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OBSERVATIONAL STUDIES ON PREVALENCE OF WATER SOLUBLE VITAMINS DEFICIENCIES ASSOCIATED WITH SEVERE ACUTE MALNUTRITION IN THE NUTRITIONAL REHABILITATION CENTER

Mulchand Shende*[1], Sanket Kadam[2], Mayuri Mokal[2], Madhura Balvir[2]

[1]Government College of Pharmacy, Vidyanagar, Karad, Maharashtra, India, 415124.
[2]Interne Students of Pharm.D, Pharmacy Practice, Government College of Pharmacy, Kathora Naka, Amravati, Maharashtra, India, 444604.

***Corresponding Author: Dr. Mulchand Shende**
Government College of Pharmacy, Vidyanagar, Karad, Maharashtra, India, 415124.

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ABSTARCT
Severe acute malnutrition (SAM) is global health problem in children contributing to childhood morbidity and mortality. Study aim was to accesses water soluble vitamins deficiencies among children with SAM and outcomes after treatments of F-75/F-100 plus vitamins mix. 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. 100 patients of NRC were enrolled in the study. Sixty nine percent (69) patients had weight/height Z score<−3 standard deviation, 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 B_6 deficient (100%) was highly prevalent in hospitalized SAM groups, followed by 99% vitamin C and 92% were vitamin B_9 deficient. Micronutrient deficiencies were highly prevalent with water soluble vitamins and recovered on application of WHO protocols during hospitalization induced satisfactory vitamin status recovery significant ($p<0.05$).

KEYWORDS: Severe acute malnutrition (SAM), 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 development.[1] Micronutrient deficiencies 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 defects.[2] Water soluble vitamins are not stored in the body, it absorbs what it needs and then it usually excretes the excess in your urine. Due to the fact that they cannot be stored, the body needs a continuous supply through a steady daily intake. Water soluble vitamins are found in fruit, vegetables and grains. Vitamin B_{12} (Cobalamin) is a common cause of macrocytic anemia, and was implicated in a number of neuropsychiatric disorders. Vitamin B_{12} deficiency is associated with hematologic, neurologic, and psychiatric manifestations. It is a common cause of macrocytic (megaloblastic) anemia and in advanced cases, pancytopenia. Neurologic sequelae from vitamin B_{12} deficiency include paresthesias, peripheral neuropathy, and demyelination of the corticospinal tract and dorsal columns (sub-acute combined systems disease). Vitamin B_{12} deficiency also has been linked to psychiatric disorders, including impaired memory, irritability, depression, dementia and, rarely, psychosis.[3] Folic acid is the parent compound of a group of naturally occurring, structurally related compounds known as the folates. Folic acid is essential for normal growth and maintenance of cells, since it acts as a coenzyme for normal DNA and RNA synthesis. Folate is vital for multiplication of cells within the fetus. A deficiency therefore affects normal cell division and protein synthesis, impairing growth. Folic acid, with vitamin B_{12} converts homo cysteinetomethionine, thereby reducing

blood levels of homo cysteine and lowering risks of heart disease. It also maintains integrity of the central nervous system and intestinal tract function and is involved in production of neurotransmitters such as serotonin.[4] Pyridoxine aids in food assimilation and protein and essential fatty acid metabolism. It activates many enzyme systems and is involved in the production of antibodies against bacterial diseases. It is linked to cardiovascular health by decreasing the formation of homo cysteine. It is also required for absorption of vitamin B_{12} and for production of monoamine neurotransmitters serotonin, dopamine, noradrenaline and adrenaline. Lack of pyridoxine may cause anemia, neuropathy, seizures, skin problems and mouth sores. [5] Vitamin B_2, or riboflavin, is one of eight B vitamins essential to human health. Vitamin B_2 acts as a coenzyme in numerous redox reactions. Food sources rich in riboflavin are organ meats, milk products, bread, fortified cereals etc. There are no adverse effect if someone intake high amount of riboflavin. Following are signs and symptoms of vitamin B_2 deficiency.[6] Vitamin C (Ascorbic acid) is essential for the formation, growth, and repair of bone, skin, and connective tissue (which binds other tissues and organs together and includes tendons, ligaments, and blood vessels). It is also essential for the normal function of blood vessels. Vitamin C helps maintain healthy teeth and gums. It helps the body absorb iron, which is needed to make red blood cells. Vitamin C also helps burns and wounds heal. Good sources of vitamin C include citrus fruits, tomatoes, potatoes, broccoli, strawberries, and sweet peppers. It protects cells against damage by free radicals, which are by-products of normal cell activity and which participate in chemical reactions within cells. Some of these reactions can cause damage over a person's lifetime. Scurvy as a clinical manifestation of severe vitamin C deficiency is caused by ascorbic acids role in collagen synthesis. Collagen type IV is the main constituent of blood vessel walls, skin, and specifically, the basement membrane zone separating the epidermis from the dermis.[7] 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 benefit.[8, 9]

