Severe Acute Malnutrition: Impact and Prevention

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ABSTRACT

The severe acute Malnutrition has been related with deficiency, poor diet and inadequate access to health care, and it remains as universal health issue that contributes to ill-health with 50% of childhood deaths due to underlying malnutrition. Bio fortification, probiotic foods and food process methods have shown the potential to beat the deficiency disease. A recently developed home primarily based treatment for severe acute deficiency disease is convalescent the lives of many thousands of kids a year. Ready-to-use Therapeutic Food has modified radically the treatment of severe deficiency disease – providing foods that are safe to use reception and guarantee fast weight gain in severely malnourished youngsters. It has been observed that the household size, household food access, and the child's age were the major predictors of severe acute malnutrition. Engaging poor families in kitchen gardening to ensure household food access and nutritious diet to the children, along with health education and promotion to the mothers of young children are therefore recommended to reduce child undernutrition.

Keywords: Malnutrition, probiotic foods, kitchen gardening

Article History:

Received: 30 December 2020

Revised: 6 March 2021

Accepted: 7 March 2021

Published: 9 March 2021

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INTRODUCTION

The crucial time for accelerated physical growth as well as overall child development is the age of children below 59 months. Children suffer from multiple forms of undernutrition if the need for nutrition is impaired. Malnutrition is a leading contributor to the global burden of illness and a major cause of child mortality nationwide. Malnutrition is a multifaceted term. It incorporates both over-nutrition and undernutrition, linked to overweight and obesity, referring to various conditions including acute and chronic malnutrition and micronutrient deficiencies. Malnutrition may have short-term effects, such as morbidity, death, and disability; or long-term consequences, including impaired cognitive growth, increased risk of illness due to either concomitant diseases or metabolic disorders, and suboptimal economic efficiency¹.

Malnutrition broadly categorized into acute, chronic or both. The classification of mild, moderate or severe malnutrition is based on anthropometric, biochemical and clinical assessment. The measures that integrate weight with height [weight-for-height and Body Mass Index (BMI) (thinness)] are used to define acute under-nutrition and over-nutrition (overweight/obesity) for different age groups while height for age describes chronic under-nutrition. Chronic malnutrition (Stunting) emerges from inadequate intake or absorption of micronutrients over a prolonged period. Developmental impairments and diminished economic ability later in life are correlated with stunting (short stature for age), the most widely used measure of chronic malnutrition. Acute malnutrition (wasting) occurs from abrupt decreases in the quality of food

consumption or diet and is also associated with pathological causes.

Anthropometric cutoffs and clinical symptoms are used to describe acute malnutrition. The meanings generally accepted, as set out by the WHO, are as follows:

- *Moderate acute malnutrition (MAM)*, defined as weight-for-height¹ z-score (WHZ) between -2 and -3 or mid-upper arm circumference (MUAC) between 115 millimeters and <125 millimeters².
- *Global acute malnutrition (GAM)* refers to MAM and SAM together; it is used as a measurement of nutritional status at a population level and as an indicator of the severity of an emergency situation³.
- *Severe acute malnutrition (SAM)* refers to a condition that is less than 115 mm in the Mid-Upper Arm Circumference (MUAC) measurement or less than minus 3SD z-score below the median in children aged 6 to 59 months. It is mostly caused by imbalance between nutritional intake and individual needs and both quantitative (number of kilocalories/day) and qualitative (vitamins and minerals, etc.) deficiencies⁴.

An estimated 155 million children under the age of five have been stunted and 52 million have been wasted in 2017. With more than half of all stunted children and two-thirds of all wasted children under the age of five living in Asia, and more than one-third of stunted children and a fifth of wasted children living in Africa, Asia and Africa both share the largest burden of malnutrition⁵.

India alone is home to an estimated 8 million children living with SAM, while Bangladesh has about 600,000 children (4%) with SAM. SAM is one of the important comorbidities leading to hospital admissions and deaths. The mortality associated with SAM is also high, ranging from 73 to 187 per 1,000. The risk of death sharply increases with the severity of malnutrition⁶.

