Undernutrition and severe acute malnutrition in children

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Undernutrition contributes to nearly 45% of all deaths in children under 5 years old globally.1 Low and middle income countries are worst affected.2 Treatment services are estimated to reach less than 15% of undernourished children.3 Healthcare providers can play a crucial role in identifying undernutrition in children and ensuring appropriate care and referral.

We provide an overview of assessment and initial management of undernutrition in children under 5 years of age. For the purpose of this paper, we focus on severe acute malnutrition, when children are at increased risk of medical complications unless diagnosed and managed promptly.

What encompasses child undernutrition and severe acute malnutrition?

Undernutrition results from insufficient intake of energy foods (carbohydrates, fats), proteins, and micronutrients (vitamins and minerals).4 Energy and protein malnutrition can manifest clinically as marasmus, kwashiorkor, and marasmic-kwashiorkor (see fig 1 and fig 2). The current World Health Organization guidelines subsume these entities into the blanket term “severe acute malnutrition,” and its variants with or without medical complications.5 Acute malnutrition results from hunger or disease, or both, and is associated with rapid weight loss or failure to gain weight. Box 1 outlines the subclinical and clinical forms of undernutrition. Iron, iodine, vitamin A, and zinc deficiencies are common micronutrient deficiencies seen in undernourished children.

**WHAT YOU NEED TO KNOW**

- Children with moderate to severe acute malnutrition have three to nine times higher mortality than well nourished children
- In areas with high rates of undernutrition, assess nutritional status of all children under 5 years old using standard anthropometric measures
- Refer children with medical complications, oedema, or poor appetite to a medical center for inpatient management with standard feeding protocols
- Children who are well and alert can be managed in the community with optimal diet, counseling mothers about child care and feeding, and regular follow-up
- The choice between ready-to-use therapeutic foods or home prepared food must be guided by local availability, costs, and caregiver preferences
How common is it?
The WHO estimates that nearly 7.7% of children under 5 years old (52 million) have wasting, of whom 17 million have severe acute malnutrition. An estimated 22.9% (154.8 million) are stunted, reflecting chronic undernutrition. Further, 47.4% (293 million children) and 33.3% (190 million) of pre-schoolers globally, have iron deficiency anaemia and vitamin A deficiency respectively. Nearly two thirds of acutely malnourished children live in South Asia, and over a quarter live in Africa.

What causes child undernutrition?
Undernutrition is both a medical and social disorder. It can be directly attributed to inadequate dietary intake or infection or disease that affects the child. Lack of sanitation and hygiene, inadequate care, economic deprivation, and food insecurity are contributory factors. Social, cultural, political, and legal factors that influence availability and use of resources further contribute to child undernutrition. Any interventions must address these factors as well.

What are the consequences?
Immediate consequences include high morbidity and mortality. Weakened mucosal barriers and an immunocompromised state predispose undernourished children to infections, especially those of the gastrointestinal and respiratory systems. In 2013, child undernutrition accounted for 1.3 million child deaths and 120 million disability adjusted life years (DALYs).

How is it diagnosed?
In communities with a high burden of child undernutrition, active case finding by community health workers who screen children through home visits or other outreach platforms helps with early detection. In addition, we recommend that healthcare providers screen all children during routine visits to a health facility.

History
Explore the carer’s concerns about a child’s growth and any current illness. The child may have cough, fever, diarrhoea, skin infections, eye or ear complaints, which suggest an infection. Ask about changes in behaviour such as lethargy, irritability, drowsiness, and loss of appetite.

A detailed diet history in terms of breastfeeding and complementary feeding (that is, timely introduction of solids and semisolid foods) is important. A nutritionist or trained health worker can help assess the child’s current dietary intake pattern in terms of the frequency, portions, variety, and composition of meals using validated tools. Understanding socioeconomic factors such as housing, occupation, family size, and dietary or childcare practices may be important, as discussed above.

