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WHO, UNICEF, and SCN Informal Consultation on Community-Based Management of Severe Malnutrition in Children

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Publication note

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Foreword

Putting the management of severe malnutrition back on the international health agenda

André Briend, Claudine Prudhon, Zita Weise Prinzo, Bernadette M. E. G. Daelmans, and John B. Mason

Key words: Severe malnutrition, child nutrition disorders, therapy, community

Severe malnutrition, defined by severe wasting (weight-for-height < -3 z-scores or $< 70\%$ of the median National Center for Health Statistics/World Health Organization [NCHS/WHO] reference) and/or the presence of nutritional edema, is a life-threatening condition requiring urgent treatment. How many lives would better treatment of severe child malnutrition save?

The prevalence of severe malnutrition is estimated as around 2% in the least-developed countries and 1% in other developing countries [1], which translates to about 10 million severely malnourished children at one time. About 10 million children under five die each year [2, 3]. Some 4 million of these are neonatal deaths, which are not generally preventable by addressing severe malnutrition, but a significant proportion of the remaining 6 million may be preventable in this way. Malnutrition, severe or otherwise, is estimated to be a contributing factor in over 50% of child deaths [4], and it is estimated that the reduction in child mortality and morbidity (i.e., loss of disability-adjusted life-years [DALYs] averted) if malnutrition were eliminated would be at least one-third [5]. No direct estimates are available of the contribution of severe malnutrition to child deaths. However, the figure suggested by Collins et al. [6] in this volume of possibly 1 million child deaths (out of 6 million) associated with severe

malnutrition is certainly possible. This estimate should be compared with those from other sources of data [7], but nevertheless its order of magnitude suggests that severe malnutrition in children is an important public health problem.

Moderate malnutrition contributes more to the overall disease burden than severe malnutrition, since it affects many more children, even if the risk of death is lower [8]. Moreover, *preventing* all forms of malnutrition remains the priority. However, existing prevention programs are imperfect, especially in the poorest countries or in countries undergoing an emergency crisis, and the prevalence of moderate plus severe malnutrition (as underweight) persists at around 25% and is falling only slowly. Many children still go on to become severely malnourished, even when prevention programs are in place, and these children will require treatment. Hence therapeutic programs are still needed as “safety nets” in parallel with prevention programs.

Thus, extensive benefit would ensue from more effective and widely available treatment of severe malnutrition. Yet until recently, developing and applying better treatment methods has had low priority—severe malnutrition can almost be regarded as a neglected disease. For example, in the *Lancet* series on child survival, management of severe malnutrition is not mentioned as a potentially lifesaving intervention [3]. Similarly, international agencies have expressed a strong commitment to achieving Millennium Development Goals (MDGs); in this context, goal 1 (to eradicate extreme poverty and hunger) and goal 4 (to reduce child mortality) are the most relevant. However, large-scale programs of treatment targeted toward severely malnourished children are not yet widely supported. Few countries, if any, even among those with a high prevalence of malnutrition, have a clear national policy aiming at detecting and treating severely malnourished children.

A possible reason for this apparent neglect is that until recently there was no clearly effective treatment strategy to prevent deaths from severe malnutrition on a large scale. Well-understood and evidence-based

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methods of treatment now exist. These have been systematically developed through research and development of protocols and suitable products, followed by extensive efficacy testing under controlled conditions; and now the experience of widespread field implementation—as yet mainly in emergencies—leads to recommendations, as laid out in this publication, for routine adoption, under both emergency conditions and other appropriate circumstances.

This is a significant advance. Until recently, the WHO recommendation was to admit severely malnourished children to the hospital as inpatients for a period of at least a month [9]. The limitations of a hospital-based approach for a condition affecting large numbers of children, particularly when hospital capacity is poor, have been recognized for more than 30 years [10, 11]. Moreover, hospital stays of several weeks for a child and mother are disruptive for families, especially when the mother has other children at home or when her labor is essential for the economic survival of the household. As a result, hospital-based management of severe malnutrition was perceived as efficacious, but not effective, on a large scale, either as part of routine health services or in emergencies [12].

