Research Article

PREVALENCE OF FAT-SOLUBLE VITAMIN DEFICIENCIES ASSOCIATED WITH SEVERE ACUTE MALNUTRITION: A PROSPECTIVE OBSERVATIONAL STUDY

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ABSTRACT

Background: Severe acute malnutrition (SAM), among children below five years of age is global health problem contributing to childhood morbidity, mortality and remains a major embarrassment to optimal human capital development in India. Objectives: Study aim was to access fat soluble vitamins deficiencies among children with SAM and outcomes after treatments with F-75/F-100 plus vitamins mix. Methods: The study was prospective observational conducted in the nutritional rehabilitation center (NRC) at district general hospital for 6 months. Anthropometric measurements were taken to determine their nutritional status. Results: 100 patients of NRC were enrolled in the study. Sixty nine percent (69) patients had weight/height (WT/HT) Z score < -3 standard deviation (3 SD), 16 % with Z score < -2 and 15% of them had Z score < -4 malnutrition. Out of 100 children, 46% children were males, and 56% children were females. Vitamin E deficiencies (54%) were highly prevalent in hospitalized SAM groups, followed by 28% vitamin D and 18% were vitamin A deficient. Conclusion: Micronutrient deficiencies were highly prevalent with fat soluble vitamins and recovered on application of WHO protocols during hospitalization induced satisfactory fat-soluble vitamin status recovery significant ($p < 0.05$).

Keywords: Severe acute malnutrition, Nutritional rehabilitation center, Z score.

INTRODUCTION

Micronutrients are vitamins and minerals fed in small quantities but are essential for body biochemical processes. They are essential in producing enzymes, hormones and metabolites which are vital role for growth and development¹. Conditions of micronutrient deficiency are prevalent among two billion people in both developing and developed countries. There are silent epidemics of vitamin and mineral deficiencies which affect people of all ages and genders, as well as certain risk groups. Not only do they cause specific diseases, they also act as aggravating circumstances in infectious and chronic diseases which have a major impact on morbidity, mortality and quality of life. Deficiencies in certain groups of people at specific risk need addition, but the maximum successful way to safely meet community health needs is through population-based interventions relating food fortification. Fortification has a protracted record of effectiveness and health for nearly a century, proven successful for the prevention of various diseases which includes birth defects².

In India, 43% of children under the age of 5 years are malnourished or undernourished. It is estimated that 1 in every 3 malnourished children live in India.⁴ Malnutrition in children is widely prevalent in developing countries and has been responsible for 60% of the 10.9 million deaths annually among children less than 5 years. Over 2/3rd of these deaths are often associated with inappropriate feeding practices that occurred during 1st year of life³. The role of micronutrients (essential trace elements and vitamins) in optimizing health and in preventing or treating disease has now become increasingly relevant. It stems

in part from the enhanced knowledge and appreciation of such nutrients 'biochemical functions, but also from the extensive but less well-founded commercial claims for these substances. It is critical that doctors and other health professionals are aware of the evidence for these substances 'nutritional essentiality and for circumstances where increased consumption can contribute to clinical benefit⁴⁻⁵.

Vitamin A deficiency (VAD) can result from inadequate intake, fat malabsorption, or liver disorders. Deficiency impairs immunity and hematopoiesis and cause rashes and typical ocular effects (e.g. Xerophthalmia, night blindness). Vitamin A deficiency (VAD) is one of the important causes of blindness in children. VAD was reported to account for 6 million deaths globally and constituted the largest disease burden (6% of deaths in children under 5 years of age) among micronutrient deficiencies⁶. Vitamin D is crucial for calcium absorption and for maintaining bone health in the pediatric population. Vitamin D plays an important role in calcium uptake for bone growth, osteoporosis and rickets prevention⁷. Vitamin E is a function as a membrane bound antioxidant. Only 20-40% of ingested vitamin E and its esters are absorbed. A common cause of vitamin E deficiency (VED) in older children and adolescents is fat malabsorption. Abeta lipoproteinemia is caused by the genetic absence of apolipoprotein B, causes fat malabsorption and steatorrhea; with progress siveneuropathy and retinopathy in the first two decades of life⁸⁻⁹. To address micronutrient deficiency among children aged 6-59 months, UNICEF collaborated with the WHO to develop a daily multiple micronutrient formula for supplementation¹⁰.

