

Anemia Among Hospitalized Children at a Multispecialty Hospital, Bangalore (Karnataka), India

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ABSTRACT

Background: Due to the limited availability of data related to anemia in hospitalized children, this research was conducted to study the occurrence, morphological patterns, distribution in different age groups, sex, and severity of anemia among children aged 6 months-12 years. **Setting:** Inpatients in department of pediatrics at a multispecialty hospital, Bangalore. **Study Design:** Descriptive cross sectional study from Oct, 2011 to Sep, 2012. **Materials and Methods:** Ethical clearance was obtained from the ethical committee of the hospital as per 1964 Declaration of Helsinki. Unrestricted random sampling method was used to select the study group consisting of 882 children between the age of 6 months and 12 years. After obtaining the consent, data were obtained and statistically analyzed using statistical tools like mean, median, standard deviation, and Chi-square test. **Results:** Out of 882 children selected, 642 (72.79%) were anemic, out of which a majority of 629 (98%) children suffered from nonhemoglobinopathies and a meagre 13 (2%) suffered from hemoglobinopathies. Children in the age group of 6 months-1 year were most affected with nonhemoglobinopathies (33%). Moderate degree of anemia (hemoglobin = 7-9.9 g/dL) was the commonest grade of anemia (80%), while microcytic hypochromic anemia was commonest morphological type of anemia (48%). Among hemoglobinopathies, thalassemia major was the most common (69%, that is 9 out of 13 patients). **Conclusion:** The occurrence of anemia among children aged between 6 months and 12 years is high and nonhemoglobinopathies predominate over the hemoglobinopathies.

Keywords: Anemia, children, hemoglobinopathies, nonhemoglobinopathies

Introduction

The World Health Organization (WHO) has estimated that globally 1.62 billion people are anemic, with the highest prevalence of anemia (47.4%) among preschool-aged children; of these 293 million children, 89 million live in India.^[1] The third National Family Health Survey (NFHS) 2005-2006 revealed that at least 80% of Indian children aged 12-23 months are anemic.^[2] Anemia is defined as a hemoglobin (Hb) level of less than the 5th percentile for age. Causes vary by age. The primary care physicians are the first persons who come across children with wide variety of health problems. Most children with anemia are asymptomatic but have atypical presentations, and the condition is detected on screening laboratory evaluation. Mild microcytic

anemia may be treated presumptively with oral iron therapy in children 6-36 months of age, who have risk factors for iron deficiency anemia. If the anemia is severe or is unresponsive to iron therapy, the patient should be evaluated for gastrointestinal blood loss. Other tests used in the evaluation of microcytic anemia include serum iron studies, lead levels, and Hb electrophoresis, and so on.^[3-5] Further, anemia in infancy and early childhood is associated with behavioral and cognitive delays, including impaired learning,^[6] decreased social achievement,^[7,8] and lower scores on tests of mental and motor development.^[9-11] Given the detrimental long-term effects and high prevalence of nutritional deficiency, its prevention in early childhood is an important public health issue.^[12] Among infants, the following characteristics confer special risks: Low socioeconomic status, consumption of cow's milk before 6 months of age, low birth weight, and prematurity.^[13] Most children with anemia are asymptomatic and have abnormal Hb or hematocrit level on routine screening. Infrequently, a child

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with anemia may have pallor, fatigue, and jaundice but may or may not be critically ill.^[14] The protocol in managing anemic infant or child is by integrating the clues from physical examination, complete blood cell count, peripheral smear, reticulocyte count, and interpretation of tests which help to arrive at a definitive diagnosis. The sparse literature available regarding anemia in hospitalized children necessitated the need for the present study and early screening and detection of anaemia will in turn help in early and better management. The present study was undertaken with an aim to find the occurrence of anemia, the patterns of anemia, its distribution in different age groups, and its severity among the hospitalized children.