Lindsay H. Allen et.al (2003) carried out study on interventions on micronutrient deficiency control in developing countries: past, present and future. [10] N. Arlappa et.al (2011) was carried out study on micronutrient deficiency disorder with aim to assess the prevalence of micronutrient deficiency among rural children of west Bengal, India.[11] A. Chaturvedi et.al (2018) carried out study on progress of SAM children in the malnutrition deficiency at malnutrition treatment center, Jharkhand.[12] M. Shende et.al (2021) were assessed previously the prevalence of fat soluble vitamins deficiencies among children with SAM and outcomes after treatments with F-75/F-100 plus vitamins mix.[13] In view of these concerns, the present study was conducted to know the prevalence of these water soluble vitamin deficiencies in severe acute malnourished children in Amravati region of central India and their probable outcomes.

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.

Criteria for research design

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.

Inclusion and exclusion criteria

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. 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. 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 exclude.[13]

Subjects, data collection, analysis and statistical methods

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.[13] All statistical tests were two-tailed and were performed at a significance level with probability (p) of 0.05.

RESULTS AND DISCUSSION

In this study, 100 children aged below 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 among population. 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 disease.[14] The signs and symptoms of individual deficiencies that were observed in children were having that particular micronutrient deficiency. Through this it was possible to see that according to prevalence of each deficiency which signs are observed maximum in that particular deficiency. Age group distribution and Z score of malnutritional children is shown in Fig. 1 and 2 respectively.

