Chapter 11. Management of Severe and Moderate Acute Malnutrition in Children

Lindsey Lenters*, Centre for Global Child Health, The Hospital for Sick Children, Toronto, Canada
Kerri Wazny*, Centre for Global Child Health, The Hospital for Sick Children, Toronto, Canada
Zulfiqar A. Bhutta, Centre for Global Child Health, The Hospital for Sick Children, Toronto, Canada & Founding Director, Center of Excellence in Women and Child Health, The Aga Khan University, Karachi, Pakistan

*Authors contributed equally to this work.

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Correspondence:
Lindsey Lenters*, Centre for Global Child Health, The Hospital for Sick Children, Toronto, Canada
Email: lindsey.lenters@sickkids.ca

Abstract

Acute malnutrition, or wasting, represents a significant public health concern across low- and middle-income countries, affecting millions of children and significantly increasing their risk of death. Over a tenth of all under-five deaths can be attributed to acute malnutrition. There are a range of strategies that can prevent the development of wasting by modifying one or more of the risk factors. These strategies dovetail into general strategies for promoting optimal growth and nutrition and include promotion of good nutritional intake through exclusive breastfeeding, optimal infant and young child feeding practices, micronutrient supplementation, and general food supplementation where needed. Improving water, sanitation and hygiene (WASH) and managing common childhood illnesses, such as diarrhea and pneumonia, also represent important strategies for preventing the development of acute malnutrition. The application of such preventive strategies is context specific and will vary depending on factors such as food security, conflict, economic stability and cultural norms. Meanwhile, the recommendations for treatment of severe acute malnutrition (SAM) are relatively more straightforward. The standard practice has been to treat all children with severe acute malnutrition in inpatient facilities; however, this is shifting to an approach that focuses on active case finding and treatment of uncomplicated cases in a
community setting, with complicated cases treated in inpatient facilities. The treatment of moderate acute malnutrition (MAM) consists of a blend of therapeutic and preventive strategies, which, again, are context-dependent. Management of acute malnutrition must be viewed on a spectrum, as the prevention and treatment of MAM impacts the prevention and treatment of SAM, and must also be considered within the broader health and socioeconomic profile of the population. Although much progress has been made over the past decades in developing evidence-based approaches to managing acute malnutrition, the burden of acute malnutrition remains unacceptably high and many questions remain unanswered with respect to the etiology of this condition, optimization of treatment protocols, and the modes for improving quality and fidelity of program implementation.

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Entries:

- CHV – Community Health Volunteer
- CHW – Community Health Worker
- CFR – Case Fatality Rate
- CMAM – Community Management of Acute Malnutrition
- CSB++ - Corn Soy Blend Plus Plus
- CTC – Community-based Therapeutic Care
- DALY – Disability-Adjusted Life Year
- DHS – Demographic Health Survey
- GAM – Global Acute Malnutrition
- GDP – Gross Domestic Product
- HAZ – Height-for-Age Z-score
- HIC – High-Income Countries
- HIV – Human Immunodeficiency Virus
- HSD/5B – WHO Hypotonic Fluid Solution
- IMAM – Integrated Management of Acute Malnutrition
- IMCI – Integrated Management of Childhood Illness
- IYCF – Infant and Young Child Feeding
- LBW – Low Birth Weight
- LMIC – Low- and Middle-Income Countries
- LNS – Lipid-based Nutritional Supplements
- LRTI – Lower Respiratory Tract Infection
- MAM – Moderate Acute Malnutrition
- MUAC – Mid-Upper Arm Circumference
- NGO – Non-Governmental Organisation
- ORS – Oral Rehydration Solution
- OTP – Outpatient Therapeutic Program
- RCT – Randomised Controlled Trial
- RL – Ringer’s Lactate
- RUFs – Ready-to-Use Foods (includes RUSF, RUTF, and LNS)
- RUSF – Ready-to-Use Supplementary Food
- RUTF – Ready-to-Use Therapeutic Food
- SAM – Severe Acute Malnutrition
- SFP – Supplemental Feeding Program
- SGA – Small for Gestational Age
- SSA – Sub-Saharan Africa
- TFC – Therapeutic Feeding Centre
- WASH – Water and Sanitation Hygiene
- WHZ – Weight-for-Height Z-score
**Introduction**

Globally, approximately 6.6 million children die before their fifth birthday every year (UNICEF 2013a). The leading killers of children are infections; pneumonia and diarrhea are responsible for 18 percent and 11 percent of all deaths under age five years, respectively (Liu and others 2012). Degrees of malnutrition are associated with an increase in risk of all-cause mortality and an increase in risk of death due to diarrhea, pneumonia and measles (Black and others 2013).

The term ‘malnutrition’ is multi-faceted cluster of conditions that refers to both overnutrition, associated with overweight and obesity, and undernutrition, referring to multiple conditions including acute and chronic malnutrition. Chronic malnutrition, as the name would suggest, describes the intake of a diet that is inadequate in essential nutrients, particularly micronutrients (vitamins and minerals) over a protracted period of time. The impact of chronic malnutrition is particularly pronounced when it occurs in a child’s first years of life, which is a period of rapid growth and development. Chronic malnutrition can result in stunting (short stature for age) and other developmental impairments. Specific micronutrient deficiencies can also result in medical conditions as a result of chronic malnutrition.

Acute malnutrition, on the other hand, occurs as a result of sudden reductions in food intake or diet quality and combined with pathological causes. Acute malnutrition has been defined in various ways, and has been referred to by various names including: protein-energy malnutrition, wasting, kwashiorkor, marasmus and malnutrition. Protein-energy malnutrition and wasting are commonly used terms and in this chapter we will use acute malnutrition and wasting interchangeably. Acute malnutrition, or wasting, is defined using anthropometric cut-offs and clinical signs. The currently accepted definitions, set out by the World Health Organization (WHO) are as follows:

*Moderate acute malnutrition (MAM)*, defined as Weight-for-Height Z-score (WHZ) between -2 and -3 or mid-upper arm circumference (MUAC) between 115-125 mm, affects 32.8 million children worldwide, 31.8 million of whom reside in low- and middle-income countries (LMICs) (Black and others 2013).

*Severe acute malnutrition (SAM)*, defined as WHZ < -3 or MUAC <115 mm, and/or the presence of bilateral pitting edema, affects 18.7 million children worldwide; 18.5 million of children with SAM reside in LMICs (Black and others 2013).

*Global acute malnutrition* (GAM) refers to both MAM and SAM together and is used as a measurement of nutritional status at a population level, often as an indicator of the severity of an emergency situation.

Marasmus and kwashiorkor are also common terms used to differentiate between types of SAM. Marasmus refers to children who are very thin for their height (i.e. meet the WHZ or MUAC cut-off) but do not have bilateral pitting edema, whereas kwashiorkor refers to children who have bilateral pitting edema.
SAM is a significant public health concern as it affects approximately 19 million children across the globe every year (Black and others, 2013). The degree of wasting is positively correlated with an increase in the risk of death (Black and others 2013). Table 1 shows all-cause and cause-specific hazard ratios for mortality by degree of wasting. Of the deaths under age five years, 11.5 percent, or approximately 800,000 deaths, can be attributed to acute malnutrition (Black and others 2013). Of these, severe acute malnutrition (SAM) is responsible for 540,000 deaths (Black and others 2013). Children with acute malnutrition have severely disturbed physiology and metabolism, and therefore need to be treated with caution. Simply re-feeding these children can lead to high rates of mortality. Particularly when additional medical complications are present (see Box 1 for list of complications), cases can be difficult to manage. Thus, specific guidelines, supported by available evidence and expertise, have been developed for managing these cases and will be discussed in this chapter.

