces some degree of error into the data and analysis. It does not necessarily introduce a systematic bias, however, because parents in different families may well differ in their assessments of symptoms or sequelae of illness. We have not tried in this monograph to evaluate the validity of parental responses relative to some definition of “truth” from the child’s point of view—that task was beyond the experiment’s means.
Measurement of health status for children at enrollment was done differently in the first experiment site (Dayton, Ohio) than in the remaining five sites (hereafter referred to as the non-Dayton sites). (Health status measures at exit from the experiment were identical for all six sites.)

Two sources were used by the HIE to measure the prevalence of anemia at enrollment among its participating children under 14 years of age: the MHQ and a medical screening examination. The MHQ for each age group had two parts—Form A and Form B—and contained several diagnosis-specific batteries through which information was obtained about the child's history of the particular condition, use of physician care for it, forms of treatment prescribed or used, and the adverse effects on the child's life brought about by or attributed to the specific condition. To reduce respondent burden, these batteries were introduced by a "skip" question. If the mother answered the skip question negatively, she skipped out to the next battery in the child's questionnaire; if she gave a positive answer, she continued on to complete the battery.

At enrollment the medical screening examination was given to a random sample of children, generally between 50 and 75 percent of all participants, depending on the site. During the examination, blood samples were taken from all children over 6 months old. A random sample (about 5 to 10 percent of screening examination participants) had extra blood drawn, so that split-sample test-retest reliability measurements could be made for the laboratories used by the HIE.

The remainder of this chapter describes our methods for detecting anemia by questionnaire and laboratory test, gives our definition of anemia, and discusses our ways of evaluating the deleterious effects of this ailment.

PREVALENCE

Medical History Questionnaire

Two versions of the MHQ battery are reproduced in Appendix B. One was used at enrollment in Dayton; the other was used at enrollment at all other HIE sites and at exit at all sites. Differences in the two forms are the result of minor changes in the non-Dayton form to provide better information on the timing of medical care for anemia.

The battery is introduced by the question, "During the past 12 months, has a doctor told you that this child has anemia (sometimes

---

*This random sample will be used to investigate the effect of a screening examination on subsequent use of medical care and health status.*
called low blood) or is he or she currently under treatment for it?"
Mothers who responded "yes" continued on to complete the battery
and those who responded "no" skipped out to the next disease-specific
battery.

Medical Screening Examination

The second source of information used to measure the prevalence of
anemia at enrollment was the blood test from the medical screening
examination. Blood was drawn from any child 6 months of age or older.
A finger stick was used for those younger than 1 year of age. Smith et
al. (1978) describe screening examination procedures in detail.

Blood samples were analyzed on the automated Coulter Model S
(described in Chapter 2) for hemoglobin, hematocrit, red blood cell
count, mean cell volume, mean cell hemoglobin, and mean cell hemo-
globin concentration. Whenever any initial measurement fell outside
the normal range of values for that measure, the test was repeated; in
such cases, the second measurement was used for all analyses.

Reference standards for hemoglobin based on values obtained with
electronic counters on large healthy populations are reported in Dall-
man and Siimes (1979). These values were adopted for use in the HIE
with the following change: the lower limits of normal hemoglobin were
defined as 0.5 g/100 ml (about 4 percent) lower than the reference
limits to allow for the effect of diurnal variation in hemoglobin concen-
tration.

Hemoglobin concentration is usually higher in the morning. Diurnal
variations as great as 15 percent have been found when blood drawn in
the morning is compared with blood drawn in the evening from the
same person; average differences are 8 percent (Stengle and Schade,
1957; Dacie and Lewis, 1975). All the HIE blood samples were drawn
after 11:00 a.m., and half were drawn between 6:00 p.m. and 10:00 p.m.
Thus, in the HIE population, hemoglobin values would be expected to
be systematically lower than values from other studies, in which blood
samples were usually drawn earlier in the day.

Insurance Claim Forms

A third source of information about the prevalence of anemia was
the insurance claim forms filed for medical care during the years cov-
ered by the HIE. These forms show the patient's reason for visiting a

---

*Blood samples taken at the exit screening examination were analyzed for serum
iron and total iron binding capacity for all children whose hemoglobin level fell below the
normal limits defined below; a transferrin saturation (SI/TIBC) was also calculated.
physician, the physician's diagnoses, any laboratory tests or procedures performed, and any medications dispensed or prescribed. This monograph does not report on data from that source.

**CRITERIA FOR CLASSIFICATION**

In summary, a child (6 months to 13 years of age) is defined as having had anemia at some time during the HIE if at least one of the following conditions is met:

1. Diagnosis of anemia of any type on at least two claim forms.
2. A hemoglobin level at the enrollment or exit screening examination that falls below the following limits (in grams per 100 ml of blood):

   | Both boys and girls: | 6 months to 4 years | 10.5  
   |---------------------|---------------------|-------
   |                     | 5 years to 8 years  | 11.0  
   |                     | 9 years to 11 years | 11.5  

   | Boys only:         | 12 years to 13 years | 12.0  
   | Girls only:        | 12 years to 13 years | 11.5  

**DISEASE IMPACT**

The adverse effects of anemia are assessed by several MHQ questions dealing with the amount of worry and concern that the illness has caused the mother or other MHQ respondent, the amount of time the child had to restrict his or her activities owing to the illness, and the number of days the child had to spend most or all of the day in bed because of the condition. The first two questions referred to the previous 3 months and the last to the past 30 days.

Responses to these disease impact questions ranged from "none" to "a great deal" or "all of the time" (or equivalent wording, depending on the item). The question about days in bed required the mother to write either zero or the specific number of days. These questions were asked for all children whose mother had responded affirmatively to the skip question in the Anemia battery.

*Blood samples were not taken from children less than 6 months of age. As noted above, these limits were defined to be 0.5 g lower than standard reference limits to account for the effect of diurnal variation on hemoglobin concentration.*
These impact questions are part of a standard set that appears repeatedly in the MHQs (for both children and adults) in association with various diseases and conditions. They were not specifically constructed to measure the symptoms or adverse consequences of anemia (or any other particular ailments) but rather to facilitate comparisons of similar kinds of impact among several diseases and conditions.

To compare disease impact between groups of children, we calculated the percentages of responses at each response level. In addition, a composite measure called "any impact" was constructed; a child was assigned a positive score for "any impact" if the mother had given an affirmative answer to at least one disease impact question.

POTENTIAL EFFECTS OF HEALTH INSURANCE

The disease impact measures discussed above will be used to assess the effects of differing levels of health insurance on the physiologic health of children with anemia. Generous health insurance might affect these health measures positively in several ways. Children with generous insurance coverage may be more likely to see a physician, be diagnosed and treated for their anemia, and be cured of it; this could reduce the prevalence of anemia among generously insured groups, compared with others, at the end of the HIE. Moreover, children often have anemia without their parents' knowing that they do. Unless anemia is severe, it has very few symptoms. Therefore, most cases of anemia are discovered by routine screening tests, such as those that children with generous health insurance are more likely to receive.

Generous insurance may also be associated with a patient's receiving more sensitive and thoughtful care (better art of care), which may serve to minimize the worry or concern the parent may have about the condition. More generous insurance could also help to alleviate some of the physical limitation attributed to anemia, because treatment may be started earlier and followed more closely. Technical medical care (e.g., diagnostic and therapeutic procedures) may improve with the generosity of the insurance; this could lead to fewer incidents of inappropriate management among the more generously insured groups.

However, expanded use of medical care prompted by more generous insurance may lead to undesirable results. Increased diagnostic efforts and nonspecific treatment among generously insured participants may, for example, result in greater worry or concern. Being labeled as anemic (perhaps erroneously) may prompt undue restriction of activity or other forms of unwarranted sick role behavior. Inappropriate or excessive use of medications may be observed.
Chapter 5

HEALTH INSURANCE EXPERIMENT
ENROLLMENT RESULTS

ANALYTIC SAMPLE

The HIE administered enrollment procedures to a total of 2712 children (0 to 13 years) in six sites. Just over 50 percent were girls, and about 15 percent were nonwhite. The average family income (in 1973-74 dollars) was about $13,000. (See the Preface for additional information about the HIE sample and enrollment population.)

As noted in Chapter 4, the pediatric MHQ was filled out for the child by a parent, typically the mother. To simplify the presentation of our results, however, we will at times in this chapter write as if the child himself or herself had completed the MHQ.

Of the 2712 children participating in the enrollment process, 2663 (98 percent) had a completed Form A of the MHQ. They included youngsters in any of the experimental HIE plans, in the Dayton control group, and in a "pre-enrollment group" in South Carolina. Of the 2712, 2523 were given Form B; in Dayton, a random sample of 184 children did not receive it. The completion rate for Form B was also almost 98 percent (2474 of 2523 children).

