To study the prevalence and types of nutritional anemia in under-five children with severe acute malnutrition

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Received - 20 April 2020 Initial Review - 06 May 2020 Accepted - 15 May 2020

ABSTRACT

Background: Anemia is an important comorbidity in under-five children with severe acute malnutrition (SAM). The data on evaluation of SAM are limited. **Aim:** This study was done for analysis of incidence and types of anemia prevalent in SAM children. **Materials and Methods:** It was a hospital-based prospective observational study conducted from July 2017 to December 2018. A total of 260 children of age <5 years and who were confirmed cases of SAM were included in the study. A detailed demography and data regarding anemia and related variables hemoglobin, mean corpuscular volume, peripheral smear, serum ferritin, Vitamin B_{12}, and folic acid levels, were recorded and analyzed. The data were entered into MS-Excel sheet and analysis was performed using SPSS version 21.0. **Results:** About 95% of anemia prevalence was found among children with SAM and most cases were of nutritional anemia (81.79%). About 54.33% of the children had mild anemia, with 79.75% had iron deficiency as the most common cause, followed by Vitamin B_{12} and folic acid deficiency. **Conclusion:** The high prevalence of anemia suggests that it may contribute as a causal factor for hospitalization in severely malnourished children. We recommend future measures for prevention and control of anemia, including increased coverage of nutritional supplementation and fortification programs.

Key words: *Iron deficiency, Microcytic, Nutritional anemia, Severe acute malnutrition*

India is facing some obstacles in the health sector in dealing with some major preventable diseases effectively. Nutritional anemia is a significant public health problem that occurs worldwide in both developed and developing countries. According to the data available from the National Family Health Survey (NFHS-4) in 2015–2016, 58.4% of the children were found to be anemic. India has the highest prevalence of severe acute malnutrition (SAM) and about 93.4 lakh (7.5%) children are estimated to be suffering from SAM as per NFHS-4 [1].

Anemia cases usually develop gradually and progressively and mostly related to iron deficiency (ID). In early childhood, poor feeding habits, especially during the weaning period, exacerbate the problem. Anemia frequently develops as breast milk is replaced by foods that are poor in iron and other nutrients, including Vitamin B_{12} and folic acid. Low oxygenation of brain tissues, a consequence of anemia, may lead to impaired cognitive function, growth, and psychomotor development, especially in children. Infants, children younger than 5 years, and pregnant women have greater susceptibility to anemia because of their increased iron requirements due to rapid body growth and expansion of red blood cells [2].

ID is the most common nutritional deficiency causing anemia in children. It generally arises when physiological requirements cannot be met by daily dietary iron ingestion as well as iron absorption. India being a developing nation, the diet and infections are a restricting factor causing the condition [3]. ID is measured by ferritin stores and depletion of ferritin is the first measurement of ID anemia (IDA). Although government has initiated various reforms for the pregnant mother and the child to keep up with the iron stores, IDA continues to be a major health problem in the country [4].

The Indian studies have consistently shown an association between anemia and under-nutrition [3,5-8]. It can be seen that anemia is influenced by socioeconomic, biological, environmental, and nutritional factors. In India, population-based information is available on anemia in under-five malnourished children; however, data on nutritional anemia in children with SAM are scarce. Thus, this study is aimed to estimate the prevalence and type of nutritional anemia in under 5-year-old SAM children who were admitted to our hospital.

MATERIALS AND METHODS

A hospital-based observational prospective descriptive study was conducted from July 2017 to December 2018, in a tertiary care hospital in West Delhi. Informed consent was taken from caregivers of the children before enrollment and ethical clearance was obtained from the institutional committee.

A total of 260 confirmed cases of SAM in children with age from 6 to 59 months were included in the study. The sample size

calculation was based on the study by Dos Santos *et al*. who observed that prevalence of anemia in under 5-year-old children was 56.6% [2]. Taking this value as reference, the minimum required sample size with 6.5% margin of error (ME) and 5% level of significance was 224. To reduce ME, total sample size taken was 247. Formula used was: $N \geq (p[1-p])/(ME/z_{\alpha})^2$ where Z_{α} is value of Z at two-sided alpha error of 5%, ME is margin of error, and p is prevalence rate.

The children with SAM and age group 6–59 months were included in the study. The children undergoing treatment for anemia, suffering from chronic systemic diseases, i.e., secondary cases of SAM (any chronic renal, cardiac, hepatic, neurological or developmental, and major anomalies/surgical cases) children suffering from known malabsorption diseases such as celiac disease, malabsorption syndromes, and cardiac failure, children suffering from known metabolic bone diseases, children on anticonvulsants, or any other medication which can interfere with cytochrome P 450 activities ketoconazole were excluded from the study. The diagnosis of SAM was based on the criteria of weight for height < −3 standard deviations (SD) and/or mid-arm circumference <115 mm, and/or bilateral pitting edema of both feet [9,10].