**Table 1 Hazard Ratios of All Cause and Cause-Specific Deaths, by Degree of Wasting**

<table>
<thead>
<tr>
<th>Weight-for-Length Z-Score</th>
<th>All Deaths HR (95% CI)</th>
<th>Pneumonia Deaths HR (95% CI)</th>
<th>Diarrhea Deaths HR (95% CI)</th>
<th>Measles Deaths HR (95% CI)</th>
<th>Other Infectious Deaths HR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;-3</td>
<td>11.6 (9.8, 13.8)</td>
<td>9.7 (6.1, 15.4)</td>
<td>12.3 (9.2, 16.6)</td>
<td>9.6 (5.1, 18.0)</td>
<td>11.2 (5.9, 21.3)</td>
</tr>
<tr>
<td>-3 to -2</td>
<td>3.4 (2.9, 4.0)</td>
<td>4.7 (3.1, 7.1)</td>
<td>3.4 (2.5, 4.6)</td>
<td>2.6 (1.3, 5.1)</td>
<td>2.7 (1.4, 5.5)</td>
</tr>
<tr>
<td>-2 to &lt;-1</td>
<td>1.6 (1.4, 1.9)</td>
<td>1.9 (1.3, 2.8)</td>
<td>1.6 (1.2, 2.1)</td>
<td>1.0 (0.6, 1.9)</td>
<td>1.7 (1.0, 2.8)</td>
</tr>
<tr>
<td>≥ -1</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
</tr>
</tbody>
</table>

Sources: LNS1 2013; Olofin 2013

In addition to increasing the risk of death due to infectious illness, wasting increases a child’s susceptibility to infections and also increases the severity of the illness (Laghari and others 2013; Long and others 2013; Meshram and others 2012; UNICEF 2013b). The relationship between malnutrition and infection is often described as a vicious cycle that begins with infections, especially diarrhea, and progresses in a child to undernourishment; the undernourishment, in turn, increases the risk of prolonged illness and the susceptibility to additional infection. Additionally, HIV infection exacerbates the risk of wasting, as well as mortality due to wasting (Sadler and others 2006).

Undernutrition can lead to reduced human and social capital over the lifespan of affected populations, thereby perpetuating undernutrition across generations, as seen in the United Nations Children’s Fund’s (UNICEF) conceptual model of undernutrition (figure 1) (UNICEF 2013b).
Figure __.1 Conceptual Framework of Determinants of Undernutrition

Disproportionate Distribution of Burden of Disease

Of children with wasting worldwide, 70 percent reside in Asia; the rates of SAM are highest in south-central Asia and Sub-Saharan Africa (Black and others 2013).

Gross inequities exist between the burden of wasted children in LMICs and high-income countries (HICs). Map __.1 shows the prevalence of wasting in children under age five years. Further inequities in the distribution of wasting can be seen between population subgroups, since poverty and food insecurity are major causes of malnutrition (Collins and others 2006). Inadequate food quality, lack of dietary diversity and infection also cause wasting (Picot and others 2012).

Map __.1 Percentage of Children Under Age Five Years Who Are Moderately or Severely Wasted [2007 – 2011, except India]
Risk Factors for Acute Malnutrition

The risk factors for MAM and SAM include the following:

- Inadequate dietary intake
- Inappropriate feeding
- Fetal growth restriction
- Inadequate sanitation
- Lack of parental education
- Family size
- Incomplete vaccination
- Poverty
- Economic, political and environmental instability and emergency situations

Laghari and others (2013) found that inappropriate feeding, including mixed or bottle-feeding and not breastfeeding, was significantly associated with severe malnutrition in children in Pakistan (Laghari and others 2013). Menon and others (2013) studied the effects of infant and young child feeding (IYCF) and water and sanitation hygiene (WASH) on wasting. The authors found that improved dietary diversity and improved WASH was associated with a better nutritional outcomes in children in India, and they concluded that integrated interventions targeted to both these risk factors will have greater impact than single interventions (Menon and others 2013). Several studies in Bangladesh, India, and Pakistan have demonstrated a correlation between low parental education and increased risk of wasting in children (Islam and others 2013; Laghari and others 2013; Long and others 2013; Menon and others 2013; Meshram and others 2012).
Poverty is another risk factor for wasting (Islam and others 2013; Meshram and others 2012) as are unsafe drinking water source and lack of toilets (Islam and others 2013). Economically disadvantaged families are conceivably less likely to have access to improved sources of drinking water, such as water from pipes or tubewells, and are less likely to have access to toilets. One study found these to be risk factors independent of the wealth index (Islam and others 2013). Another study, which did not assess WASH indicators, found family wealth index to be significantly associated with wasting (Meshram and others 2012). Both studies also found larger family sizes to be associated with an increased risk of wasting (Islam and others 2013; Meshram and others 2012), as did a study in Pakistan (Laghari and others 2013). A study in Burkino Faso found incomplete vaccinations and maternal literacy status to be risk factors for wasting relapse in that country (Somasse and others 2013).

Finally, investigators studying the correlation between fetal growth restriction and child wasting at age 24 months found that infants born small for gestational age (SGA) or those with low birth weight (LBW) were at a significantly increased risk of being wasted at 24 months (Cao and others 2013). Both SGA and LBW were also associated with statistically significant risks of stunting and underweight at 24 months (Cao and others 2013). LBW was found to be a risk factor for severe malnutrition in children under age five years in Pakistan (Laghari and others 2013).

Incidence of SAM is often exacerbated during emergencies, such as drought, famine, or armed conflict (Hall, Blankson, and Shoham 2011). While indicators such as household food consumption, harvest yield, and staple food prices are early warning signs of imminent food insecurity, increases in incidence of SAM or global acute malnutrition (GAM) are often present once the nutritional emergency has commenced (Hall, Blankson, and Shoham 2011).

In addition to death, malnutrition has serious physiological consequences including reductive adaptation, marked immunosuppression, and concurrent infection (Collins and others 2006). Families of children treated for malnutrition in in-patient facilities face economic consequences from loss of wages due to missed work by caretakers (Martorell and others 2010).

