


# Severe Iron Deficiency Anemia in Infants and Young Children, Requiring Hospital Admission

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## Abstract

**Objective.** This study evaluated patient characteristics, milk intake, and associated lab findings of children 6 months to 5 years old, admitted to a children's hospital with severe iron-deficiency anemia (IDA). **Methods.** A chart review was conducted on patients admitted with microcytic anemia (hemoglobin concentration less than 7 g/dL), accompanied by a low serum ferritin and/or low serum iron level between January 2000 and December 2006. **Results.** A total of 18 children with severe IDA were evaluated. Many had parents with private insurance and jobs. Almost all children drank >24 ounces of milk daily. Hemoglobin on admission was 3.8 g/dL, and the mean of the patients' mean corpuscular volume was 52.8 fL. Median iron levels were 4 µg/dL. **Conclusions.** Severe IDA is still prevalent in children, yet physicians may not perform necessary testing. The devastating long-term effects of severe IDA should prompt clinicians to screen for severe IDA in children regardless of absent risk factors.

## Keywords

iron deficiency, anemia, child nutrition disorders, infant nutrition disorders, milk, recommended dietary intake

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## Introduction

For many years, iron-deficiency anemia (IDA) in infants and young children has received considerable attention in the pediatric community because of relatively high prevalence and known detrimental effects on neurological development, cognitive function, exercise tolerance, immune function, and school performance.<sup>1–5</sup> In addition, there has been recent recognition of an association between IDA and stroke in young children.<sup>6</sup> Wide-ranging national initiatives and aggressive educational efforts have contributed to a significant decline in the prevalence of IDA in recent decades.<sup>4</sup> For example, Sherry et al<sup>7</sup> examined the change in prevalence of IDA in 5 states between the early 1980s to the mid-1990s, showing declines in IDA of 48% to 75%. However, despite this progress, IDA still occurs in children and is most prevalent in high-risk populations, such as preterm and low-birth-weight infants, those of Southeast Asian ancestry, and those from urban settings.<sup>8–10</sup> Conservative estimates indicate that 7% of 1- to 2-year-old children in the United States are iron deficient.<sup>11</sup> In 2005, Eden<sup>12</sup> reported that in children aged 1 to 2 years from the United States and the United Kingdom, 30% had iron

deficiency and 10% had IDA. This prevalence is even greater in children who are overweight (20%)<sup>5</sup> and of Mexican American descent (17%).<sup>13</sup>

In addition to the known long-term consequences of IDA, some children will experience acute life-threatening clinical events, including tachycardia, tachypnea, hypotension, respiratory distress, and congestive heart failure. Children with these findings will often present to emergency departments rather than to offices or clinics of their primary care pediatricians. The presence of one or more of these findings will prompt, appropriately, admission to inpatient pediatric units.

Given the extensive literature on IDA in infants and children in the past 2 to 3 decades, we were surprised to encounter a subset of children with IDA severe enough to warrant admission to our suburban children's

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hospital. Even more impressive, most of these children did not fit the high-risk profile that would predict severe IDA. These considerations led to our interest in better understanding these admissions. The purpose of this study was to evaluate the patient characteristics, milk intake, and associated laboratory findings of children 6 months to 5 years old who were admitted to a Midwest suburban children's hospital with IDA.

## Patients and Methods

Prior to study conduct, a HIPAA and informed consent waiver was granted, and protocol approval was received from the local institutional review board. A retrospective chart review was completed to identify children 6 months to 5 years old who were admitted to our institution for severe IDA between January 2000 and December 2006. We defined severe IDA as a microcytic anemia with a hemoglobin concentration less than 7 mg/dL, accompanied by a low serum ferritin and/or low serum iron level, when available. Children were included if they did not have an underlying condition that explained their severe IDA. Children with other explanations for severe anemia (eg, neoplasm, trauma, or gastrointestinal bleeding) were excluded to look solely at the prevalence of nutritional anemia.

For children who met eligibility requirements, we examined their inpatient records and gathered data on their demographics, medical and dietary histories, presenting symptoms, physical findings, laboratory findings, and clinical management. Descriptive statistics were used to describe patient characteristics, milk intake, and laboratory findings on admission.

