Management of severe acute malnutrition in children

Steve Collins, Nicky Dent, Paul Binns, Paluku Bahwere, Kate Sadler, Alistair Hallam

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.

Published **Online**
September 25, 2006
DOI:

Valid International Ltd, Oxford, UK (S Collins MD, N Dent MSc, P Binns RGN, P Bahwere MD, K Sadler MSc, A Hallam BM BCh); **Centre for International Child Health, Institute of Child Health, Guilford Street, London, UK** (S Collins, K Sadler)

Correspondence to:
Dr Steve Collins, Valid International Ltd, Unit 14 Standingford House, 26 Cave Street, Oxford OX4 1BA
steve@validinternational.org

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[1]), which is called "wasted"; the presence of bilateral pitting oedema of nutritional origin, which is called "oedematous malnutrition";[2] or a mid-upper-arm circumference of less than 110 mm in children age 1–5 years.[3,4] 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[5] 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";[6] 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,[7] 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.[8–12] 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 homoeostasis. However, as the severity of nutritional insult increases, these adaptations progressively limit the body's ability to respond to stresses such as infection.[15–17] 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.[18–21] However, while the child-survival movement commonly acknowledges the importance of undernutrition, defined as low weight for age,[22] 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.[22] 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[23,24] and about 2% of children in developing countries have SAM.[24] In India alone, 2·8% of children under 5 years of age (over 5 million children) are severely wasted[25–27] and in many poor countries such as Malawi, SAM is the commonest reason for paediatric hospital admission.[28]

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[29,30] and severe wasting is associated with a mortality rate of 73–187 per 1000 children per year.[29] 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.[5,31] By contrast, since the 1970s there have been management protocols capable of achieving case-fatality rates of 1–5%,[15,32,33] and well-resourced humanitarian agencies using these protocols frequently achieve mortality rates under the 10% level stipulated in the international Sphere Project standards.[4,34,35]

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).[2,36–39] 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[33,40–44] and during emergency humanitarian interventions.[34,45] 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.[46,47]

The persistence of high case-fatality rates is commonly attributed to inappropriate case management as a result of poor knowledge.[5,48] 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.[25,37,49–52] 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,[53] 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,[54] 15

Regions†	Under-5 population 2000 (×1000)	Wasting prevalence (%)		Wasting numbers (×1000)		Annual mortality numbers		
		Moderate & severe	Severe	≥2 Z scores below WFH	≥3 Z scores below WFH	2–3 Z scores below WFH*	>3 Z scores WFH†	Total
Sub-Saharan Africa	106 394	10	3	10 639	3192	565 768	421 767	987 535
Middle East and north Africa	44 478	7	2	3114	890	168 942	117 547	286 489
South Asia	166 566	15	2	24 985	3331	1 644 950	440 201	2 085 151
East Asia and Pacific	159 454	4	-	6378	-	484 528	-	484 528
Latin America and Caribbean	54 809	2	0	1096	-	83 273	-	83 273
CEE-CIS and Baltic states	30 020	4	1	1201	300	68 416	39 668	108 084
Industrialised countries	50 655	-	-			-	-	-
Developing countries	546 471	9	2	49 182	10 929	2 905 951	1 444 214	4 350 164
Least developed countries	110 458	10	2	11 046	2209	671 290	291 918	963 209
Total	707 584			60 228	13 139	3 577 241	1 736 132	5 313 373

Population and prevalence of wasting from UNICEF global database on child malnutrition 2001.[24] CEE-CIS=Central and Eastern Europe and Commonwealth of Independent States. WFH=weight-for-height index. *Moderate mortality rate=76/1000/year (average of nine studies range 30–148 for children with <80% weight for height or –2 z scores).[29] †Severe mortality rate=132/1000/year (average of five studies, range 73–187 children with mid-upper-arm circumference <110 mm).[29]