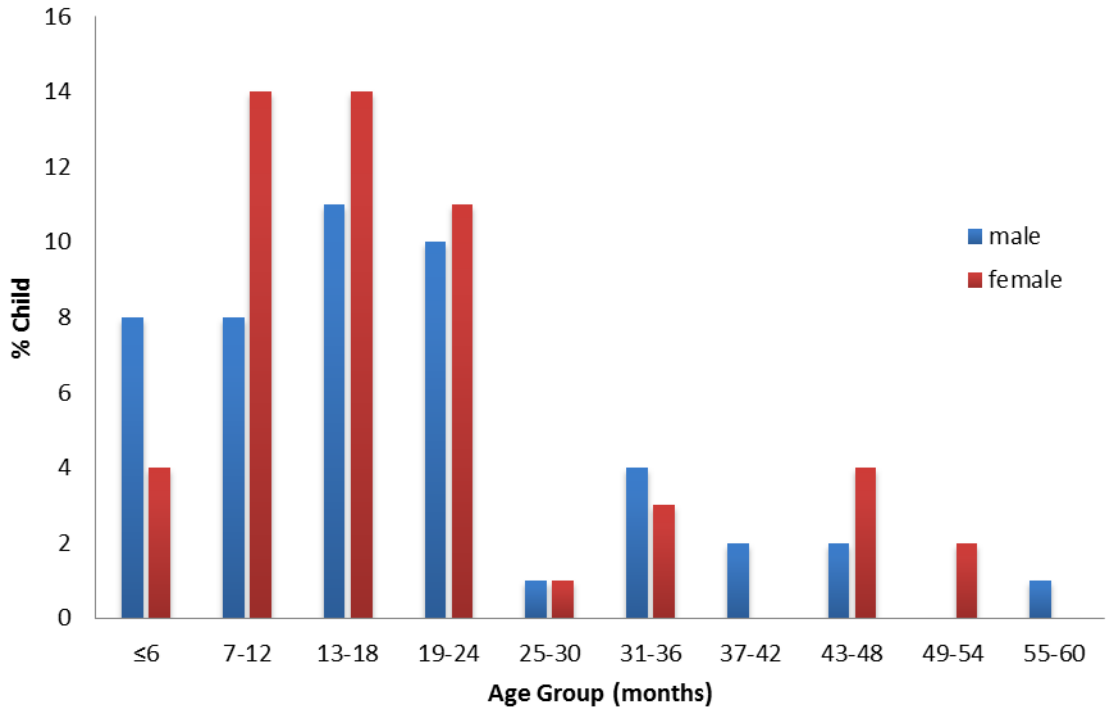

Fig. 1: Age wise distribution of SAM children.

Each child was found more than two micronutrient deficiencies at a same time. In the study, among children under 5 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. These indicates more number of children suffering from underweight due to insufficiency of food material, lack of knowledge of diet and health, hygiene and the presence of diseases. As those children having 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. The result showed that 69, 16 and remaining 15 children were <-3 SD, <-2 SD and <-4 SD respectively. This results is indicated that malnutrition has become a serious issue in health system as children were deficient found with <-4 SD Z score which was an alarming sign. [13] 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 (Fig. 1). 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%).

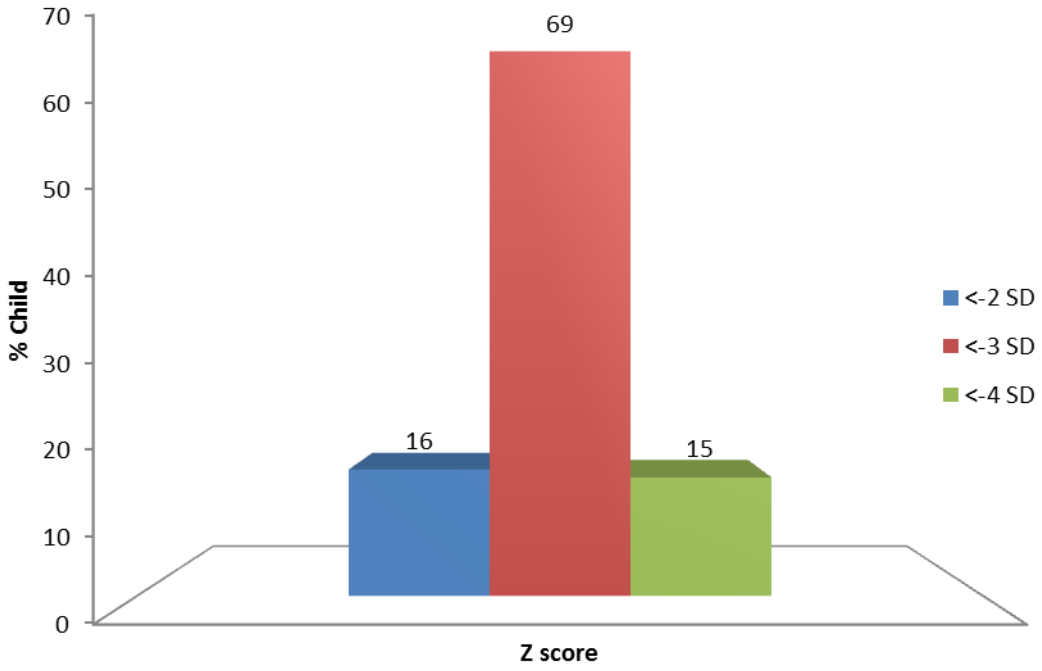

Fig. 2: Z score of SAM patients.

As growing and 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 includes CBC, chest-X ray, kidney function test (KFT), liver function test (LFT), USG-abdomen were performed as per need. On observation of water soluble vitamin deficiencies in SAM patients, the vitamin B complex containing 100% children had deficiency of vitamin B_6 at peak point in all of children population, 92% of vitamin B_9, 90% of vitamin B_2 and 59% of vitamin B_{12} while vitamin C was found in 99% of subjects. Incidences of the different water vitamin deficient (VAD) children with SAM are given in table 1 and 2.

Table 1: Signs of water soluble vitamin B_{12}, B_2 and B_6 deficient children with SAM.