Lindsay H. Allen et.al (2003) carried out study on interventions on micronutrient deficiency control in developing countries: past, present and future. He determines micronutrient deficiencies in Egypt, Kenya, and Mexico¹¹. N. Arlappa et.al (2011) was carried out study on micronutrient deficiency disorder among the rural children of west Bengal India. The aim of study was to assess the prevalence of micronutrient deficiency among rural children of west Bengal, India. By using methods of a community based cross-sectional study was carried out on 9228 and 437 pre-school children respectively for assessment of vitamin A deficiency (VAD) and anemia¹². A. Chaturvedi et.al (2018) carried out study on progress of SAM children in the malnutrition deficiency at Malnutrition Treatment center, Jharkhand¹³. In view of these concerns, vitamin A, D and E deficiency from this region, the present study was conducted to know the prevalence these fat-soluble vitamin deficiencies in severe acute malnourished children in Amravati region of central India.

MATERIALS AND METHODS

This prospective observational study was carried out in nutritional rehabilitation centre, district hospital, Amravati of vidarbha region in the state of Maharashtra among population for the period of 6 month. The institutional review board approved the present study. Patient was informed about the purpose of the study and written consent was taken prior to their participation in the study. An informed consent to participate in research of samples, ensure the confidentiality of the information received and used only for research purposes were fully met. Patients of either sex of below 5-year age groups inpatient of NRC, district hospital, Amravati, profound diagnosis given by physician were included for this study.

Inclusion Criteria

All children between the age group of 1-60 months reporting consecutively in the department of Pediatrics and fulfilling any one of the following criteria as per WHO guidelines to define severe acute malnutrition with regard to growth parameters were included in study. A total of 100 children of age between 1 month to 6 months whose weight for height infants >45cm length, *Z score* <-3SD with or without bilateral pitting edema, for infants <45cm length, visible severe wasting with presence of bilateral pitting edema on both feet (excluding other causes of edema) and in infant more than 6 months of age (6 months to 5 years) mid upper arm circumference (MUAC) < 11.5 cm (115mm), bilateral pitting edema and glossy visible severe wasting were included in the study.

Exclusion Criteria

Those patient's caretaker not willing to sign consent, early discharged and children diagnosed with hemolytic anemia, congenital mental disorder (CMD), chronic kidney disease (CKD), congenital heart disease (CHD), and cerebral palsy were excluded.

Method of Data Collection

Sample size was 100 populations of nutritional rehabilitation centre, district hospital, Amravati over a period of 6 months from September 2019 to February 2020. Patient data relevant to the study has been collected from treatment charts/case sheets, laboratory reports and patient or patient's care giver's interview by using prevalidated case record patient data collection form. The data was categorized into socio demographic details of child and anthropometry measures, general findings, micronutrient deficiencies, lab investigations, daily diet plan, feeding questionnaire, routine treatment, immunization, discharge with

overall outcomes and other relevant information. Quantitative variables were analysed by measures of central tendency (mean and median) and dispersion (standard deviation). Comparison of proportions was performed with Fischer exact test and analysis of variance was computed. All statistical tests were two-tailed and were performed at a significance level with probability (*p*) of 0.05.

RESULTS

In this study, 100 children aged between 1 months to 5 years were fulfilled the defined criteria for severe acute malnutrition admitted in nutritional rehabilitation centre, district hospital, Amravati of vidarbha region in the Maharashtra state among population for the period of 6 month. Amongst the study, 46 were male and 54 were female.

