Management of severe acute malnutrition in children

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Severe acute malnutrition (SAM) is defined as a weight-for-height measurement of 70% or less below the median, or three SD or more below the mean National Centre for Health Statistics reference values, the presence of bilateral pitting oedema of nutritional origin, or a mid-upper-arm circumference of less than 110 mm in children age 1–5 years. 13 million children under age 5 years have SAM, and the disorder is associated with 1 million to 2 million preventable child deaths each year. Despite this global importance, child-survival programmes have ignored SAM, and WHO does not recognise the term “acute malnutrition”. Inpatient treatment is resource intensive and requires many skilled and motivated staff. Where SAM is common, the number of cases exceeds available inpatient capacity, which limits the effect of treatment; case-fatality rates are 20–30% and coverage is commonly under 10%. Programmes of community-based therapeutic care substantially reduce case-fatality rates and increase coverage rates. These programmes use new, ready-to-use, therapeutic foods and are designed to increase access to services, reduce opportunity costs, encourage early presentation and compliance, and thereby increase coverage and recovery rates. In community-based therapeutic care, all patients with SAM without complications are treated as outpatients. This approach promises to be a successful and cost-effective treatment strategy.

Introduction

Severe acute malnutrition (SAM), is defined as a weight-for-height measurement of 70% or more below the median, or three SD or more below the mean National Centre for Health Statistics reference values (that will likely be replaced by new WHO growth curves 9), which is called “wasted”; the presence of bilateral pitting oedema of nutritional origin, which is called “oedematous malnutrition” 9; or a mid-upper-arm circumference of less than 110 mm in children age 1–5 years. 9 Many advanced cases of SAM are complicated by concurrent infective illness, particularly acute respiratory infection, diarrhoea, and gram-negative septicaemia. By contrast, chronic malnutrition (termed “stunted”) is defined by a height-for-age indicator. In addition, a composite form of malnutrition including elements of both stunting and wasting is defined with a weight-for-age indicator. As these different forms of malnutrition have different causes and require substantially different treatments, clear nomenclature to differentiate them is needed. Case-fatality rates in hospitals treating SAM in developing countries average 20–30% and have remained unchanged since the 1950s 10 despite the fact that clinical management protocols capable of reducing case-fatality rates to 1–5% have been in existence for 30 years. In 1992, this failure to translate scientific knowledge of what is needed to treat malnutrition into effective large-scale interventions, was criticised as “nutrition malpractice” 11; 13 years and numerous studies and clinical manuals later, there is an even greater discrepancy between actual practice in most institutions treating SAM and our knowledge of what works.

The treatment of severe acute malnutrition occupies a unique position between clinical medicine and public health. The causes are essentially poverty, social exclusion, poor public health, and loss of entitlement, 12 and most cases can be prevented by economic development and public-health measures designed to increase dietary quantity and quality alone, with no need for clinical input. However, as acute malnutrition becomes more severe, normal physiological mechanisms that adapt the organism to low food intake become more pronounced. 13,14 These “reductive adaptations” affect every physiological function in the body, 13–15 mobilising energy and nutrient reserves and decreasing energy and nutrient demands; they are initially beneficial and allow the organism to maintain homeostasis. However, as the severity of nutritional insult increases, these adaptations progressively limit the body’s ability to respond to stresses such as infection. 13–15 In practice, inpatient units treating SAM are commonly confronted by extremely ill patients who need intensive medical and nursing care. Most of these units are in the poorest parts of the poorest countries and have severe capacity constraints, in particular, very few skilled staff. In addition, most carers of malnourished patients come from the poorest families and have great demands on their time. To achieve an impact at a population level, management protocols must take these socioeconomic realities into account, balancing the potentially conflicting demands and ethics of clinical medicine with those of public health.