Materials and Methods

The present study was carried out in department of pathology and pediatrics at a multispecialty hospital, Bangalore, Karnataka, India from October, 2011 to September, 2012. Ethical clearance was taken as per the norms of the hospital and an informed consent was taken from the parents/guardian of the children (subjects being minors). Unrestricted random sampling method was used to select the study group consisting of 882 children between the age of 6 months and 12 years. A total of 2 mL of venous blood was drawn under aseptic precautions in an ethylene diamine tetra acetate containing vacutainer. The hematological details like Hb, red blood cell (RBC) count, hematocrit, mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), mean corpuscular hemoglobin concentration (MCHC), red cell distribution width (RDW), platelet count, white blood cell (WBC) count were recorded by using Sysmex KX-21N, 3 part differential analyzer. Peripheral blood smear after staining with Leishman's stain was examined under binocular microscope for count and morphology of RBC, WBC, platelets. Special investigations like electrophoresis, sickling test, bone marrow aspiration were done wherever needed. Bone marrow aspiration was done using Salah's needle at the posterior superior iliac spine. Slides were stained with Leishman's stain (for studying morphology), Pearls Prussian blue (for detecting iron stores), and studied under oil immersion using a binocular microscope.

Statistics

Data obtained were compiled, tabulated, and analyzed. Descriptive statistics were computed with percentages, mean, standard deviation, and Chi-square test was applied to test the association of age with occurrence of anemia (nonhemoglobinopathies and hemoglobinopathies) using Smith's statistical package version 2.80. $P < 0.05$ was considered statistically significant.

Results

Table 1 shows out of the 882 hemograms analyzed, 642 depicted anemic status, thus the occurrence of anemia was found to be 72.79%. Of the 642 children, 375 (58%) were found to be males and 267 (42%) were found to be females. Thus, male to female ratio was found to be 1.4:1. Infants (6 months-1 year) were found to be most commonly

affected constituting to 33%, followed by school-going children (6 years-12 years, 26%), toddlers (2 years-3 years, 25%), and preschool children (4 years-5 years, 16%).

Table 2 shows distribution of 642 anemic patients as those having nonhemoglobinopathies and those with hemoglobinopathies. Of the 642 patients, 629 (98%) had nonhemoglobinopathies and 13 (2%) had hemoglobinopathies. Of the 629 nonhemoglobinopathies, 208 (33%) children in the age group 6 months-1 year were most affected and 102 (16%) in the age group 4-5 years were least affected. Among hemoglobinopathies, 7 (54%) children in the age group 6-12 years were most affected, followed by 4 (30%) children in the age group 2-3 years and equal occurrence of 1 (8%) in both the age groups 6 months-1 year and 4-5 years.

On application of Chi-square test, there was no significant association observed between age and occurrence of anemia (nonhemoglobinopathies and hemoglobinopathies) with Chi square value of 7.199 and P value of 0.0657. In other words, there is no set pattern of occurrence of hemoglobinopathies and nonhemoglobinopathies in different age groups.

Table 2 also shows bone marrow examination. Among the 629 children with nonhemoglobinopathies, bone marrow aspiration was done for 10 children. A total of five (50%) children showed micronormoblastic maturation followed by three (30%) children had megaloblastic maturation, one child (10%) showed normoblastic maturation, and another child (10%) showed hypoproliferative bone marrow.

Table 3 shows the severity and morphologic types of nonhemoglobinopathies in different age groups and it depicts that

Table 1: Age and sex distribution of the study population

Age	Male	Female	Total
6 m-1 y	135 (21)	74 (12)	209 (33)
2-3 y	94 (14)	69 (11)	163 (25)
4-5 y	62 (10)	41 (6)	103 (16)
6-12 y	84 (13)	83 (13)	167 (26)
Total	375	267	642 (100)

Figures in parenthesis are in percentage, m: Months; y: Years

Table 2: Distribution of nonhemoglobinopathies/hemoglobinopathies and bone marrow findings in different age groups

Age group	NH	H	Bone marrow findings				
			A	B	C	D	T
6 m-1 y	208 (33)	1 (08)	-	-	1	-	1
2-3 y	159 (25)	4 (30)	-	1	1	-	2
4-5 y	102 (16)	1 (08)	-	-	-	-	-
6-12 y	160 (26)	7 (54)	1	2	3	1	7
Total	629	13	1	3	5	1	10

Figures in parenthesis are in percentage. NH: Nonhemoglobinopathies; H: Hemoglobinopathies; A: Normoblastic; B: Megaloblastic; C: Micronormoblastic; D: Hypoproliferative; m: Months; y: Years

most children in all the age groups suffered from moderate anemia and microcytic hypochromic anemia being the commonest with the highest number of 166 (29.39%) found among children of age group 6 months to 1 year and least number of 75 (11.92%) in the 4-5 years age group. Macrocytic anemia was the least common morphological type of anemia in all the age groups.