## Results

### Sample

A total of 18 children met eligibility criteria for our study, and all were from suburban communities outside Chicago, Illinois. Child/family characteristics are shown in Table 1. The vast majority (72.2%) were 13 to 24 months of age and from English-speaking households (76.4%). A majority (61.1%) of the children were female, and although the sample was somewhat equally distributed across racial ethnic groups, a surprisingly high proportion (61.1%) were privately insured. Employment data were available for parents of 15 patients, revealing that 73.3% had at least 1 employed parent/guardian.

### Dietary Intake

Specific milk intake was known for 13 (72.2%) of the children (Table 2). All but 1 child (92.3%; n = 12) drank greater than 24 ounces of cow's milk per day. Documentation

**Table 1.** Sample Characteristics.

	Number of Patients (%), n = 18
Age (months)	
6-12	1 (5.6%)
13-24	14 (77.8%)
25-36	1 (5.6%)
37-50	2 (11.1%)
Gender	
Female	11 (61.1%)
Male	7 (38.9%)
Race	
Asian	7 (38.9%)
Hispanic	6 (33.3%)
Caucasian	5 (27.8%)
Insurance status	
Private	11 (61.1%)
Public aid	4 (22.2%)
Uninsured	2 (11.1%)
Self-pay	1 (5.6%)
Employed parent/guardian <sup>a</sup>	
Yes	11 (73.3%)
No	4 (26.7%)
Primary language <sup>b</sup>	
English	13 (76.4%)
Spanish	4 (23.6%)

<sup>a</sup>Data represent 15 patients.

<sup>b</sup>Data represent 17 patients.

regarding dietary intake of foods other than milk was highly variable.

### Laboratory Findings

The laboratory findings on admission are shown in Table 3. The mean hemoglobin on admission was 3.8 g/dL (range = 1.7-6.3 g/dL). The mean value for the patients' mean corpuscular volume (MCV) levels was 52.8 fL (range = 41.4-72.1 fL). Serum iron levels were available for 7 patients (38.9%), with a median level of 4.0 µg/dL (range = 1-80 µg/dL). Ferritin levels were available in 15 patients and were below normal (<6 ng/mL) in 73.3% (see Table 3).

### Clinical Management

Among the children, 10 (55.6%) were sufficiently ill to require packed red blood cell transfusions. Indications for transfusions included the presence of fever or signs of cardiac compromise (eg, tachycardia). All the children were started on oral iron replacement therapy and stabilized rapidly, allowing discharge home for continued treatment and monitoring of anemia.

**Table 2.** Daily Cow's Milk Intake.

Volume Ingested Per Day	Number of Patients (%), n = 13
<16 oz	0 (0%)
16-23 oz	1 (7.7%)
24-32 oz	5 (38.5%)
>32 oz	7 (53.8%)

**Table 3.** Initial Laboratory Evaluation.

	Mean (Range)	n	Normal Values
Hemoglobin concentration (g/dL)	3.8 (1.7-6.3)	18	10.5-13.5
Hematocrit (%)	13.3 (5.0-22.9)	17	33.0-40.0
Mean corpuscular volume (fL)	52.8 (41.4-72.1)	18	70.0-86.0
Reticulocyte count	3.8 (1.2-10.0)	18	0.3-2.5
Total iron binding capacity (μg/dL)	399.5 (241-555)	10	250-425
	Number of Participants (%)		Normal Values
Ferritin (ng/mL) <sup>a</sup>			6.0-24.0
<1	6 (40.0%)		
1-6	5 (33.3%)		
>6	4 (26.7%)		
Iron (μg/dL) <sup>b</sup>			37.0-181.0
<10	6 (75.0%)		
10-37	0 (0%)		
>37	2(25.0%)		

<sup>a</sup>Data represent 15 patients.

<sup>b</sup>Data represent 8 patients.

## Discussion

Despite national initiatives and aggressive educational efforts, IDA remains a common nutritional deficiency in children in the United States and throughout the world.<sup>14</sup> In our setting, 18 children were admitted for severe IDA over a 6-year period. The majority had parents who were privately insured (61.1%) and employed (73.3%). The presence of insurance coverage and employment may have suggested to clinicians that this population of children would not be at high risk for IDA.<sup>15</sup> Also, the perception that these children were low risk may partially explain why many of them did not have serum iron levels or other appropriate testing performed. Physicians may not have initiated a full evaluation for IDA because of a false sense that these children would not have IDA.