Worldwide public-health significance of malnutrition

Malnutrition is a major public-health problem throughout the developing world and is an underlying factor in over 50% of the 10–11 million children under 5 years of age who die each year of preventable causes. 16–21 However, while the child-survival movement commonly acknowledges the importance of undernutrition, defined as low weight for age, 16 the importance of acute malnutrition is seldom mentioned. For example, none of the five papers of the recent child survival series in The Lancet mention acute malnutrition. 17 This is a serious omission; acute malnutrition is an extremely common disorder, associated with high rates of mortality and morbidity and requiring specialised treatment and prevention interventions. Worldwide there are about 60 million children with moderate acute and 13 million...
with severe acute malnutrition. About 9% of sub-Saharan African and 15% of south Asian children have moderate acute malnutrition and about 2% of children in developing countries have SAM. In India alone, 2.8% of children under 5 years of age (over 5 million children) are severely wasted and in many poor countries such as Malawi, SAM is the commonest reason for paediatric hospital admission.

The risk of mortality in acute malnutrition is directly related to severity: moderate wasting is associated with a mortality rate of 30–148 per 1000 children per year and severe wasting is associated with a mortality rate of 73–187 per 1000 children per year. This equates to over 1.5 million child deaths associated with severe wasting and 3.5 million with moderate wasting every year. These numbers do not include children who die of oedematous malnutrition (kwashiorkor), a form of SAM that in some countries is more common than the wasted form, and probably, therefore, underestimate the total number of child deaths directly associated with acute malnutrition (table).

High case-fatality rates for SAM
Over the past 50 years, in most resource-poor settings, case-fatality rates for severe malnutrition treated in health facilities have remained at 20–30% for marasmus (wasting malnutrition) and up to 50–60% for kwashiorkor. By contrast, since the 1970s there have been management protocols capable of achieving case-fatality rates of 1–5% and well-resourced humanitarian agencies using these protocols frequently achieve mortality rates under the 10% level stipulated in the international Sphere Project standards.

Current management protocols
At present, an exclusive inpatient approach to the clinical care of SAM is recommended. The core of accepted WHO management protocols is ten steps in two phases (stabilisation and rehabilitation). The approach requires many trained staff and substantial inpatient bed capacity. Where these are available and sufficient attention is paid to the quality of care, there is good evidence that these protocols can substantially decrease case-fatality rates in both stable environments and during emergency humanitarian interventions. However, despite the success of these protocols when implemented in specialised units, their publication has not led to widespread decreases in case-fatality rates in most hospitals in the developing countries.

The persistence of high case-fatality rates is commonly attributed to inappropriate case management as a result of poor knowledge. The accepted view is that wider implementation of the WHO guidelines through in-service training and incorporation into medical and nursing curricula is the key to substantially decreasing case-fatality rates worldwide. However, whereas there is good evidence that adequate training of health staff in the management of SAM is essential if the implementation of the WHO guidelines is to be effective, the evidence base supporting the view that the wider implementation of the WHO guidelines is key to the reduction of case-fatality rates is weak. There have been no published controlled trials looking at the effect of the use of the WHO protocol in operational settings. In their absence, the evidence of the positive effects of these protocols comes from observational studies done in a few selected hospitals or well-resourced, non-governmental-organisation, humanitarian operations. These studies all suggest that the availability of sufficient resources, particularly skilled and motivated health staff, is a vital determinant of success and effectiveness. In practice, the many skilled staff needed are rarely available. For example, in Malawi in 2003–04 there were only 1.13 physicians and 25.6 nurses per 100 000 people.

<table>
<thead>
<tr>
<th>Regions†</th>
<th>Under-5 population 2000 (&lt;1000)</th>
<th>Wasting prevalence (%)</th>
<th>Wasting numbers (&lt;1000)</th>
<th>Annual mortality numbers</th>
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<tr>
<td></td>
<td>Moderate &amp; severe</td>
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<td>≥2 Z scores below WFH</td>
<td>≥3 Z scores below WFH</td>
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<td>2</td>
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<td>Total</td>
<td>707,584</td>
<td>60,228</td>
<td>13,139</td>
<td>3,577,241</td>
</tr>
</tbody>
</table>