However, although some of these problems could in principle be overcome by a community-based approach, this was rarely effective until new products and procedures started to be tested in the 1990s, as discussed by Ashworth [13] in this issue of the *Food and Nutrition Bulletin*. The situation is now ready to change with the implementation of effective community-based intervention strategies for the management of severe malnutrition in children without complications, which hitherto had required hospital care.

The first step in this potential transformation came with the development of new therapeutic diets. Previously, high-energy milk products had been used, even when the child had enough appetite to take nonliquid foods. As an alternative, ready-to-use therapeutic foods (RUTF) were developed in the form of energy-dense pastes or biscuits containing no water so they would not support bacterial growth (which is a major drawback of milk-based liquid diets). These were shown to be efficacious in producing rapid weight gain [14, 15], and they can be used in the community. This combination of safer therapeutic foods and their feasible use in the home has begun to transform the way severe malnutrition is managed in the community in both emergency and nonemergency settings [16]. Addition of adapted mineral and vitamin supplements to the local diet also seems to increase the efficacy of programs based on the use of locally available nutrient-rich foods, but this approach requires further research to determine its effectiveness [17].

The local production of RUTF is described in the paper by Manary in this volume [18]. The energy-dense RUTF products were tested in a number of experi-

mental settings and shown to be efficacious for the treatment of severe malnutrition. Mortality rates were low and rapid rates of recovery were achieved that were comparable to or even higher than those achieved with earlier approaches. A proviso is that severe malnutrition with complications, especially when the appetite is poor, does not respond well and still requires inpatient treatment, including liquid diets. The efficacy studies are described and synthesized in the paper by Ashworth in this volume [13].

Large-scale community-based approaches using RUTF were first implemented in emergency settings, where agencies “voted with their feet” in the last 2 years by dramatically increasing the number of severely malnourished children they could treat [19]. Data from these real-life, nonexperimental programs necessarily only allow less rigorous evaluation, but the indications are that the impact, in terms of mortality reduction and success of rehabilitation, is extensive. The implementation and results of these programs are described by Collins et al. in this volume [6].

It is likely that the same approach can be used successfully on a large scale in communities in non-emergency settings, as well as in conjunction with hospital-based treatment of children with complications, and this has the potential to vastly increase the coverage of effective treatment of severely malnourished children. However, upscaling these programs at a national level in countries with the highest prevalence of severe malnutrition will represent a challenge that should not be underestimated. From the experience of a nongovernmental organization, the paper by Gatchell et al. in this volume [20] described issues to be addressed for the community-based management of severe malnutrition to be sustainable. Nonetheless, community-based health and nutrition programs today have considerable coverage [21], and being based on local health workers and community organizations, they may well provide a route for wider adoption of RUTF for treatment of severe malnutrition where it is a significant problem; put the other way, a missing component of such programs has been the ability to treat severe (uncomplicated) cases without referral and admission, and RUTFs may fill this gap.

This special issue of the *Food and Nutrition Bulletin* reports on a WHO/UNICEF/Standing Committee on Nutrition (SCN) meeting on community-based management of severe malnutrition in children that took place in Geneva on November 21–23, 2005, and brought together some 50 international experts and representatives from the World Food Programme (WFP), the United Nations High Commissioner for Refugees (UNHCR), the Red Cross, research institutions, major international nongovernmental organizations, and representatives of ministries of health. It describes the recent developments and the emerging consensus taking place in this rapidly evolving area. As

a background for discussion, WHO commissioned five papers, which examined the current state of knowledge concerning the following:

- » Methods to detect cases of severely malnourished children in the community;
- » Efficacy and effectiveness of community-based treatment of severe malnutrition;
- » Key issues in the success of community-based management of severe malnutrition;
- » Local production and provision of RUTF for the treatment of severe malnutrition;
- » Sustainability of programs of community-based management of severe malnutrition.

The papers are published in this issue together with the meeting report. Field guidelines will be developed based on the general principles, conclusions, and recommendations derived from this meeting, which, if

implemented on a large scale, will prevent thousands of child deaths. Let us hope that these developments will contribute to putting the detection and treatment of severe malnutrition on the international agenda for child survival—and to successfully treating many more malnourished children than are reached today.