Examination
Measure the child’s weight, length or height, and mid-upper arm circumference with well calibrated instruments. These anthropometric measures are plotted in the WHO growth charts as composite indicators of weight relative to age, height/length relative to age, and weight relative...
to height/length (www.who.int/childgrowth/standards/en/). The WHO child growth standards are available for girls and boys from birth to 18 years of age and provide a reference to classify undernutrition, as outlined in box 1.

Mid-upper arm circumference reflects both muscle mass and subcutaneous fat. This simple measurement has been found to adequately identify children with severe acute malnutrition as compared with weight relative to height/length, however, correlations between the two are poor. While both mid-upper arm circumference and weight relative to height/length have high specificity for detecting children at risk for death (>95%), both indicators have low sensitivities (<10%) for predicting death. The two criteria are used independently to guide admission. Box 2 outlines criteria for identifying severe acute malnutrition in children under 5 years.

Note the child’s general appearance and behaviour, including apathy, irritability, and drowsiness. Look for clinical features of malnutrition. Marasmic children have severe wasting with loss of muscle and fat mass, resulting in low weight for height/length or low mid-upper arm circumference, or both. Kwashiorkor presents with bilateral pitting oedema of the lower legs and feet that can become generalised. The child may have skin lesions and dry, thin, and brittle hair with lightening of colour. Children with marasmic-kwashiorkor show the features of both conditions.

**When to refer?**

Refer urgently children with severe acute malnutrition who have oedema or any medical complications listed in fig 3 to a hospital, preferably with a paediatric ward or a designated nutrition rehabilitation unit, for inpatient management. Children less than 6 months old with severe acute malnutrition should be managed as inpatients regardless of complications as they require close monitoring and support to prevent deterioration and restore optimal feeding.

In areas with an operational WHO programme for severe acute malnutrition, guidelines provided by the WHO for screening and referral are followed (see fig 3).

**How is it managed?**

Only 10-15% of children with severe acute malnutrition require inpatient care at presentation. Children without medical complications or oedema, who have a good appetite, and are clinically well and alert can be managed in the community. An interdisciplinary approach involving a clinician, nutritionist, and community health worker or nurse is crucial. Ensure regular follow-up at the health centre or through home visits by community health workers to assess improvement in nutritional status and detect any complications.

Box 3 provides a summary of the WHO protocol for community based management of moderate to severe acute malnutrition. The key components of management are described below.

**Nutrition**

Safe palatable foods with high energy content and adequate micronutrients form the cornerstone of nutritional management. Traditionally, home based, locally available foods are recommended, with adequate frequency and volume. During the past decade, ready-to-use therapeutic foods (RUTF) with standardised compositions have become available and are provided by government programmes or through international aid in countries with high rates of undernutrition. RUTF are soft or crushable energy-dense foods enriched with micronutrients (see appendix 2 on bmj.com). These can be consumed easily by children from the age of 6 months old without adding water, therefore precluding bacterial growth. RUTF can be used safely without refrigeration and in conditions where hygiene is suboptimal.

In some settings, it may be possible to prescribe appropriate therapeutic diet using locally available nutrient-dense foods with added micronutrient supplements. However, this approach requires careful monitoring because nutrient adequacy is hard to achieve.

The evidence on effectiveness of RUTF compared with home based food is inconclusive, however. A Cochrane review in 2013 (4 trials, 2894 children) assessed the efficacy of different compositions of RUTF compared with each other or with a standard diet of flour porridge. There was very low quality evidence that RUTF improve weight and mortality. The authors conclude that either RUTF or flour porridge can be used based on availability, cost, and practicality. In a recent randomised controlled trial (906 children with uncomplicated severe acute malnutrition) in India, RUTF use was associated with higher weight gain and recovery compared with micronutrient enriched, energy-dense, home prepared foods. However, 40% of children showed no recovery even after 16 weeks of use of RUTF.