The screening examination was administered to 1651 children at the six sites. Those who received the examination represented a random sample of about 60 percent of the entire sample. Nine additional children were examined without completing Form B of the MHQ. As mentioned earlier, not everyone was examined at enrollment; this was deliberate, to study how participation in the screening examination affected later use of medical services and health status.

The main topics covered in this chapter are the following: prevalence of anemia, by age and sex; use of medical care or drugs and other therapies for the problem; negative impacts of the illness on the child or parent; and presence of the condition according to the different health insurance plans.

PREVALENCE OF ANEMIA ACCORDING TO THE MEDICAL HISTORY QUESTIONNAIRE

A total of 2467 children had complete data on the skip question about a physician diagnosis of anemia within the previous year. Only 49 of
these children (2.0 percent) had been so diagnosed: 14 (0.6 percent) currently were anemic or were under treatment for it and 35 (1.4 percent) had been ill in the past year but were now cured. (Seven children missed this question.) The number of cases was almost identical by sex: 24 boys and 25 girls reportedly had had anemia at some time during the past 12 months.

Of these 49 children, about two-thirds were taking one or more treatments for their anemia. As shown in Table 2, almost twice as many respondents reported doctor prescriptions for iron pills or shots as were currently using them. In contrast, the percentage of children using vitamin pills or shots was almost twice as high as the percentage who had been given that type of prescription. In addition, the percentages of respondents reporting that a doctor had prescribed a special diet and blood transfusions in the past 12 months were slightly higher than those reporting that they currently followed such therapies, but the numbers of such children were quite low.

Table 3 presents current treatment combinations for 49 children whose mothers had indicated that the child had had anemia in the past year (and possibly still did). Current treatment was evenly divided among (a) iron with or without another therapy, (b) vitamins or special diet (but no iron), and (c) no treatment at all. The most common single treatment was vitamins alone, followed by iron alone. None of the children received blood transfusions.

PREVALENCE OF ANEMIA ACCORDING TO SCREENING EXAMINATION FINDINGS

Hematology data were available for 1535 of the 1651 children who were screened (93 percent). Of the 116 who did not have blood tests, 55 refused to have blood drawn and 34 were less than 6 months old; 27 blood samples could not be obtained or were not analyzable.

**Hemoglobin**

The HIE uses hemoglobin rather than hematocrit values to define anemia because hemoglobin can be measured with greater reliability than hematocrit on the Coulter automated machines. The sensitivity and specificity of the two measures were compared in the HIE monograph on anemia in adults (Scott et al., 1980). Our analysis of the 72 adult cases in which hemoglobin and hematocrit values disagreed showed that hemoglobin is also a more sensitive screening measure for
Table 2

**DISTRIBUTION OF RESPONSES TO QUESTIONS ABOUT ANEMIA FROM THE MHQ: TREATMENTS PRESCRIBED BY PHYSICIAN AND FOLLOWED**

<table>
<thead>
<tr>
<th>Question</th>
<th>Response</th>
<th>Number</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>In the past 12 months, has a doctor prescribed any of these treatments for your anemia?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Special diet</td>
<td>Yes</td>
<td>8</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>38</td>
<td>78</td>
</tr>
<tr>
<td></td>
<td>Missing</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>49</td>
<td>100</td>
</tr>
<tr>
<td>Iron pills or shots</td>
<td>Yes</td>
<td>22</td>
<td>63</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>16</td>
<td>33</td>
</tr>
<tr>
<td></td>
<td>Missing</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>49</td>
<td>100</td>
</tr>
<tr>
<td>Vitamin pills or shots</td>
<td>Yes</td>
<td>13</td>
<td>27</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>33</td>
<td>67</td>
</tr>
<tr>
<td></td>
<td>Missing</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>49</td>
<td>100</td>
</tr>
<tr>
<td>Blood transfusions</td>
<td>Yes</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>44</td>
<td>90</td>
</tr>
<tr>
<td></td>
<td>Missing</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>49</td>
<td>100</td>
</tr>
</tbody>
</table>

Do you currently take any of the following treatments for anemia, whether or not a doctor prescribed them?

<table>
<thead>
<tr>
<th>Question</th>
<th>Response</th>
<th>Number</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Special diet</td>
<td>Yes</td>
<td>6</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>40</td>
<td>82</td>
</tr>
<tr>
<td></td>
<td>Missing</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>49</td>
<td>100</td>
</tr>
<tr>
<td>Iron pills or shots</td>
<td>Yes</td>
<td>17</td>
<td>35</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>30</td>
<td>61</td>
</tr>
<tr>
<td></td>
<td>Missing</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>49</td>
<td>100</td>
</tr>
<tr>
<td>Vitamin pills or shots</td>
<td>Yes</td>
<td>22</td>
<td>45</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>24</td>
<td>49</td>
</tr>
<tr>
<td></td>
<td>Missing</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>49</td>
<td>100</td>
</tr>
<tr>
<td>Blood transfusions</td>
<td>Yes</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>45</td>
<td>92</td>
</tr>
<tr>
<td></td>
<td>Missing</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>49</td>
<td>100</td>
</tr>
</tbody>
</table>
Table 3

CURRENT TREATMENTS FOR ANEMIA

<table>
<thead>
<tr>
<th>Current Treatment</th>
<th>Number</th>
<th>Percent^[a]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iron</td>
<td>17</td>
<td>35</td>
</tr>
<tr>
<td>Iron alone</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Iron plus vitamins</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>Iron plus special diet</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Iron plus diet and vitamins</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Vitamins or special diet</td>
<td>16</td>
<td>33</td>
</tr>
<tr>
<td>Vitamins alone</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>Special diet alone</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Vitamins plus special diet</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>No treatment</td>
<td>16</td>
<td>33</td>
</tr>
</tbody>
</table>

Total: 49 101

^[a]Percentages may not sum to 100 because of rounding.

anemia; it identified 22 cases of small cell or iron-deficiency anemia that would not have been detected by screening hematocrit alone.

The distribution of hemoglobin levels by age and sex is shown in Table 4. The mean is equal to the median for most age and sex groups. This suggests that this population's values are approximately normally distributed.

Table 5 shows the prevalence rates for anemia according to age and sex, where anemia is defined in terms of the hemoglobin values in grams/100 ml of blood, as discussed in Chapter 4 (both sexes, ages 6 months to 2 years: 10.0; ages 2 to 12 years, 11.0; boys, 13 years, 12.5; girls, 13 years, 11.5). Overall anemia rates were slightly lower among girls than among boys (9.8 and 10.2 percent, respectively). Age-specific prevalences of anemia were slightly higher among girls than boys with the exceptions of infancy and ages 12 to 13. Boys of ages 12 to 13 had almost twice the prevalence of anemia when compared with the rate in girls of the same ages (18.6 versus 9.6).
Table 4

DISTRIBUTION OF HEMOGLOBIN VALUES ACCORDING TO SEX AND AGE GROUP

<table>
<thead>
<tr>
<th>Distributional Measure</th>
<th>Boys</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>6 Months-1 Year</td>
<td>2-4 Years</td>
<td>5-8 Years</td>
<td>9-11 Years</td>
<td>12-13 Years</td>
</tr>
<tr>
<td>Number screened</td>
<td>70</td>
<td>147</td>
<td>241</td>
<td>192</td>
<td>140</td>
</tr>
<tr>
<td>Median value</td>
<td>11.8</td>
<td>12.2</td>
<td>12.4</td>
<td>12.5</td>
<td>12.8</td>
</tr>
<tr>
<td>Mean value</td>
<td>11.6</td>
<td>12.3</td>
<td>12.3</td>
<td>12.5</td>
<td>12.8</td>
</tr>
<tr>
<td>Mean ± 2 SD</td>
<td>8.9-14.3</td>
<td>10.7-13.8</td>
<td>10.8-13.9</td>
<td>10.9-14.1</td>
<td>10.9-14.6</td>
</tr>
<tr>
<td>10th to 90th percentile</td>
<td>9.6-13.3</td>
<td>11.3-13.2</td>
<td>11.3-13.2</td>
<td>11.4-13.5</td>
<td>11.6-14.1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Girls</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Number screened</td>
<td>77</td>
<td>134</td>
<td>227</td>
<td>190</td>
<td>114</td>
</tr>
<tr>
<td>Median value</td>
<td>11.7</td>
<td>12.1</td>
<td>12.3</td>
<td>12.5</td>
<td>12.8</td>
</tr>
<tr>
<td>Mean value</td>
<td>11.5</td>
<td>12.1</td>
<td>12.3</td>
<td>12.5</td>
<td>12.7</td>
</tr>
<tr>
<td>Mean ± 2 SD</td>
<td>8.5-14.6</td>
<td>10.2-14.0</td>
<td>10.6-14.0</td>
<td>10.5-14.5</td>
<td>10.8-14.5</td>
</tr>
<tr>
<td>5th to 95th percentile</td>
<td>8.4-14.0</td>
<td>10.7-13.7</td>
<td>10.8-13.5</td>
<td>10.7-14.0</td>
<td>11.2-14.0</td>
</tr>
<tr>
<td>10th to 90th percentile</td>
<td>9.4-13.3</td>
<td>11.0-13.2</td>
<td>11.3-13.2</td>
<td>11.2-13.8</td>
<td>11.6-13.8</td>
</tr>
</tbody>
</table>

*SD is standard deviation.