Signs of vitamin deficiency	Number of child	Number of child (%)
Signs of vitamin B_{12} deficiency (59%)		
Pale or Jaundiced skin	12	20.34
Weakness and fatigue	6	10.17
Breathless and dizziness	1	1.69
High Temperature	2	3.39
Greying of Hair	1	1.69
Knuckle Pigmentation	6	10.17
Pale or Jaundiced skin associated other signs like Knuckle Pigmentation, Sensation of Pins and needles, Breathless and dizziness, High Temperature, Greying of Hair	26	44.07
Weakness and fatigue with other signs like Greying of Hair, Breathless and dizziness, High Temperature, Changes in Mobility, Knuckle Pigmentation	5	8.47
Signs of vitamin B_2 deficiency (90%)		
Seborrheic dermatitis	2	2.22
Weight loss	70	77.78
Photophobia, Weight loss	3	3.33
Angular stomatitis, Weight loss	2	2.22
Photophobia, Seborrheic dermatitis, Weight loss	1	1.11
Glossitis, Angular stomatitis, Weight loss	1	1.11
Seborrheic dermatitis, Dizziness, Weight loss	11	12.22

Signs of vitamin B_6 deficiency (100%)		
Anaemia (Pallor)	53	53
Mouth Sores	1	1
Anaemia (Pallor), Seizures	2	2
Anaemia (Pallor), Oily, flaky, swelling, white patches	30	30
Anaemia (Pallor), Seborrheic dermatitis, Oily, flaky, swelling, white patches	7	7
Anaemia (Pallor), Seizures, Seborrheic dermatitis, Oily, flaky, swelling, white patches	7	7

Vitamin B_{12} deficiency level gives us an insight about the deficiencies signs in our study of 59% population. Out of 59, about 31(52.54%) of the children had one or more pathological features of vitamin B_{12} deficiency. In total, 26 (44.07%) had each Pale or Jaundiced skin associated other signs while 12 (20.34%) children of each had Pale or Jaundiced skin. The ultimate solution for the prevention of this deficiency lies in educating people to eat food rich in vitamin B complex.

Table 2: Signs of water soluble vitamin B_9 & C deficient children with SAM.

Signs of vitamin deficiency	Number of child	Number of child (%)
Signs of vitamin B_9 deficiency (92%)		
Pale skin	3	3.26
Weight loss	19	20.65
Lethargy, Weight loss, Breathlessness	5	5.43
Pale skin, Weight loss	2	2.17
Tinnitus, Weight loss	2	2.17
Weight loss, Lack of Appetite	20	21.74
Fatigue, Pale skin, Weight loss	2	2.17
Fatigue, Weight loss, Lack of Appetite	2	2.17
Lethargy, Headache, Weight loss	1	1.09
Lethargy, Pale skin, Weight loss	2	2.17
Lethargy, Weight loss, Lack of Appetite	5	5.43
Pale skin, Weight loss, Lack of Appetite	11	11.96
Fatigue, Pale skin, Weight loss, Lack of Appetite	7	7.61
Breathlessness, Pale skin, Weight loss, Lack of Appetite	3	3.26
Fatigue, Lethargy, Breathlessness, Pale skin, Weight loss	2	2.17
Fatigue, Lethargy, Pale skin, Weight loss, Lack of Appetite	3	3.26
Lethargy, Breathlessness, Pale skin, Weight loss, Lack of Appetite	2	2.17
Fatigue, Lethargy, Breathlessness, Pale skin, Weight loss, Lack of Appetite	1	1.09
Signs of vitamin C deficiency (99%)		
Pallor	33	33
Irritability, Pallor	36	37
Diarrhea, Pallor	8	8
Irritability, Diarrhea, Pallor	20	20
Irritability, Diarrhea, Pallor, Anorexia	2	2

Breast feeding can protect children during first 6 months. From age of 6 months it is crucial to start semisolid food contains vitamin B_{12}. The prevalence of vitamin B_2, B_6 and B_9 deficiency among the 100 malnourished children were 90, 100 and 92% respectively. This could be related to decrease nutritional intake, poor sunlight exposure and possibly impaired absorption because of enteric dysfunction or a disease process. [15] There were majority of patients suffering with weight loss, Anemia (Pallor), Seborrheic dermatitis, Oily, flaky, swelling and white patches. The percent wise distribution of multinutrient deficiency is shown in table 3. 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 management.[15] During the study, it was observed that each child was suffering from more than two micronutrient deficiencies.