Table: **Worldwide burden of acute malnutrition in children aged less than 5 years**

www.thelancet.com **Published online September 25, 2006 DOI:**

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%.[55] 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.[54] 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.[56] 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.[43,44,57,58] In sub-Saharan Africa, a high proportion of severely malnourished children admitted to nutritional rehabilitation units are now also HIV positive,[55,57–63] particularly those with marasmus.[57,59] 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.[57] 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,[58,64] their recovery is slower than that of uninfected children. HIV infection is also associated with high rates of complication and case fatality.[55,57,59]

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.[65,66] 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;[67,68] 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.[31,69–72] These concerns persist today.[73]

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.[31,74] 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.[75–77] In others, mortality and relapse rates both during treatment and after discharge were high[72,78] and rates of weight gain were low.[79,80] 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.[42]

In 2001, Ashworth reviewed 27 such programmes from the 1980s and 1990s.[81] 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 successful[81] and that the early discharge of severely malnourished patients from inpatient treatment units is usually hazardous.[52] 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.[82]

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.[42,83] 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.[83,84] Similar improvements in cost-effectiveness of care were seen in home-treatment programmes in Jamaica.[85]

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.[86] In contrast to the water-based F100, ready-to-use therapeutic food is an oil-based paste with an extremely low water activity.[87] As a result, ready-to-use therapeutic food does not grow bacteria even when accidentally contaminated,[88] 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[89] with basic technology that is readily available in developing countries.[90,91]

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.[92] 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.[28] In the same trial, 56% of the HIV-positive children treated with ready-to-use therapeutic food also achieved 100% weight for height.[64] 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.[93] 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[55] 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.[94–97] 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.[73] 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[73] and include intensive community consultation and mobilisation to maximise understanding and participation. This design minimises the costs to families and maximises access to treatment.[98] 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[99–102] and has recently been endorsed as an independent criterion for admission into therapeutic feeding programmes by an informal consultation of WHO.[103,104] The use of this

measure requires no complicated equipment and can easily be taught to community-based workers, making it practical for use in resource-poor settings.[105,106]

Community-based therapeutic care's clinical approach is based on the fact that the severity of SAM, its prognosis, and the determinants of successful treatment are primarily dependent on the time to presentation.[28,30,55,68,99,107,108] SAM is classified on the basis of whether there are coexistent life-threatening complications[109] (figure). Children presenting with SAM complicated by life-threatening illness receive inpatient care according to the WHO treatment protocols. Those with SAM but without life-threatening complications are treated through weekly or fortnightly attendance in outpatient therapeutic programmes. In outpatient therapeutic programmes, they receive an 837 kJ/kg/day (200 kcal/kg/day) take-home ration of ready-to-use therapeutic food, a course of oral broad-spectrum antibiotics, vitamin A, folic acid, anthelminthics and, if appropriate, antimalarials. To increase access to treatment and encourage earlier presentation, outpatient therapeutic programmes are decentralised and implemented through standard primary health-care units or even non-permanent access points. This approach results in most children presenting at a stage when they can still be treated effectively as outpatient by front-line health staff, which greatly reduces the need for trained clinic staff, thereby easing integration into routine health services.

Case-fatality rates among 23 511 unselected severely malnourished children treated in 21 programmes of community-based therapeutic care in Malawi, Ethiopia, and Sudan, between 2001 and 2005, were 4·1%, with recovery rates of 79·4% and default rates of 11·0%. 74% of these severely malnourished children were treated solely as outpatients.[94,95,103] Coverage rates for nine of these programmes have been estimated with a new coverage-survey technique designed to provide more precise coverage estimates of health-care programmes.[110] Average coverage was 72·5%,[95,103] substantially higher than coverage rates seen in comparable centre-based programmes which are often less than 10%.[111,112] Similar positive results have recently been published from Niger, where Médecins sans Frontières (MSF) cared for more than 60 000 children with SAM with an approach based on outpatient therapeutic programmes. About 70% of patients were treated solely as outpatients and overall case-fatality ratios were about 5%.[113]