Cell Size (Mean Corpuscular Volumes)

Mean cell volume by itself is an unreliable indicator of anemia; it is useful, however, in differentiating among causes of anemia. MCV is at its highest level at birth and at its lowest level at 3 to 6 months of age; subsequently it rises until adulthood. The cutoffs for MCV must, therefore, be age-specific.

MCV values for children who were at the extremes of MCV for their age group were designated "small" (if they were less than the 5th percentile) or "large" (if they were greater than the 95th percentile). The age categories were collapsed by cell size. Table 6 gives the MCV distribution in the HIE pediatric population according to anemia status based on hemoglobin values.

Small cell size is, as expected, not particularly predictive of anemia status—only 34 percent of children designated as having small cell size were also classified as anemic. Nonetheless, small cell size is associated with iron-deficiency anemia. Of the 154 children who were anemic, 25
Table 5

**Prevalence Rates of Anemia per 100 Children by Age and Sex, Based on Hemoglobin Values**

<table>
<thead>
<tr>
<th>Age Group (in years)</th>
<th>Boys</th>
<th></th>
<th></th>
<th></th>
<th>Girls</th>
<th></th>
<th></th>
<th></th>
<th>Total</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cases per Sample</td>
<td>Rate</td>
<td>Cases per Sample</td>
<td>Rate</td>
<td>Cases per Sample</td>
<td>Rate</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.5-1</td>
<td>13/70</td>
<td>18.6</td>
<td>14/77</td>
<td>18.2</td>
<td>27/147</td>
<td>18.4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2-4</td>
<td>2/147</td>
<td>1.4</td>
<td>6/134</td>
<td>4.5</td>
<td>8/281</td>
<td>2.8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5-8</td>
<td>14/241</td>
<td>5.8</td>
<td>14/227</td>
<td>6.2</td>
<td>28/468</td>
<td>6.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9-11</td>
<td>26/192</td>
<td>13.5</td>
<td>28/190</td>
<td>14.7</td>
<td>54/382</td>
<td>14.1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12-13</td>
<td>26/140</td>
<td>18.6</td>
<td>11/114</td>
<td>9.6</td>
<td>37/254</td>
<td>14.6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.5-13</td>
<td>81/790</td>
<td>10.2</td>
<td>73/743</td>
<td>9.8</td>
<td>154/1535</td>
<td>10.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Anemia was defined as hemoglobin (in g/100 ml) below certain values, adjusted for age, sex, and diurnal variation; see text.*

percent had small cell size, whereas only 6 percent of the 1374 nonanemic children had small cell size. None of those who were anemic had abnormally large cell size; 3 percent of those who were not anemic had large MCV.

**Disease Impact**

To assess the impact of anemia among children who had or whose parents believed they had anemia, we asked three questions on the MHQ concerning (a) the amount of recent parental worry about anemia, (b) the amount of time the child had restricted activity because of the ailment, and (c) the number of days spent in bed that were attributed to anemia. (See Appendix B for the exact wording of the questions.) All mothers who responded positively to the initial question in the Anemia battery (regarding whether a doctor had said their child had anemia now or had had it in the past) answered these questions, regardless of whether the child was anemic according to the screening examination test for hemoglobin.
Table 6

DISTRIBUTION OF CELL SIZE IN THE HIE POPULATION, 
BY ANEMIA STATUS

<table>
<thead>
<tr>
<th>Anemia Status at Screening Examination&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Small &lt;sup&gt;b&lt;/sup&gt;</th>
<th>Normal &lt;sup&gt;b&lt;/sup&gt;</th>
<th>Large &lt;sup&gt;b&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anemic (n=154)</td>
<td>39 (25)&lt;sup&gt;c&lt;/sup&gt;</td>
<td>115 (75)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Not anemic (n=1374)</td>
<td>76 (6)</td>
<td>1259 (92)</td>
<td>39 (3)</td>
</tr>
</tbody>
</table>

<sup>a</sup>Based on previously defined hemoglobin values; see text.

<sup>b</sup>Mean corpuscular volume in cubic microns. Definitions for small and large are based on age-specific distributions of MCV from surveys of healthy populations.

<sup>c</sup>Row percentages are shown in parentheses.

The distribution of disease impact responses is given in Table 7 for the 49 children labeled anemic by the MHQ question. Parental worry was the most common adverse effect reported by the MHQ respondents; 45 percent reported at least a little worry about her child's illness. Only 14 percent claimed that the child had restricted his or her activities because of the condition, and no one reported any days in bed associated with her child's anemia. Altogether, 49 percent of the mothers reported at least one adverse effect of anemia.

Table 8 compares the adverse effects of anemia for three groups of children: those who had low hemoglobin levels from the screening examination and met the HIE definition of anemia; those who had normal hemoglobin; and those who were not screened for anemia. Table C.1 in Appendix C shows the detailed distribution of responses to these questions.

The mothers of only 5 children with low hemoglobin completed the Anemia battery, compared with 22 mothers of children with normal hemoglobin at the screening examination and 22 mothers of children who were not screened. Comparing the degree of adverse effects should therefore be done with caution. For about half of those children who did not currently have anemia and half of those children whose anemia
Table 7

<table>
<thead>
<tr>
<th>Question</th>
<th>Response</th>
<th>Number</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>During the past 3 months, how much has this child’s anemia worried or concerned you?</td>
<td>A great deal</td>
<td>6</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>Somewhat</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>A little</td>
<td>13</td>
<td>27</td>
</tr>
<tr>
<td></td>
<td>Not at all</td>
<td>27</td>
<td>53</td>
</tr>
<tr>
<td></td>
<td></td>
<td>49</td>
<td>100</td>
</tr>
<tr>
<td>During the past 3 months, how often has anemia kept this child from doing the kinds of things that other children that age do?</td>
<td>All of the time</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Most of the time</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Some of the time</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>A little of the time</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>None of the time</td>
<td>42</td>
<td>86</td>
</tr>
<tr>
<td></td>
<td></td>
<td>49</td>
<td>100</td>
</tr>
<tr>
<td>During the past 30 days, how many days has anemia kept this child in bed all or most of the day?</td>
<td>0 days</td>
<td>49</td>
<td>100</td>
</tr>
</tbody>
</table>

status was unknown, the illness occasioned some worry for the parent. No activity restriction in the previous 3 months due to anemia was reported for the 5 children with low hemoglobin, whereas 9 percent of children without anemia currently and 23 percent who were not screened evidently had limited their daily activities. Those who were undergoing treatment (see Appendix Table C.1) reported more disease impact in all categories than those who were not.

The distribution of responses to the three impact questions for all children regardless of whether they had a completed Anemia battery is seen in Appendix Table C.2. Scores equal to no impact were assigned to all children whose mothers had denied any physician diagnosis of anemia for the child in the previous year. Among those children with low hemoglobin, less than 1 percent had any adverse effects from the illness. These results were not unexpected because unless anemia is severe it has very few symptoms. The results emphasize the need for a blood test to diagnose anemia; the MHQ was effective only in finding a history of anemia.

The median response categories for the impact questions among those children who actually had a positive response (i.e., a response
Table 8

<table>
<thead>
<tr>
<th>Anemia Status at Screening Examinationa</th>
<th>Number of Children</th>
<th>Percent with Parental Worry</th>
<th>Percent with Activity Restriction</th>
<th>Percent with Any Impactb</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anemia present</td>
<td>5</td>
<td>20</td>
<td>0</td>
<td>20</td>
</tr>
<tr>
<td>Anemia not present</td>
<td>22</td>
<td>45</td>
<td>9</td>
<td>46</td>
</tr>
<tr>
<td>Not screened for anemia</td>
<td>22</td>
<td>50</td>
<td>23</td>
<td>59</td>
</tr>
<tr>
<td>Total</td>
<td>49</td>
<td>45</td>
<td>14</td>
<td>49</td>
</tr>
</tbody>
</table>

a Determined by age-specific hemoglobin level; see text.
b No child spent a day in bed because of anemia.

other than "none") are shown in Table 9. The median response for worry was "little" and, for activity restriction, "some." No days in bed were reported in any group.

The medians shown in Table 9 summarize the perceived severity of the effects of anemia. To determine whether the apparent differences in severity were statistically significant, we analyzed all the responses (including "none") by using the Wilcoxon Two-Sample Test. Responses did not differ greatly between those for children who were physiologically anemic and those for children who were not; however, parents of children who were currently under treatment for anemia had significantly more worry than those whose offspring were not under treatment (p < 0.01).