While rates of stunting (defined as Height-for-Age Z-score (HAZ) < -2) have declined by 35 percent since 1990, rates of wasting have only declined by 11 percent in the same period (Black and others 2013). Treatment and prevention of malnutrition intersects the domains of clinical medicine and public health (Collins and others 2006); prevention can be addressed through attention to upstream determinants of food insecurity and poverty, while clinical management can be achieved through food supplementation that increases the caloric, macronutrient and micronutrient intake. Approaches to treating malnutrition have evolved in recent decades and a shift from inpatient management of severe malnutrition to a community-based therapeutic care model (CTC) represents a major turning point in the treatment of malnutrition (Collins and others 2006).
Prevention of Acute Malnutrition

Providing Adequate Nutrition and Disease Prevention Strategies

The recent series in The Lancet on maternal and child nutrition outlines the body of evidence for effective interventions to prevent the development of malnutrition in children. Key interventions to prevent the development of acute malnutrition include appropriate breastfeeding\(^1\) and complementary feeding practices\(^2\) (Bhutta and others 2013a). Disease prevention strategies are important in breaking the infection-malnutrition cycle, particularly around the management of diarrhea and repeated respiratory infections (Bhutta and others 2013b). The bodies of evidence on effective approaches to preventing malnutrition largely focus on stunting and underweight as outcomes, and therefore may not be completely transferrable to the prevention of wasting. However, an integrated approach to optimizing healthy growth in infants and children should have a marked impact on reducing rates of wasting. For further information, refer to [link to appropriate chapters]

Seasonal Supplementation

One preventive strategy specific to acute malnutrition involves periodic blanket feeding programs. In many food-insecure settings, a seasonal spike in the incidence of MAM and SAM is seen in the period before the harvest. Seasonal distribution of food rations is an increasingly common approach that aims to suppress the cyclic rise in cases of acute malnutrition. These supplemental feeding programs, which may be targeted by geographic region or by age group, tend to include all children who have, or are at risk for, MAM. While the evidence to date remains limited on the effectiveness or cost-effectiveness of such approaches for the prevention of MAM, several studies have investigated the use of RUF supplementation for non-wasted children to reduce seasonal increases in population-wide prevalence rates of wasting (Defourney and others 2009; Grellety and others 2012; Hall and other 2011; Huybregts and others 2012; Isanka 2009; Karakochuk 2012).

For example, a blanket supplementary feeding program in Niger provided children ages six to 26 months (MUAC > 110 mm) with roughly 50 g/d of RUSF (Defourney and others 2009). The authors reported that fewer children in the target locality presented in need of therapeutic care than in previous years; however, it was not possible to rule out overall improvements in food security in the absence of a comparison group in the study.

Another study, also in Niger, by Isanaka and others (2009) randomized villages to receive the intervention (one packet of RUTFs per day for children) versus no intervention. The intervention was estimated to have led to a 36 percent difference in the incidence of

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\(^1\) Appropriate breastfeeding is defined by the WHO as early initiation (within the first hour of life) and exclusive breastfeeding on demand for the first 6 months of life.
http://www.who.int/nutrition/topics/exclusive_breastfeeding/en/

\(^2\) Appropriate complementary feeding practices, or infant and young child feeding, have been outlined by the WHO and are available at http://www.who.int/mediacentre/factsheets/fs342/en/
wasting and a 58 percent difference in the incidence of severe wasting (Isanaka and others 2009). While the authors claimed that the difference represented a reduction in wasting, some reviewers argue that the statistically significant difference could be ascribed to increased incidence of wasting in the control villages coupled no change in the intervention sites (Hall and others 2011).

Other interventions to stimulate access to foods and boost purchasing power could be implemented in emergency or food-insecure situations where there are viable markets. These include interventions with growing bodies of supportive evidence, such as voucher schemes and cash transfers (Bhutta and others 2013a).

**Therapeutic Foods for Preventing and Treating Acute Malnutrition**

F75 and F100 are specially formulated milks that are used in inpatient settings to treat SAM. F75 is given to children in the stabilization phase of inpatient treatment; children are provided with approximately 80 to 100 kcal/kg/d spread over eight to 12 meals per day for three to seven days and is not designed for weight gain (personal communication, Nutriset; UNICEF 2014). F100 is given during the rehabilitation phase of inpatient treatment of SAM, providing children with approximately 100 to 200 kcal/kg/d for three to four weeks (UNICEF 2014; personal communication, Nutriset).

Because F75 and F100 require preparation and have high moisture content, they cannot be stored for long at room temperature and are not given to caretakers to prepare at home for children (UNICEF catalogue).

The development of ready-to-use foods (RUFs) has facilitated the emergence of the community-based treatment model. These products are more nutrient-dense than available home foods and do not require preparation; they typically have very low moisture content and are resistant to microbes.

- Ready-to-use therapeutic foods (RUTFs), which are specially formulated bars, pastes, or biscuits that provide high-quality protein, energy, and micronutrients
- Ready-to-use supplementary foods (RUSFs)
- Lipid-based nutritional supplements (LNS)
- Plumpy’Doz, Plumpy’Sup, and Plumpy’Nut, which are common RUFs used to prevent or treat MAM and SAM, are given to supplement children’s diets:
  - Plumpy’Doz, designed to prevent or treat MAM in infants and children ages six to 36 months, is given through a general distribution
  - Plumpy’Sup, designed to treat MAM in infants under age six months, is given for two months in quantities of 75 kcal/kg/d
  - Plumpy’Nut, designed to treat MAM or SAM in infants under age six months: For MAM treatment, children receive one to two 92 gram sachets (doses) per day. For SAM treatment, children receive two to three sachets per day. The quantity of Plumpy’Nut for treating SAM is intended to meet a child’s full daily nutritional requirements (Nutriset).
• Supercereal Plus, formerly called Corn Soy Blend Plus Plus (CSB++) can be given as food rations to families for the prevention of MAM.

Nutrient composition of some common formulated foods for treatment and prevention of acute malnutrition are shown in table __.2.

**Table __.2 Nutritional Composition of Common Formulated Foods for the Prevention and Treatment of Acute Malnutrition**

<table>
<thead>
<tr>
<th></th>
<th>F75* (100g of milk powder)</th>
<th>F100 * (100g milk powder)</th>
<th>Plumpy'Sup (100g)</th>
<th>Plumpy'Doz (100g)</th>
<th>Plumpy'Nut (100g)</th>
<th>Supercereal Plus (100g dry matter)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Recommended Serving Size (kcal/kg/d)</strong></td>
<td>80-100</td>
<td>200</td>
<td>75</td>
<td>46.3 g/d</td>
<td>SAM: 200</td>
<td>MAM: 75</td>
</tr>
<tr>
<td><strong>Macronutrients</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>N/A*</td>
</tr>
<tr>
<td><strong>Energy (kcal)</strong></td>
<td>446</td>
<td>520</td>
<td>520-550</td>
<td>534-587</td>
<td>520-550</td>
<td>410</td>
</tr>
<tr>
<td><strong>Protein (g)</strong></td>
<td>5.9</td>
<td>&gt;13g</td>
<td>12.6-15.4</td>
<td>13.4-17.7</td>
<td>13-16g</td>
<td>&gt;16.4</td>
</tr>
<tr>
<td><strong>Lipid (g)</strong></td>
<td>15.6</td>
<td>&gt;26g</td>
<td>31.5-38.6</td>
<td>26.7-39.1</td>
<td>26-36g</td>
<td>&gt;4.1</td>
</tr>
<tr>
<td><strong>Minerals</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Potassium (mg)</strong></td>
<td>775</td>
<td>1100</td>
<td>980-1210</td>
<td>660-870</td>
<td>1100-1400</td>
<td>140</td>
</tr>
<tr>
<td><strong>Calcium (mg)</strong></td>
<td>560</td>
<td>300</td>
<td>300-350</td>
<td>800-980</td>
<td>300-500</td>
<td>452</td>
</tr>
<tr>
<td><strong>Phosphorus (mg)</strong></td>
<td>330</td>
<td>300</td>
<td>300-350</td>
<td>530-660</td>
<td>300-600</td>
<td>232</td>
</tr>
<tr>
<td><strong>Magnesium (mg)</strong></td>
<td>50</td>
<td>80</td>
<td>80-100</td>
<td>115-140</td>
<td>80-100</td>
<td>--</td>
</tr>
<tr>
<td><strong>Zinc (mg)</strong></td>
<td>12.2</td>
<td>11</td>
<td>12-15</td>
<td>8.7</td>
<td>11-14</td>
<td>5</td>
</tr>
</tbody>
</table>

*Supercereal Plus is given in bulk to families

**Sources:** Nutriset catalogues; Supercereal Plus from USAID specifications.

**Note:** N/A = Not applicable

**Management of Moderate Acute Malnutrition**

In recent years, growing attention has focused on the management of MAM including treatment as an intervention in itself in addition to its instrumental importance in preventing the development of SAM. The typology of interventions and their indicated uses in different contexts has been the topic of considerable discussion and has led to the publication of several guiding documents. However, in practice, considerable ambiguity remains in the classification of interventions and considerable evidence gaps exist in the knowledge of the most effective interventions.