Community-based therapeutic care has also shown promise as an intervention to assist children with SAM infected with HIV. 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.[114] 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

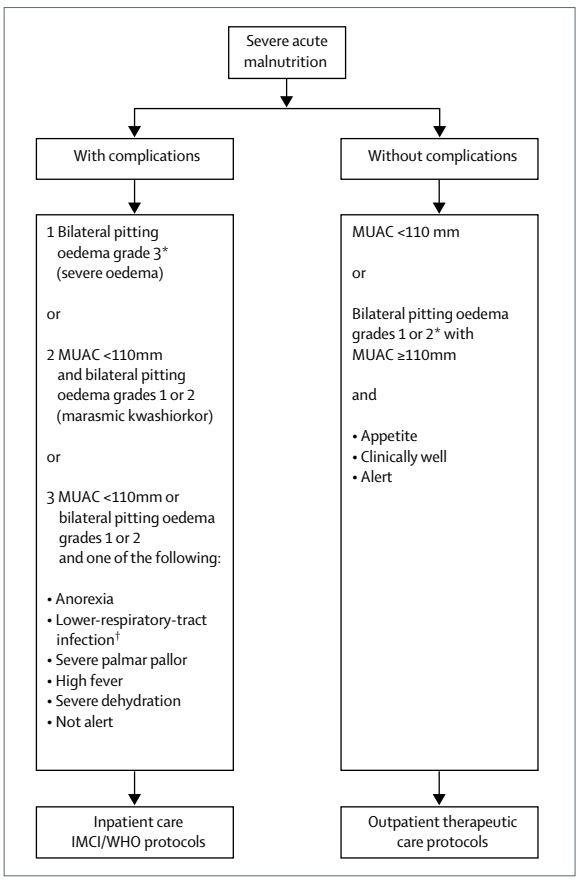

Figure: **Classification of severe acute malnutrition used in community-based therapeutic care**
MUAC=mid-upper-arm circumference. ICMI=Integrated Management of Childhood Illness. *Grade 1=mild oedema on both feet or ankles; grade 2=moderate oedema on both feet, plus lower legs, hands, or lower arms; grade 3=severe generalised oedema affecting both feet, legs, hands, arms, and face. †IMCI criteria:[39] 60 respirations/min children less than 2 months; 50 respirations/min for age 2–12 months; 40 respirations/min for ages 1–5 years; 30 respirations for age >5years.

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.[115] 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.[103,115] 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.[103] 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,[112,116] 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.[104,117] 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.

Acknowledgments

This work was supported by funding from Concern Worldwide. Concern Worldwide has been engaged in the research and development of community-based therapeutic care but has had no influence over the text of this review.