RELIABILITY OF HEMATOLOGY MEASUREMENTS

Reliability refers to the ability of a measurement to produce the same results when the same object is measured. In the HIE, a repeat test of randomly selected blood samples was used to evaluate the reliability of the screening examination measurements. Of the 1535 blood samples taken at the screening examination, 82 (5.3 percent) were

1 This procedure compares differences in central tendency between two groups, by ranking responses from lowest to highest among all members of the population and then summing the ranks for each group. It is equivalent to the Mann-Whitney U Test.
Table 9

<table>
<thead>
<tr>
<th>Anemia Status at Screening Examination</th>
<th>Worry</th>
<th>Activity Restriction</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Anemia present</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Taking iron or transfusions</td>
<td>(b)</td>
<td>(b)</td>
</tr>
<tr>
<td>Taking vitamins or diet</td>
<td>Little</td>
<td>(b)</td>
</tr>
<tr>
<td>No current treatment</td>
<td>(b)</td>
<td>(b)</td>
</tr>
<tr>
<td><strong>Anemia not present</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Taking iron or transfusions</td>
<td>Little</td>
<td>Little/some&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>Taking vitamins or diet</td>
<td>Little</td>
<td>(b)</td>
</tr>
<tr>
<td>No current treatment</td>
<td>Little</td>
<td>(b)</td>
</tr>
<tr>
<td><strong>Not screened for anemia</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Taking iron or transfusions</td>
<td>Some</td>
<td>Some/most&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>Taking vitamins or diet</td>
<td>Little/some</td>
<td>(b)</td>
</tr>
<tr>
<td>No current treatment</td>
<td>Great</td>
<td>Most</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Little</td>
<td>Some</td>
</tr>
</tbody>
</table>

<sup>a</sup>Medians are based on the positive responses (i.e., excluding "none") to questions about disease impact of anemia. The distribution of responses is shown in Appendix C, Table C.1.

<sup>b</sup>No enrollees responded positively to this item.

<sup>c</sup>Dual median.

randomly selected to be retested. Each sample was divided in two, and the second samples were independently labeled and sent to the laboratory at different times of day, so that they would not be processed in the same batch. Comparison of the first and second measurement of these 82 split samples provides an estimate of their reliability.

The difference between the first and second measurement of hemoglobin ranged from -2.4 to +1.1 g/100 ml; the mean difference was +0.04 g, and the standard deviation of that mean difference, 0.42 g. The 95-percent confidence interval around the mean difference is
- 0.05 and +0.13. This level of reliability of laboratory tests is quite adequate for HIE purposes.

VALIDITY OF THE MEDICAL HISTORY QUESTIONNAIRE

Validity refers to the extent to which a measure assesses what it proposes to assess. One indication of the validity of the MHQ questions about anemia is how well the answers agree with anemia status based on hemoglobin values from the screening examination, the latter being taken as "truth." Table 10 gives the data pertinent to this comparison.

Of the 1524 children who were screened for hemoglobin and who also answered the Anemia battery, 152 were classified as anemic because of low hemoglobin levels. None in this group of 152 was described on the MHQ as being currently under treatment for anemia. Thus, the sensitivity of the MHQ, i.e., the proportion of children with abnormally low

Table 10

NUMBER OF CHILDREN WITH AND WITHOUT ANEMIA, BASED ON MHQ RESPONSES AND HEMOGLOBIN VALUES

<table>
<thead>
<tr>
<th>Anemia Status, Based on Screening Hemoglobin Value</th>
<th>Anemic</th>
<th>Not Anemic</th>
<th>Total Number Screened</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anemia Status, Based on MHQ Response</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anemia currently being treated with iron, transfusions, diet, or vitamins</td>
<td>0</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>Anemia in the past, no current treatment</td>
<td>5</td>
<td>15</td>
<td>20</td>
</tr>
<tr>
<td>Never had anemia</td>
<td>147</td>
<td>1350</td>
<td>1497</td>
</tr>
<tr>
<td>Total</td>
<td>152</td>
<td>1372</td>
<td>1524</td>
</tr>
</tbody>
</table>

*Based on previously defined hemoglobin values; see text.*
hemoglobin who had also been classified by MHQ data as being under treatment for anemia, was zero. If the 5 children who had had anemia in the past are included with those under current treatment, the MHQ sensitivity becomes 3.3 percent (5 of 152). The specificity (i.e., the proportion not anemic who answered negatively to the MHQ) was 99 percent (1365 of 1372 children). If the 15 with anemia in the past who were not currently under treatment are classified as anemic, the specificity drops to 98 percent.

For the 147 children in the HIE with anemia whose parents completed the MHQ, 98 percent of the parents were unaware of the presence of the illness (although a few had known about their child's anemia in the past). This is probably not too surprising, because the levels of anemia detected in our screening examination were not too severe and mild anemia is essentially a symptomless problem. Such a finding does suggest, however, that asking a parent if the child has anemia or is currently under treatment for anemia is not an effective method of determining if a child is actually anemic. Blood tests, particularly hemoglobin tests, are needed to screen for the presence of anemia.

PREVALENCE OF ANEMIA ACCORDING TO THE HIE INSURANCE PLANS

Table 11 shows the distribution of children with anemia among the HIE experimental plans. The 16 plans, described in more detail in the Preface, have been grouped into four kinds of fee-for-service plans, based on their levels of coinsurance or maximum dollar expenditure. The two prepaid group practice plans are both located at the Group Health Cooperative of Puget Sound (GHC), in Seattle, Washington. Only the children who were assigned to one of these plans and who could be classified as to the presence of anemia on the basis of screening examination data are included in the analyses. Anemia was defined as a screening hemoglobin value below certain normal limits, adjusted for age, sex, and diurnal variation, as outlined in Chapter 4.

Differences in prevalence of anemia among the four types of fee-for-service plans were not statistically significant. This is as expected and reflects the unbiased assignment of people to plans at the time of enrollment into the HIE, before data from the MHQ or the medical screening examination were collected. Not shown in Table 11 is the prevalence of anemia among children assigned to the fee-for-service plans (taken together) in Seattle. It was 5.7 percent (11 of 193 children screened), which was not significantly different from the 2.7 percent rate (5 of 186) in the prepaid experimental plan in Seattle. The prepaid
Table 11

PREVALENCE OF ANEMIA, BY EXPERIMENTAL HEALTH INSURANCE PLAN

<table>
<thead>
<tr>
<th>Experimental Health Insurance Plan&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Number of Children Classifiable&lt;sup&gt;b&lt;/sup&gt;</th>
<th>Number with Anemia</th>
<th>Percent with Anemia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fee-for-service (all sites)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Free care</td>
<td>372</td>
<td>35</td>
<td>9.4</td>
</tr>
<tr>
<td>25- or 50-percent coinsurance</td>
<td>276</td>
<td>29</td>
<td>10.5</td>
</tr>
<tr>
<td>95-percent coinsurance</td>
<td>211</td>
<td>24</td>
<td>11.4</td>
</tr>
<tr>
<td>Individual deductible</td>
<td>223</td>
<td>16</td>
<td>7.2</td>
</tr>
<tr>
<td>Prepaid group practice&lt;sup&gt;c&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Experimental</td>
<td>186</td>
<td>5</td>
<td>2.7</td>
</tr>
<tr>
<td>Control</td>
<td>87</td>
<td>2</td>
<td>2.3</td>
</tr>
<tr>
<td>Total</td>
<td>1355</td>
<td>111</td>
<td>8.2</td>
</tr>
</tbody>
</table>

<sup>a</sup>See the Preface for details of insurance coverage.

<sup>b</sup>Includes only children screened for hemoglobin at enrollment whose families had been assigned to an experimental health insurance plan.

<sup>c</sup>Seattle only. See text for site-specific comparison with fee-for-service plans.

control plan is not strictly comparable to any other HIE plan, even in Seattle, because it comprised people who had already been participating in the GHC before the HIE began at that site. The prevalence rates of anemia between the experimental and control GHC plans (2.7 and 2.3 percent, respectively) were not significantly different.
Chapter 6

QUALITY-OF-CARE CRITERIA FOR ANEMIA IN CHILDREN

The HIE criteria for judging the quality of care for anemia (Appendix D) are based on the use of relevant laboratory tests to establish the diagnosis of anemia and on rules for therapy, once a specific diagnosis has been made. These criteria cannot take into account the results of laboratory tests ordered by a physician, results that might heavily influence the amount and direction of further diagnostic procedures. The HIE does not collect data on laboratory test results, nor does it examine medical records of physicians in private practice. Some criteria dealing with therapy assume that a specific and correct diagnosis has already been made, an assumption that cannot be verified or confirmed with the limited information available through HIE claim forms and questionnaires.

