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Profile of Anemia Among Admitted Pediatric Patients: A Retrospective Study

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Abstract

Introduction: Anemia remains a major public health challenge worldwide, particularly affecting children under five years of age in developing countries. It contributes significantly to morbidity, impairs growth and cognitive development, and increases susceptibility to infections. Identifying clinical patterns and hematological profiles is vital to guide effective prevention and management strategies.

Methods: A retrospective descriptive study was conducted at a tertiary care center in Central India, including children aged 1 month to 14 years admitted between August and December 2019 with anemia at admission. Demographic data, clinical presentation, nutritional status, and laboratory parameters were collected from hospital records. Hematological indices and additional investigations were analyzed to determine anemia types and etiologies. Statistical analysis was performed using SPSS software, and associations were assessed with chi-square tests.

Results: Out of 610 admitted children, 182 (46.2%) were anemic. Male children (53.8%) slightly outnumbered females (46.2%), but the difference was not statistically significant. The highest prevalence was observed in children under five years (76.9%), with most cases showing moderate anemia (48.3%), followed by mild (28.5%) and severe (23.1%). Microcytic anemia was the most common morphological type (61.5%). Nutritional anemia predominated, with 43 cases of iron deficiency and 14 cases of vitamin B12 deficiency. Severe acute malnutrition (SAM) was present in 38 children and significantly associated with anemia severity ($p = 0.028$). Hemolytic anemias, infections, and pancytopenia also contributed to severe presentations.

Conclusion: Nutritional anemia remains the most prevalent and preventable cause of anemia in hospitalized children, strongly linked to poor dietary practices and malnutrition. Enhancing nutrition education, early screening for hemoglobinopathies, and strengthening public health interventions are essential to reduce childhood anemia burden.

Keywords: Anemia, Nutritional anemia, Children, Hematological profile, Malnutrition, Microcytic anemia.

INTRODUCTION

Anemia continues to be a major global health concern, particularly affecting children in developing nations. According to the World Health Organization (WHO), anemia contributes significantly to morbidity and mortality among children under five years of age, with nearly 42% estimated to be anemic worldwide [1]. In India, despite ongoing public health initiatives, the prevalence of anemia among young children remains alarmingly high, exceeding 50% in many states [2,3]. The high burden of anemia in children can be attributed to multiple factors, including nutritional deficiencies, recurrent infections, and inherited hematological disorders. Poor dietary practices, late introduction of complementary feeding, and

frequent illnesses exacerbate the risk, creating a vicious cycle of malnutrition and impaired immunity [4]. Anemia not only impacts physical growth but also hampers cognitive development and school performance, affecting the overall well-being and future potential of children [5].
Identifying the clinical patterns and hematological characteristics of anemia in hospitalized children can aid in early diagnosis, tailored interventions, and targeted preventive strategies. Understanding the interplay between anemia severity, nutritional status, and infection patterns is crucial for implementing effective public health measures.

AIMS AND OBJECTIVES

Aim

To analyze the clinical spectrum and hematological profile of anemia in hospitalized children and to assess its association with age, gender, and nutritional status.

Objectives

1. To determine the prevalence and severity distribution of anemia among hospitalized children aged 1 month to 14 years.
2. To evaluate the morphological types and probable etiologies of anemia based on laboratory parameters.
3. To examine the relationship between anemia severity and nutritional status in children, particularly those under five years of age.
4. To identify associated co-morbid conditions, including infections and hematological disorders, contributing to anemia.

MATERIALS AND METHODS

Study design and setting

A retrospective descriptive study was conducted in the Pediatric Department of a tertiary care center in Mediciti Institute Of Medical Sciences, Hyderabad . The study included children admitted to the pediatric intensive care unit (PICU) and general pediatric ward over a five-month period, from August to December 2024-25.

Study population

Children aged 1 month to 14 years who were found to have anemia at the time of admission were included. Anemia was defined according to WHO age-specific hemoglobin cut-off values.

Inclusion criteria

- Children between 1 month and 14 years of age.
- Hemoglobin levels below WHO-defined thresholds for anemia.

Exclusion criteria

- Children with a known history of chronic hemolytic anemia or aplastic anemia.
- Children younger than 1 month or older than 14 years.

Data collection

Patient data were retrieved from the hospital records, including demographic details (age and gender), clinical presentation, nutritional assessment, and relevant laboratory investigations. Nutritional status was categorized as severe acute malnutrition (SAM), moderate acute malnutrition (MAM), or well-nourished based on WHO criteria.
Hematological evaluations included hemoglobin concentration, total leukocyte count, differential count, platelet count, mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), mean corpuscular hemoglobin concentration (MCHC), packed cell volume (PCV), red cell distribution width (RDW), reticulocyte count, and peripheral smear examination. Additional specific tests, such as hemoglobin electrophoresis, serum ferritin, iron studies, vitamin B12 levels, and bone marrow examination, were recorded when available.