References

1 WHO. WHO child growth standards. *Acta Paediatr* 2006; **95** (suppl): 1–101.
2 WHO. Management of severe malnutrition: a manual for physicians and other senior health workers. Geneva: WHO, 1999.
3 UNHCR. Handbook for emergencies, 2nd edn. Geneva: UNHCR, 1999.
4 SPHERE project team. The SPHERE humanitarian charter and minimum standards in disaster response, 2nd edn. Geneva: The SPHERE Project, 2003.
5 Schofield C, Ashworth A. Why have mortality rates for severe malnutrition remained so high? *Bull World Health Organ* 1996; **74:** 223–29.
6 Berg A. Sliding towards nutrition malpractice; time to reconsider and redeploy. *Am J Clin Nutr* 1992; **57:** 3–7.
7 UNICEF. Strategy for improved nutrition of children and women in developing countries. New York: UNICEF, 1990.
8 Cahill GF. Starvation in man. *N Engl J Med* 1970; **282:** 668–75.
9 Forbes GB, Drenick EJ. Loss of body nitrogen on fasting. *Am J Clin Nutr* 1979; **32:** 1570–74.
10 Waterlow JC. Metabolic adaptation to low intakes of energy and protein. *Ann Rev Nutr* 1986; **6:** 495–526.
11 Keys A. The biology of human starvation, 1st edn. Minnesota: Minnesota press, 1950.
12 McCance RA, Widdowson EM. Studies in undernutrition, Wuppertal 1946–9, 1st edn. London: Medical Research Council, 1951.
13 Winick M. Hunger disease. New York: Wiley-Interscience, 1979.
14 Waterlow JC. Protein energy malnutrition, 1st edn. London: Edward Arnold, 1992.
15 Golden M. The effects of malnutrition in the metabolism of children. *Trans R Soc Trop Med Hyg* 1988; **82:** 3–6.
16 Golden MH, Waterlow JC, Picou D. Protein turnover, synthesis and breakdown before and after recovery from protein-energy malnutrition. *Clin Sci Mol Med* 1977; **53:** 473–77.
17 Reid M, Badaloo A, Forrester T, Heird WC, Jahoor F. Response of splanchnic and whole-body leucine kinetics to treatment of children with edematous protein-energy malnutrition accompanied by infection. *Am J Clin Nutr* 2002; **76:** 633–40.
18 Black RE, Morris SS, Bryce J. Where and why are 10 million children dying every year? *Lancet* 2003; **361:** 2226–34.
19 Caulfield LE, de Onis M, Black RE. Undernutrition as an underlying cause of child deaths associated with diarrhea, pneumonia, malaria, and measles. *Am J Clin Nutr* 2002; **80:** 193–98.
20 Rice AL, Sacco L, Hyder A, Black RE. Malnutrition as an underlying cause of childhood deaths associated with infectious diseases in developing countries. *Bull World Health Organ* 2000; **78:** 1207–21.
21 Pelletier DL, Frongillo EA. Changes in child survival are strongly associated with changes in malnutrition in developing countries. *J Nutr* 2003; **133:** 107–19.
22 The Bellagio Child Survival Study Group. The child survival series. *Lancet* 2003; **361:** 1–38. 2003.
23 UNICEF. State of the worlds children 2005. New York: UNICEF, 2005.
24 UNICEF. UNICEF global database on child malnutrition. http://www.childinfo.org/areas/malnutrition/wasting.php (accessed Dec 20, 2005).
25 Bhan MK, Bhandari N, Bhal R. Management of the severely malnourished child: perspective from developing countries. *BMJ* 2003; **326:** 146–51.
26 International Institute of Population Sciences. National family health survey (NFHS2),1998-99. Mumbai: International Institute of Population Sciences, 2000.
27 CIA. CIA World Fact Book. http://www.cia.gov/cia/publications/factbook/index.html . (accessed Sept 10, 2006).
28 Manary MJ, Ndkeha MJ, Ashorn P, Maleta K, Briend A. Home based therapy for severe malnutrition with ready-to-use food. *Arch Dis Child* 2004; **89:** 557–61.
29 Pelletier DL. The relationship between child anthropometry and mortality in developing countries: implications for policy, programs and future research. *J Nutr* 1994; **124** (suppl): 2047S–81S.
30 Chen LC, Chowdhury A, Huffman SL. Anthropometric assessment of energy-protein malnutrition and subsequent risk of mortality among preschool children. *Am J Clin Nutr* 1980; **33:** 1836–45.
31 Cook R. Is hospital the place for the treatment of malnourished children? *J Trop Pediatr Environ Child Health* 1971; **17:** 15–25.
32 Golden MHN. Severe Malnutrition. In: Weatherall DJ, Ledington JGG, Warrell DA, eds. The Oxford textbook of medicine, 3rd edn. Oxford: Oxford University Press; 1996: 1278–96.
33 Ahmed T, Ali M, Ullah MM, et al. Mortality in severely malnourished children with diarrhoea and use of a standardised management protocol. *Lancet* 1999; **353:** 1919–22.
34 Prudhon C, Briend A, Laurier D, Golden MH, Mary JY. Comparison of weight- and height-based indices for assessing the risk of death in severely malnourished children. *Am J Epidemiol* 1996; **144:** 116–23.
35 Collins S, Sadler K. The outpatient treatment of severe malnutrition during humanitarian relief programmes. *Lancet* 2002; **360:** 1824–30.
36 Ashworth A, Jackson A, Khanum S, Schofield C. Ten steps to recovery. *Child Health Dialogue* 1996: 10–2.
37 WHO informal consultation. Informal consultation to review current literature on severe malnutrition. Geneva: WHO, 2004.
38 WHO. Management of the child with a serious infection or severe malnutrition : guidelines for care at the first-referral level in developing countries. Geneva: World Health Organization; 2000.
39 WHO. Improving child health—IMCI: the integrated approach. Geneva: World Health Organization, 1997.
40 Chopra M, Wilkinson D. Treatment of malnutrition. *Lancet* 1995; **345:** 788.
41 Wilkinson D, Scrase M, Boyd N. Reduction in in-hospital mortality of children with malnutrition. *J Trop Pediatr* 1996; **42:** 114–15.
42 Khanum S, Ashworth A, Huttly SR. Controlled trial of three approaches to the treatment of severe malnutrition. *Lancet* 1994; **344:** 1728–32.
43 Puoane T, Sanders D, Chopra M, et al. Evaluating the clinical management of severely malnourished children—a study of two rural district hospitals. *S Afr Med J* 2001; **91:** 137–41.
44 Deen JL, Funk M, Guevara VC, et al. Implementation of WHO guidelines on management of severe malnutrition in hospitals in Africa. *Bull World Health Organ* 2003; **81:** 237–43.
45 Grellety Y. The management of severe malnutrition in Africa (dissertation). University of Aberdeen, 2000.
46 Briend A. Management of severe malnutrition: efficacious or effective? *J Pediatr Gastroenterol Nutr* 2001; **32:** 521–22.
47 Waterlow JC. Intensive nursing care of kwashiorkor in Malawi. *Acta Paediatr* 2000; **89:** 138–40.
48 Schofield C, Ashworth A. Severe malnutrition in children: high case-fatality rates can be reduced. *Afr Health* 1997; **19:** 17–18.
49 Ashworth A, Schofield C. Latest developments in the treatment of severe malnutrition in children. *Nutrition* 1998; **14:** 244–45.