Malnutrition is a outcome of a complex interplay of nutrition-specific and nutrition-sensitive factors. Nutrition-specific factors include Insufficient food and nutrient intake, improper eating, caregiving, and

parenting activities, and the burden of infectious diseases. Food insecurity; insufficient parental, household and community care resources; restricted access to health services; and an unhygienic climate are nutrition-sensitive factors. Enhancing childhood malnutrition needs efficient implementation of measures that are both nutrition-sensitive and nutrition-specific⁷.

WHO suggests a community-based approach program for the treatment of both acute mild and severe malnutrition with ready-to-use supplementary food (RUSF) and ready-to-use therapeutic food (RUTF) for children over 6 months of age. The program comprises of inpatient stabilization treatment for complicated severe acute malnutrition (SAM) management, outpatient clinical elements for uncomplicated SAM, and supplemental feeding for moderate acute malnutrition (MAM)⁸. UNICEF also supports community-based management of acute malnutrition with ready-to-use therapeutic foods (RUTF). RUTF is safe, cost effective, and has saved hundreds of thousands of children's lives in recent years. Severe acute malnutrition is a major killer of children under five, accounting for approximately 1 million deaths annually. Around 20 million children worldwide are estimated to be suffering from this condition, of which only approximately 10 -15 per cent currently receive treatment using RUTF⁹.

EPIDEMIOLOGY AND DIAGNOSIS OF SAM

SAM affects almost 20 million children under 5 years of age, resulting up to 1 million deaths per year by rising the susceptibility of serious infection to death. the most vulnerable age for malnutrition is 6 to 18 months (When growth velocity and brain development are extremely high); but, with many low-income environments adding solids to children as young as 2 months, it is widely recognised that SAM may occur in infants aged: **Severe wasting** (marasmus) refers to middle upper arm circumference [MUAC] <-3 Z scores in children aged 0 to 59 months (according to the 2006 WHO growth standards). Nutritional oedema (kwashiorkor) defined as bilateral pitting oedema^{10,11}.

Diagnosis of SAM

The main diagnostic features are:

- weight-for-length/height < -3SD or
- mid-upper arm circumference < 115 mm or
- oedema of both feet.

CLASSIFICATION OF SAM

The absence or presence of medical complications classifies children with SAM :

Uncomplicated SAM: Children with a maintained appetite and clinically healthy without symptoms of illness or any other indication. It is considered that retained appetite suggests the absence of significant metabolic distress. These patients, with ready-to-use therapeutic foods, are thought to be most properly treated as outpatients.

Complicated SAM: Children that have clinical characteristics of illness, metabolic disturbance, extreme oedema, hypothermia, vomiting, severe dehydration, severe anaemia, or loss of appetite require initial inpatient therapy with low-protein milk-based feeds. When problems have been addressed, children are discharged to continue nutritional management as an outpatient is prescribed¹².

TWO PRINCIPAL FORMS OF SAM

SAM's two primary modes are:

Marasmus is generally caused by prolonged inadequate intake of energy and protein. The main symptoms are considerable loss of subcutaneous fat and muscle mass, resulting in a skeletal appearance. Conditions are characterized by a gaunt expression and extreme wasting of the muscles¹³.

Kwashiorkor is generally caused by prolonged inadequate intake of protein. The main symptoms are liver enlargement, wasting, hypoalbuminaemia, steatosis, bilateral lower limb oedema/face oedema, also associated with skin symptoms (shiny or cracked skin, burn-like appearance)¹⁴.

It is possible to associate the two forms (marasmic-kwashiorkor). SAM is followed, in addition to these characteristic symptoms, by severe physiopathological disorders (metabolic disorders, anaemia, weakened immunity, susceptibility to

infections that are frequently difficult to diagnose, etc.). There are frequent and potentially life-threatening risks. In the absence of adequate medical management, mortality rates can be elevated.

EFFECTS OF SAM

Increases the risk of infection, infectious disease, and weakens the immune system. Protein-energy malnutrition and the deficiencies of specific micronutrients, such as vitamins, iron, and zinc, increase the susceptibility to infections. Impaired function of the brain and lower energy also represent downward spiral of malnutrition as then victims are less able to perform tasks they need to earn an income, gain an education, or acquire food. Hypoglycemia (low blood sugar) may result if a child does not eat for 4 to 6 hours. Hypoglycemia has to be considered if there is limpness, convulsion, loss of consciousness, or lethargy^{15,16}.