Optimal nutrition and health-promoting practices are not always attained for a variety of reasons, whether due to a lack of knowledge or a lack of access to an appropriate diet and health care services. The result can lead to the development of MAM, particularly in situations of insufficient macronutrient intake that contribute to weight loss and the development of acute malnutrition.
Since wasting represents a loss of body mass relative to the child’s height, the standard practice has been to provide the child with additional, energy and nutrient-dense foods to promote weight gain. The management of MAM can be broadly categorized into preventive and treatment strategies. The selection of the specific management approach is context-specific; for example, different approaches are warranted for populations that are relatively more stable and food secure than for populations experiencing significant food insecurity or humanitarian emergencies.

**Strategies for Prevention**
Strategies for the prevention of MAM include approaches discussed in other chapters that promote optimal growth and nutritional status as well as the prevention of infection generally. The promotion of appropriate breastfeeding and complementary feeding practices (link to IYCF recommendations and IYCF Chapter), promoting access to appropriate health care for the prevention and treatment of disease (link to relevant chapter) and improving sanitation and hygiene practices (link to section on WASH) are important for preventing poor nutritional outcomes. Micronutrient supplementation is an important part of promoting optimal nutrition when adequate micronutrients cannot be obtained from the diet; while micronutrient deficiencies are most commonly linked to stunted linear growth, these deficiencies can also contribute to the development of wasting, for example, through the malnutrition-infection cycle. Undernourished children, including those with micronutrient deficiencies such as zinc, iron, or vitamin A, tend to be more susceptible to infection, which can contribute to weight loss through increased metabolism, as well as reduced nutrient intake and/or absorption (Guerrant and others 2008; Petri and others 2008).

**Strategies for Treatment**
No consensus exists on the optimal treatment of MAM; however, in 2008, the WHO established a working group to approach the topic of dietary management of MAM. Since then, the emphasis on exploring optimal food-based treatments for MAM has increased (GNC 2012). The guidelines in the WHO technical note for the use of supplementary foods for managing MAM in children ages six to 59 months state that the focus should be on providing locally available, nutrient-dense foods to improve nutritional status and prevent the development of SAM (WHO 2012). In situations of food shortage, supplementary foods have been supplied but with suboptimal effectiveness. The technical note suggests that an energy intake of 25 kcal/kg/d in addition to the nutrient requirements for a non-malnourished child would likely support a reasonable rate of weight gain without promoting obesity. However, there is currently no evidence-informed recommendation for the composition of specially formulated foods for treating MAM (WHO 2012).

The treatment of MAM can be achieved through different approaches, depending on the setting. In food-secure populations where families have access to adequate, safe, affordable and nutritious foods, caregivers should be counselled and supported in using high-quality, home-available foods to promote recovery in acutely malnourished children (Bhutta 2013a). This intervention should be coupled with general health promotion
approaches to help mitigate the underlying factors that contribute to the development of acute malnutrition (for example, WASH and health-seeking behaviors). Two recent systematic reviews (Lazzerini, Rupert, and Pani 2013; Lenters and others 2013) found no significant differences in mortality between the provision of any type of specially formulated food and the standard care (medical care and counselling without food provision). Children provided with food were significantly more likely to recover, based on two studies in the meta-analysis (Lazzerini, Rupert, and Pani 2013). This systematic review could not identify any trials investigating the effect of improving the adequacy of local diets.

The literature search conducted by Lenters and others identified very few rigorous trials that compared the provision of therapeutic foods, such as RUTFs or RUSFs, to other types of interventions aimed at modifying the upstream factors that contribute to the development of wasting (Lenters and others 2013). In a study by Singh and others, the mean weight gain was significantly higher in the group provided with RUTFs than in the standard care group where mothers were taught to prepare a high-calorie cereal milk (Singh and others 2010). However, since this study assessed nutritional status using weight-for-age, it children who were not wasted may have been included in the study.

Ashworth and Ferguson (2009) reviewed of dietary counselling for the treatment of MAM and collected programmatic data from United Nations agencies, nongovernmental organizations (NGOs), and national programs to assess whether recommendations were likely to meet children’s dietary needs. The authors concluded that messages tended to be vague and were unlikely to be effective. Their review also aimed to assess the effectiveness of dietary counselling in the management of MAM and suggested, based on an analysis of 10 studies, that counselling families on the consumption of family foods can have a positive effect on weight gain. However, this review does not contain a meta-analysis; the studies included are a mix of quasi-experimental and observational data and employ a variety of indices to measure malnutrition.

In food-insecure populations, including humanitarian emergency contexts, feeding programs are used to reduce mortality and prevent further deterioration of children’s nutritional status. Through supplemental feeding programs’ (SFPs) food rations are provided either through blanket distribution to a defined population (such as to all families with one or more children ages six to 59 months) or through targeted distribution (such as to children identified as having MAM). The standard practice is to provide a food ration centred around a staple food such as a fortified blended flour, commonly CSB (GNC 2012).

Recently, emphasis has been placed on improving specially formulated foods for the treatment of MAM. Specifically, there has been a focus on enhancing the formulation of fortified blended flours and on the development of lipid-based nutritional supplements (LNS), also known as RUSFs. RUSFs were modelled on the RUTFs created for the treatment of SAM in a community-based setting. Typically, RUSFs are peanut-paste based products, fortified with milk powder, sugar, and a micronutrient premix. Alternative formulations are being developed and researched to replace the peanut base
with other legumes and milk powder with alternative protein sources. (Matilsky and others 2009; Oakley and others 2010; Sandige and others 2004).

A recent Cochrane review (Lazzerini, Rupert, and Pani 2013) compared the effectiveness of LNS to fortified blended flours. This review concluded that both products appear to be effective in the treatment of MAM; thus, there is insufficient evidence to recommend the use of LNS over CSB, despite the growing interest from the policy and programming community in these new specially formulated foods. No reduction in mortality, differences in numbers of children progressing to SAM or dropping out of the study were found when comparing LNS to CSB for the five studies included in the meta-analysis. Yet, treatment with LNS led to an increase in recovery by 10 percent compared to CSB and a slightly improved nutritional status among those recovered. No significant differences were seen when Supercereal Plus, formerly known as CSB++, was compared to LNS. These findings are echoed in the systematic review conducted by Lelters and others (2013) as part of The Lancet series on maternal and child nutrition, as well as a review conducted by the Food Aid Quality Review group (Webb and others, 2011).

In situations that warrant the provision of supplemental foods, there is a growing recognition of the need to use integrated approaches to address the immediate need for an improved diet to treat MAM and prevent the progression to SAM, and simultaneously to address the underlying factors. Livelihood diversification, social protection schemes, and conditional cash transfers are some of the approaches that are being explored in these contexts (Bhutta and others 2013a).