50 Ashworth A. Treatment of severe malnutrition. *J Pediatr Gastroenterol Nutr* 2001; **32:** 516–18.

51 Ashworth A, Chopra M, McCoy D, et al. WHO guidelines for management of severe malnutrition in rural South African hospitals: effect on case fatality and the influence of operational factors. *Lancet* 2004; **363:** 1110–15.

52 Ashworth A, Sanders D, Chopra M, McCoy D, Schofield C. Improving quality of care for severe malnutrition. *Lancet* 2004; **363:** 2089.

53 Brewster D, Manary M. Treatment of severe malnutrition. *Lancet* 1995; **345:** 453.

54 WHO. WHO global health atlas—human resources for health 2005. http://www.who.int/globalatlas/dataQuery (accessed Sept 10, 2006).

55 Brewster D, Manary M, Graham S. Case management of kwashiorkor: an intervention project at seven nutrition rehabilitation centres in Malawi. *Eur J Clin Nutr* 1997; **51:** 139–47.

56 World Bank. Rising to the challanges—the millenium development goals for health. Washington: World Bank, 2004.

57 Kessler L, Daley H, Malenga G, Graham S. The impact of the human immuno deficiency virus type 1 on the management of severe malnutrition in Malawi. *Ann Trop Paediatr* 2000; **20:** 50–56.

58 Ticklay IM, Nathoo KJ, Siziya S, Brady JP. HIV infection in malnourished children in Harare, Zimbabwe. *East Afr Med J* 1997; **74:** 217–20.

