Effect of Iron Supplementation on Malnourished Children with Diarrhoea and Anemia

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Abstract

Twenty one children admitted into Dhaka Shishu Hospital with diarrhoea were studied for the effect of iron supplementation on their iron status. The age of the children ranged from six months to five years. The children were anemic (mean Hb : 7.8 g/dl) and malnourished (less than 60% weight-for-age). The children were given oral iron supplementation at a dose of 5 mg/kg body weight for 14 consecutive days. No significant improvement in iron nutrition status was observed in the children, either in terms of haemoglobin and iron concentration, total iron binding capacity (TIBC) or transferrin saturation. The data indicate that the treatment of anemia in children with diarrhoea warrants a different kind of approach rather than oral administration.

Introduction

Childhood malnutrition and diarrhoea are common in most developing countries and are responsible for the high proportion of death in children[1], It has been reported that diarrhoea and respiratory infection were more than twice as common in anemic as in nonanemic population[2].

Experimental evidence from various studies suggests that anemia predisposes to infections[3,4]. Although an association between diarrhoea and anemia has been shown, the exact role of iron is not yet clear. Therefore, a careful study of the iron status as it relates to anemia in selected groups of malnourished diarrhoeal children has been undertaken to evaluate the possible contribution of iron supplementation to diarrhoeal disease. It is widely believed that the most effective method of decreasing iron deficiency anemia in high prevalence countries is iron supplementation of susceptible population segments. It might reasonably be expected that a reduction in

Bangladesh Journal of Nutrition, Vol. 12, Nos. 1 & 2, December 1999. Institute of Nutrition and Food Science, University of Dhaka, Bangladesh.

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prevalence of malnutrition and anemia in under 5 children will reduce the diarrhoeal morbidity and mortality rates.

Materials and methods

Patients

Twenty one case of various types of diarrhoeal patients with haemoglobin level of 10 g percent or less admitted to Diarrhoeal unit of Dhaka Shishu Hospital, Dhaka, from February 1992 to October 1992 formed the subject of the present study. Children aged between 6 months and 5 years having diarrhoea with less than 60% NCHS (National Center for Health Statistics) weight-for-age (malnourished) were chosen. All the patients were assessed provisionally in the out patient department by a trained doctor.

After admission, the patients were reassessed. Minimum routine examinations necessary for the treatment of the patients were done in all cases. These included estimation of haemoglobin concentration, total and differential counts of white blood cells, albumin-globulin ratio and total protein level of serum. In some instances, additional investigations such as x-ray of chest, ECG, routine examinations of urine and stool, blood grouping, etc, were also done. When the results of all these investigation were found within the normal limit except haemoglobin concentration, the patients were given iron tablets (5 mg/kg body weight) for two weeks. In addition to iron, the iron tablets contained fumarate and folic acid. Also the general physical condition and nutritional status of the patients were scored. Height, weight and mid-upper arm circumference were also recorded for each subject. Nutritional status was measured using the indicator weight-for-age and height-for-age using the criteria of NCHS. Haemoglobin was estimated as cyanomethemoglobin[5].

Estimation of Serum Iron and TIBC

With the consent of the parents, a sample of 2 ml of venous blood was drawn aseptically with a sterile disposable syringe from each patient. The blood was then transferred into a dry test tube and kept standing for 30 min, then centrifuged for 15 min at 3,000 rpm. The serum thus obtained was used for determinations as described below. Serum iron was measured by the World Health Organization (WHO) method of iron determination, a modification of the technique originally described by Bothwell and Mallet[6] using a commercial kit.

Total iron binding capacity (TIBC) was assayed by a method differing slightly from that originally described by Ramsay[7]. This was also determined by using a commercially available kit. Transferrin saturation in serum was calculated by dividing iron concentration by the total iron binding capacity[8].

Student's *t*-test was used for the statistical analysis of the data.