of the 26 districts had on average fewer than 1·5 nurses per facility, and five districts had fewer than one nurse per facility; there were ten districts without a Ministry of Health doctor, and four districts without any doctor (Vujicic M, World Bank, personal communication). Perhaps as a result of these constraints, the use of similar protocols had little effect on CFRs in nutrition rehabilitation units in Malawi, only reducing them from 25% to 20%.43 The paucity of skilled health staff is not restricted to Malawi and in 20 of the African countries most affected by acute malnutrition there are fewer than four doctors and 22 nurses per 100 000 people.44 The World Bank has identified the lack of skilled human resources as a fundamental constraint to the improvement of health outcomes and the reaching of Millennium Development Goals.45 In practice, shortages of skilled staff commonly preclude the effective and sustainable implementation of WHO guidelines for the management of SAM.

Effect of HIV and tuberculosis

HIV and tuberculosis are increasing the workloads of hospital units treating SAM through both the direct effects of infection and the indirect negative effects on livelihoods and food security. HIV and tuberculosis infection decrease skilled human resource capacity in health services, raise the prevalence of SAM, and increase case-fatality rates.46,47,48 In sub-Saharan Africa, a high proportion of severely malnourished children admitted to nutritional rehabilitation units are now also HIV positive,49,50,51 particularly those with marasmus.52,53 In 2000 in Malawi for example, 34% of the severely malnourished children admitted to the Blantyre Queen Elizabeth hospital nutritional rehabilitation unit were HIV positive.54 Although experience in resource-poor, sub-Saharan countries has shown that many HIV-positive children can recover normal nutritional status when given standard treatment protocols for SAM without antiretroviral drugs,55,56 their recovery is slower than that of uninfected children. HIV infection is also associated with high rates of complication and case fatality.42,43,45

Treatment at home and in the community

Concerns over the limited capacity of hospital units to treat SAM are not new. Since the 1960s, the high cost and poor success rates of inpatient treatment have prompted debate over whether hospitals were the best places to treat SAM.57,58 There are several well-known weaknesses of a centre-based approach: limited inpatient capacity and lack of enough skilled staff in hospitals to treat the large numbers needing care;59,60 the centralised nature of hospitals promotes late presentation and high opportunity costs for carers; and the serious risks of cross infection for immunosuppressed children with SAM and the high mortality rates before and after discharge.61,62,63 These concerns persist today.64,65

In the 1970s, these problems prompted moves to demedicalise the treatment of SAM and move the locus of treatment away from hospitals to communities, into either simple nutrition rehabilitation centres, existing primary health-care clinics, or the homes of those affected.66,67 The results from early outpatient treatment programmes were variable. Some achieved low mortality and positive effects on growth while children were attending nutrition rehabilitation centres, but usually these benefits were not maintained after discharge.68,69 In others, mortality and relapse rates both during treatment and after discharge were high70,71 and rates of weight gain were low.72,73 The requirement for children to attend each day and eat in the nutrition rehabilitation centres has also resulted in low programme coverage, often proving to be unpopular with mothers and resulting in high default rates.74,75

In 2001, Ashworth reviewed 27 such programmes from the 1980s and 1990s.76 Only six (22%) of the 27 achieved case-fatality rates of less than 5%, average weight gains of more than 5 g/kg/day, and relapse or readmission rates of less than 10%—Ashworth concluded that home treatment is rarely successful77 and that the early discharge of severely malnourished patients from inpatient treatment units is usually hazardous.78 In 2005, Ashworth updated her review to include an additional six studies of ready-to-use therapeutic food. Five (83%) of these six studies were considered to be successful; a far greater success rate than in those studies not using ready-to-use therapeutic food.79

Two other programmes, both in Bangladesh, have reported successful rehabilitation of children with SAM discharged to home care after 1 week of inpatient management with mixtures of local foods combined with the provision of multivitamins and minerals.80,81 The costs for home-based treatment of US$29 and US$22.30 were substantially lower than those of US$156 and US$74.60 for hospital care.82 Similar improvements in cost-effectiveness of care were seen in home-treatment programmes in Jamaica.83