**Treatment of Severe Acute Malnutrition**

Approaches to identifying, referring and treating SAM cases have been evolving over decades and a mix of programmatic approaches can be found globally. The WHO endorses community-based management of uncomplicated SAM and continues to recommend that children with poor appetite, severe edema (+++), any of the Integrated Management of Childhood Illness (IMCI) danger signs, or medical complications (Box 1) be treated in inpatient facilities in accordance with their 10-Step Model (see figure 2). (WHO 2013b).

This section focuses on the WHO-endorsed treatment approaches. While these approaches are evidence-informed and reviewed by expert panels, much of the recommendations are rooted in imperfect evidence, supplemented by best practices and expert opinion.

From the 1950s-90s, case fatality rates (CFR) for the treatment of SAM in health facilities remained static and were typically 20 to 30 percent (Ashworth and others 2003; Collins and others 2006), while specialized treatment centers were able to achieve CFRe under 5 percent (Collins and others 2006).

As a response to the high CFRe and high opportunity costs of inpatient treatment, a community-based approach to treating acute malnutrition has received growing attention from the academic and humanitarian sectors over the past 15 years. While community-
based treatment of malnutrition was first called CTC, it can also be called community management of acute malnutrition (CMAM) and integrated management of acute malnutrition (IMAM). For clarity, this chapter refers to community-based management as CMAM.

**Community-Based Treatment**

The first CTC programs, implemented in the early 2000s, achieved recovery rates of almost 80 percent and CFRs of less than 5 percent (Collins and others 2006). Over 75 percent of children treated for malnutrition in the CTC programs were treated on an outpatient basis, thereby limiting the opportunity costs to caregivers.

The CTC model of treatment rests on the four following principles:

- Maximum coverage and access
- Timeliness
- Appropriate care
- Care for as long as it is needed (Collins and others 2006).

The CTC model strives to reach all severely malnourished children prior to the development of medical complications and to provide appropriate care until recovery. The CTC model uses community health workers or volunteers (CHWs or CHVs) to actively find cases of wasting within the community. Children are screened to assess their nutritional status, typically using MUAC cut-offs and simple algorithms to assess for the presence of medical complications, which would then necessitate referral to a facility-based treatment program.

The most commonly seen medical complications in SAM are outlined in box __.1. Only about 15 percent of children with SAM have medical complications that require inpatient treatment (Collins and others 2006). Substantial programmatic evidence has demonstrated that the community-based model can achieve low mortality rates and lower opportunity costs to caregivers, resulting in lower default rates (Collins and others 2006; Guerrero and Rogers 2013). Defaulters are children who are lost to follow-up (Sphere 2011).

**Box __.1 Common Medical Complications in Severe Acute Malnutrition**
Collins and others (2006) reported on several elements of successful CTC programs:

- **Using MUAC to screen children for wasting:** Children with MUAC < 110 mm (note: WHO now recommends cut-off of <115mm) are referred to outpatient therapeutic programs (OTPs). Children with complications, such as bilateral pitting edema, anorexia, lower respiratory tract infection (LRTI), severe palmar pallor, high fever, or severe dehydration, or who are not alert, are referred to inpatient care.

- **Limiting inpatient eligibility:** This limitation to children who have complications lessens the opportunity costs on their caregivers. Inpatient treatment facilities are often long distances from families’ homes and require a caregiver to remain with the child. This can lead to low adherence rates if caregivers are unable to be away from home and work commitments for extended periods of time. This approach also lowers the children’s exposure to nosocomial infections in the treatment center.

- **Discharging upon stabilization:** Children admitted as inpatients can be discharged to outpatient treatment once their conditions have stabilized.
Children admitted to outpatient treatment receive 200 kcal/kg/day of RUTFs. In the CMAM model, mothers, rather than health professionals, administer the RUTFs to their children and may experience increased levels of motivation since they can witness the positive responses of their children to the treatment they administer. The rapid changes in the children’s condition provides positive feedback to those associated with the cure and strengthens community motivation for case-finding, thereby increasing coverage (Collins and others 2006).

The new WHO guidelines (WHO 2013b) recommend that children with MUAC < 115mm or bilateral pitting edema be referred to a community-based treatment center for a full assessment. Treatment centers should use MUAC, WHZ (< 115 mm or < -3, respectively), or bilateral edema to diagnose SAM. Children should be discharged from treatment using the mode of classification of their admittance to the program. Children who were admitted based on MUAC should be discharged once their MUAC is ≥ 125 mm for at least two weeks or their WHZ is ≥ -2 for at least two weeks. Children who were admitted based on their edema should be discharged based on the measurement routinely used in the program. Once discharged, the children should be followed up periodically to avoid relapses.

Further recommendations issued in the updated WHO guidelines include: children who are not treated with fortified therapeutic foods should receive a high dose of vitamin A on admission; children who receive therapeutic food do not need the high dose of vitamin A upon admission; RUTFs should be given to children regardless of whether they have diarrhea; and, children treated in a facility setting be transitioned to RUTFs, rather than F100, after F75 (WHO 2013b).

The CMAM model is also endorsed in the Sphere project guidelines. These guidelines represent an evidence-based, sector-wide consensus on minimum standards for humanitarian relief. Targets for SAM treatment programs are outlined with the view of ensuring the delivery of high quality programming. The Sphere guidelines state that treatment programs for SAM should achieve a low CFR less than 10 percent, a recovery rate higher than 75 percent, and a defaulter rate less than 15 percent.

**WHO’s 10-Step Program**
The WHO published a 10-step guide to inpatient management of complicated SAM to combat the poor CFRs in some health facilities (WHO 2003); the WHO subsequently undertook a series of systematic reviews and has updated the guidelines on the management of severe malnutrition (WHO 2013b).

These systematic reviews aimed to collate evidence related to treatment of SAM, including: criteria for identifying SAM; discharge; follow-up; treatment of HIV-positive children with SAM; appropriate hydration; and, treatment of infants younger than age six months with SAM. Overall, the reviews found low or very low quality evidence to support their recommendations due to limited availability of randomized controlled trials (RCTs) investigating the treatment options.
The 10-Step Plan for inpatient management of severe acute malnutrition is shown in figure __.2. The 10 steps are divided into three phases:

- **Initial treatment**: Hypoglycemia, hypothermia, dehydration, and infections; electrolyte imbalances are corrected, as are micronutrient deficiencies, with the exception of iron deficiency.
- **Rehabilitation**: Electrolyte imbalances and micronutrient deficiencies continue to be corrected and iron is added. Feeding is increased to stimulate catch-up growth, and children are prepared for discharge.
- **Follow-up**: Increased feeding is continued to recover lost weight (Picot and others 2012; WHO 2003).

Throughout all phases, the children’s emotional and sensorial development should be stimulated.