Table 3: Multiple micronutrient deficiencies children with SAM.

Vitamins and micronutrients deficiencies	Number of children	Percentage of children (%)
B_{12}, Folic acid, B_6, B_2, C, A, D, E and minerals (Iron, Iodine and Zinc)	3	16.66
B_{12}, Folic acid, B_6, B_2, C, D, E and minerals (Iron, Iodine, Zinc and Calcium)	6	21.42
B_{12}, Folic acid, B_6, B_2, C, E and minerals(Iron, Iodine and Zinc)	16	29.62

The maximum children associated micronutrients deficient were 16 of 54 (29.62%) vitamin B complex with other micronutrients deficient of E and minerals (Iron, Iodine and Zinc), followed by 6 of 28 (21.42%) with vitamin D and 3 of 18 (16.66%) with vitamin A.

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 Fig. 3. As per name indicates, nutritional rehabilitation centre, 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. 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 water soluble vitamins deficiencies. For outcomes, data like whether the child was cured, non-responder and death, or medically transferred to other hospital was recorded. The death, defaulter, non-responder, unknown cause was not observed during entire conduction of study in nutritional rehabilitation centre (NRC).

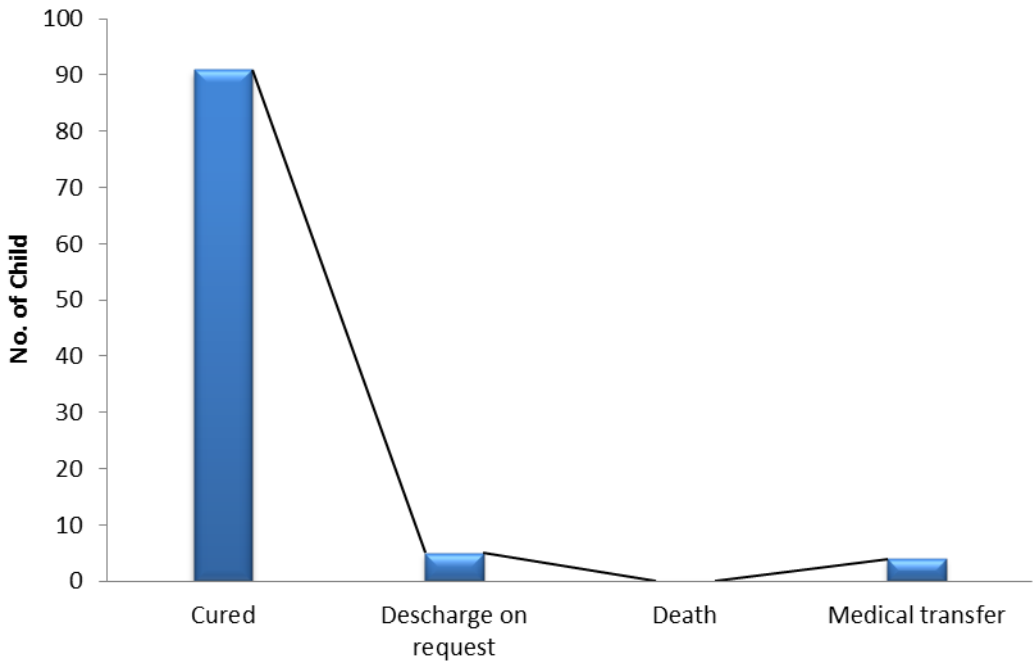

Fig. 3: NRC performance for SAM patients.

Recovery rate of water 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.

CONCLUSIONS

Prevalence of water soluble vitamin deficient was more in age group of 7-18 months. Based on signs, symptoms and clinical reports, it was observed that vitamin B_6 deficiency was found at peak point in all (100%) subjects while vitamin C was found in 99% of subjects. On physical examination and diagnosed report of many childrens were found multimicronutrient 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 water soluble vitamins among Indian children beyond delivering proper supplementation.

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