TREATMENT OF SAM

The current WHO recommendations for management of SAM are based on facility-based treatment for initial stabilization phase and nutritional rehabilitation phase followed by continued management at home.

Stabilisation phase

Prevention and treatment of hypoglycaemia

Tracking the levels of glucose in patients with SAM is of the greatest priority; their blood glucose should be measured upon admission. Routine feeding has to be continued over a 24-hour span (not disrupted at night). If it is present, the patient, ideally with oral feeds or fluids, should be actively treated, as mortality can therefore be prevented^{17,18}.

Prevention and treatment of hypothermia

Since mortality is associated with hypothermia, it is important to control the temperature of the body upon admission and during reheating. This can take place for 2 hours until the temperature of the infant remains > 36.5 ° C. it is important to monitor blood glucose levels during hypothermia episodes. The patient should be fed immediately or, if necessary, rehydration should begin. Using a warmed blanket to rewarm children and put a heater or lamp nearby.

Treatment of dehydration and diarrhoea

In the presence of oedema, management of dehydration in chronically malnourished children may be difficult. Breastfeeding or starter formula feeding should be promoted to avoid dehydration when a child has ongoing watery diarrhoea. Stool losses should be replaced with approximate volumes of oral rehydration solution, which is much safer than intravenous fluids.

Overhydration and repeated intravenous boluses during resuscitation increase mortality. The amount of fluid administered is determined by the child's response and monitored by pulse and respiratory rates. With improvement in these rates, intravenous fluid (half-strength Darrow's solution with 5% dextrose) boluses should be discontinued.

Additional treatment modalities for diarrhoea include the use of zinc supplementation. In dysentery, the administration of intravenous cefotaxime or ceftriaxone must be considered^{4, 19}.

Correction of electrolyte imbalances

There is excess body sodium in all chronically malnourished children, even though plasma sodium may be poor. Fluids, or feeds containing excessive sodium, may cause mortality. Deficiencies in potassium and magnesium are also exist and can take at least 2 weeks to resolve. Oedema is partly due to these imbalances and is consequently not treated with a diuretic.

Treatment of infection

In severe malnutrition the usual signs of infection. Therefore, broad-spectrum antibiotics with adequate Gram- positive and -negative cover should be provided. Where specific infections are identified, specific antimicrobials should be administered, e.g. metronidazole for gastrointestinal infections and infestations²⁰.

Correction of micronutrient deficiencies

Deficiencies in vitamins and minerals are normal in malnutrition. For at least 2 weeks, supplementation should be given. While anaemia is often present, it is not initially appropriate to start iron supplementation, but to postpone it until the child has a healthy appetite and begins to gain weight - usually by the second week²¹.

Start cautious feeding

In two stages, feeding a malnourished child takes place. A careful approach is needed during the stabilization process because of the weakened physiological condition of the child and reduced homeostatic capacity. Ideally, a ~75 kcal/100 mL and 0.9 g protein/100 mL starter formula should be initiated. F-75 therapeutic milk, low in protein, sodium and calories (0.9 g of protein and 75 kcal per 100 ml) is used in the initial phase of treatment. A resumption of appetite and loss of all oedema, which typically occurs around 1 week after admission, are indicators of advancement to the recovery level. To avoid the risk of heart failure, a gradual transition to the recovery process is advised²².

Rehabilitation phase

To obtain optimum intakes and rapid weight gain of 10 g/kg/day, a rigorous approach to feeding is required in the rehabilitation phase. Ready-to-Use Supplementary Food (RUSFs) and Ready-to-use therapeutic food (RTUF) packages have been successful, not only during outpatient management programmes, but also during the rehabilitation phase. RUSFs are fortified with micronutrients and contain essential fatty acids and quality protein such as Upma mix, Khichdi mix with dal analogue, Sweet Porridge, Nutrimix powder, Kuzhandai Amudhu, powder etc. RTUF are foods which are ready for consumption such as peanut paste enriched with milk solids, such as Plumpy'nut, some other examples of RUTF are given in table 1^{23,24}. Peanut butter changes the physical and functional properties of the food to viscous liquid product rather than a powder. Nutritional composition of a typical RUTF is given in table 2²⁵⁻²⁷.