The HIE data sources include detailed Medical History Questionnaires and screening examination results at enrollment and at exit. Also, problem-oriented insurance claim forms filed during the HIE provide information on patients' reasons for seeking care, physicians' diagnoses, laboratory tests, and other procedures ordered or carried out and medications dispensed or prescribed. Pharmacy claim forms provide information on prescriptions filled.

With the restrictions noted above in mind, we will use the criteria listed in Appendix D to test hypotheses regarding the relationship between insurance level and quality of care. Favorable outcomes include the absence of curable forms of anemia, little or no disability from the condition, and parent knowledge that the child has the condition. Good processes of care include appropriate diagnostic tests, therapy, and follow-up. The criteria are expressed in a form that assumes that the level or quality of care has been high.
Appendix A

LEAD POISONING

DEFINITION AND MEASUREMENT

Elevated lead absorption and lead poisoning are significant health problems for children, especially members of lower income families who live in urban areas. Even though public health and education efforts and screening programs have lowered the incidence of serious lead poisoning in the nation, concern remains about subclinical levels of lead poisoning, especially for children (as lead is more harmful to children than adults).

Low-level (or incipient) lead poisoning can be detected through numerous screening methods and diagnostic laboratory tests (see Marsh and Koenig, 1982), before the ailment has progressed to the point of recognizable symptoms. Moreover, several steps to treat and reverse lead poisoning are available. The most important are removal of all sources of lead from the child's environment and help from medical and other professionals as regards nutrition and behavioral factors. More drastic interventions such as chelation therapy are indicated in severe cases.

For these reasons (fairly high occurrences of the problem in some pediatric populations, relative ease of detection, and responsiveness to medical care), the Health Insurance Experiment decided to investigate lead poisoning in children as a possible indicator of the effect of different levels of health insurance on the health status of that age group. The remainder of this appendix describes the measurement of lead (in general and in the HIE) and presents the results from our enrollment procedures.

Lead poisoning occurs when lead accumulates in and adversely affects body tissues such as the bone, marrow, kidneys, and brain. This accumulation occurs when lead intake (usually through ingestion) exceeds excretion (through the bile and urine) and nonharmful storage in the bones.

A warning sign of possible lead poisoning is an elevated blood lead level. A common threshold defining lead poisoning is >30 µg per 100 ml whole blood, although normal blood lead values in children can range from 15 to 40 µg. The higher the blood lead level, the more likely a child has lead poisoning, especially if levels taken weeks to
months apart are repeatedly high. Because blood lead levels can fluctuate greatly from week to week, depending on the amount of daily lead ingestion versus the amount of excretion and benign bone storage, laboratory tests of other than blood lead levels are often used to confirm the presence and degree of lead poisoning. Symptoms may not be present except in very severe cases, but in children early symptoms can be similar to those of anemia (e.g., irritability and lethargy), colicky pain, vomiting, or constipation. Later signs include effects on the nervous system and mild to moderate anemia.

Measures of free erythrocyte protoporphyrin (FEP) or amino levulinic acid (ALA) are often made to indicate the extent of lead poisoning. Lead in the bone marrow blocks the normal use of FEP and ALA in the production of hemoglobin in red blood cells; consequently, these and related chemicals accumulate in high levels in people with lead poisoning. Because this adverse but reversible condition generally occurs before any kidney or brain involvement and damage, these measures are particularly well-suited for detecting those with early lead poisoning before irreversible complications ensue.

The Center for Disease Control (CDC) has developed a definition of lead poisoning that has been widely adapted for both clinical and epidemiologic work (CDC, 1975; 1978). The CDC definition is based on the results of both blood lead and FEP determinations (in micrograms per 100 ml of whole blood), which place children into one of four risk groups for lead poisoning: Group I (blood lead \( \geq 29 \) and FEP \( \geq 59 \)) is considered normal; Groups II and III are minimally and moderately elevated, respectively; and Group IV (blood lead \( \geq 80 \) and FEP \( \geq 190 \)) is considered to have extremely elevated values with a high likelihood of suffering damage from lead poisoning (CDC, 1978). In the few cases where a discrepancy between the blood lead and FEP results within classes, the FEP result is the more likely to reflect the true status of the child.

The technical definition used by the CDC for lead poisoning includes the following criteria:

1. A confirmed (two successive determinations) blood lead \( \geq 80 \) \( \mu g/100 \) ml with or without symptoms;
2. FEP level \( \geq 190 \) \( \mu g/100 \) ml with or without symptoms;
3. Confirmed blood lead 50 to 80 \( \mu g/100 \) ml with compatible symptoms that cannot be explained otherwise, or with associated abnormal FEP, ALA-d, urinary ALA, or urinary coproporphyrin levels or abnormal calcium disodium EDTA mobilization tests;
4. FEP level of 110 to 189 \( \mu g/100 \) ml with compatible symptoms that cannot be explained otherwise.
LEAD POISONING

Undue or increased lead absorption is defined by the CDC as a blood lead level of 30 to 79 µg with an elevated FEP, except where the elevated FEP level is caused by iron deficiency.

PREVALENCE AND DISEASE IMPACT

Laboratory Findings

The HIE screened children 1 to 5 years of age (inclusive) for lead poisoning. It was not feasible to do both blood lead and FEP tests on all examined children at the screening examination because of prohibitive costs, so we chose to determine only blood lead values at enrollment. The FEP is a simple and sensitive test for lead poisoning, however, and at exit it was decided that FEP levels would be determined before blood lead level; blood level was measured only if FEP was elevated. (An extra tube of blood to permit determination of lead level had been drawn on every child aged 1 to 5 for use if the FEP was elevated.)

At both entrance and exit, blood for lead determinations was drawn using venipuncture. Lead levels were determined at enrollment by the atomic absorption micro method and at exit by the anodic stripping voltammetry method. (See Smith et al., 1978, for further details.)

For enrollment, HIE definitions of lead poisoning rely only on the blood level to classify children according to the CDC criteria. We recognized that this approach might produce some false-positive results owing to lead contamination in the blood sample or a sporadic increase in a child’s blood lead concentration. To minimize this problem in the HIE, the laboratory used personnel who passed CDC proficiency testing in obtaining and processing valid blood lead specimens. In addition, if the blood lead level was greater than 40 µg/100 ml, the determination was repeated on the same blood sample. This second value was used in the analysis. Because we were interested in whether more lead screening and followup would result from more generous health insurance, we considered it important to evaluate the extent to which health care providers in the various sites were detecting and following up children who may have had only a temporary increase in blood lead level regardless of whether or not they had clinical lead poisoning.

Because a local laboratory was used in each HIE site, different methods were used among the sites to determine blood lead levels. (Each laboratory had passed proficiency testing by the CDC for its method and followed widely accepted guidelines for minimizing sample

---

1Because lead poisoning is commonly considered not to occur in Seattle, we did not screen for blood leads in that site at enrollment.
collection error.) At each site, reliability checks were done using split sample analysis of approximately 10 percent of the specimens. If a determination was elevated, it was repeated by the laboratory as part of its in-house quality control procedures; both values were reported to the HIE.

In summary, the main HIE approach at enrollment was to screen children 1 to 5 years of age for their risk of lead poisoning on the basis of blood lead level. Those with a blood lead value of 30 μg per 100 ml whole blood or greater were considered at risk for lead poisoning. Depending on the actual value, all screened children were categorized as belonging to one of the CDC classes defined above.

**Medical History Questionnaire**

In addition to the physiologic measure, we attempted to gather information on the prevalence of diagnosed lead poisoning through a small set of questions on the pediatric MHQ. The skip question for this Lead Poisoning battery was "Has a doctor ever said that this child had lead poisoning?" Any parent who answered "no" was instructed to skip to the next battery; any who answered "yes" went on to complete a set of disease impact items analogous to those for anemia (activity restriction in the previous 3 months, days in bed in the previous 30 days, and parental worry about the child's problem within the past 3 months).

Very few children, if any, were expected to have had this kind of disability because of the relative rarity of this degree of illness. If such children were identified, however, it would imply that very inadequate lead screening and diagnosis had occurred previously, because the outcome of good care should be environmental prevention and early detection without morbidity.

**ENROLLMENT RESULTS**

**Prevalence and Disease Impact**

The skip question for the Lead Poisoning battery about a physician diagnosis of the problem was answered for 189 children. All respondents answered "no" and skipped out of the battery. Thus, prevalence by questionnaire and disease impact as of enrollment cannot be assessed.
Table A.1

<table>
<thead>
<tr>
<th>Blood Lead Level</th>
<th>Number</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal: 0-29 µg</td>
<td>301</td>
<td>84.8</td>
</tr>
<tr>
<td>Minimally elevated: 30-49 µg</td>
<td>36</td>
<td>10.1</td>
</tr>
<tr>
<td>Moderately elevated: 50-79 µg</td>
<td>17</td>
<td>4.8</td>
</tr>
<tr>
<td>Extremely elevated: ≥80 µg</td>
<td>1</td>
<td>0.3</td>
</tr>
<tr>
<td>Total</td>
<td>355</td>
<td>100.0</td>
</tr>
</tbody>
</table>

*aSeattle children were not screened.