A Cochrane review published in 2013 (8 randomised controlled trials, 10 037 children) reported that lipid based therapeutic foods and specially formulated foods such as corn-soy blended foods are effective in treatment of moderate acute malnutrition. However, no study evaluated the impact of improving the local diet to increase its nutritional content. No studies were done in Asia, where moderate acute malnutrition is most prevalent.

**Medicines**

The WHO guidelines recommend broad spectrum antibiotics for children with uncomplicated severe acute malnutrition, but evidence for their role is limited. Antihelminthics may be offered for deworming, but there is no consensus on their role in undernutrition.
Acute undernutrition
Screening and referring children under 5 years old

Trained community health workers are well positioned for early identification of children with severe acute malnutrition. According to WHO guidelines, undernourished children are managed by following an integrated management protocol, involving both community as well as facility based care.

Screening criteria

- **WEIGHT FOR HEIGHT**
  - Weight relative to height/length (WFH) compared against WHO growth standards
  - Below –3 SD: Less than 3 standard deviations below median
  - –3 SD to –2 SD: Between 3 and 2 standard deviations below median
  - Above –2 SD: More than 2 standard deviations below median

- **MID-UPPER ARM CIRCUMFERENCE**
  - This can identify children with severe acute malnutrition
  - Less than 115 mm
  - Between 115–124 mm
  - More than 125 mm

- **BILATERAL PITTING EDEMA**
  - Verified when normal thumb pressure applied on top of feet for 10 seconds leaves an indentation
  - Present
  - Not present

**ANY** of the above

**ALL** of the above

**SAM**
Severe acute malnutrition

**MAM**
Moderate acute malnutrition

**Normal**

**Medical complications or failed appetite test?**

- **Yes**
  - Inpatient therapeutic care
  - On discharge

- **No**
  - Outpatient therapeutic care
  - Nutrition counselling and supplementary feeding

**Check for medical complications**

- Oedema
- Persistent vomiting
- Very weak
- Apathetic
- Fever (axillary temperature > 38.5°C)
- Children with fast breathing
- Chest indrawing
- Cyanosis
- Extensive skin lesions
- Eye lesions
- Post-measles states
- Diarrhoea
- Dehydration
- Based on history and clinical signs
- Hypothermia
- Severe anaemia
- Or any other sign which the clinician thinks warrants transfer to inpatient facility for assessment or care

**Appetite test**

Conducted by trained health workers or clinicians as part of a programme following WHO guidelines

- Child is given a packet or pot of RUTF (ready-to-use therapeutic food)
- The child should eat a proportion of the RUTF calculated relative to child’s weight

- **Yes**
  - Praise mother and give counselling

- **No**

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Fig 3 | Screening and referral of children at risk of severe acute malnutrition

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Health education
Awareness among mothers on appropriate nutrition practices plays a vital role in preventing and managing undernutrition. A critical part of nutritional support is the amount and frequency of feeds, with cautious yet frequent initial feeding in small amounts. The WHO recommends use of therapeutic feeds F-75 and F-100. Feeding strategies at various phases are explained in appendix 3 on bmj.com. Micronutrient supplementation with iron, vitamin A, folic acid, and additional minerals is advised to correct deficiencies. The guidelines recommend antibiotics in these children even without any obvious clinical signs of infection, according to local antibiotic resistance patterns.6

Feeding severely acutely malnourished young infants is labour intensive and requires a different approach from that needed for older children.

The evidence on effectiveness of the WHO protocols is inconclusive, largely due to variations in implementation.5 A systematic review on effectiveness of WHO protocols for inpatient management of severe acute malnutrition showed large variations in case fatality rates in the range of 3.4% to 35%.41 A recent systematic review (9 studies) found a 41% reduction in case fatality rates (odds ratio 0.59 (95% confidence interval 0.46 to 0.76)) when WHO guidelines for facility based management of severe acute malnutrition were followed.42

Early detection of severe acute malnutrition with and without medical complications and evidence based integrated management involving continuum of care will be key to the success of strategies for minimising the burden of severe acute malnutrition in the community.