Ready-to-use therapeutic food

The Ashworth review indicates that the recent development of ready-to-use therapeutic food has greatly eased the difficulties associated with providing a suitable high-energy, nutrient-dense food that is safe for use in outpatient programmes. Ready-to-use therapeutic food is an energy-dense food enriched with minerals and vitamins, with a similar nutrient profile but greater energy and nutrient density than F100, the diet recommended by WHO in the recovery phase of the treatment of SAM.84 In contrast to the water-based F100, ready-to-use therapeutic food is an oil-based paste with an extremely low water activity.85 As a result, ready-to-use therapeutic food does not grow bacteria even when accidentally contaminated,86 allowing it to be kept unrefrigerated in simple packaging for several months. As the food is eaten uncooked,
heat-labile vitamins are not destroyed during preparation and the labour, fuel, and water demands on poor households are minimised. The production process is simple, and ready-to-use therapeutic food can be made from local crops with basic technology that is readily available in developing countries.\textsuperscript{56-\textdegree11}

In a clinical trial in severely malnourished children in Senegal, energy intakes (808 kJ/kg/day vs 573 kJ/kg/day, p<0.001), rates of weight gain (15.6 g/kg/day vs 10.1 g/kg/day, p<0.001) and time to recovery (17.3 days vs 13.4 days, p<0.001) were all significantly greater in those receiving ready-to-use therapeutic food than in those receiving F100.\textsuperscript{99-\textdegree103} Trials in Malawi have also successfully used a take-home ration given to children in the recovery phase of the treatment of SAM. In one, a take home ration of 730 kJ/kg/day (175 kcal/kg/day) successfully rehabilitated HIV-negative, severely malnourished children, after early discharge from a nutrition rehabilitation units providing initial, phase-one care according to WHO protocols. Rates of weight gain (5.2 g/kg/day vs 3.1 g/kg/day) and the proportion of children recovering to 100% weight for height (95% vs 78%, relative risk [RR] 1.2, 95% CI 1.1–1.3) were significantly better in the ready-to-use therapeutic food groups when compared with groups receiving a larger amount of energy from corn–soya-blend flour supplied by the World Food Programme.\textsuperscript{94} In the same trial, 56% of the HIV-positive children treated with ready-to-use therapeutic food also achieved 100% weight for height.\textsuperscript{44}

In another trial implemented in rural nutrition-rehabilitation units, 730 kJ/kg/day of locally made ready-to-use therapeutic food given during the rehabilitation phase of treatment produced significantly better rates of weight gain (3.5 g/kg/day vs 2.0 g/kg/day), recovery (79% vs 46%, RR 2.8 95% CI 2.5–3.1), and mortality (3.0 vs 5.4%, OR 0.5, 95% CI 0.3–0.7) than did the standard inpatient treatment with F100, followed by outpatient supplementation with a large one-off ration (50 kg) of corn-soya-blend flour.\textsuperscript{11} However the rates of weight gain on the ready-to-use therapeutic food regime were far lower than the 10–15 g/kg/day that can be achieved with a ration of 730 kJ/kg/day. The combination of low rates of weight gain and low mortality rates indicates that this was probably due to sharing of the ration.

The development of ready-to-use therapeutic food has allowed much of the management of SAM to move out of hospitals. By shortening the duration of inpatient treatment from an average of 30 days to only 5–10 days, the move towards using ready-to-use therapeutic food in the recovery phase of treatment reduces the resources needed to treat SAM, which improves cost-effectiveness. The provision of phase-one inpatient care for all cases, however, still requires substantial resources and entails substantial opportunity costs for carers. A requirement for inpatient care also means that programmes must be implemented from hospitals and large clinics with inpatient facilities. Centralised treatment increases barriers to access for rural communities where acute malnutrition is most prevalent. Increased barriers to access and opportunity costs serve to delay presentation, making the disorder harder to treat, and increase the number of patients with complications. These barriers increase costs and case-fatality ratios and decrease the proportion of severely malnourished children who are able to access treatment, thereby reducing coverage (unpublished).