*bConsistent with the diagnosis of lead poisoning according to CDC definitions.

Laboratory Findings

Tests of blood lead level were done at all sites except Seattle, and a total of 355 children were screened (Table A.1). Only 1 child (0.02 percent of the sample) had a confirmed blood lead level greater than 80 µg/ml, which is defined as lead poisoning. Almost 5 percent had moderately elevated levels and 10 percent, minimally elevated. Thus, 53 children (15 percent of those screened) should be monitored for blood lead levels, and 1 child should be treated.

The prevalence of blood lead levels greater than 30 µg among children 6 months through 5 years of age in the United States is 3.9 percent (NCHS, 1982). This is approximately one-quarter of the rate found in the HIE. The disparities between the two studies may arise from three factors. First, the HIE oversampled families of low income—a higher risk group. Second, NCHS documented that blacks have higher blood lead levels overall than whites. Because we did not measure blood lead
levels in Seattle, the proportion of blacks in our screened sample of children may be higher than in the nation as a whole. Finally, measurement error, a relatively small sample size, and random variation may account for some of the difference.

RELIABILITY

A repeat test of randomly selected blood samples was used to evaluate the reliability of the blood lead measurements. Five samples were retested. The difference between the first and second measures of blood lead level ranged from -5.0 to +1.3.0 µg with an average difference of 2.4, a standard deviation of 5.8, and a 95-percent confidence interval of -0.2 to +5.0. This level of test-retest reliability is acceptable for our purposes.
Appendix B

ANEMIA AND LEAD POISONING BATTERIES FROM THE MEDICAL HISTORY QUESTIONNAIRE

ENROLLMENT MEDICAL HISTORY QUESTIONNAIRE
NON-DAYTON, FORM B, AGES 5-13

ANEMIA

62. DURING THE PAST 12 MONTHS, HAS A DOCTOR TOLD YOU THAT THIS CHILD HAS ANEMIA (a-nee-ma, SOMETIMES CALLED LOW BLOOD) OR IS HE OR SHE CURRENTLY UNDER TREATMENT FOR IT?

(Circle one)

No, child does not have it .......................... 1 — Go to 69, page 21
Yes, child has it or is under treatment for it ...... 2
Yes, child had it, but is now cured .................. 3

63. DURING THE PAST 12 MONTHS, HAS A DOCTOR PRESCRIBED ANY OF THESE TREATMENTS FOR THIS CHILD'S ANEMIA? (Circle one number on each line)

<table>
<thead>
<tr>
<th>A. Special diet</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>B. Iron pills or shots</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>C. Vitamin pills or shots</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>D. Blood transfusions</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

64. DOES THIS CHILD CURRENTLY TAKE ANY OF THE FOLLOWING TREATMENTS, WHETHER OR NOT A DOCTOR PRESCRIBED THEM? (Circle one number on each line)

<table>
<thead>
<tr>
<th>A. Special diet</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>B. Iron pills or shots</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>C. Vitamin pills or shots</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>D. Blood transfusions</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

1Used at all HIS sites except Dayton at enrollment and in all sites upon exit. Revisions incorporated in this version were based on experience with the initial Dayton battery.
65. WHEN WAS THE LAST TIME THIS CHILD SAW A DOCTOR ABOUT ANEMIA?

(Circle one)

Within the past 3 months ........................................ 1
3 - 6 months ago .................................................... 2
7 - 12 months ago .................................................... 3
More than 1 year ago ................................................. 4

66. DURING THE PAST 3 MONTHS, HOW MUCH HAS THIS CHILD'S ANEMIA WORRIED OR CONCERNED YOU?

(Circle one)

A great deal ......................................................... 1
Somewhat .............................................................. 2
A little ................................................................. 3
Not at all ............................................................... 4

67. DURING THE PAST 3 MONTHS, HOW OFTEN HAS ANEMIA KEPT THIS CHILD FROM DOING THE KINDS OF THINGS THAT OTHER CHILDREN THAT AGE DO?

(Circle one)

All of the time ...................................................... 1
Most of the time .................................................... 2
Some of the time ................................................... 3
A little of the time ............................................... 4
None of the time ................................................... 5

68. DURING THE PAST 30 DAYS, HOW MANY DAYS HAS ANEMIA KEPT THIS CHILD IN BED ALL OR MOST OF THE DAY? (Write in number. If none, write "0")

_______ days in bed last month
ENROLLMENT MEDICAL HISTORY QUESTIONNAIRE
NON-DAYTON, FORM B, AGES 0-4

ANEMIA

28. DURING THE PAST 12 MONTHS, HAS A DOCTOR TOLD YOU THAT THIS CHILD HAS ANEMIA (“a-NEE-mee-a,” SOMETIMES CALLED LOW BLOOD) OR IS HE OR SHE CURRENTLY UNDER TREATMENT FOR IT?

(Circle one)
No, child does not have it .................................... 1 — Go to 35.

---
Yes, child had it or is under treatment for it ...... 2
Yes, child had it, but is now cured ..................... 3

---

29. DURING THE PAST 12 MONTHS, HAS A DOCTOR PRESCRIBED ANY OF THESE TREATMENTS FOR THIS CHILD’S ANEMIA? (Circle one number on each line.)

<table>
<thead>
<tr>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Special diet</td>
<td>1</td>
</tr>
<tr>
<td>B. Iron pills or shots</td>
<td>1</td>
</tr>
<tr>
<td>C. Vitamin pills or shots</td>
<td>1</td>
</tr>
<tr>
<td>D. Blood transfusions</td>
<td>1</td>
</tr>
</tbody>
</table>

---

30. DOES THIS CHILD CURRENTLY TAKE ANY OF THE FOLLOWING TREATMENTS, WHETHER OR NOT A DOCTOR PRESCRIBED THEM? (Circle one number on each line.)

<table>
<thead>
<tr>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Special diet</td>
<td>1</td>
</tr>
<tr>
<td>B. Iron pills or shots</td>
<td>1</td>
</tr>
<tr>
<td>C. Vitamin pills or shots</td>
<td>1</td>
</tr>
<tr>
<td>D. Blood transfusions</td>
<td>1</td>
</tr>
</tbody>
</table>

---

31. WHEN WAS THE LAST TIME THIS CHILD SAW A DOCTOR FOR ANEMIA?

(Circle one)
Within past 3 months ........................................ 1
3 - 6 months ago ............................................. 2
7 - 12 months ago ........................................... 3
More than 1 year ago ......................................... 4
32. DURING THE PAST 3 MONTHS, HOW MUCH HAS THIS CHILD'S ANEMIA WORRIED OR CONCERNED YOU? (Circle one)
   A great deal ........................................ 1
   Somewhat ............................................. 2
   A little ............................................... 3
   Not at all ............................................. 4

33. DURING THE PAST 3 MONTHS, HOW MUCH OF THE TIME HAS ANEMIA KEPT THIS CHILD FROM DOING THE KINDS OF THINGS THAT OTHER CHILDREN THE SAME AGE DO? (Circle one)
   All of the time ...................................... 1
   Most of the time .................................... 2
   Some of the time ................................... 3
   A little of the time ................................ 4
   None of the time .................................... 5

34. DURING THE PAST 30 DAYS, HOW MANY DAYS HAS ANEMIA KEPT THIS CHILD IN BED FOR ALL OR MOST OF THE DAY? (If none, write in "0.")
   _____ days in bed last month
35. HAS A DOCTOR EVER SAID THAT THIS CHILD HAD LEAD POISONING?
   Yes ............................................. 1 —Answer 36
   No ............................................. 2 —Go to 42.

36. DURING THE PAST 12 MONTHS, HAS A DOCTOR PRESCRIBED ANY MEDICINES FOR THE LEAD POISONING?
   Yes ............................................. 1
   No ............................................. 2

37. DOES THIS CHILD CURRENTLY TAKE ANY MEDICINES FOR LEAD POISONING?
   Yes ............................................. 1
   No ............................................. 2

38. WHEN WAS THE LAST TIME THIS CHILD SAW A DOCTOR FOR LEAD POISONING?
   (Circle one)
   Within the past 3 months ......................... 1
   3 - 6 months ago ................................ 2
   7 - 12 months ago ................................. 3
   More than 1 year ago ............................. 4

39. DURING THE PAST 3 MONTHS, HOW MUCH HAS THIS CHILD'S LEAD POISONING WORRIED OR CONCERNED YOU?
   (Circle one)
   A great deal ..................................... 1
   Somewhat ........................................ 2
   A little ......................................... 3
   Not at all ...................................... 4

40. DURING THE PAST 3 MONTHS, HOW MUCH OF THE TIME HAS LEAD POISONING KEPT THIS CHILD FROM DOING THE KINDS OF THINGS OTHER CHILDREN THAT AGE DO?
   (Circle one)
   All of the time .................................. 1
   Most of the time ................................ 2
   Some of the time ................................ 3
   A little of the time .............................. 4
   None of the time ................................. 5

2Used at all HIS sites except Dayton. This version was used for both age groups.
41. DURING THE PAST 30 DAYS, HOW MANY DAYS HAS LEAD POISONING KEPT THIS CHILD IN BED FOR ALL OR MOST OF THE DAY? (If none, write in "0.")