Questions for future research
• How effective are ready-to-use therapeutic foods that comply with WHO specifications compared with foods prepared using indigenous recipes and augmented with micronutrients?
• What is evidence of using routine antibiotics in community based management of severe acute malnutrition?
• What are the effective ways to promote transition from ready-to-use therapeutic foods to home based foods?
• What factors affect successful transition from facility based management to community based management of severe acute malnutrition?

Health education for mother or caregiver
• Health education during periodic visits for CMAM may cover the following themes:
  • Appropriate feeding practices
  • Advantages of continued breastfeeding
  • Feeding during illness
  • Management of common illness such as diarrhea
  • Characteristics of complementary food
  • How to improve quality and energy density of locally available food items
  • Importance of timely immunisation
  • Recognising danger signs

Discharge criteria
• A child is discharged from CMAM when she or he achieves
  • Weight for height/length > –2 standard deviations of median growth standard or mid-upper arm circumference ≥125 mm
  • No oedema for two consecutive sessions or CMAM visits
  • Child clinically well and alert
  • Minimum of 2 months in treatment

It is advisable to follow up a child at least 4 times during the first 12 months after discharge.

### Table 1 | WHO 10 steps for treatment of severe acute malnutrition with medical complications

| Management step | Stabilisation | Rehabilitation. |
|-----------------|---------------|-----------------|
| 1. Treat/prevent hypoglycaemia | Days 1-2 | Weeks 1-2 |
| 2. Treat/prevent hypothermia | Yes | — |
| 3. Treat/prevent dehydration | Yes | — |
| 4. Correct electrolyte imbalance | Yes | Yes |
| 5. Treat infections | Yes | Yes |
| 6. Correct micronutrient deficiencies | Yes, non-iron | Yes, with iron |
| 7. Start cautious feeding | Yes | — |
| 8. Rebuild wasted tissues (catch-up growth) | — | — |
| 9. Provide loving care and play | Yes | Yes |
| 10. Prepare for follow-up | — | — |

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Box 3: Summary of WHO protocol for community based management of severe acute malnutrition

- Children with severe acute malnutrition should undergo a full clinical evaluation to identify medical complications plus an “appetite” test (see appendix 1 on bmj.com).
- Children who pass the appetite test and are clinically well and alert should be treated as outpatients by following protocols for community based management of malnutrition (CMAM).
- Children with medical complications or severe oedema or who fail the appetite test should be treated as inpatients and should be managed by the facility based management protocol.

Community based management
- This includes anthropometric and medical assessment, appetite test, enrolment in the programme, nutritional treatment, medicines, and health education.
- Children are followed up while enrolled in the programme.
- Follow-up
  - Children are called for follow-up every week. Mid-upper arm circumference and weight are measured, and appetite test is performed:
    - If weight gain is satisfactory, the mother is encouraged to continue the care.
    - If weight loss is static or there is weight loss, a medical history is taken to check for danger signs or any complications. Compliance with use of ready-to-use therapeutic foods or dietary advice and medicines is assessed.
    - Routine home visits or follow-up between CMAM sessions are not required unless the mother or caregiver misses follow-up visits or if the child has poor weight gain.

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**CLINICAL UPDATES**

Involving a nutritionist or trained health worker to counsel the mother on meal planning and effective nutrition and child care practices. The key aspects of nutrition counselling for mothers are mentioned in box 3.

Hospital based management of severe acute malnutrition
The three phases of inpatient management include stabilisation, transition, and rehabilitation, based on response to treatment and recovery of the child. Table 1 outlines the 10 steps of facility based management of severe acute malnutrition according to the WHO guidelines. A critical part of nutritional support is the amount and
CLINICAL UPDATES

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Appendix 1: How to conduct an appetite test

Appendix 2: Details of ready-to-use therapeutic food for malnourished children

Appendix 3: Feeding strategy in 3 phases of facility based management of severe acute malnutrition

Infographics: Screening and referral of children at risk of severe acute malnutrition