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A review of methods to detect cases of severely malnourished children in the community for their admission into community-based therapeutic care programs

Mark Myatt, Tanya Khara, and Steve Collins

Abstract

Background. *The complexity and cost of measuring weight-for-height make it unsuitable for use by community-based volunteers. This has led community therapeutic care programs to adopt a two-stage screening and admission procedure in which mid-upper-arm circumference (MUAC) is used for referral and weight-for-height is used for admission. Such a procedure results in many individuals being referred for care on the basis of MUAC but subsequently being refused treatment because they do not meet the weight-for-height admission criterion. This “problem of rejected referrals” has proved to be a major barrier to program uptake.*

Objective. *To systematically review methods to detect cases of severely malnourished children in the community for their admission into community-based therapeutic care programs.*

Methods. *Clinical and anthropometric methods for case detection of severely malnourished children in the community were reviewed with regard to their ability to reflect both mortality risk and nutritional status.*

Results. *MUAC, with the addition of the presence of bipedal edema, was found to be the indicator best suited to screening and case detection of malnutrition in the community. The case definition “MUAC < 110 mm OR the presence of bipedal edema,” with MUAC measured by a color-banded strap, is suitable for screening and case detection of malnutrition in the community for children aged between 6 and 59 months. Monitoring and discharge criteria were also reviewed.*

Conclusions. *There is no compelling evidence to support a move away from using weight in combination with clinical criteria for monitoring and discharge.*

Key words: Anthropometry, child mortality, community-based management, mid-upper-arm circumference, severe childhood malnutrition

Introduction

Case detection at the community level and the definition of appropriate referral and admission criteria are important factors in achieving adequate levels of coverage for the treatment of severe malnutrition. These considerations have not, until recently, received much attention, because the delivery of services to the severely malnourished has been dominated by intensive treatment delivered in high-dependency inpatient units at high cost to both the provider (e.g., staffing, infrastructure) and the patient and family (e.g., risk of nosocomial infection, loss of carer for siblings, and loss of labor to household). These high costs lead to a scarcity of provision and are barriers to accessing care that limit program coverage [1, 2].

A new model of delivering care has been proposed, called community-based therapeutic care (CTC), that is designed to address the limitations of inpatient care [3]. CTC programs use decentralized networks of outpatient treatment sites (usually located at existing primary health-care facilities), small inpatient units (usually located in existing local hospital facilities), and large numbers of community-based volunteers to provide case detection and some follow-up of patients in their home environments. Patients with severe malnutrition, with good appetite, and without medical complications are treated in an outpatient therapeutic program (OTP) that provides ready-to-use therapeutic food (RUTF) and medicines to treat simple medical conditions. The food and medicines are taken at home, and the patient attends an OTP site weekly or fortnightly for monitoring and resupply. Severely malnourished persons with medical complications and/or anorexia are treated in an inpatient stabilization center (SC) where they receive standard World Health Organization (WHO)-recommended initial care until they

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have enough appetite and are well enough to continue with outpatient care [4]. CTC programs have treated more than 9,000 severely malnourished children in Ethiopia, Malawi, and Sudan, meeting Sphere Project targets for clinical outcomes and achieving coverage of over 70% in most cases [5]. The CTC delivery model was conceived, developed, and implemented in complex emergency contexts. There are, however, no compelling technical reasons why the CTC model cannot be implemented in developmental settings. Experience of implementing CTC in transitional and developmental contexts is currently being acquired in Bangladesh, Ethiopia, Malawi, and Zambia.

The WHO manual on the treatment of severe malnutrition recommends that children who have a weight-for-height z-score below -3.00 or a weight below 70% of the median weight-for-height (W/H) according to the National Center for Health Statistics (NCHS) reference population median, or who have bipedal edema, be referred for inpatient treatment [4]. This case definition was devised for use in clinical settings by clinical staff and has proved problematic when used in CTC programs. The complexity and cost of the W/H indicator make it unsuitable for use by community-based volunteers. The use of a two-stage referral and admission system, in which referral is based on mid-upper arm circumference (MUAC) measured in the community by community-based volunteers, and admission is based on W/H measured at the treatment site by program staff, has proved to be a barrier to accessing care. The use of an adequately sensitive MUAC threshold (i.e., a MUAC threshold likely to identify all or almost all persons meeting the W/H-based admission criteria) results in many patients being referred for care who are then refused treatment because they do not meet the W/H-based admission criteria [6].