59 Prazuck T, Tall F, Nacro B, t al. HIV infection and severe malnutrition: a clinical and epidemiological study in Burkina Faso. *AIDS* 1993; **7:** 103–08.

60 Mgone CS, Mhalu FS, Shao JF, et al. Prevalence of HIV-1 infection and symptomatology of AIDS in severely malnourished children in Dar Es Salaam, Tanzania. *J Acquir Immune Defic Syndr* 1991; **4:** 910–13.

61 Amadi B, Mwiya M, Musuku J, et al. Effect of nitazoxanide on morbidity and mortality in Zambian children with cryptosporidiosis: a randomised controlled trial. *Lancet* 2002; **360:** 1375–80.

62 Amadi B, Kelly P, Mwiya M, et al. Intestinal and systemic infection, HIV, and mortality in Zambian children with persistent diarrhea and malnutrition. *J Pediatr Gastroenterol Nutr* 2001; **32:** 550–54.

63 Chintu C, Luo C, Bhat G, et al. Impact of the human immunodeficiency virus type-1 on common pediatric illnesses in Zambia. *J Trop Pediatr* 1995; **41:** 348–53.

64 Ndekha MJ, Manary MJ, Ashorn P, Briend A. Home-based therapy with ready-to-use therapeutic food is of benefit to malnourished, HIV-infected Malawian children. *Acta Paediatr* 2005; **94:** 222–25.

65 Sadre M, Donoso G. Treatment of malnutrition. *Lancet* 1969; **2:** 112.

66 Lawless J, Lawless MM. Admission and mortality in a children's ward in an urban tropical hospital. *Lancet* 1966; **2:** 1175–76.

67 Gueri M, Andrews N, Fox K, Jutsum P, St Hill D. A supplementary feeding programme for the management of severe and moderate malnutrition outside hospital. *J Trop Pediatr* 1985; **31:** 101–08.

68 Brewster D. Improving quality of care for severe malnutrition. *Lancet* 2004; **363:** 2088–89.

69 Cook R. The financial cost of malnutrition in the "Commonwealth Caribbean". *J Trop Pediatr* 1968; **14:** 60–65.

70 Roosmalen-Wiebenga MW, Kusin JA, de With C. Nutrition rehabilitation in hospital—a waste of time and money? Evaluation of nutrition rehabilitation in a rural district hospital in southwest Tanzania: I, short-term results. *J Trop Pediatr* 1986; **32:** 240–43.

71 Roosmalen-Wiebenga MW, Kusin JA, de With C. Nutrition rehabilitation in hospital—a waste of time and money? Evaluation of nutrition rehabilitation in a rural district hospital in South-west Tanzania: II, long-term results. *J Trop Pediatr* 1987; **33:** 24–28.

72 Reneman L, Derwig J. Long-term prospects of malnourished children after rehabilitation at the Nutrition Rehabilitation Centre of St Mary's Hospital, Mumias, Kenya. *J Trop Pediatr* 1997; **43:** 293–96.

73 Collins S. Changing the way we address severe malnutrition during famine. *Lancet* 2001; **358:** 498–501.

74 Bengoa JM. Nutrition rehabilitation centres. *J Trop Pediatr* 1967; **13:** 169–76.

75 King KW, Fougere W, Webb RE, Berggren G, Berggren WL, Hilaire A. Preventive and therapeutic benefits in relation to cost: performance over 10 years of Mothercraft Centers in Haiti. *Am J Clin Nutr* 1978; **31:** 679–90.

76 Beghin ID, Viteri FE. Nutritional rehabilitation centres: an evaluation of their performance. *J Trop Pediatr Environ Child Health* 1973; **19:** 403–16.

77 Beaudry-Darisme M, Latham MC. Nutrition rehabilitation centers—an evaluation of their performance. *J Trop Pediatr Environ Child Health* 1973; **19:** 299–332.