On observation of fat-soluble vitamin deficiencies in SAM patients, 54% children had deficiency of vitamin E at peak point in more than half while vitamin D and A were found in 28% and 18 % of subjects respectively. Age group distribution and *Z score* of malnutritional children is shown in Figure 1. The cohort included 12, 22, 25, 21, 2, 7, 2, 6, 2 and 1% children in age group ≤6, 7-12, 13-18, 19-24, 25-30, 31-36, 37-42, 43-48, 49-54 and 55-60 months, respectively (Figure 2). Incidences of the vitamin A deficient (VAD) children with SAM are given in Table 1. Among 28 children of vitamin D deficiency, majorly 8 (28.57%) bossing of skull, 7 (25%) osteoporosis and 5 (17.86%) alopecia were significant (*p*<0.01) as compared to these three features associated with widening of wrist and bowing of legs with rickets rosary 8 (28.57%) individually (Table 2). In the study, among 54 children of vitamin E deficiency (VED), it was observed that 52 (96.3%) muscle weakness and 1 (1.85%) each had squint and both muscle weakness with loss of vibration and sensation (Figure 3). The percent wise distribution of multinutrient deficiency is shown in Table 3. After proper planned diet (F-75/F-100, special feed, complementary feed) along with breastfeeding and treatment of micronutrients, out of 100 population, 91%, 5% and 4% were completely cured, discharge on request and medically transferred due to other co-morbidities respectively as shown in Figure 4.

DISCUSSION

Malnutrition is a serious global issue. Among children under five years of age in the developing world, 206 million are stunted, 50 million are wasted, and 167 million are underweight due to lack of food and the presence of disease¹⁴. The signs and symptoms of individual deficiencies that were observed in children were having that micronutrient deficiency. Through this it was possible to see that according to prevalence of each deficiency which signs are observed maximum in that deficiency. In the present study, it was observed that more than half of children with SAM were female.

Each child was found to have more than 2 micronutrient deficiencies at a same time so it's very serious issue. So, education related to micronutrients is must in society so that all can stand for it and minimize the future generations from harmful effects. In our study, among children under five years of age, 5% was underweight, 15% were both underweight and stunting, and 29% were from all three underweight, stunting and wasting, 16% were stunting and wasting and 35% had wasting and underweight due to lack of food and the presence of disease. This conclude that a greater number of children were suffering from underweight due to insufficiency of food material, lack of knowledge about diet and health, hygiene and the presence of disease. Food intake is not proper as a result weight loss and the body burns down fats

resulting into wasting. These factors are adversely impact on height into stunting.

Table 1: Signs of Vitamin A Deficient Children with SAM

Signs of vitamin A deficiency	Number of children	Percentage of child (%)
Xerophthalmia	1	5.56
Conjunctivalxerosis	4	22.22
Bitot's spot	4	22.22
Dry conjunctiva	1	5.56
Red and sticky eyes	2	11.11
Xerophthalmia, conjunctivalxerosis, corneal xerosis	1	5.56
Xerophthalmia, bitot's spot	2	11.11
Xerophthalmia, night blindness	1	5.56
Bitot's spot, corneal scaring	1	5.56
Bitot's spot, red and sticky eyes, corneal scaring	1	5.56

Table 2: Signs of Vitamin D Deficiency Children with SAM

Signs of vitamin D deficiency	Number of children	Percentage of child (%)
Widening of wrist	2	7.14
Osteoporosis	7	25.00
Alopecia	5	17.86
Bossing of skull	8	28.57
Widening of wrist, Bowing of legs, Rickets rosary, Bossing of skull	1	3.57
Widening of wrist, Osteoporosis	1	3.57
Widening of wrist, Alopecia	1	3.57
Osteoporosis, Alopecia	3	10.71

Table 3: Multiple Micronutrient Deficiencies Children with SAM

Vitamins and micronutrients deficiencies	Number of children	Percentage of children (%)
A, D, E, B ₁₂ , Folic acid, B ₆ , B ₂ , C and minerals (Iron, Iodine and Zinc)	3	16.66
D, E, B ₁₂ , Folic acid, B ₆ , B ₂ , C and minerals (Iron, Iodine, Zinc and Calcium)	6	21.42
E, B ₁₂ , Folic acid, B ₆ , B ₂ , C and minerals(Iron, Iodine and Zinc)	16	29.62