An alternative option is a higher energy and protein-containing formula, such as the WHO F-100 formula (F-100 therapeutic milk, in which the concentration of protein and calories is higher i.e. 2.9 g of protein and 100 kcal per 100 ml, replaces F-75 after several days, once the patient is stabilised). It is designed to promote rapid weight gain (approximately 500 kcal per 100 g). RUTF are the only therapeutic foods which can be used in ambulatory treatment. Continued monitoring after transition would include weight assessment every morning.

Table 1: Some Ready-To-Use Therapeutic Food (RUTF)

Name	Description
BP-100	a nutrient-fortified wheat-oat bar designed to provide similar nutritional profile to F-100 by World Health Organization
Citadel spread	a paste of peanuts, sugar, milk powder, and oil in use since 1971
K-Mix 2	a high energy food, made by UNICEF in the 1960s
Medika	a therapeutic food enriched with peanut butter produced and distributed by the Meds and Food for Kids
Mamba	
Nutribun	a fortified bread product made by USAID and distributed under Food for Peace program
Plumpy'nut	a solid RUTF, produced in France since 1996 for the treatment of severe acute malnutrition

Furthermore, it is important to give drinking water, in addition to meals, especially if the ambient temperature is high or the child has a fever²⁸.

Provide sensory stimulation, emotional support and follow-up after recovery

Delayed mental and behavioral development occurs in severe malnutrition. The patient should be provided with a happy and stimulating atmosphere, with structured play therapy for 30 minutes per day provided as soon as the child is well enough to be involved. A consistent follow-up schedule, including regular weight assessment, should be used to ensure that booster immunizations and vitamin A are provided^{29,30}.

CONCLUSION

The findings of this study indicated that household food access and child's age were independently associated with Severe acute malnutrition (SAM).

Table 2: Nutritional Composition Of A Typical Ready-To-Use Therapeutic Food (RUTF)

Nutrient	Composition
Energy	520-550 Kcal/100g
Lipids	45 to 60% total energy
Moisture content	2.5%
maximum Proteins	10 to 12% total energy
Calcium	300 to 600 mg/100g
Copper	1.4 to 1.8 mg/100g
Iodine	70 to 140 µg/100g
Iron	10 to 14 mg/100g
Magnesium	80 to 140 mg/100g
Phosphorus	300 to 600 mg/100g
Potassium	1100 to 1400 mg/100g
Selenium	20 to 40 µg
Sodium	290 mg/100g maximum
Zinc	11 to 14 mg/100g
Vitamins A	0.8 to 1.1 mg/100g
Vitamins D	15 to 20 µg/100g
Vitamins E	20 mg/100g minimum
Vitamins K	15 to 30 µg/100g
Vitamins B1	0.5 mg/100g minimum
Vitamins B2	1.6 mg/100g minimum
Vitamins C	50 mg/100g minimum
Vitamins B6	0.6 mg/100g minimum
Vitamins B12	1.6 µg/100g minimum
Niacin	5 mg/100g minimum
Pantothenic acid	3 mg/100g minimum
Folic acid	200 µg/100g minimum
Biotin	60 µg/100g minimum
n-3 fatty acids	0.3% to 2.5% of the total energy
n-6 fatty acids	3% to 10% total energy

Hence, education and awareness to the mothers could play a vital role in improving child nutrition status. Our findings emphasized the need to strengthen the nutrition status of children by promoting access to food and various source of nutrition. Nutrition programs should be prepared to serve the poorest and disadvantaged mothers and children during and after an emergency. Several studies had proven the effectiveness of RUSFs and RUTF (with adjusted dosage for supplementary ration) for the treatment of Severe acute malnutrition (SAM). Large-scale epidemiological studies are needed to investigate the determinants of SAM and explore the best approach to deal with SAM during emergencies.

CONFLICT OF INTEREST

None

AUTHOR'S CONTRIBUTIONS

The BV collected the data and prepared manuscript under supervision of AF. Both authors approved the manuscript for publication.

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