78 Pecoul B, Soutif C, Hounkpevi M, Ducos M. Efficacy of a therapeutic feeding centre evaluated during hospitalization and a follow-up period, Tahoua, Niger, 1987–1988. *Ann Trop Paediatr* 1992; **12:** 47–54.

79 Heikens GT, Schofield WN, Dawson S, Grantham-McGregor S. The Kingston project: I—growth of malnourished children during rehabilitation in the community, given a high energy supplement. *Eur J Clin Nutr* 1989; **43:** 145–60.

80 Heikens GT, Schofield WN, Dawson SM, Waterlow JC. Long-stay versus short-stay hospital treatment of children suffering from severe protein-energy malnutrition. *Eur J Clin Nutr* 1994; **48:** 873–82.

81 Ashworth, A. Community-based rehabilitation of severely malnourished children: a review of successful programmes. London: London School of Hygiene and Tropical Medicine, 2001.

82 Ashworth, A. Efficacy and effectiveness of community-based treatment of severe malnutrition . *Food Nutr Bull* 2006; **27** (suppl): S24–48.

83 Ahmed, T. Community-based nutritional rehabilitation without food distribution: experience from Bangladesh, in WHO, UNICEF and SCN informal consultation on community-based management of severe malnutrition in children. http://www.who.int/child-adolescent-health/ (accessed Sept 10, 2006).

84 Ashworth A, Khanum S. Cost-effective treatment for severely malnourished children: what is the best approach? *Health Policy Plan* 1997; **12:** 115–21.

85 Bredow MT, Jackson AA. Community based, effective, low cost approach to the treatment of severe malnutrition in rural Jamaica. *Arch Dis Child* 1994; **71:** 297–303.

86 Briend A, Lacsala R, Prudhon C, Mounier B, Grellety Y, Golden MHN. Ready-to-use therapeutic food for treatment of marasmus. *Lancet* 1999; **353:** 1767–68.

87 Briend A. Highly nutrient-dense spreads: a new approach to delivering multiple micronutrients to high-risk groups. *Brit J Nutr* 2001; **85** (suppl 2)**:** S175–79.

88 Briend A. Treatment of severe malnutrition with a therapeutic spread. *Field Exchange* 1997; **2:** 15.

89 Collins S, Henry CJK. Alternative RUTF formulations. Emergency Nutrition Network 2004; special supplement 2: 35–37.

90 Fellows P. Local production of RUTF. Emergency Nutrition Network 2004; special supplement 2: 33–35.

91 Sandige H, Ndekha MJ, Briend A, Ashorn P, Manary MJ. Home-based treatment of malnourished Malawian children with locally produced or imported ready-to-use food. *J Pediatr Gastroenterol Nutr* 2004; **39:** 141–46.

92 Diop EHI, Dossou NI, Ndour MM, Briend A, Wade S. Comparison of the efficacy of a solid ready to use food and a liquid milk-based diet for the rehabilitation of severely malnourished children: a randomized trial. *Am J Clin Nutr* 2003; **78:** 302–07.

93 Ciliberto MA, Sandige H, Ndekha MJ, et al. Comparison of home-based therapy with ready-to-use therapeutic food with standard therapy in the treatment of malnourished Malawian children: a controlled, clinical effectiveness trial. *Am J Clin Nutr* 2005; **81:** 864–70.

94 Collins S. Community-based therapeutic care—a new paradigm for selective feeding in nutritional crises: Humanitarian Policy Network paper 48. London: Overseas Development Institute, 2004.

95 Khara T, Collins S. Community-therapeutic care (CTC). Emergency Nutrition Network 2004; special supplement 2: 1–55.

96 Emergency Nutrition Network. ENN report on an inter-agency workshop. http://www.ennonline.net/docs/CTCreport.pdf (accessed Sept 10, 2006).