At admission, all children were assessed and treated for emergency signs, and then detailed history of the illnesses and physical examinations was done as a routine procedure. About 4 ml of venous blood sample and 3 ml of ethylenediaminetetraacetic acid blood was drawn for estimation of hemoglobin (Hb), mean corpuscular volume, serum ferritin, Vitamin B_{12}, folic acid level, and examination of peripheral smears. These anemic cases were classified into nutritional and non-nutritional anemia on the basis of biochemical parameters (serum ferritin, folic acid, and Vitamin B_{12} levels). The WHO criterion (Hb <11 g/dL) was used to diagnose anemia [11]. To categorize the degree of anemia, the following cutoff points were used: 10.0–10.9 g/dL – mild anemia; 7.0–9.9 g/dL – moderate anemia; and <7 g/dL – severe anemia.

The continuous variables were presented as mean±SD and median. The categorical variables were expressed as frequencies and percentages. Nominal categorical data between the groups were compared using Chi-square test or Fisher's exact test as appropriate. The comparison of normally distributed continuous variables between the groups was formed using Student's t-test for all statistical tests, $p<0.05$ was considered as statistically significant. The data were entered into MS excel sheet and analysis was performed using SPSS version 21.0.

RESULTS

Among the total of 260 SAM children who visited the department during the study period, 247 children had anemia (prevalence 95%). The mean age of the study children was 23±13.83 months. A majority of children (59.62%) were <2 years of age and 40.38% were 2–5 years. There were 147 (56.54%) males and 113 (43.46%) females. Among the 247 anemic children, nutritional deficiencies were seen in 210 (85.02%) children, in the form of iron (ferritin), Vitamin B_{12}, folic acid, or mixed nutritional deficiency; as determined in the study (Table 1)

Most of the children (54.25%) had mild anemia, 33.2% had moderate anemia, and 12.55% had severe anemia. On the basis of morphology, majority of the children had microcytic anemia (55.06%), followed by dimorphic in 37.65%, macrocytic in 5.26%, and normocytic in 2.02%. There was no significant difference in the type of anemia in different genders ($p>0.05$); as shown in Table 2.

In dimorphic anemia, the most common deficiency was ferritin (78.49%); and in seven children, both ferritin and Vitamin B_{12}, were low. In microcytic anemia, the most common deficiency was ferritin (85.29%); followed by Vitamin B_{12} and folic acid. In seven children, both ferritin and Vitamin B_{12}, were low and in one patient, both ferritin and folic acids were low. In macrocytic anemia, the most common deficiency was Vitamin B_{12} (84.62%); followed by ferritin and folic acid. In one child, both ferritin and Vitamin B_{12} were low and in one child both Vitamin B_{12} and folic acids were low. In normocytic anemia, no deficiency is shown in Table 3.

Table 1: Distribution of biochemical parameters

Bio chemical parameters	Low (%)	Normal (%)	Mean±Std	Median (IQR)
Ferritin (ng/ml)	192 (77.73)	55 (22.27)	14.16±14.87	8.4 (6.300–12.300)
Folic acid (ng/ml)	3 (1.21)	244 (98.79)	12.23±3.53	12.3 (9.300–15.150)
Vitamin B_{12} level (pg/ml)	32 (12.96)	215 (87.04)	197.21±154.57	128 (86.400–255.500)

Table 2: Association of type of anemia and gender

Type of anemia	Gender		Total	p value
	Female (n=108)	Male (n=139)		
Dimorphic	39 (36.11)	54 (38.8)	93 (37.65)	0.418
Normocytic	4 (3.70)	1 (0.72)	5 (2.02)	
Microcytic	59 (54.63)	77 (55.40)	136 (55.06)	
Macrocytic	6 (5.5)	7 (5.04)	13 (5.26)	
Total	108 (100.00)	139 (100.00)	247 (100.00)	

$\chi^2=2.833$

Table 3: Distribution of biochemical parameters in various type of anaemia

Type of anemia	Low ferritin (ng/ml) (%)	Low folic acid (ng/ml) (%)	Low Vitamin B_{12} level (pg/ml) (%)
Dimorphic (n=93)	73 (78.49)	1 (1.08)	12 (12.90)
Normocytic (n=5)	0 (0.00)	0 (0.00)	0 (0.00)
Microcytic (n=136)	116 (85.29)	1 (0.74)	9 (6.62)
Macrocytic (n=13)	3 (23.08)	1 (7.69)	11 (84.62)

DISCUSSION

Some of the highest rates of child malnutrition and mortality in under-five children in the world are seen in our country. Anemia among children between 6 and 59 months is still a major social and medical problem [12]. Anemia, if not diagnosed and treated may become severe which is a leading cause of pediatric morbidity, hospitalization, and mortality. It has been seen that SAM with anemia shows higher mortality as compared to without anemia [12]. We found that prevalence of anemia was 95% in SAM children.