Community-based management of acute malnutrition

During the past 5 years, a growing number of countries and international relief agencies have adopted a community-based model for the management of acute malnutrition, called community-based therapeutic care.\textsuperscript{94-\textdegree97} This model provides a framework for an integrated public-health response to acute malnutrition, treating most patients with SAM solely as outpatients and reserving inpatient care for the few with SAM and complications.\textsuperscript{71} The model also aims to integrate treatment with various other interventions designed to reduce the incidence of malnutrition and improve public health and food security. Programme design attempts to take into account the socioeconomic factors, particularly poverty, high workloads for women, and the exclusion from health and education services that contribute to the late presentation of cases of acute malnutrition. Programmes are therefore very decentralised to minimise geographical barriers to access and include intensive community consultation and mobilisation to maximise understanding and participation. This design minimises the costs to families and maximises access to treatment.\textsuperscript{88} The decentralised design also means that, in non-emergency situations, there are few cases of SAM at any one access point and the quantities of ready-to-use therapeutic food required to treat them are therefore small. In current Ministry of Health implemented programmes in Malawi, for example, a health-centre treating 15 children with SAM per month requires 160 kg (eight boxes) of ready-to-use therapeutic food. This small quantity can be delivered easily together with other routine health supplies. This eases the problems associated with integrating community-based therapeutic care into existing health services, even in resource-poor settings.

The use of mid-upper-arm circumference as the sole anthropometric indicator for screening and admission into community-based therapeutic care also facilitates community participation, helping to devolve responsibility for selection of patients towards the community. Mid-upper-arm circumference is an indicator of acute malnutrition that reflects mortality risk\textsuperscript{90-\textdegree93} and has recently been endorsed as an independent criterion for admission into therapeutic feeding programmes by an informal consultation of WHO.\textsuperscript{71,94} The use of this
Community-based therapeutic care has also shown promise as an intervention to assist children with SAM. A cohort trial in Malawi assessed the effectiveness of community-based therapeutic care in the treatment of SAM in HIV-positive and HIV-negative children and examined its use as an entry point for home-based care programmes targeting people living with HIV/AIDS. 59% of the severely malnourished HIV-positive children not receiving antiretroviral drugs recovered compared with 83·4% of the HIV-negative children (p<0·002, unpublished). However, at a mean follow-up of 15 months after discharge, 53% of HIV-positive children had relapsed into moderate acute malnutrition compared with 10·4% of the HIV-negative children. HIV-positive children therefore need continual community-based monitoring after discharge and, for treatment to be optimally effective, community-based programmes for SAM must be integrated with home-based care and antiretroviral-drug programmes for HIV. In this study, the uptake rate for voluntary counselling and testing for children attending the programme was greater than 90%, far greater than usually seen in Malawi (unpublished). This finding shows a high potential for synergy and integration between community-based therapeutic care, home-based care, and antiretroviral-drug programmes for HIV.

Programmes of treatment for SAM tend to be highly cost-effective in terms of additional years of life gained.
because they precisely target resources at children with a very high mortality risk. Initial data indicate that the cost-effectiveness of emergency community-based therapeutic care is comparable to mainstream child-survival interventions, such as vitamin-A provision or oral rehydration therapy for diarrhoeal disease. Estimates from two established emergency programmes were US$101–197 per admission which is equivalent to between US$12 and US$132 for each year of life gained dependent on the assumptions made for the mortality rates of untreated SAM.\(^\text{10,11}\) The exact figure depends on the density and prevalence of severe acute malnutrition, the numbers of acutely malnourished children treated, the infrastructure present, accessibility, and the estimation of case-fatality ratios in untreated SAM.\(^\text{10,11}\) Although these are broad ranges, they are below the $150 threshold described by the World Bank as highly cost-effective. The development of local production of ready-to-use therapeutic food with new cheaper recipes based on locally available grains and pulses should further reduce costs.

**Conclusion**

Where sufficient resources are available, the WHO inpatient treatment model for SAM can achieve low case-fatality rates. However, exclusive inpatient treatment strategies are resource-intensive and require many skilled staff. Because the prevalence of SAM is highest in resource-poor environments, there is usually a substantial mismatch between the many patients requiring treatment and few skilled staff and scarce resources available to treat them. The HIV/AIDS pandemic is further lowering resource availability and increasing the numbers of acutely malnourished children, aggravating this mismatch and increasing case-fatality rates.