Operational research undertaken within CTC programs has found that as a result of this *problem of rejected referrals*, carers of referred children become unwilling to bring their children for admission into the program even when the child's condition deteriorates, carers of rejected children actively disparage the program, local leaders become disillusioned with the program, and the levels of staff and volunteer morale and performance fall [6–9]. In some programs the problem of rejected referrals was solved by moving toward a unified MUAC-based referral and admission criterion [9]. In other situations, where there was institutional resistance to the adoption of a unified MUAC-based referral and admission system, the problem of rejected referrals was solved by instituting a system of incentive payments for carers of referred children [10].

Referral of large numbers of children to treatment sites for second-stage screening by a two-stage system also tends to lead to crowding and long waits at treatment sites and the diversion of often scarce resources away from treatment and carer education toward

crowd-control and second-stage-screening activities. Long waits at treatment centers have a negative impact upon the community's perception of programs, and this has a negative impact upon program coverage [6, 11]. Crowding and waiting times could be considerably reduced by the use of a unified (i.e., single-stage) referral and admission system.

Operational research undertaken within CTC programs in developmental settings has found that health workers and carers tend to be confused by the difference between classifications based on weight-for-age (W/A), weight-for-height (W/H), and height-for-age (H/A) in situations in which growth-monitoring programs using W/A or community nutrition programs using H/A are operating. This confusion gives rise to a problem of inappropriate, and thus rejected, referrals, leading to problems with program acceptance and integration with existing health-care providers [12, 13].

It is now clear that the implementation of community-based treatment strategies for severe malnutrition in emergency and developmental contexts will require a reassessment of case-detection methods for severe malnutrition. This report presents a review of the options available for case detection of severely malnourished children in the community suitable for use in programs that follow the CTC model of care delivery.

Selecting an appropriate indicator

Conceptual and methodologic framework

The defining characteristics of an appropriate case-detection method depend upon the context in which case detection is taking place. A failure to account for context may lead to inappropriate case-detection methods being adopted and controversy regarding the appropriateness of adopted methods. Sackett and Holland [14] provide a general, and generally accepted, framework for assessing the appropriateness of case-detection methods in different contexts by scoring the relative importance of a set of properties that may be used to typify all case-detection methods:

- » Simplicity: the method can be easily administered by nonclinicians;
- » Acceptability: the method is acceptable to the subject and others;
- » Cost: the overall cost of the method;
- » Precision: the degree of reproducibility among independent measurements of the same true value (also known as *reliability*);
- » Accuracy: the proximity of a measurement to its true value;
- » Sensitivity: the proportion of diseased subjects who test positive;
- » Specificity: the proportion of healthy subjects who test negative;

» Predictive value: the probability that a person with a positive test has the disease or that a person with a negative test does not have the disease.

Sackett and Holland identify four distinct contexts in which case-detection methods are applied: epidemiologic surveys and surveillance, case detection in the community (screening), case-finding in clinical contexts, and diagnosis in clinical contexts.

Beaton and Bengoa [15] recommend that indicators suitable for screening and case detection of malnutrition in the community should, in addition to the properties identified by Sackett and Holland [14], allow for *completeness of coverage* and be both *objective* and *quantitative*. Coverage in this context refers to the coverage of case-detection activities rather than the coverage of the treatment program. This has both a spatial and a temporal component. Completeness of coverage implies that all persons at risk are routinely and repeatedly screened. Coverage of a case-detection method may therefore be seen as a product of simplicity, acceptability, and cost, as well as of factors relating to program organization, rather than as a separate property. In situations of relative resource scarcity, completeness of coverage can only be achieved by simple, acceptable, and low-cost case-detection methods.