Data analysis

Data were analyzed using SPSS software. Descriptive statistics (frequency, percentage, mean, and standard deviation) were used for summarizing categorical and continuous variables. Chi-square test and logistic regression analysis were employed to explore associations between anemia severity and demographic or nutritional variables. A p-value < 0.05 was considered statistically significant.

RESULTS

During the study period, a total of **610 patients** were admitted to the PICU and pediatric ward, of which **182 patients** met the inclusion criteria and were included in the study. The prevalence of anemia was found to be **46.2%** among hospitalized children.
In our study, **53.8%** of children were boys and **46.2%** were girls. The most commonly affected age group was under-five children, comprising **76.9% (n = 140)**.
Among the 182 anemic children:

- **9.3%** were below 6 months, **28.5%** were between 6 months to 1 year, **39%** were between 1 to 5 years, **15.3%** were between 5 to 10 years, **7.7%** were between 10 to 14 years.

Severity of anemia

According to WHO hemoglobin cutoffs:

- Mild anemia: **52 (28.5%)** children, Moderate anemia: **88 (48.3%)** children, Severe anemia: **42 (23.1%)** children.

Morphological type (MCV-based)

Based on MCV values, the patients were classified as:

- Microcytic anemia: **112 (61.5%),** Normocytic anemia: **53 (29.1%),** Macrocytic anemia: **17 (9.3%).**

Etiology of anemia

The most common cause was **nutritional anemia**, observed in the majority of cases:

- Isolated iron deficiency: **43 children**
- Vitamin B12 deficiency: **14 children**
- Combined protein-energy malnutrition and micronutrient deficiency: **8 children**
- Severe acute malnutrition (SAM): **42 children**
- Moderate acute malnutrition (MAM): **25 children**

Hemolytic anemia was diagnosed in **21 children**, with breakdown as follows:

- Thalassemia: **7,** Sickle cell anemia: **8 ,** G6PD deficiency: **2 ,**Malaria-related hemolysis: **2 ,** Autoimmune hemolytic anemia: **2**

Other causes included:

- Leukemia: **3 children,** Aplastic anemia: **4 children,** Hemophilia with ongoing bleeding: **1 child,** Sepsis-related anemia: **6 children .** Chronic disease-related anemia: **14 children** (including CKD, CHD, cerebral palsy, global developmental delay, HIV)

Nutritional status in under-five children

Out of 140 children under 5 years: SAM was present in **38 children,** MAM in **25 children,** Well-nourished: **77 children .** There was a significant association between nutritional status and anemia severity (p-value = 0.028).

Infection as a contributing factor

Infection was the most common cause for admission, seen in **18.6%** of cases. Pneumonia: **13 children**, Sepsis: **17 children.** Urinary tract infection: **3 children,** Tubercular meningitis: **2 children,** Pulmonary tuberculosis: **4 children**

Bicytopenia and pancytopenia

Bicytopenia was seen in **18%** of anemic patients, mostly presenting as anemia with thrombocytopenia. Common causes included SAM (5), sepsis (5), vitamin B12 deficiency (3), hemolytic anemia (1), DIC (2), CKD (1), others.

Pancytopenia was observed in **9%** of patients (n = 16). Causes included aplastic anemia (4), sepsis (3), thalassemia major (2), sickle cell disease (1), severe malnutrition with B12 deficiency (3), cerebral malaria (1), unknown (2).

Among pancytopenic patients: **11 patients improved and were discharged, 5 patients unfortunately succumbed to illness.**

Table 1: Distribution of anemia according to gender

S. No.	Gender	Mild	Moderate	Severe	Total patients	Chi-square test	p-value
1	Male	26	49	23	98		
2	Female	26	39	19	84	3.87	0.144
3	**Total**	52	88	42	182		

Male children showed a slightly higher proportion of anemia; however, the difference was not statistically significant.

Table 2: Distribution of anemia in children according to age group

S. No.	Age group	Mild	Moderate	Severe	Total patients	Chi-square test	p-value
1	<1 year	22	27	12	61		
2	1–5 years	18	42	11	71		
3	>5 years	12	19	19	50	7.25	0.122
4	**Total**	52	88	42	182		

Anemia was most prevalent in children under 5 years, but severity distribution did not show a significant age association.

Table 3: Distribution of anemia based on nutritional status in under-five children

S. No.	Nutrition status	Mild	Moderate	Severe	Total patients	Chi-square test	p-value
1	SAM	4	24	10	38		
2	MAM	5	12	8	25		
3	Well nourished	21	30	8	59	12.94	0.028
4	**Total**	30	66	26	122		

A significant association was found between poor nutritional status and increased severity of anemia in under-five children.