During the initial treatment phase, frequent feeding is important to prevent both hypoglycaemia and hypothermia. As hypoglycaemia and hypothermia often occur together, children with hypothermia (axillary < 35.0 °C; rectal < 35.5 °C) should be checked for hypoglycaemia. Children who are conscious with dextrostix <3mmol/l or 54 mg/dl should be given 50ml bolus of 10% glucose or 10% sucrose solution orally or by nasogastric tube. Children who are unconscious, lethargic or convulsing should be given 10% glucose (5mg/kg) intravenously followed by 50ml of 10% glucose or sucrose by nasogastric tube. After, F-75 should be given to both groups of children every thirty minutes for two hours, followed by F-75 every two hours, day and night. Children with hypothermia should be rewarmed by being clothed, covered with a warmed blanket, placed near a heater or lamp or placed on the mother’s chest (skin-to-skin) and covered. Dehydration should be treated as described below per the WHO’s 2013 Update. Infections should be treated routinely upon admission and especially in cases of hypothermic and hypoglycaemic children by provision of a broad-spectrum antibiotic and measles vaccination for un-immunized children older than 6 months. Micronutrient deficiencies should be treated by giving Vitamin A (200,000 IU for children older than 12 months, 100,000 IU for children 6-12 months and 50,000 IU for children 0-5 months) coupled with daily multivitamin, folic acid, zinc and copper supplementation for at least two weeks. Iron supplementation should only be given once children have begun gaining weight.

Feeding during the initial treatment phase should be approached cautiously due to the fragility of the child’s physiological state. Children should be fed frequently with low osmolarity and low lactose feeds of approximately 100kcal/kg/d; the feed should have 1-1.5g protein/kg/d and 130 mg/kg/d of fluid. Children with oedema should receive 100ml/kg/d of fluid. Breastfed children should be encouraged to continue breastfeeding.

During the rehabilitation phase, F-75 should be replaced with F-100 in the same amounts for 48 hours before increasing successive feeds by 10ml until some remains unconsumed. Children’s respiratory and pulse rates should be monitored closely during this time. After
transition to F-100, children should received feed consisting of 100-200kcal/kg/d and 4-6g protein/kg/d at least every four hours. Breastfeeding should continue to be encouraged.

After recovery, parents should be taught to feed children frequently with energy- and nutrient-dense foods and to continue to stimulate their children’s sensorial and emotional development. Parents should be requested to bring children back for regular follow-up checks. Vitamin A supplementation every six months and booster immunizations should be given.

The WHO guidelines were reviewed and updated in 2013 with several notable changes. For example, dehydrated children who are not in shock should be rehydrated orally or by nasogastric tube using ReSoMaL or half-strength WHO low-osmolarity oral rehydration solution with added potassium and glucose, with the exception of children who are suspected of having cholera or who have profuse watery diarrhea. These children should be hydrated with full-strength WHO low-osmolarity oral rehydration solution. Children who are severely dehydrated or with signs of shock should be rehydrated intravenously, using half-strength Darrow’s solution with 5 percent dextrose, Ringer’s lactate solution with 5 percent dextrose or, if neither is available, 0.45 percent saline with 5 percent dextrose. See WHO guidelines for complete set of updates (WHO 2013b).

**Figure__.2 World Health Organization’s 10-Step Plan for the Management of Severe Acute Malnutrition**

<table>
<thead>
<tr>
<th>Activity</th>
<th>Initial treatment</th>
<th>Rehabilitation</th>
<th>Follow-up</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treat or prevent</td>
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<td></td>
</tr>
<tr>
<td>1. Hypoglycaemia</td>
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<tr>
<td>2. Hypothermia</td>
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<tr>
<td>3. Dehydration</td>
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<tr>
<td>4. Correct electrolyte imbalance</td>
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<td>5. Inset infection</td>
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<tr>
<td>6. Correct micronutrient deficiencies</td>
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<tr>
<td>Begin feeding</td>
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<tr>
<td>8. Increase feeding to recover lost weight (“catch-up growth”)</td>
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<tr>
<td>9. Stimulate emotional and sensorial development</td>
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<tr>
<td>10. Prepare for discharge</td>
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</table>

*Source: Picot 2012; WHO 2003.*

**Treatment of Edematous Acute Malnutrition**

Edematous acute malnutrition, commonly referred to as *kwashiorkor*, is a particular presentation of acute malnutrition that includes bilateral pitting edema. Kwashiorkor is a form of malnutrition characterized by stunted growth, generalized edema, dermatologica
manifestations, and hepatic steatosis (Garrett 2013). This type of acute malnutrition is predominately seen in Sub-Saharan Africa (SSA) and is less common in acutely malnourished children in East Asia and Pacific and in South Asia. Its etiology is not well understood; it has been attributed to a range of factors including insufficient dietary protein, excessive oxidative stress, a compromised intestinal wall (“leaky gut syndrome”) and intestinal inflammation (Garrett 2013; Smith and others 2013). The prevailing theory now implicates the intestinal microbiota; certain microflora appear to play a role in the development of kwashiorkor based on a longitudinal comparative study of Malawian twins by Smith and colleagues (2013), as well as a mouse study by Garrett that utilized fecal transplants from healthy children and children with kwashiorkor (Garrett 2013; Smith and others).

The severity of edema can vary and is graded as + (mild: both feet), ++ (moderate: both feet, plus lower legs, hands, or lower arms) or +++ (severe/generalized: both feet, legs, hands, arms, and face) (WHO 2013b). Given that children with severe edema have a higher risk of mortality even in the absence of other medical complications, the recommendation is to treat these children in an inpatient setting (WHO 2013b). The treatment protocol for children with edematous malnutrition is largely the same with several important caveats that are outlined in the WHO guidelines for the treatment of acute malnutrition (WHO 2013b). For example, initial refeeding should occur at a rate of 100 ml/kg/d as opposed to the general recommendation of 130 ml/kg/d, with a tailored schedule for progression after initial refeeding (Ashworth and others 2003).

The optimal setting for managing children with SAM who have mild to moderate edema remains unclear; in practice, these children may be treated in outpatient settings or referred to inpatient facilities, depending on the protocol of particular programs. There have been no RCTs comparing inpatient treatment to community-based treatment for this group. A WHO evidence review found eight reports describing outcomes for single cohorts of children with edema treated in the community for SAM. These reports found an average recovery rate of 88 percent and case fatality rate under 4 percent. However, the authors graded this evidence as very low, stating that it is difficult to make any firm recommendations about the effectiveness and safety of outpatient treatment for children with mild to moderate edema (WHO 2013c).

At country and sub-country levels, prevalence and incidence rates of edematous SAM are not well-characterized and experts have called for more data on its prevalence to establish the burden as an initial step to shed light on its public health importance (personal communication, CMAM forum). According to the CMAM Forum, the proportion of edematous SAM ranges from 0 percent in Indonesia and Albania to over 70 percent in the Former Yugoslav Republic of Macedonia and Nicaragua (personal communication, CMAM forum).

**Costs and Cost-Effectiveness of Treatment Severe Acute Malnutrition**
Approximately 80 percent of all SAM cases can be effectively treated in the community (Bachmann 2010). A recent review of cost of treatment found that community-based treatment of SAM was consistently less expensive and had similar or better outcomes as compared to inpatient treatment; however, since many studies were non-randomized, this could be the result of children who were more severely ill being admitted (Bachmann 2010).

According to Horton and colleagues (link to chapter on cost-effectiveness), CMAM represents “an attractive strategy from a cost-effectiveness perspective”. The high risk of death coupled with reductions in programming costs as the CMAM model has developed, lead to a cost-effective strategy. Of the three studies identified and reviewed by Horton, cost-effectiveness ranged from $26-39 per DALY saved.