Jelliffe and Jelliffe [16] recommend that indicators suitable for detecting cases of malnutrition in early childhood should, in addition to having the properties identified above, be reasonably independent of precise knowledge of the subject's age, since this is often difficult to ascertain accurately in the contexts in which programs treating severe malnutrition are required.

Table 1 reproduces the original analysis of Sackett and Holland [14], modified to include the properties identified by Beaton and Bengoa [15] and Jelliffe and Jelliffe [16].

An important *operational* consideration is who will apply the case-detection method. This report assumes that case-detection methods will be applied by minimally trained community-based volunteers with limited schooling and low levels of numeracy and literacy. For this reason, the relative importance of the simplicity of application has been increased from “moderate,” as suggested in the original analysis of Sackett and Holland [14], to “crucial” in **table 1**. The meaning of this property is also changed from the original “easily administered by nonclinicians” to “capable of being administered by minimally trained community-based volunteers with limited schooling and low levels of numeracy and literacy.”

The original Sackett and Holland [14] framework places more emphasis on sensitivity (deemed “crucial” in their original framework) than on specificity (deemed “moderate” in their original framework). This lack of emphasis on specificity may be better suited to situations in which *suspected cases* detected by screening and case detection in the community are then confirmed by more precise, accurate, and specific methods in a clinical context (i.e., using methods that meet the requirements that Sackett and Holland [14] specify for case-finding in clinical contexts). In such situations, screening and case-finding in the community refers to screening for referral into a second-stage screen that decides admission rather than screening for

TABLE 1. Relative importance of key properties of case-detection methods in different contexts^a

Property	Context			
	Epidemiologic survey/surveillance	Screening and case detection in the community	Case-finding in clinical contexts	Diagnosis in clinical contexts
Simplicity	++++	++++	–	–
Acceptability	++++	+++	+	–
Cost	++++	++	–	–
Objectivity	++++	++++	++++	++++
Quantitativeness	++++	++++	–	–
Independence of age	++++	++++	–	–
Precision (reliability)	+ (individual)	++	++++	++++
Accuracy	++++ (group)			
	+ (individual)	++	++++	++++
	++++ (group)			
Sensitivity	+	++	+++	+++
Specificity	+	++++	++++	++++
Predictive value	+	++	++++	++++

a. Scoring of importance: – irrelevant, + minor, ++ moderate, +++ major, ++++ crucial. The table reproduces the original analysis of Sackett and Holland [14], modified to include the properties identified by Beaton and Bengoa [15] and Jelliffe and Jelliffe [16].

admission. This report concentrates on case-detection methods that unify referral and admission and allow screening staff to refer children for admission rather than for further screening, because such a procedure avoids the problem of rejected referrals. In a unified referral and admissions system, case-detection methods should be specific as well as sensitive, and the relative importance of these properties will differ from those originally specified by Sackett and Holland [14]. With a case-detection method based around (for example) a threshold value of an anthropometric indicator of nutritional status, a large proportion of deaths in untreated individuals (50% or more) should occur in children below the case-defining threshold. Deaths in children below the case-defining threshold are likely to be related to nutritional status and to respond to dietary treatment. Case-detection methods should, therefore, be highly specific, and a good case-detection method will have reasonable levels of sensitivity at high levels of specificity. For this reason, the relative importance of sensitivity and specificity presented in **table 1** has been reversed from that presented in the original analysis of Sackett and Holland [14].

Habicht [17] reviews the relative importance of the properties of case-detection methods in the contexts of screening and surveillance of nutritional status. In this analysis, the relative costs of misdiagnosis, financial and other, are proposed as an additional property to be considered when selecting a case-detection method. Under situations of scarcity of capacity, this consideration favors the adoption of methods that are designed to match capacity to treat rather than the need to treat. Such methods will usually have high specificity but low sensitivity. A consequence of matching capacity to treat rather than need to treat is that the case-detection method will select only the most extreme cases. This results in a case-detection method that excludes the opportunities offered by early detection and consequent early treatment and resolution, which further exacerbates problems associated with scarcity. The analysis of Habicht [17] seems, therefore, best suited to delivery models that can be characterized by extreme scarcity of capacity relative to need and in which a false positive misdiagnosis may have negative consequences for the subject and the family as well as high financial cost to the provider. It may not be well suited to alternative models of delivery, such as the CTC model, designed to reduce many aspects of scarcity (e.g., bed scarcity) and the unintended negative consequences (e.g., nosocomial infection) associated with inpatient care. In addition, the ability of CTC programs to treat large numbers of severely malnourished children as outpatients relies, to a large extent, on early detection and consequent early (low-dependency) treatment and resolution. For these reasons, the analysis of case-detection methods presented in this report will treat false positive misdiagnosis costs as being of secondary