______ days in bed last month

42. HAS A DOCTOR EVER TOLD YOU THAT THIS CHILD HAD CANCER?

Yes ........................................... 1 — Answer 43
No ........................................... 2 — Go to 52, page 14

43. WHERE IS, OR WAS, THE CANCER LOCATED?

(Circle one)

Eye ........................................... 01
Connective tissue (sarcoma) .................. 02
Brain and central nervous system ............ 03
Bone ........................................... 04
Adrenal gland (neuroblastoma) ............... 05
Kidney (Wilms) or urinary tract ............. 06
Blood (leukemia) ................................ 07
Lymph glands or nodes (lymphoma) ........ 08
Lung ........................................... 09
Liver .......................................... 10
Mixed tissues (teratoma) ..................... 11
Somewhere else ................................ 12
Where?

44. WHEN WAS THE CANCER FIRST DIAGNOSED? (WHEN WERE YOU FIRST TOLD ABOUT IT?)

(Circle one)

Within the past 6 months .................... 1
6 months to 1 year ago ..................... 2
2 - 3 years ago .............................. 3
More than 3 years ago ...................... 4
ANEMIA AND LEAD POISONING BATTERIES FROM THE MHQ

ENROLLMENT MEDICAL HISTORY QUESTIONNAIRE
DAYTON, FORM B, AGES 5-13

9. DURING THE PAST 12 MONTHS, HAS A DOCTOR TOLD YOU THAT THIS CHILD HAS ANEMIA (SOMETIMES CALLED LOW BLOOD) OR IS HE CURRENTLY UNDER TREATMENT FOR IT? ("ANEMIA" PRONOUNCED "A-NEE-ME-A")

NO, HE DOES NOT HAVE IT .......................... 3 (GO to q. 17, page 5)

YES, HE HAS IT OR IS UNDER TREATMENT
FOR IT ............................................ 1 (GO to q. 10)

YES, HE HAD IT, BUT IT IS NOW CURED ...... 2

10. Has a doctor prescribed any of these treatments for this child's anemia? CIRCLE YES OR NO FOR EACH.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Special diet</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Iron pills or shots</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vitamin pills or shots</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Blood transfusions</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

11. Does this child currently take any of the following treatments, whether or not a doctor prescribed them? CIRCLE YES OR NO FOR EACH ONE.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Special diet</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Iron pills or shots</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vitamin pills or shots</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Blood transfusions</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

12. Is this child currently under a doctor's care or supervision for anemia?

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>1</td>
</tr>
<tr>
<td>No</td>
<td>2</td>
</tr>
</tbody>
</table>
13. During the past 3 months, how much pain has this child's anemia caused him or her?
(Circle one.)
A lot ............... 1
Some ............... 2
A little ............. 3
None at all .......... 4

14. During the past 3 months, how much has this child's anemia worried or concerned you?
(Circle one.)
A lot ............... 1
Somewhat ............ 2
A little ............. 3
Not at all ........... 4

15. During the past 3 months, how often has anemia kept this child from doing the kinds of activities other children the same age do?
(Circle one.)
All of the time ........ 1
Most of the time ...... 2
Some of the time ..... 3
A little of the time ... 4
None of the time ...... 5

16. During the past 30 days, how many days has anemia kept this child in bed all or most of the day? (IF NO DAYS IN BED, WRITE IN "0").

_______ Days in bed
ENROLLMENT MEDICAL HISTORY QUESTIONNAIRE
DAYTON, FORM B, AGES 0-4

ANEMIA

1. DURING THE LAST 12 MONTHS, HAS A DOCTOR TOLD YOU THAT THIS CHILD HAS ANEMIA (SOMETIMES CALLED LOW BLOOD) OR IS HE CURRENTLY UNDER TREATMENT FOR IT? ("ANEMIA" PRONOUNCED "A-NEE-ME-A")

(Circle one.)

NO, HE DOES NOT HAVE IT .................. 3  (GO to q. 9, page 3)
YES, HE HAS IT OR IS UNDER TREATMENT FOR IT .................. 1
YES, HE HAD IT, BUT IT IS NOW CURED .................. 2  (GO to q. 2)

2. During the last 12 months, has a doctor prescribed any of these treatments for this child's anemia? CIRCLE YES OR NO FOR EACH.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Special diet</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Iron pills or shots</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Vitamin pills or shots</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Blood transfusions</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

3. Does this child currently take any of the following treatments, whether or not a doctor prescribed them? CIRCLE YES OR NO FOR EACH ONE.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Special diet</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Iron pills or shots</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Vitamin pills or shots</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Blood transfusions</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>
4. Is this child currently under a doctor's care or supervision for anemia?
   Yes .......................... 1
   No .............................. 2

5. During the past 3 months, how much pain has this child's anemia caused him or her?
   (Circle one.)
   A lot .......................... 1
   Some ........................... 2
   A little ........................ 3
   None at all ........................ 4

6. During the past 3 months, how much has this child's anemia worried or concerned you?
   (Circle one.)
   A lot .......................... 1
   Somewhat ........................ 2
   A little ........................ 3
   Not at all ........................ 4

7. During the past 3 months, how often has anemia kept this child from doing the kinds of activities other children the same age do?
   (Circle one.)
   All of the time .................. 1
   Most of the time ................. 2
   Some of the time ................ 3
   A little of the time ............ 4
   None of the time ............... 5

8. During the past 30 days, how many days has anemia kept this child in bed all or most of the day? (IF NO DAYS IN BED, WRITE IN "0").
   _______ Days in bed
Appendix C

DISTRIBUTION OF RESPONSES TO DISEASE IMPACT QUESTIONS

The following two tables present the numbers and percentages of responses to two disease impact questions from the MHQ for the same categories of anemia status that were summarized earlier in Chapter 5. Only parent's worry and child's activity restriction are included, as no child was reported to have spent any days in bed because of anemia.

Table C.1 shows the responses regarding the 49 children whose mothers had in fact answered these questions. Table C.2 shows the responses for all 2545 children with completed MHQs, regardless of whether their mothers had responded to the questions about the adverse consequences of anemia. Responses equivalent to no impact were assigned to the 2496 in Table C.2 who did not actually have responses because of negative answers to earlier items (see Chapter 5). In both tables, the number of people in each anemia category is shown in parentheses. The number of responses may not add to the subtotals for these categories, however, because missing responses are not shown (less than 1 percent of all responses).

The entries in the “level of impact” column are given in abbreviated form. The full questions and responses are shown in Appendix B.
Table C.1

DISTRIBUTION OF RESPONSES TO DISEASE IMPACT QUESTIONS FROM THE MHQ, BY ANEMIA STATUS: CHILDREN WITH COMPLETED BATTERY

<table>
<thead>
<tr>
<th>Anemia Status from Screening Examination</th>
<th>Parental Worry</th>
<th>Activity Restriction</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Level of Impact</td>
<td>Number</td>
</tr>
<tr>
<td><strong>Anemia present</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Taking iron or transfusions (n = 1)</td>
<td>Great</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Some</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Little</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>None</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Taking vitamins or diet (n = 2)</td>
<td>Great</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Some</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Little</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>None</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No current treatment (n = 2)</td>
<td>Great</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Some</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Little</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>None</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Anemia not present</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Taking iron or transfusions (n = 6)</td>
<td>Great</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Some</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Little</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>None</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Taking vitamins or diet (n = 8)</td>
<td>Great</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Some</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Little</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>None</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No current treatment (n = 8)</td>
<td>Great</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Some</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Little</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>None</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table C.1—continued

<table>
<thead>
<tr>
<th>Anemia Status from Screening Examination</th>
<th>Parental Worry</th>
<th>Activity Restriction</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Level of Impact</td>
<td>Number</td>
</tr>
<tr>
<td>Not screened for anemia</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Taking iron or transfusions (n = 10)</td>
<td>Great</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Some</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Little</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>None</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Taking vitamins or diet (n = 6)</td>
<td>Great</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Some</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Little</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>None</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No current treatment (n = 6)</td>
<td>Great</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Some</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Little</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>None</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table C.2

**Distribution of Responses to Disease Impact Questions from the MHQ, by Anemia Status: Children with Completed MHQs**

<table>
<thead>
<tr>
<th>Anemia Status from Screening Examination</th>
<th>Parental Worry</th>
<th>Activity Restriction</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Level of Impact</td>
<td>Number</td>
</tr>
<tr>
<td></td>
<td>Great</td>
<td>0</td>
</tr>
<tr>
<td>Anemia present (n = 154)</td>
<td>Some</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Little</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>None</td>
<td>153</td>
</tr>
<tr>
<td></td>
<td>Missing</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anemia not present (n = 1374)</td>
<td>Great</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Some</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Little</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>None</td>
<td>1364</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unknown (not screened) (n = 946)</td>
<td>Great</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Some</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Little</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>None</td>
<td>935</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total (n = 2474)</td>
<td>Great</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Some</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Little</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>None</td>
<td>2452</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Among all those with a completed MHQ; children whose mother had skipped out of the Anemia battery were scored as "none."

bLess than 0.5 percent.
Appendix D

QUALITY-OF-CARE CRITERIA FOR ANEMIA

All criteria listed below, unless otherwise specified, refer only to children who have anemia according to the HIE definition (see Chapter 4). They will be used in analyses at the completion of the HIE.