The recent maternal and child nutrition series in *The Lancet* estimated the cost of increasing coverage of SAM treatment to 90 percent in 34 high-burden countries. The authors used the WHO-CHOICE database to obtain labour costs by country and assumed 15 percent of SAM cases would require inpatient care. Of the complicated cases, 50 percent would require inpatient care for seven days and outpatient care for eight weeks; the remaining 50 percent of complicated cases would require inpatient care for an additional 14 days. The authors assumed uncomplicated SAM cases would be treated with RUTF for eight weeks. Inpatients would require 60 minutes per day of a nurse’s time, and outpatients would require 10 minutes per visit for weekly visits with health personnel. The overall cost of scaling up SAM treatment to 90 percent in these target countries was estimated to be US$2.6 billion. Of this amount, approximately 35 percent of the costs were consumables, which is in line with the costs of other studies’ estimates for RUTFs for treatment of SAM.

**Inpatient Treatment Programs**

Inpatient treatment programs have several disadvantages for treating children who do not have complications and may not require it. Resource constraints, such as limitations on the numbers of skilled staff members or capacity, can limit the number of children who can be treated. The centralized nature of the facilities means that the difficulties patients face in transport can result in delayed presentation of cases and lower coverage rates. An evaluation of 21 community-based treatment programs in Ethiopia, Malawi, and Sudan found an average coverage rate of 72.5 percent compared to less than 10 percent coverage in inpatient programs, where coverage is defined as the proportion of children needing treatment who receive it for inpatient programs (Collins and others 2006). Moreover, as mothers often need to stay with children for longer than three weeks, inpatient treatment can cause families in terms of lost labor and economic productivity, as well as pose challenges for families with other children at home. Finally, hospitalization puts children at risk of cross infection (Bachmann 2010; Collins and others 2006; Tekeste and others 2012).
Facility-based treatment is required for complicated cases, however. This represents approximately 15-20 percent of SAM cases (Collins 2006, Bachmann 2010). We were unable to find any recent studies reporting the costs of inpatient treatment of SAM other than the assumptions of costs made in the 2013 LNS Series. Cost for inpatient treatment of SAM would be highly context-dependent, as estimating the cost of inpatient treatment would need to take into consideration infrastructure and human resources costs, which could vary significantly between countries.

Community-Based Programs

Several recent studies have examined the costs and cost-effectiveness of CMAM programs. One study examined the cost-effectiveness of a CMAM program delivered by community health workers (CHWs) in Bangladesh compared to standard inpatient treatment (Puett and others 2012). The CHWs in the intervention group received training, monthly refreshers, on-going supervision, and are engaged in screening children monthly for SAM. Children with uncomplicated SAM were monitored weekly and received weekly rations of RUTFs, one dose of folic acid, and a five-day course of antibiotics. The CHWs in the comparison group were trained to find cases of SAM and refer them to inpatient treatment. In estimating the costs of treatment, the authors included costs of running the program, including supervision, training and monitoring, commodity costs, and household costs, as well as caretaker’s time and transportation costs. The authors found that the CMAM program cost US$26 per disability-adjusted life-year (DALY) averted and US$869 per life saved. The costs of SAM treatment in the control group were US$1,344/DALY and US$45,688 per life saved, respectively.

Another study in Ethiopia that retrospectively examined the costs of CMAM versus treatment in a therapeutic feeding center (TFC) found that costs were substantially lower in the CMAM program, with a cost per recovered child for the CMAM and TFC of US$145.50 and $320.00, respectively (Tekeste and others 2012). Studies in Malawi and Zambia examining the costs of CMAM compared to hypothetical simulations of no care both found CMAM to be cost-effective and on par with other child health interventions, including universal salt iodization, iron fortification, immunization, and micronutrient fortification. The study in Zambia also found CMAM to be cost-effective according to the WHO standards, as the cost per DALY gained was less than the per capita national gross domestic product (GDP). The study in Malawi found CMAM to cost US$42 per DALY averted, while the study in Zambia found CMAM to cost US$53 per DALY averted. The authors estimated the cost per child to be US$203 and per life saved to be US$1,760 (Bachmann 2009; Wilford, Golden, and Walker 2012).

In many CMAM programs, RUTFs are a major contributor to the cost of treatment, taking up 24 percent to 43 percent of the total cost of treatment per child (Bachmann 2009; Puett and others 2012; Tekeste and others 2012). One potential way to mitigate the costs of RUTFs is to supply children with locally produced RUTFs. Assuming each child needs approximately 11 kg of RUTF for rehabilitation for children who are HIV-negative and 22 kg for children who are HIV-positive, treating children with imported Plumpy’Nut would cost US$55 and US$110 per HIV-negative and HIV-positive child,
respectively; in contrast, treating children with locally produced RUTFs would cost approximately US$22 and US$44 per HIV-negative and HIV-positive child, respectively (Ashworth 2006). Investigations are on-going with respect to the effectiveness of locally-produced RUTF, potential formulations utilizing locally available and acceptable ingredients, and feasibility of a decentralized approach.

Overall, CMAM programs are both less expensive and as effective as inpatient care or TFCs, and accordingly are highly cost-effective for treating children with uncomplicated SAM. Community-based programs have higher coverage rates and the potential to catch cases earlier due to active case finding of CHWs and CHVs; these programs are present lower opportunity costs for families and caregivers of children with SAM. RUTF represents a significant portion of the costs for CMAM programs; exploring the use of local rather than imported constituents could lessen the relatively high cost of RUTFs.

**Emerging Evidence and Research Priorities**

The management of SAM has transformed rapidly over the past 15 years, with a shift to focusing on identifying cases early and minimizing in-patient treatment. There is a growing body of evidence to suggest that the community-based approach can improve health outcomes for affected children (Collins and others 2006; Guerrero and Rogers 2013, Lenters and others 2013). Similarly, studies and evidence-based practice have demonstrated that low mortality rates can be achieved through careful management of complicated SAM in an inpatient facility, following the WHO guidelines (WHO 2003).

Despite burgeoning interest in acute malnutrition and the CMAM model from the humanitarian sector, as well as from governments and academic institutions. Many questions remain with regard to etiology, effective treatment approaches (particularly for sub-populations such as children with HIV), long-term outcomes and the most effective modes for implementing and sustaining high quality programs. Furthermore, interpretations of the existing body of SAM and MAM literature are limited by several study design issues; these shortcomings highlight the need for greater geographical representation, additional long-term studies, and changes in sampling approaches.

**Considering Antibiotic Treatment**

New evidence is emerging on the importance of managing SAM, including uncomplicated SAM, not only through food-based interventions but also through a package of care that includes antibiotic treatment. The use of broad-spectrum antibiotics has been conditionally recommended for treatment of uncomplicated SAM in community-based treatment programs (WHO and others 2007). Local governments and policy makers are asked to make this determination in light of their local context. Although routine antibiotic treatment at the enrolment stage in CMAM programs is part of the CMAM protocols of many organizations, this practice remains a contentious issue in the eyes of many academics.
One systematic review of antibiotics as part of SAM management concluded that the evidence for the addition of antibiotics to therapeutic regimens for uncomplicated SAM is weak, and urges for further efficacy trials (Alcoba and others 2013). Another review concluded also that the evidence was insufficient to recommend antibiotic use (Picot and others 2012). A recent RCT in Malawi looked at children with uncomplicated SAM treated in a community setting compared RUTFs to RUTFs plus antibiotics (either amoxicillin or cefdinir); the trial found a significantly higher mortality rate in children receiving placebo than in either antibiotic arm (amoxicillin RR: 1.55, 95 percent CI 1.07-2.24; cefdinir RR: 1.80, 95 percent CI 1.22-2.64) (Trehan and others 2013). Criticisms have been raised, however, because HIV-infection rates are high in this region and could represent a major cause of immunodeficiency, however 68% of the children enrolled were not tested for HIV (Koumans, Routh and Davis, 2013). Additionally, questions have been raised regarding the approach to analysis (Okeke, Cruz and Keusch 2013), further supporting the call for additional research.