Results

Table 1 shows the characteristics of twenty one children from Dhaka Shishu Hospital included in this study. Out of the 21 diarrhoeal patients 14 (66.7%) were male and 7 (33.3%) were female. The male-female ratio was 2 : 1. The age of the patients ranged from 6 months to 5 years. More than one-third of them were within 1 to 3 year of age group and only a few of them were over 4 years (Table 1). Mean height for the subject was 68.67 cm and mean weight was 5.8 kg. The average weight-for-age and height-for-age of the children were 45% and 78% of the National Centre for Health Statistics (NCHS) reference respectively[9].

Table 1. Characteristics of diarrhoeal children on admission[a].

			Variable						
No. of	Age	Sex	Weight		Height		Albumin	Total (protein)	MUAC
Patient	(month)	(M/F)	kg	(%)*	cm	(%	g/l)	(g/l)	
1.	8	F	2.5	30	48	69	3.4	5.9	8.0
2.	8	F	4.0	46	58	82	2.7	7.5	9.5
3.	9	M	3.1	33	55	76	2.2	4.3	8.0
4.	10	M	3.9	42	55	76	2.7	6.2	11.0
5.	12	M	5.4	53	59	77	2.2	4.0	11.0
6.	12	M	5.3	52	68	89	3.6	6.8	9.0
7.	12	F	4.7	49	72	96	3.0	6.3	9.5
8.	15	M	4.1	37	66	83	2.2	4.0	9.0
9.	24	M	4.6	36	71	81	2.1	3.8	8.0
10.	24	F	7.7	64	75	86	1.8	4.6	10.0
11.	29	M	5.0	36	59	64	4.0	7.4	7.0
12.	30	F	6.5	50	74	81	2.3	5.8	11.5
13.	30	M	6.7	49	68	74	2.7	5.4	11.0
14.	30	M	6.4	48	71	77	2.8	6.4	11.0
15.	36	M	6.4	41	68	71	4.0	7.0	11.0
16.	36	F	8.5	61	65	70	2.4	5.2	9.5
17.	42	M	6.5	42	77	78	1.4	4.4	9.0
18.	42	M	7.4	34	77	65	2.7	5.6	10.0
19.	48	M	8.0	48	89	86	3.4	6.8	12.0
20.	54	M	7.0	40	74	69	3.2	6.2	9.0
21.	60	F	10.0	56	98	90	2.8	4.9	11.0

[a]For details of patients, see materials and methods.

*Weight-for-age and height-for-age are expressed as a percentage of the National Center for Health Statistics Standard. MUAC = Mid-upper arm circumference.

Out of 21 cases of diarrhoea, about 48% of patients has Hb levels below 8 g percent. The lower level observed was 4.4 g percent. In a report of the International Nutritional Anemia Consultive Group[10], the cut-off level of Hb for younger children (upto 10 years of age) is set at 11 g/dl. Thus, if we follow this criteria, all children were found anemic (data not shown).

Table 2 shows the haemoglobin, serum iron, TIBC concentration and transferrin saturation of diarrhoeal children on admission and after supplementation of iron. There were significantly lower level of haemoglobin and iron in all patients than the criteria levels recommended by WHO for iron deficiency[11]. It was found that the level of iron in all patients were lower even after supplementation of iron (Table 2). On the other hand, the concentration of serum total iron binding capacity (TIBC) was higher in all patients after supplementation of iron with lower levels of transferrin saturation. There was no correlation between haemoglobin, serum iron and TIBC. Betkerur *et al.*[12] also did not find any correlation between serum iron, TIBC and severity of anemia.

Table 2. Haemoglobin, iron, TIBC and transferrin saturation values before and after treatment with iron-folate tablet[a].

Parameters	Before treatment (on admission)	After treatment
Haemoglobin (g/dl)	7.77±0.9	8.50±1.2
Iron (μg/dl)	68.09±7.5	61.15±6.4
TIBC (μg/dl)	228.9±17	261.9±18
Transferrin saturation (%)	32.33±4.6	25.02±3.0

[a]For details of patients, see materials and methods. Values are mean ± SE. The differences between data obtained from subjects before and after treatment were statistically analysed by student's *t*-test. No significant difference was found.