Figure 1: Z score of SAM patients

Figure 2: Age wise distribution of SAM children

Figure 3: Signs of vitamin E deficiency

Figure 4: NRC performance for SAM patients

As those children comes under <-3 SD criteria of *Z score*, or MUAC ≤ 11.5 cm or Bilateral pitting edema are termed to be severe acute malnourished (SAM) children. Anthropometry is the simplest way for diagnosis of malnutrition and consists of Height, Weight, MUAC, presence of edema or not. According to WHO guidelines, *Z score* was determined by weight and height. Figure 1 shows that, out of 100 childrens, 69, 16 and remaining 15 children were <-3 SD, <-2 SD and <-4 SD respectively. This result is indicated that malnutrition has become a serious issue in health system as children were deficient found with <-4 SD *Z score* which is an alarming sign. More than half of the total population female (54%) were malnourished children, but difference is not much bigger between genders, so micronutrient deficiencies could take place in any gender. Both genders are equally at high risk for micronutrient deficiency and malnutrition. There were higher prevalence of severe acute malnutrition and micronutrient deficiency in children in age group 13-18 (25%). As increasing age demands of child also gets increased nutrition and due to factors like parents lack of knowledge about proper feeding practices and economy factor which leads to malnutrition with various deficiencies. All necessary results of lab tests were recorded for the organ functioning of child as well as defects inside the body. These tests include CBC, chest-X ray, kidney function test (KFT), liver function test (LFT), USG-abdomen were performed as per need. Vitamin A deficiency (VAD) level gives us an insight about the deficiency's signs in our study of 18% population. Out of 18 (100%), about 6(33.33%) of the children had one or more pathological features of vitamin A deficiency. In total, 4 (22.22%) had each conjunctival xerosis and bitot's spot while 2 (11.11%) children of each had red and sticky eyes and xerophthalmia with bitot's spot. These four features were significantly associated with vitamin A deficiency. The ultimate solution for the prevention of this deficiency lies in educating people to eat food rich in vitamin A. Breastfeeding can protect children during first 6 months. From age of 6 months, it is crucial to start semisolid food contains vitamin A.

The prevalence of vitamin D deficiency among the 100 malnourished children was 28%. This could be related to decrease nutritional intake, poor sunlight exposure and possibly impaired absorption because of enteric dysfunction or a disease process¹⁵. There were no patients suffering with reticulocytosis and hyperbilirubinemia. Micronutrient and macronutrient supplements should be given according to standard protocols. Nutritional rehabilitation in the form of ready-to-use therapeutic food (RUTF) and vitamin supplements is important in management¹⁶. During the study, it was observed that each child was suffering from more than two micronutrient deficiencies. The maximum children were 16 of 54 (29.62%) vitamin E with other micronutrients deficient, followed by 6 of 28 (21.42%) vitamin D and 3 of 18 (16.66%) vitamin A with associated micronutrients deficient. The highest combined micronutrient deficiencies within enrolled subjects were observed significantly of vitamin E ($p<0.05$).

As name indicates, nutritional rehabilitation centre (NRC), feeding and appropriate therapeutic supplementation has great importance based on appetite test, feed formula as supplement was started to each child (F-75/F-100). All micronutrients were administered from day 1 to 15 until discharge. Vitamin A was administered on day 1 only as per the guidelines given by WHO. The quantity administered per day was calculated as per their requirements. Special feed comprising of roasted groundnuts, milk powder, coconut oil and sugar mixture was also provided (33/25g) in NRC with other complementary feed like rice, dal, paratha and soups. Daily observed the subjects for positive

respond and dosage of micronutrients were continued for proper calories to overcome the signs of fat-soluble vitamins deficiencies. For outcomes, data like whether the child was cured, non-responder and death, or medically transferred to other hospital was recorded. Death, defaulter, non-responder, unknown cause was not observed during entire conduction of study in nutritional rehabilitation centre (NRC). Recovery rate of fat-soluble vitamins on admission and discharge (before and after hospitalization) was taken into consideration for comparison of performance of NRC and it was statistically significant ($p=0.016$). Hence use of micronutrients during hospitalization was significant on cured of child ($p<0.05$). Weaning is a crucial transition in childhood nutrition. The transition from breast feeds to introduction of complementary food at this point should be appropriate and optimum to meet the protein, energy and micronutrient needs of the child.