Though there is growing interest and attention being given to antibiotics for the management of SAM, our understanding of the issue is far from definitive. Due to the small number of studies with limited generalizability, as well as the costs and resistance risks associated with broad use of antibiotics, this topic requires further investigation urgently. Additional studies are needed to strengthen the evidence base on whether children with uncomplicated SAM should receive routine antibiotics, including specific investigations of children with additional medical conditions, such as HIV.

**Treatment of Infants Under 6 Months**

The updated WHO guidelines for managing acute malnutrition reviewed the evidence for infants with SAM who are less than 6 months of age (WHO 2013b). Although this systematic review found no controlled studies in children under age six months, the guideline group made strong recommendations for the treatment of SAM in this age group due to the need for guidance in treating this subset of children with SAM; the guideline group noted that the recommendations pose no or negligible risk of harm to the infants.

In addition to the complications that apply to all children with SAM, the WHO recommends that infants younger than age six months with SAM should be admitted for inpatient treatment if any of the following conditions apply: failure to gain weight or recent weight loss; pitting edema; failure to feed effectively; or, if there is evidence of the need for more detailed examination or intensive support for medical or social issues, for example, if their caregivers are depressed or disabled. Infants younger than age six months who are admitted to an inpatient treatment center for SAM should receive parenteral antibiotics; children admitted to outpatient children should receive a broad-spectrum oral antibiotic.

The establishment or re-establishment of breastfeeding should be the priority feeding approach for infants with SAM who are younger than six months of age. If female
caregivers are unable to breastfeed, wet-nursing from an HIV-negative wet nurse should be encouraged. F75 or F100 can be given as a supplement to breast milk, or, where breastfeeding is not possible, with infant formula. Infants can be discharged once their clinical complications and edema have resolved, their appetite and alertness have returned, their weight has increased at least 5 g/kg/d, their immunizations have been checked, and arrangements for community-based follow-up have been made with the mother. Infants younger than six months can be discharged from all care once they are feeding well, either breastfeeding or with formula, have had adequate weight gain, and reached WHZ < -2.

Despite the strong recommendations issued by the WHO, further research in this area is needed to establish an empirical evidence base for effective treatment of children < 6 months who have SAM.

**Additional Research Gaps**

Picot and others conducted a Delphi exercise (a standardized method for obtaining expert consensus) to prioritize interventions and research questions related to SAM for systematic evaluation. The authors found no research for some of the identified priorities, including the following (Picot 2012):

- Management of subgroups of children, including those with HIV, H. pylori, and tuberculosis
- Program sustainability, long-term survival, and relapse rates
- Barriers to treatment program implementation
- Methods to increase appetite, food intake, weight gain, and catch-up growth.

In terms of additional research gaps, broader geographical representation is needed as the majority of trials are set in Sub-Saharan Africa, yet acute malnutrition is also a significant problem in Asia (Guerrero and Gallagher 2012).

Furthermore, while RUTF was developed in tandem with the CMAM process, uncertainty remains around the optimal formulation of therapeutic foods for the management of acute malnutrition. A meta-analysis on the effects of RUTF versus corn-soy blend (CSB) in treating SAM found no significant differences in mortality between groups (Lenters and others 2013). However, children receiving the RUTF were significantly more likely to recover and had significantly greater height, MUAC, and weight gain, although the evidence for these outcomes was graded of low-to-moderate quality and many outcomes had significant heterogeneity. The results from a systematic review conducted by Schoonees and colleagues (2013) investigating RUTF versus standard care for treatment of SAM echo those found by Lenters and others (2013). Both systematic reviews concluded that the evidence is limited, and more high-quality studies are needed to further evaluate the effects of RUTFs versus CSB.
**Study Design and Methodological Issues**

High quality studies (including RCTs and appropriately controlled quasi-experimental trials) with long-term follow-up to assess relapse rates are needed. Most studies follow children for a short period of time and only report changes during the intervention, providing little insight into what happens after treatment. Studies with a short follow-up time are not able to adequately measure time-to-recovery; children who have not recovered by the end of the intervention are labelled *non-responders*. This practice fails to give an accurate picture of how long it would have taken for the children to recover—a key element in assessing cost-effectiveness or whether another underlying issue, such as HIV infection, is hindering recovery.

Long-term studies are needed to establish not only whether sustained recovery occurs, but also whether treatment with lipid-based supplements that promote rapid weight gain pose any health risks. An additional area that needs further exploration is in how to define *healthy recovery*. The focus has been on basic anthropometric measurements of MUAC, height and weight, with thresholds used to establish when a child who has recovered from acute malnutrition. These thresholds correspond with lower risk of mortality; however, very little research has been conducted into body composition or the type of tissue accretion through treatment with lipid-based nutritional supplements.

The vast majority of SAM and MAM trials rely on passive recruitment: caregivers present at health centers with the affected children. Therefore, study results may not be generalizable if the caregivers who seek help from the health centers differ systematically from those who do not bring their children for treatment.

**Considering Quality of Programming and Integrated Interventions**

There has been a trend toward studying the effectiveness of one specially formulated food versus another through RCTs. Although the relative effectiveness of products is an appropriate field of study, it is also important to remember that the products are delivered within the context of a program and that the effectiveness of the treatment depends significantly on the quality of care (Puoane and others 2008). Further implementation research is needed to understand how to effectively deliver high-quality programs to consistently achieve optimal outcomes.

Additionally, with respect to MAM, it is essential not to lose sight of the need for upstream, integrated approaches in the face of growing interest in specially formulated foods for the treatment of MAM. Lenters and colleagues (2013) conducted a rapid Delphi exercise in tandem with a systematic review and meta-analysis of approaches to managing MAM and found a striking discordance: intervention trials identified through the systematic literature review all focused on comparing specially formulated food while a thematic analysis of what experts believe to be the optimal management of MAM illustrated that a much more comprehensive approach is needed. The effectiveness of disease prevention and treatment, WASH interventions, community empowerment,
livelihood diversification and other upstream interventions need to be studied to prevent the development of MAM and its progression to SAM.

**Standardizing Definitions and Metrics**

There is a need for standardized definitions and metrics to be able to compare the relative effectiveness of interventions, whether individual treatments or integrated packages. The significant variability in the definition of acute malnutrition used across studies or the lack a clear case definition hinders the possibility of pooling data in meta-analyses. Inclusion criteria using the WHO definition of moderate and severe acute malnutrition (using weight-for-height or MUAC) produces results specific to wasting in cases where a study chooses to include a mix of children with wasting, stunting, and underweight, disaggregated data should be presented according to type of undernutrition.

**Conclusions**

The evidence base for the effectiveness of RUFs to treat SAM and MAM is growing. Although the meta-analysis by Lenters and colleagues as well as reviews by other authors demonstrate positive effects on a range of outcomes, critical evidence gaps remain, as do challenges to effectively implementing programs and reducing the prevalence of wasting (Ashworth and Ferguson 2009; Lazzerini, Rupert, and Pani 2013; Lenters and others 2013; Picot and others 2012; Schoones and others 2013). These gaps and challenges can readily be explored through high-quality, coordinated research that uses agreed-upon definitions and metrics.
References


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