Discussion

In the present study the iron deficiency status of diarrhoeal children has been reported and an attempt was made to demonstrate the effect of iron supplementation on them. The patients were mostly children from the lower socio-economic strata who were attending hospitals and were thus not necessarily representative of the whole population.

Iron deficiency is the most common cause of anemia which predisposes infection including diarrhoeal attack in Bangladesh as well as in other parts of the world. It is possible that gastrointestinal pathology during diarrhoeal disease may interfere with the absorption of iron. Due to its multiple potential origins, it is difficult to say to what extent iron deficiency is due to dietary lack or excessive need on the part of individuals or the general population during diarrhoeal disease.

In this study, the recovery of haemoglobin level and serum iron was incomplete with respect to normal values even after supplementing iron tablet to the patients for 14 days. Although, the serum iron concentration remained virtually unchanged, there was some drop in the transferrin saturation. This was due to the fact that the TIBC, which reflects the amount of circulating transferrin, slightly rose during the experimental period. It is possible that this may occur due to the biologically unavailability of the dietary iron.

Our results indicated that the amount of iron absorbed by the intestinal tract was not satisfactory even after treatment with iron tablet, Intestinal morphological changes due to diarrhoea may be the reason for the limited mucosal iron transfer and low absorption. It is also possible that the slow recovery of patients' haemoglobin level may be due to the severe depletion of iron in the subjects on admission and small period of iron supplementation. Our results indicated that on average 14 days of iron treatment (5 mg/kg B.W) was insufficient to restore normal serum iron indices in those subjects. Therefore, supplementation for more that 14 day is apparently needed in cases of such extreme iron depletion. Further research is needed to know the required time period of iron supplementation response based on haemoglobin level.

Acknowledgements

The authors deeply appreciate the cooperation of the children and their parents who cooperated with this study, and the stuffs of children ward of Dhaka Shishu Hospital, especially Ms. Nasreen Banu, Nutritionist of Dhaka Shishu Hospital. This work was supported by a research grant from the Ministry of Science and Technology, Government of Bangladesh.

References

1. James JW. Longitudinal study of the morbidity of diarrhoeal and respiratory infections in malnourished children. Am. J. Clin. Nutr. 1972; 25 : 690-694.

2. Samir SB, Soekirman MS, Darwin K and Scrimshaw NS. Iron deficiency anemia and the productivity of adult males in Indonesia. Am. J. Clin. Nutr. 1979; 32:916-925.

3. Baggs RB and Miller SA. Nutritional iron deficiency as a determinant of host resistance in the rat. J. Nutr. 1973; 103 : 1554-1560.

4. Chandra RK. Iron and immunocompetence. Nutr. Rev. 1976; 34 : 129-132.

5. Cachmar JF. Hemoglobins, porpyrins, and related compounds. In : Fundamentals of clinical chemistry (N. W. Tietz, editor), W. B. Saunders and Co., Philadelphia 1970; 263-297.

6. Bothwell TH and Mallet B. The determination of iron in plasma or serum. Biochem. J. 1955; 59 : 599-602.

7. Ramsay WNM. Plasma iron. In : Advances in clinical chemistry (H. Sobotka and C. P. Stewart, editors), Academic Press Inc., New York 1958; I.

8. International Committee for Standardization in Hematology (Iron Panel). The measurement of total and unsatrurated iron-binding capacity in serum. Br. J. Haematol. 1978; 38 : 281-290.

9. Hamill PVV, Drizd, TA, Johnson CL, Redd RB, Roche AF and Moore WM. Physical growth : National Center for Health Statistics Percentiles. Am. J. Clin. Nutr. 1979; 32 : 607-629.

10. Iron deficiency in infancy and childhood. A report of the International Nutritional Anemic Consultative Group (INACG), 1979.

11. World Health Organization. Nutritional Anaemias : Report of a WHO Group of Experts, WHO technical report series No. 503, Geneva, 1972.

12. Betkerur UN, Shah DS, Billur PK and Shah SH. Patterns of anemia in childhood. Ind. J. Paed. 1971; 8 : 350.