importance. It is important to note, however, that the requirement of moderate sensitivity at high specificity, as discussed above, will minimize the number of false positives.

Indicators of potential usefulness

Pelletier [18] identifies confusion between nutritional status and indicators of nutritional status as an additional source of controversy in selecting a case-detection method for malnutrition. The terms “nutritional status” and “anthropometric status” are, for example, often used interchangeably. Nutritional status refers to the internal state of an individual as it relates to the availability and utilization of nutrients at the cellular level. This state cannot be observed directly, so *observable indicators* are used instead. The range of indicators of nutritional status, none of which taken alone or in combination are capable of providing a full picture of an individual’s nutritional status, can be categorized as

- » Biochemical: laboratory assays that measure specific aspects of a subject’s metabolism, such as tests to determine serum albumin levels;
- » Clinical assessment: the presence of clinical signs suggestive of malnutrition, such as visible wasting and bipedal edema;
- » Anthropometric: measurements of the physical dimensions of a subject used alone, in combination, or corrected for age.

Case definitions may use items from any or all of these categories (e.g., a case definition may use a single anthropometric indicator or use a diagnostic algorithm that combines biochemical tests, clinical assessment, and anthropometry).

Biochemical indicators require laboratory facilities, costly equipment, and highly qualified staff to perform and interpret tests, as well as equipment, facilities, and protocols for collecting, storing, and transporting specimens and for reporting results. These requirements make biochemical indicators unsuitable candidates for field-based case-detection methods. Case-detection methods using biochemical indicators will not, therefore, be considered further in this report.

A number of anthropometric indicators have been used in case definitions of severe malnutrition. This report considers weight-for-age (W/A), height-for-age (H/A), weight-for-height (W/H), mid-upper-arm circumference (MUAC), mid-upper-arm circumference-for-age (MUAC/A), and mid-upper-arm circumference-for-height (MUAC/H). In all cases the indicator is measured or derived from measured components (e.g., weight and height for W/H) and the value of the indicator is compared with a threshold value. Individuals for whom the indicator falls below the threshold value are classified as malnourished.

Considerations of how well a case definition may be

said to represent an individual's nutritional status may not be the best criterion to judge the utility of a case definition in a programmatic context. Doing so may result in the selection of case definitions that are only weakly related to the aims of a program. The primary aim of most programs treating severe malnutrition is to prevent mortality. For such programs, therefore, the most useful case definition will be one that can identify individuals who are at high risk of dying if they remain untreated, but who would be likely to survive if treated in an appropriate nutritional support program. This realization has led a number of workers to argue that the utility of case definitions for malnutrition is defined more by their ability to reflect mortality risk than by their ability to reflect nutritional status [18–30].

This report will systematically review the relative utility of case definitions of severe malnutrition within the framework outlined in **table 1** and the preceding discussion.

Simplicity

Clinical assessment has proved successful with highly qualified clinical staff providing good reproducibility, validity (i.e., when compared with a range of biochemical indicators), and predictions of clinical course in surgical patients in a well-resourced setting [31]. Jelliffe and Jelliffe [16] caution that clinical assessment can only be performed by examiners who have been carefully and practically trained. Simoes et al. [32] reported good agreement between the clinical diagnosis of malnutrition made by trained nurses and by a reference pediatrician in primary-care settings in Ethiopia. Bern et al. [33] also reported good results with a single trained health worker in a district hospital in Kenya using visible severe wasting and/or bipedal edema as the case definition for severe malnutrition. This finding is, however, problematic, because anthropometric indicators (W/A and W/H) were used to validate the results, and the study subjects were weighed and measured and the anthropometric indicators were calculated at the time of the clinical assessment by the same health worker who performed the clinical assessment. Hamer et al. [34] reported poor results using the same case definition and validation criteria with trained registered and auxiliary nurses in a tertiary-level referral hospital in Gambia. In this study, the observers were initially blinded with regard to the anthropometric status of individual children.