Onyeneho *et al*. analyzed a large number of children from the 2015 to 2016 Indian National Fertility and Health Survey and found that in the poorest household 63.2% children and in the richest household 52.9% children were anemic [3]. John *et al*. found that 30% of the children belonging to the upper middle class in Kerala were anemic and none of the children had SAM [6]. Bharati *et al*. studied the prevalence of anemia in children of 6–59-month-old children in India. Data were taken from the fourth round of the NFHS-4 in 2015–2016. A total of 56.3% of the children were anemic in 2015–2016; 1.5% children were severely anemic, 27.6% were moderate, and 27.2% were mildly anemic [8]. Dwivedi *et al*. recorded a prevalence rate of 85% in a city in Madhya Pradesh [12]. Jain *et al*., in their study, found that the prevalence of anemia was 59.9% in 137 children of age 1–2 years in urban slums of Meerut [13]. Such high prevalence of anemia shows that it is a major problem in our country.

We included SAM children of under-five age group and found that there were 139 (56.28%) males and 108 (43.72%) females. The mean age of the children in our study was 22.86 months. A majority (63.56%) of children was <2 years of age and 36.44% were 2–5 years of age. John *et al*. reported that a higher proportion of children <2 years of age (40.7%) had IDA and there was no sex predilection [6]. In study by Janjale *et al*., incidence of severe anemia was more in <3.5 years age group (50.85%). Male to female ratio was 1.45:1 [7]. As reported by Bharati *et al*., the most common age group affected with anemia was 12–23 months with prevalence rate of 68.1% followed by 9–11 months (prevalence, 67.2%) and 6–8 months (prevalence, 65.9%) [8]. Dwivedi *et al*. reported 100 cases of SAM, of which 62% were males and 38% were females. The mean age of the children was 15.85 months [12]. Thus, majority of children were <2 years of age as seen in our study.

The initial 18–24 months of age becomes very crucial for nutrition and growth of the child. Wang *et al*. mentioned that the first 18 months of life were the most important for long-term childhood well-being [14]. It is well-known that insufficient food intake in this period is common, and inadequate breastfeeding or complementary feeding is responsible for growth stunting and infant morbidity, including nutritional anemia in millions of children around the world.

In our study, we found that the majority of the children had mild anemia (54.25%), moderate anemia was seen in 33.2% children, and severe anemia was observed in 12.55% children. In the study by Jain *et al*., 24.3% had severe anemia, 49.8% children had moderate anemia, and 26.8% had mild anemia [13]. In a study by Dwivedi *et al*., the majority of SAM children had moderate anemia (42%) with mild anemia in 24% and severe anemia in only 19% patients and 15% children were without anemia [12]. In contrast, Thakur *et al*. found that a majority (67.3%) had severe anemia; and 13.8% had moderate anemia [15]. The more cases of severe anemia increase the requirement of blood transfusion in the children. In their study, 25% required blood transfusion. This is an indication toward nutritional anemia being a very common comorbidity of SAM and its severity may demand hospital admission with blood transfusion.

In our study, the most common type of anemia was microcytic which was seen in 136 (55.06%) children, followed by dimorphic anemia in 37.65% children. Very few children had macrocytic and normocytic anemia. ID was the most common nutritional deficiency in the study. Our study results were similar to study by Thakur *et al*., where the most common type of anemia was microcytic due to ID (38.6%), followed by megaloblastic anemia (30.5%) [15]. In contrast, in the study by Dwivedi *et al*., the most common type of anemia was macrocytic, followed by microcytic anemia [12]. This may be due to the fact that most of these children had anisocytosis and showed features of dimorphic anemia which was treated with iron at the first level, leading to a relative recovery of iron stores and deficiency of Vitamin B_{12} or folate resulting in macrocytosis.

The study had few limitations. First, being a single center hospital-based study, the results cannot be extrapolated to study the prevalence of nutritional anemia in the general population. Second, our study being a cross-sectional observational study, the role of diet, socio-economic status, and other comorbid illnesses in SAM could not be established. Finally, the lack of control population and long-term follow-up data further posed limitations in studying the treatment protocol and complications.

CONCLUSION

The high prevalence of anemia suggests that it may contribute as a causal factor for hospitalization in severely malnourished children. This study stresses the importance of evaluating the overall nutritional status of patients. We recommend future measures for prevention and control of anemia, including increased coverage of nutritional supplementation and fortification programs.

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Funding: None; Conflicts of Interest: None Stated.

How to cite this article: Jangid RK, Kumar A, Anita, Mahapatra C, Yadav M, Singhal S, *et al.* To study the prevalence and types of nutritional anemia in under-five children with severe acute malnutrition. Indian J Child Health. 2020; 7(6):270-273.

Doi: 10.32677/IJCH.2020.v07.i06.007