97 Grobler-Tanner C, Collins S. Community therapeutic care (CTC): a new approach to managing acute malnutrition in emergencies and beyond. Washington DC: Food and Nutrition Technical Assistance Project, Academy for Educational Development, 2004.

98 Guerrero S, Mollison S. Engaging communities in emergency response: the CTC experience in Western Darfur. In Humanitarian Exchange. Humanitarian Policy Network eds. London: Overseas Development Institute, 2005: 20–22.

99 Briend A, Dykewicz C, Graven K, Mazumder RN, Wojtyniak B, Bennish M. Usefulness of nutritional indices and classification in predicting death of malnourished children. *BMJ* 1986; **293:** 373–76.

100 Alam N, Wojtyniak B, Rahaman MM. Anthropometric indicator and risk of death. *Am J Clin Nutr* 1989; **49:** 884–88.

101 Briend A, Garenne M, Maire B, Fontaine O, Dieng K. Nutritional status, age and survival: the muscle mass hypothesis. *Eur J Clin Nutr* 1989; **43:** 715–26.

102 Vella V, Tomkins A, Ndiku J, Marshal T, Cortinovis I. Anthropometry as a predictor for mortality among Ugandan children, allowing for socio-economic variables. *Eur J Clin Nutr* 1994; **48:** 189–97.

103 WHO. Report of an informal consultation on the community-based management of severe malnutrition in children. http://www.who.int/child-adolescent-health/publications/NUTRITION/CBSM.htm. (accessed Sept 10, 2006).

104 Myatt M, Khara T, Collins S. A review of methods to detect cases of severely malnourished children in the community for their admission into community-based therapeutic care programs. *Food Nutr Bull* 2006; **27**(suppl): S7–23.

105 Velzeboer MI, Selwyn BJ, Sargent S, Pollitt E, Delgado H. The use of arm circumference in simplified screening for acute malnutrition by minimally trained health workers. *J Trop Pediatr* 1983; **29:** 159–66.

106 Berkley J, Mwangi I, Griffiths K, et al. Assessment of severe malnutrition among hospitalized children in rural Kenya: comparison of weight for height and mid upper arm circumference. *JAMA* 2005; **294:** 591–97.

107 Pelletier DL, Frongillo EA Jr, Schroeder DG, Habicht JP. The effects of malnutrition on child mortality in developing countries. *Bull World Health Organ* 1995; **73:** 443–48.

108 Bairagi R. On validity of some anthropometric indicators as predictors of mortality. *Am J Clin Nutr* 1981; **34:** 2592–94.

109 Collins S, Yates R. The need to update the classification of acute malnutrition. *Lancet* 2003; **362:** 249.

110 Myatt M, Feleke T, Sadler K, Collins S. A field trial of a survey method for estimating the coverage of selective feeding programs. *Bull World Health Organ* 2005; **83:** 20–26.

111 Van Damme W. Medical assistance to self-settled refugees. Guinea 1990–1996. Antwerp: ITG Press, 1998.

112 Jha P, Bangoura O, Ranson K. The cost-effectiveness of forty health interventions in Guinea. *Health Policy Plan* 1998; **13:** 249–62.

113 Tectonidis M. Crisis in Niger—outpatient care for severe acute malnutrition. *N Engl J Med* 2006; **354:** 224–27.

114 Guerrero S, Bahwere P, Sadler K, Collins S. Integrating CTC and HIV/AIDS Support in Malawi. *Field Exchange* 2005; **25:** 8–10.

115 Collins S, Sadler K, Dent N, et al. Key issues in the success of community-based management of severe malnutrition. *Food Nutr Bull* 2006; **27:** S49–82.

116 World Bank. World development report 1993, investing in health. Oxford: Oxford University Press, 1993.

117 Hamer C, Kvatum K, Jeffries D, Allen S. Detection of severe protein-energy malnutrition by nurses in The Gambia. *Arch Dis Child* 2004; **89:** 181–84.