Any indicator that includes an age component requires that age be ascertained accurately. Bairagi [35] reported that indicators that include an age component (i.e., H/A, W/A, and MUAC/A) are more sensitive to random errors in age than to random errors in anthropometry. Hamer et al. [34], working in a setting where accurate dates of birth were available, found that nurses had difficulty in accurately performing the

arithmetic required to calculate age from date of birth and date of examination, although it should be noted that this was not covered in their training. Velzeboer et al. [36] reported that minimally trained community health volunteers in rural Guatemala had difficulties in performing date arithmetic.

Multicomponent indicators (i.e., W/A, H/A, W/H, MUAC/A, and MUAC/H) usually require finding values by looking them up in multidimensional tables or by plotting the values of the individual components on a “growth chart” for location with regard to a reference curve. This requires familiarity with a number of mathematical concepts (digit recognition, number formation, magnitude estimation, number order, number comparison, and graphical presentation of number), even if the required operations are to be performed mechanically. Velzeboer et al. [36] tested the post-training ability of five minimally trained community health volunteers in rural Guatemala to calculate the W/H indicator. They reported that four of the five could not complete the test unsupervised because of problems with rounding decimal numbers (required for looking up values in tables) and that the one worker who completed the test unsupervised required over an hour to calculate 10 indicator values, of which 4 were incorrect. Hamer et al. [34] reported that registered and auxiliary nurses in a tertiary-level referral hospital in Gambia had difficulties in using growth charts immediately after training. It is unlikely, therefore, that these tasks could be performed by minimally trained community-based volunteers.

Sommer and Loewenstein [29] reported that MUAC/H, when measured with a device known as a QUAC stick, is a multicomponent indicator that does not require use of a table or reference to a growth chart. The QUAC (Quaker arm circumference) stick avoids the use of a table by having the MUAC thresholds defining malnutrition marked on a “height” stick. A child taller than the corresponding mark on the height stick for his or her measured MUAC is classified as malnourished. The impetus for the development of the QUAC stick was to improve the speed of measurement rather than to remove the need for supervision of staff during measurements. Davis [37] reported that under field conditions the method “was simple enough to be performed by unskilled Nigerians *under supervision*” (emphasis added). The utility, rapidity, and relative simplicity of the QUAC stick have also been reported by Loewenstein and Phillips [38] and Arnhold [39].

Alam et al. [19], in a comparison of W/A, H/A, W/H, MUAC, MUAC/A, and MUAC/H, reported that MUAC required only simple and inexpensive equipment and was faster and easier for minimally trained workers to perform in door-to-door screening than any of the other indicators tested. The fact that MUAC is a single linear measurement allows it to be used without the need for numbers, arithmetic, tables, or plotting of data

on growth charts. Shakir and Morley [40] suggest the use of a color-banded cord to measure MUAC, with colors corresponding to classifications of malnutrition. Shakir [41] reported that a color-banded plastic strip simplified MUAC measurements further and provided immediate classifications in field situations when performed by minimally trained paramedical personnel in Iraq. This ability to make immediate classifications in the field by using a readily understandable “traffic light” system intuitively related to thinness may have a potential for raising awareness among community members of the prevalence of malnutrition, which is an essential first step in the process of mobilizing community action to counter the problem.

Acceptability

Velzeboer et al. [36], in a comparison of W/H and MUAC in Guatemala, reported that younger children tended to become upset and agitated during both weight and height measurements and that no such behavior was observed during the measurement of MUAC. Their characterization of these children as “traumatized” may be a little strong, as any trauma resulting from this situation is unlikely to have lasting consequences. The unpleasantness associated with weight and height measurement may, however, reduce the acceptability of indicators that use weight and/or height measurements to children, their carers, and community-based volunteers and have a negative impact upon the coverage of case-detection activities, particularly if carers of sick children refuse to have their children weighed and measured. Any tendency of younger children to become agitated during weight and height measurements may also have a negative impact on the precision and accuracy of measurement. There are no reports of difficulties in measuring height with the use of the QUAC stick.