Table 4: Severity of anemia, neutropenia, and thrombocytopenia in pancytopenic patients

S. No.	Severity	Anemia	Neutropenia	Thrombocytopenia
1	Mild	0	5	3
2	Moderate	6	4	5
3	Severe	10	7	8
Total	—	16	16	16

Most pancytopenic patients presented with severe anemia, and a higher proportion had associated severe neutropenia and thrombocytopenia.

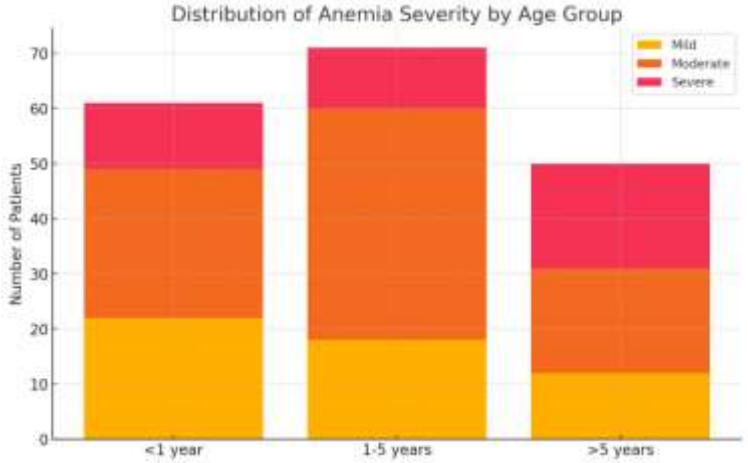

FIGURE 1. **Distribution of Anemia Severity by Age Group**

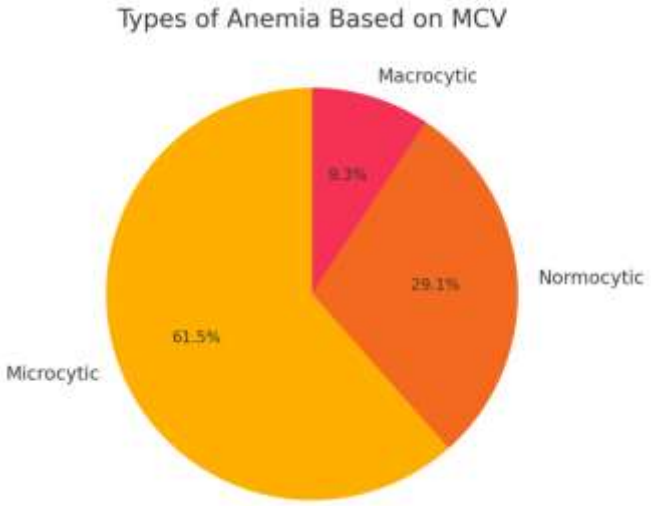

FIGURE 2. **Types of Anemia Based on MCV**

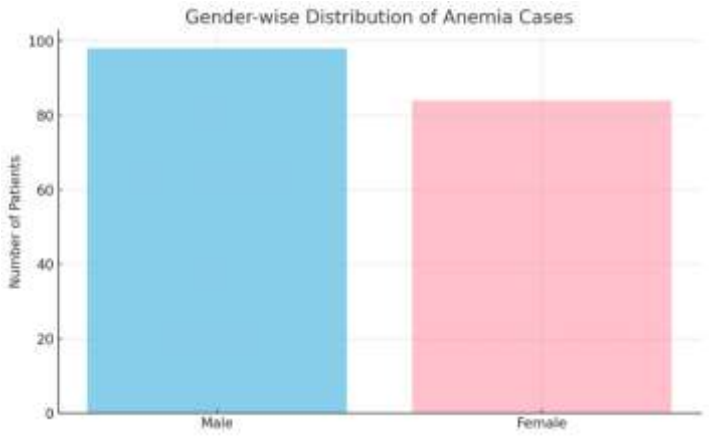

FIGURE 3. **Gender-wise Distribution of Anemia Cases**

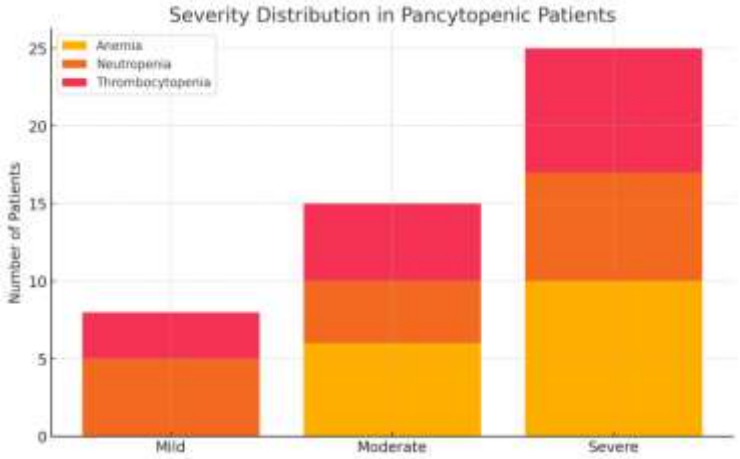

FIGURE 4. **Severity Distribution in Pancytopenic Patients**

DISCUSSION

According to the World Health Organization (WHO), anemia remains a significant global public health issue, especially in children under five years of age, with nearly 42% estimated to be anemic worldwide [1]. In our study, the prevalence of anemia among hospitalized children was 46.2%, which aligns with findings from other studies conducted in India and similar developing regions [2, 3].

In our revised study, anemia was more common in boys (53.8%) than girls (46.2%), although this difference was not statistically significant ($p = 0.144$). Similar gender distributions have been reported in various studies, with some showing male predominance (Kanchana et al., Mahroof et al.) [5, 6], while others noted either a female predominance or no significant difference [7].

Children under five years of age were the most affected group, accounting for 76.9% of anemic cases. Among these, the majority belonged to the 1–5 year age group (39%), followed by 6 months to 1 year (28.5%), and below 6 months (9.3%). The high prevalence in this age group could be attributed to increased nutritional requirements for rapid growth, frequent infections, and inadequate complementary feeding practices (Sudhagandhi et al., Assefa et al.) [7, 8].

Based on severity, moderate anemia was most common (48.3%), followed by mild (28.5%) and severe (23.1%) anemia. Similar patterns have been described in other studies where moderate anemia often dominates (Stevens et al.) [9].

Morphologically, microcytic anemia was most prevalent (61.5%), followed by normocytic (29.1%) and macrocytic anemia (9.3%). This reflects iron deficiency anemia as the leading cause, as microcytosis is a characteristic feature (Cardoso et al., Santo et al.) [10, 11].

Nutritional anemia was identified as the most common etiology in our cohort, with 43 children having isolated iron deficiency and 14 with vitamin B12 deficiency. Additionally, 38 children were diagnosed with severe acute malnutrition (SAM), and 25 with moderate acute malnutrition (MAM). The significant association between poor nutritional status and severity of anemia ($p = 0.028$) underscores the crucial role of nutrition in preventing anemia. Similar findings have been