Table 4 shows the mean of parameters in nonhemoglobinopathies and hemoglobinopathies. Among nonhemoglobinopathies parameters Hb, RDW, and MCV were evaluated as follows: Mean Hb was found to be 8.5 g/dL, with a maximum value of 11 g/dL, minimum of 3.2 g/DL, and a standard deviation of 1.3466. Mean RDW was 17.23, with a maximum of 28.6, minimum of 12 and a standard deviation of 1.8510. Mean MCV was 75.08 fl, with a maximum of 105 fl, minimum of 49 fl, and a standard deviation of 9.9348.

Among hemoglobinopathies Hb, RDW, MCV, reticulocyte count, and HbF were evaluated as follows: Mean Hb was 6.23 g/dL, minimum was 4.3 g/dL, and maximum was 10.5 g/dL with a standard deviation of 1.8931. Mean RDW was 24.41, minimum was 18.10 and maximum was 24.41 with a standard deviation of 6.5526. Mean MCV was 65.04 fl with a minimum of 52 fl, maximum of 78.90 fl and a standard deviation of 6.7106. Mean reticulocyte count was 0.163×10^{12} with a minimum of 0.08×10^{12} , maximum of 0.36×10^{12} and a standard deviation of 0.343. Mean HbF was 31.69, with a minimum of 3.00, a maximum of 90.10, and a standard deviation of 23. fl- femto litres, NNA-Normocytic normochromic anaemia, HbE-Haemoglobin E, HbDE-Haemoglobin DE, MCHA-Microcytic hypochromic anaemia, HbF- Haemoglobin F (Fetal Haemoglobin)

Figure 1 shows the distribution of various types of hemoglobinopathies in the study population. Thalassemia

major was the most common type of hemoglobinopathy seen in nine (54%) children followed by thalassemia minor among two (30%) children, and equal incidence of about one (8%) child each suffering from sickle cell anemia and sickle cell thalassemia.

Discussion

One of the major areas for improvement in primary care is prevention of nutritional deficiency like anaemia, because it has been associated with visual and auditory dysfunctioning, cognitive, behavioural abnormalities, and delay in psychomotor development. Appropriate screening and subsequent diagnostic testing will allow most cases of anemia to be diagnosed at the earliest. This should happen at the level of primary care physicians to choose screen and treat approach to prevent complications of anemia at level of primary care itself. The children with suspected nutritional deficiency can be screened, treated, and

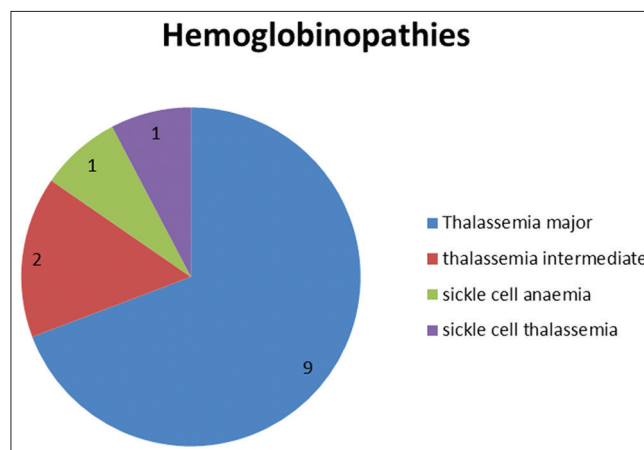


Figure 1: Distribution of various types of hemoglobinopathies in the study population

Table 3: The pattern of severity and morphologic types of nonhemoglobinopathies in different age groups

Age	Hemoglobin (%)			Type (%)			
	Mild	Moderate	Severe	MCHA	Macro	Dimorphic	NNA
6 m-1 y	23 (3.65)	166 (26.39)	19 (3.02)	100 (15.89)	8 (1.27)	53 (8.42)	47 (7.47)
2-3 y	17 (2.70)	122 (19.39)	20 (3.17)	77 (12.24)	4 (0.63)	43 (6.83)	35 (5.56)
4-5 y	13 (2.06)	75 (11.92)	14 (2.22)	42 (6.67)	5 (0.79)	30 (4.76)	25 (3.97)
6-12 y	27 (4.29)	114 (18.12)	19 (3.02)	90 (14.30)	6 (0.95)	27 (4.29)	37 (5.88)
Total	80 (12.7)	477 (75.82)	72 (11.43)	309 (49.1)	23 (3.64)	153 (24.3)	144 (22.88)