New approaches for the management of SAM, such as community-based therapeutic care, complement the existing WHO inpatient protocols. These programmes use ready-to-use therapeutic food to treat most children suffering from SAM as outpatients, reserving inpatient treatment for those with complications. They are designed to decrease barriers to access, encourage earlier presentation, reduce opportunity costs associated with treatment, and encourage compliance by patients. Treatment of most patients with SAM solely as outpatients reduces inpatient caseloads to more manageable levels, which helps decongest crowded inpatient units, decreases the risks of nosocomial infection, and increases the time available to staff to devote to the sickest children. These new approaches have greatly reduced case-fatality rates and increased coverage rates—initial data indicate that they are very cost-effective.

**The way forward**

Community-based therapeutic care should now be scaled up in both emergency and non-emergency settings and appropriate training included in medical, nursing, and primary health-care curricula. To start this process, WHO, UNICEF, and the UN Standing Committee on Nutrition recently convened an informal consultation on the community-based management of severe malnutrition in children. The meeting began the process of incorporating these techniques into the WHO guidelines.\(^\text{31}\) This is an essential step. However, improvements in treatment protocols, programme design, and training are, by themselves, insufficient. If community-based therapeutic care is to attain its maximum potential in reducing avoidable child mortality, there must be changes in funding priorities and child survival strategies. Leveraging these changes will require strong evidenced-based advocacy highlighting the global importance of SAM and communicating clearly the fact that highly cost-effective interventions exist.

WHO should adopt the term “acute malnutrition” to differentiate wasting and oedematous malnutrition from growth faltering and stunting. Acute malnutrition has different causes, different indicators, and requires different interventions to chronic malnutrition. Without a clear and appropriate nomenclature these differences are obscured, which results in confusion over treatment strategies and mixed messages going out to policymakers.

Second, the global importance of SAM as a major cause of avoidable mortality must be better communicated and the child survival agenda must give greater priority to treatment of the disorder. This requires SAM to be included as a specific cause of death in mortality-surveillance data and included as a diagnosis in standard morbidity surveillance. Without this, the high numbers of deaths and high morbidity attributable to SAM will continue to go unrecorded and un-noticed.

Third, nutritionists should communicate the fact that there are successful and highly cost-effective interventions for SAM. Although the hospital-based treatment of SAM is more cost-effective than many of the mainstream child-survival interventions, such as treatment of severe diarrhoea in hospitals or vitamin-A distribution,\(^\text{11,12}\) this has been poorly communicated to policymakers and funders. Community-based therapeutic care promises to increase this cost-effectiveness further. There is a need for more cost-effectiveness data and for these findings to be communicated to policymakers.

Last, an appropriate indicator of acute malnutrition, such as mid-upper-arm circumference, should be included as a standard element in both growth monitoring programmes and integrated management of childhood illness to allow these programmes to diagnose acute malnutrition more effectively. This indicator is essential if cases of SAM are to be caught early, before complications arise and while cheap outpatient treatment is possible. At present, growth-monitoring programmes do not include any indicator of acute malnutrition and integrated management of childhood illness includes only “visible severe wasting”, an indicator that is subjective, difficult to use in practice,
and unreliable.\textsuperscript{10–12} Mid-upper-arm circumference is easy to use and efficient at identifying those children who need specialist interventions—without this, most cases of SAM will go undiagnosed and untreated.

Achieving the fourth Millennium Development Goal of a two-third reduction in childhood mortality will not be possible unless SAM is addressed effectively. For interventions to fulfil their potential, policymakers must give SAM an urgency commensurate with its global importance as a leading cause of preventable childhood mortality.

Conflict of interest statement

The authors work for Valid International Ltd, an organisation that has been engaged in the research and development of community-based therapeutic care. Dr Collins and Dr Hallam are also unpaid directors of Valid Nutrition, a not-for-profit company established to research and manufacture ready-to-use therapeutic food in developing countries.

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References

Review