Given the retrospective nature of this study, we could not identify the factors that may have precipitated IDA. One such factor may have been lack of parental knowledge of proper nutrition. Parents may not be fully aware of recommendations for daily milk intake. For young children, the American Academy of Pediatrics (AAP) and the American Heart Association have advised that a maximum of 16 ounces of milk be consumed daily.<sup>16</sup> More recently, the AAP recommendation for vitamin D intake has doubled to 400 IU/d to prevent rickets.<sup>17</sup> However, this requirement translates to an equivalent of 32 ounces of milk per day, which can result in a lowered intake of other foods and can lead to IDA. More than a quarter of the children in our study had documented nutritional histories that indicated excessive cow's milk intake (>24 oz/d) as a potential contributing factor. It is also possible that these children consumed insufficient meat or other iron-containing foods and that this played a role in their IDA.

Certain unique cultural practices specific to different ethnic backgrounds may have also contributed to iron deficiency in some patients. More than a third (38.7%) of the children in our sample were Asian. Among Asian children, early introduction of tea into the diet may lead to satiety, which precludes ingestion of sufficient iron-containing foods. Also, although it is known that vitamin C-containing drinks increase iron absorption,<sup>12</sup> herbal beverages and tea (because of tannins) commonly decrease iron availability.<sup>18</sup> In a study reported by Kwiatkowski et al,<sup>8</sup> it was determined that Asian children frequently consume a diet of milk, rice, and soup, with little meat.

Similarly, it is well known that many Hispanic children continue bottle feeding beyond 1 year of age.<sup>13</sup> This habit can easily lead to ingestion of excessive volumes of milk, exceeding the previously mentioned recommendations for milk intake.<sup>1,3</sup> In 2006, Sutcliffe et al<sup>19</sup> reported that children who were still drinking milk from bottles at between 2 and 3 years of age were at much higher risk for iron depletion. Media influence is also an important factor to consider in pediatric patients. Recent television and magazine advertisements show prominent celebrities with milk moustaches, encouraging milk intake. It is possible that this emphasis in today's popular culture is creating an overreliance on milk as a source of nutrition, thus increasing the risk of IDA.

Although our results point to the continued presence of severe IDA in what many may presume to be a low-risk population, certain limitations deserve mention. Our sample size is small and represents a single children's hospital. Furthermore, because the study was retrospective in design, we had limited data available on the child and family characteristics, dietary intake, and

laboratory findings. Some researchers are using newer laboratory markers for determining the severity of IDA that we were unable to use in our retrospective study. For example, Brotanek et al<sup>5</sup> used transferring saturation, free erythrocyte protoporphyrin, and serum ferritin levels as their main determinants of IDA.<sup>5</sup> Similarly, Domellöf et al<sup>20</sup> used standard markers for IDA, such as hemoglobin, MCV, and ferritin. However, they also investigated levels such as zinc protoporphyrin and transferrin saturations. During our study period, these laboratory tools were not used routinely in our hospital laboratory.

No matter how it is diagnosed, IDA continues to be a significant problem in young children. The prevalence of IDA may even rise, given the upward trends in pediatric obesity and poor nutrition. A large US study by Brotanek et al<sup>5</sup> found that 20% to 24% of obese toddlers, regardless of socioeconomic background, suffer from IDA, which in turn may contribute to other problems, including developmental delay, exercise intolerance, immune deficiency, and poor school performance.<sup>1,2</sup> Given these and other consequences, health care providers must be vigilant in identifying IDA in seemingly lower-risk populations. Although previous studies have identified IDA to be more prevalent in children from certain high-risk populations,<sup>8,9,13,15</sup> our findings indicate that this may not be the case, and such preconceptions may deter clinicians from looking for IDA in children.

## Conclusion

We found that children with severe IDA are still presenting with some regularity to our suburban children's hospital. With that in mind, it is important to continue and to expand public health initiatives to raise awareness and ultimately prevent IDA in children. Pediatricians and other clinicians should not rely on traditional stereotypes but should be wary of the possibility of iron deficiency and subsequent anemia in all children.

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## Author Contributions

KL conceptualized and helped design the study, performed the data analyses and interpretation, assisted in drafting the initial manuscript, and gave her final approval. JR conducted the

literature review, gathered retrospective data by chart review, analyzed data, drafted the abstract, and gave his final approval. HM conceptualized and helped design the study; selected relevant literature; dismissed literature not used; performed the data analyses and interpretation; drafted, reviewed, and revised the manuscript; and approved the final manuscript as submitted. DBA helped design the study, reviewed and artfully revised various drafts of the manuscript, and gave her final approval.

## Declaration of Conflicting Interests

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