Figures in parenthesis indicate percentage. m: Months; MCHA: Microcytic hypochromic anaemia; NNA: Normocytic normochromic anaemia; y: Years

Table 4: Mean of parameters in nonhemoglobinopathies and hemoglobinopathies

Parameters	Nonhemoglobinopathies (n=629)				Hemoglobinopathies (n=13)			
	Max	Min	Mean	SD	Max	Min	Mean	SD
Hb (g %)	11	3.20	8.51	1.3466	10.5	4.30	6.23	1.8931
RDW	28.6	12	17.23	1.8510	42.10	18.10	24.41	6.5526
MCV (fl)	105	49	75.08	9.9348	78.90	52.0	65.04	6.7106
Reticulocyte count	-	-	-	-	0.36×10^{12}	0.08×10^{12}	0.163×10^{12}	0.343
HbF (g %)	-	-	-	-	90.10	3.00	31.69	23.13

Hb: Hemoglobin; MCV: Mean corpuscular volume; RDW: Red cell distribution width; SD: Standard deviation

followed-up at the primary care level, so that the complications such as cognitive and behavioral effects of anemia can be prevented. Anaemia has multifactorial causes involving complex interaction between nutrition and other factors like infectious diseases, and this complexity presents a challenge to effectively address the population determinants of anaemia. Reduction of knowledge gaps in research and policy and improvement of the implementation of effective population-level strategies will help to alleviate the anaemia burden in low-resource settings.^[15-17]

In the present study, occurrence of anemia among the study population was found to be 642 (72.79%), out of which 629 (98%) had non hemoglobinopathies and 13 (2%) suffered from hemoglobinopathies.

Nonhemoglobinopathies

The following aspects are discussed comparing with other studies.

Distribution among different age groups

In the present study, infants (6 months-1 year) were found to be most affected constituting to 33% followed by school-going children (6-12 years, 26%), toddlers (2-3 years, 25%), and preschool children (4-5 years, 16%). The occurrence of anemia was 50% in infants < 2 years of age and varied between 14% and 22% in 6-11-year-old children.^[18]

According to the NFHS 1998-99, 74% of the children in the age group of 6-35 months were anemic.^[19] In the study conducted by Gomber *et al.*, 76% of children were anemic in the age group of 3 months-3 years.^[20] Osório *et al.*, have noticed the incidence of anemia to be 40.9% in the age group of 6-59 months.^[21]

Sex distribution

Out of 642 anemic children, 375 (58%) were males and 267 (42%) were females. The male to female ratio was found to be 1.4:1. A similar sex distribution was noted in the study conducted by Gomber *et al.*,^[22] in which out of the 95 children studied for etiology of anemia, 51 were boys and 44 were girls. There was no difference in sex distribution in the study conducted by Kapoor *et al.*^[23]

Severity or grading

Our study depicted that most children in all the age groups suffered from moderate anemia. Among 629 children with nonhemoglobinopathies, 477 (75.8%) had moderate degree of anemia. In comparison, the study conducted by Gomber *et al.*,^[22] among children aged 5-5.9 years, mild anemia was found in 28.9% and moderate anemia in 2.9% of children.^[22] In another study conducted by Vishwanath *et al.*,^[24] it was found that of the 100 children evaluated 89 children had iron deficiency anemia and 48% had mild, 42% had moderate, and 10% had severe anemia.

Morphologic types of anemia

In the present study, MCHA 309 (49%) was most common followed by dimorphic 153 (24%), NNA 144 (22%), and

macrocytic 23 (4%). This is in comparison to Kapoor *et al.*,^[23] study in which MCHA was most common (43.2%) followed by equal incidence of NNA and dimorphic anemia (27%), while the least common was macrocytic anemia (2.7%). Gomber *et al.*,^[20] have adopted an etiological classification of anemia rather than morphological classification. They found iron deficiency anemia to be the most common (41%) and folate deficiency to be least common (2.2%).