emphasized in various Indian studies (Ramana Shastry, Madoori et al.) and WHO guidelines recommending micronutrient fortification and supplementation [12, 13, 16, 17].

Among the other causes, hemolytic anemias were found in 21 children, including thalassemia (7), sickle cell anemia (8), G6PD deficiency (2), malaria-related hemolysis (2), and autoimmune hemolytic anemia (2). These findings highlight the importance of early screening for hemoglobinopathies and inherited red cell disorders, particularly in high-prevalence areas (Janjale et al.) [14].

Infections were a major reason for hospitalization in 18.6% of anemic children. Pneumonia, sepsis, and tuberculosis were the leading infections identified. Infections can exacerbate anemia through mechanisms such as hemolysis, bone marrow suppression, and increased inflammatory cytokines affecting erythropoiesis (Sahu et al.) [19].

We also found bicytopenia in 18% and pancytopenia in 9% of anemic children. Among pancytopenic patients, aplastic anemia, severe infections, and severe malnutrition were common underlying causes. The high mortality in this subgroup (5 out of 16) highlights the need for prompt diagnosis and intensive management. Similar trends were observed in studies conducted in South Asia and African regions (Shazia et al., Jan et al.) [15, 18].

Our study reiterates that nutritional anemia remains the most prevalent and preventable cause of anemia in hospitalized children. Addressing nutritional deficiencies, ensuring timely introduction of complementary feeding, deworming, and improving hygiene can significantly reduce the anemia burden. Moreover, strengthening community awareness programs and integrating routine screening for hemoglobinopathies into antenatal and early childhood care can aid in early identification and management.

CONCLUSION

In this study, anemia was found to be highly prevalent among hospitalized children, with the greatest burden observed in those under five years of age. Nutritional anemia emerged as the most common cause, significantly associated with poor nutritional status and highlighting the critical role of dietary practices and micronutrient deficiencies.

The predominance of microcytic anemia underscores the continued public health challenge posed by iron deficiency in this population. Hemolytic anemias, infections, and severe malnutrition further contributed to the severity and complexity of cases, particularly in children presenting with pancytopenia and multiple cytopenias.

These findings reinforce the urgent need for comprehensive community-based strategies focused on early nutrition education, timely complementary feeding, micronutrient supplementation, and regular screening for inherited hemoglobin disorders. Strengthening preventive measures, improving caregiver awareness, and integrating routine anemia screening into pediatric health programs can collectively reduce the burden and long-term complications of anemia in children.

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