CONCLUSION

From the results, it was found that a greater number of female children was affected by micronutrient deficiencies and malnourished. Prevalence of fat-soluble vitamin deficient was more in age group of 13-18 months. Based on signs, symptoms and clinical reports, it was observed that vitamin E deficiency was found at peak point in more than half of (54%) subjects while vitamin D and A were found in 28% and 18% of subjects respectively. On physical examination and diagnosed report of many childrens were found more than two micronutrient deficiencies particular deficiency of vitamins, minerals, and trace elements at a same time. Protocol use of feeding and appropriate therapeutic supplementation during hospitalization was significant on (91%) cured of child ($p<0.05$). These findings of our study support the need for a broad public health strategy for the control of malnourish due to fat soluble vitamins among Indian children beyond delivering proper supplementation.

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REFERENCES

1. World Health Organization: Micronutrients. World Health Organization 2012 <http://www.who.int/nutrition/topics/micronutrients/en/index.html>.
2. Gupta P. ed. Clinical Methods in Paediatrics. Anthropometry: assessment of growth, New Delhi: CBS Publishers & Distributors, 2009; 4: 55-105.
3. World Health Organization child growth standards and the identification of severe acute malnutrition in infants and children. World Health Organization 2016 <http://www.who.int/nutrition/publications/severemalnutrition/9789241598163/en/>.
4. Larry E. Johnson. Vitamin A Deficiency. MSD Manual 2019 <https://www.msdmanuals.com/en-in/home/disorders-of-nutrition/vitamins/vitamin-a-deficiency>.
5. Lee JY, So TY, Thackray J. A review on vitamin D deficiency treatment in pediatric patients. Journal of Pediatric Pharmacology and Therapeutics. 2013; 18(4):277-91.
6. Black RE, Allen LH, Bhutta ZA, et al. Maternal and child under nutrition: global and regional exposures and health consequences. The Lancet. 2008; 371(9608): 243-260.

7. National Institutes of Health, Vitamin D. <http://ods.od.nih.gov/Research/VitaminD.aspx> (accessed October 2012).
8. World Health Organization & Food and Agriculture Organization of the United Nations, Guidelines on food fortification with micronutrients. World Health Organization & Food and Agriculture Organization of the United Nations 2006 http://www.who.int/nutrition/publications/micronutrients/guide_food_fortification_micronutrients.pdf.
9. Van Hasselt PM, De Koning TJ, Kvist N. Prevention of vitamin K deficiency bleeding in breastfed infants: lessons from the Dutch and Danish biliary atresia registries. *Pediatrics* 2008; 121:e857-e863.
10. World Health Organization: Preventing and controlling micronutrient deficiencies in populations affected by an emergency. World Health Organization 2007 http://www.who.int/nutrition/publications/micronutrients/WHO_WFP_UNICEFstatement.pdf.
11. Allen LH. Interventions for micronutrient deficiency control in developing countries: past, present and future. *Journal of Nutrition*. 2003; 133(11): 3875S-8S.
12. Arlappa N, Laxmaiah A, Balakrishna N, et al. Micronutrient deficiency disorders among the rural children of West Bengal, India. *Annals of Human Biology*. 2011; 38(3):281-9.
13. Chaturvedi A, Patwari AK, Soni D, et al. Progress of children with severe acute malnutrition in the malnutrition treatment centre rehabilitation program: evidence from a prospective study in Jharkhand, India. *Journal of Nutrition*. 2018; 17(1):69.
14. WHO Guideline: Updates on the Management of Severe Acute Malnutrition in Infants and Children. Geneva: World Health Organization 2013 <https://www.who.int/publications-detail-redirect/9789241506328>
15. Autier P, Boniol M, Pizot C, et al. Vitamin D status and ill health: a systematic review. *Lancet Diabetes and Endocrinology*. 2014; 2: 76–89.
16. Scherbaum V, Furst P. New concepts on nutritional management of severe malnutrition: the role of protein. *Current Opinion in Clinical Nutrition and Metabolic Care*. 2000; 3(1):31-8.

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