Rarely, alternative criteria will be tested to see if the insurance plan effects differ for slight variations in the threshold value of the criterion. In criteria referring to the MHQ, the mother is assumed to be the proxy respondent for the child. Numerical diagnostic codes (given in parentheses) are from the Hospital-International Classification of Diseases (HICDA-II), adapted for use in the United States (2d ed., 1973).

PATIENT OUTCOMES

1. If the child had anemia at the time of the enrollment screening examination, then (a) the anemia was less severe at the exit screening examination; or (b) (alternative to (a)) the anemia was no longer present at the exit screening examination.

2. If the child had had at least two visits to a physician during the HIE for primary diagnosis of anemia of any type, then the mother reported that the child had had anemia on the exit MHQ.

3. If the child had had two or more visits to a physician at least 6 months before exit from the HIE for a diagnosis of a treatable form of anemia (iron-deficiency anemia, HICDA-II 280-280.9; other deficiency anemia, 281.0-281.9; acute hemorrhagic anemia, 285.1; unspecified anemia, 285.9), then he or she did not have anemia at the exit screening examination.

4. If the child was treated with iron at least 3 months before exit from the HIE, then he or she did not have anemia at the exit screening examination.

5. If the child had iron-deficiency anemia at the exit screening examination, then, on the exit MHQ, the mother reported (a) "none at all" or "a little" worry about anemia, (b) restriction of activity "none of the time," and (c) "zero" days in bed attributed to anemia.

6. If the child did not have anemia at the exit screening examination but the mother nevertheless reported on the exit MHQ that the
child had anemia, then she reported no worry, no activity restriction, and no days in bed attributed to anemia.  
7. If the child had iron-deficiency anemia at the exit screening examination, then the mother reported on the exit MHQ that the child (a) had anemia, (b) was taking iron, and (c) had seen a physician about anemia within the past 6 months. 
8. If the child had macrocytic anemia at the exit screening examination, then the mother reported on the exit MHQ that the child (a) had anemia and (b) had seen a physician about anemia within the past 6 months.

PROCESSES OF MEDICAL CARE

Anemia in General

1. If the child had anemia at the time of the enrollment screening examination, but the mother reported on the enrollment MHQ that the child did not have anemia, then there is followup for the anemia within 3 months after the enrollment screening examination:
   a. A hematocrit, hemoglobin, or complete blood count (CBC) is performed.
   b. (Alternative to (a)). A diagnosis of anemia of any type (280-285.9) appears on at least one claim form.
   c. (Alternative to (a)). The mother writes “anemia” (or a similar term) as the reason for a visit to the child’s physician on at least one claim form.

2. If the child had two or more visits to a physician during the HIE for a primary diagnosis of anemia, then on at least one of these visits the mother had written “anemia” (or a similar term) as the reason for the child’s visit.

3. If the child was diagnosed for the first time during the HIE as having anemia of any type (280-285.9), then the following tests were performed:
   a. A CBC within 1 month before or after the first appearance of the diagnosis (on the claim form).
   b. A reticulocyte count within 1 month before or after the first appearance of the diagnosis.
   c. A followup hematocrit, hemoglobin, or CBC within 3 months after the first appearance of the diagnosis.

4. If the child had received transfusions of any kind of blood constituents as an outpatient and had not been hospitalized for anemia in the
preceding 3 months, then the child does not have a diagnosis of iron-deficiency anemia (280-280.9), other deficiency anemia (281-281.9), or unspecified anemia (285.9).

5. If the child has received steroid therapy for anemia, then he or she does not have a diagnosis of iron-deficiency anemia (280-280.9), other deficiency anemia (281-281.9), hereditary hemolytic anemia (282-282.9), or unspecified anemia (285.9).

6. If the child had a diagnosis of anemia of any type (280-285.9), then, since the diagnosis was made, he or she had not taken any of the following prescribed drugs without also taking folate: phenytoin, phenobarbital, primidone, methotrexate, or other antineoplastic agents.

7. The child had not received any unknown injections (drug name not specified) for anemia.

Iron-Deficiency Anemia

8. If the child was diagnosed for the first time during the HIE as having iron-deficiency anemia (280-280.9), then he or she received the following:

   a. At least 3 months of iron therapy.
   b. At least one reticulocyte count within 21 days after therapy began.
   c. At least one hematocrit, hemoglobin, or CBC within 1 month after therapy began.
   d. (Alternative to (c)). At least two hematocrits, hemoglobins, or CBCs within 3 months after therapy began.

9. If the child received iron injections, then he or she
   a. Had a diagnosis of iron-deficiency anemia (280-280.9) on at least one claim form.
   b. Had already received at least a 1-month trial of oral iron.
   c. Had had at least two checks of hematocrit, hemoglobin, or CBC and at least one check of reticulocyte count before the first injection.
   d. (Alternative to (c)). Had had at least one check of hematocrit, hemoglobin, or CBC and at least one check of reticulocyte count before the first injection.
   e. Had a followup hematocrit, hemoglobin, or CBC within 3 months after the first injection.
   f. Had had injections extended over a maximum period of 6 weeks.

Exclusion: If the child has a diagnosis of disease of the esophagus, stomach, duodenum (530-537.9), or intestine (560-569.9), or has had an
operation on the esophagus, stomach, or intestine (45-46.9), then
criteria (b), (c), and (d) do not apply.

10. If the child received prescribed oral iron therapy, then he or
she

a. Had a diagnosis of iron-deficiency anemia (280-280.9) on at
least one claim form.

b. Had at least one visit to a physician for anemia every 6
months while taking iron.

c. Had at least one check of hematocrit, hemoglobin, or CBC
every 6 months while taking iron.

Macrocytic Anemia

11. If the child was diagnosed for the first time during the HIE as
having megaloblastic anemia, pernicious anemia, other vitamin B-12
deficiency anemia, or folate-deficiency anemia (281-281.9), then the
following tests were performed within 3 months after the diagnosis:

a. Serum B-12 and serum folate.

b. (Alternative to (a)). Serum B-12.

12. If the child was diagnosed for the first time during the HIE as
having pernicious anemia (281.0) or other vitamin B-12 deficiency ane-
mia (281.1), then he or she

a. Received vitamin B-12 therapy after the diagnosis was made.

b. Received a check of hematocrit, hemoglobin, or CBC within 3
months after the start of vitamin B-12 therapy.

13. If the child was diagnosed for the first time during the HIE as
having folate-deficiency anemia (281.2), then he or she

a. Received folate therapy after the diagnosis was made.

b. Received a check of hematocrit, hemoglobin, or CBC within 3
months after the start of folate therapy.

14. If the child received vitamin B-12 injections, then he or she

a. Had a diagnosis of pernicious anemia (281.0) or other vitamin
B-12 deficiency anemia (281.1) on at least one claim form.

b. Had at least one check of hematocrit, hemoglobin, CBC, or
serum B-12 every 6 months while receiving vitamin B-12 in-
jections.
15. If the child received prescribed folate therapy, then he or she
   a. Had a diagnosis of folate-deficiency anemia (281.2) on at least
      one claim form.
   b. Had at least one visit to a physician for anemia every 6
      months while taking folate.
   c. Had at least one check of hematocrit, hemoglobin, CBC, or
      serum folate every 6 months while taking folate.

16. If the child had a diagnosis of anemia secondary to a hemoglobinopathy, then he or she had at least one visit to a physician for this
    diagnosis every 6 months.
REFERENCES


Dallman, P. R., "Iron Deficiency: Diagnosis and Treatment (Nutrition in Medicine)," Western Journal of Medicine, 134:496-505, 1981.