Red cell indices studied

In the present study, mean Hb, MCV, RDW was 8.5 g/dL, 75.08 fl, 17.23, respectively in comparison to study conducted by Geibel Herbert N which had a mean Hb, MCV, RDW of 9.78 g/dL, 64.34 fl, 17.20, respectively.^[25] In the study conducted by Osorio, mean hemoglobin was found to be 11 g/dL.^[21] In another study conducted by Aulakh *et al.*,^[26] among the iron deficiency anemia group, the mean RDW value among children with mild, moderate, and severe anemia was $16.60 \pm 1.78\%$, $17.95 \pm 1.91\%$, and $20.55 \pm 1.32\%$, respectively.

Hemoglobinopathies

Patients with hemoglobinopathy syndrome are commonly encountered in hematology clinic. Of these, the commonest disorder of hemoglobinopathy syndrome in India is thalassemia.^[27]

The following findings of the present study are discussed comparing with other studies.

Distribution among different age groups

Of the 13 children with hemoglobinopathies, majority were in the age group of 6-12 years 7 (53%) followed by 2-3 years 4 (31%). There was an equal occurrence among 6 months-1 year 1 (8%) and 4-5 years 1 (8%).

Sex distribution

Of the 13 children with hemoglobinopathies, 8 were males and 5 were females. Thus, the male to female ratio was found to be 1.6:1.

Distribution of types of hemoglobinopathies

In the present study, thalassemia major was the most common type of hemoglobinopathy seen in 9 (54%) children followed by thalassemia minor among 2 (30%) children and equal incidence of about 1 (8%) child each suffering from sickle cell anemia, and sickle cell thalassemia. In the present study, homozygous thalassemia was the most common. In a study conducted by Mitra,^[27] HbE was found to be the most common, followed by homozygous thalassemia and least common was HbDE disease.

Red cell indices

In the present study, the mean Hb, mean MCV, mean RDW, mean retic, and mean HbF were 6.23 ± 1.8 g/dL, 65.04 ± 6.7 fl, 24.41 ± 6.5 , $0.163 \times 10^{12} \pm 0.3$, and 31.69 ± 2.3 , respectively. According to study conducted by Roberts and El Badawi,

in β thalassemia-mean Hb, mean MCV, mean RDW, mean reticulocyte count, and Mean HbF-were 12.5 ± 1.9 , 63.3 ± 4.7 , 14 ± 1.5 , $0.178 \pm 0.09 \times 10^{12}$, 5.1 ± 3.6 , respectively, in sickle cell anemia-Mean Hb, mean MCV, mean RDW, mean reticulocyte count, and mean HbF were 8.5 ± 1.3 g/dL, 89.4 ± 8.4 fl, 16.8 ± 3.4 , $0.353 \pm 0.132 \times 10^{12}$ and 33.3 ± 17.6 , respectively and in sickle thalassemia-Mean Hb, mean MCV, mean RDW, mean retic, and mean HbF were 9.4 ± 2 , 68.4 ± 5.3 , 16.4 ± 2.2 , $0.37 \pm 0.290 \times 10^{12}$ and 24.9 ± 11.2 , respectively. Further, it was found that RDW was highest in sickle cell anemia followed by in sickle thalassemia and β thalassemia and was least in iron deficiency anemia,^[28] which is similar to that seen in present study. A study conducted by Madan *et al.*,^[29] showed mean Hb in iron deficiency to be 8.1 g/dL, in thalassemia trait with iron deficiency to be 10.7 g/dL and thalassemia trait without iron deficiency to be 11.6 g/dL. Another study showed increased RBC count with mild anemia and marked reduction in MCV, MCH, to be a reliable indicator of thalassemia trait.^[30]

Conclusion

The occurrence of anemia among children aged between 6 months and 12 years is high and nonhemoglobinopathies predominate over the hemoglobinopathies.

Recommendation

There is an urgent need to initiate specific public health action to prevent anemia considering the grave consequences of anemia and iron deficiency on the physical and mental growth and development of these children and on their long-term health. Appropriate diagnostic tests will allow most cases of anemia to be diagnosed. There must be a uniform definition of screening criteria. As anemia in infants is common, screening should be done in this age group.

Limitations of the present study

1. Data are limited to one hospital.
2. Iron levels could not be studied in these cases due to financial burden on the patient.

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