Cost

Clinical assessment requires highly trained and relatively highly paid personnel if it is to be performed to an acceptable standard [16, 31, 34]. The opportunity costs associated with diverting clinic staff from direct patient care to community-based case-detection activities is a factor that should also be considered with regard to using clinical assessment for case detection in the community. Measurement of height and weight requires costly and delicate equipment that must be calibrated and maintained [29, 36, 37, 42]. The required equipment may not be available even at the level of the referral hospital [43]. The costs of providing and maintaining equipment may be acceptable in highly centralized programs with dedicated case-detection teams but are likely to prove unacceptable in programs relying on decentralized networks consisting of large

numbers of community-based volunteers for case detection. Measurement of MUAC and MUAC/H by the QUAC stick can be performed with the use of low-cost and maintenance-free equipment [37, 40, 41]. To obtain weight and height measurements with precision and accuracy, it is generally considered that three persons are required: two to take the measurements and one to supervise, record the measurements, and calculate indicator values [44]. It may prove difficult to find a sufficient number of qualified community-based volunteers to undertake these measurements. The use of weight and/or height measurement will also have a considerable personnel, payroll, and logistics overhead if dedicated case-detection teams are employed.

Objectivity and quantitiveness

The subjective nature of clinical assessment may lead to acceptability problems, since carers may feel that nonclinical criteria (i.e., social, racial, or tribal discrimination) are being applied. Corruption is also an issue that must be considered with any subjective criterion. Clinical assessment is generally recognized as subjective, difficult to standardize, and difficult to express quantitatively [16, 34, 37]. Anthropometric indicators are both objective and quantitative, although there are problems of bias with indicators that include an age component when age cannot be ascertained accurately [34, 35].

Age independence

Age independence has two components. An indicator may be said to be independent of age if its value is not influenced by the age of the subject or if the predictive power (i.e., the power of predicting mortality) is independent of the age of the subject. One way of ensuring age independence is to adjust indicators to account for the age of the subject. This is done with H/A, W/A, and MUAC/A. The problem with this approach is that it is often difficult to ascertain age accurately [16, 34, 37], and indicators that include an age component are known to be more sensitive to random errors in age, which increase with increasing age, than to random errors in anthropometry [35]. In situations where the dates of birth or exact ages are unknown, this is likely to be a major problem. Because children grow fast, small errors in estimating age may lead to large errors in indicator values. In famine and in situations in which displacement and familial separation are common, fieldworkers are often required to estimate the age of children on the basis of little or no information. Estimates “by eye” are biased by assumptions about the relationship between height and age that are likely to be invalid in situations of nutritional stress. In these cases, indicator values will be subject to errors, probably systematic and upwards, that are products of random

errors in estimating age and systematic errors in estimating age that may be influenced by growth failure [45]. MUAC and MUAC/H are known to be relatively independent of age, with reference medians increasing only slightly (i.e., by approximately 17 mm) between the ages of 1 and 5 years [16, 19, 30, 37, 42, 46, 47], but they are age-dependent in children below 1 year of age [47]. The relationship between MUAC and age is shown in **figure 1**. The predictive power of MUAC (i.e., the power of predicting mortality) is, however, independent of age even in children below 1 year of age [22, 30, 48–50]. Berkley et al. [50] reported consistently high case-fatality rates in hospitalized Kenyan children of all ages between 12 and 59 months with low MUAC values, which they define as ≤ 115 mm; this result suggests that unadjusted (i.e., by age) MUAC may be useful in clinical settings. W/H is also independent of age between the ages of 1 and 5 years [42, 51], but the predictive power (i.e., the power of predicting mortality) of W/H may change with age [26].

Precision and accuracy

The accurate ascertainment of age is problematic in many developing countries [16, 34, 37], which casts doubt on the accuracy of indicators that include an age component [35, 45]. It is often asserted that, in terms of precision and accuracy of measurement, MUAC compares unfavorably with W/H (e.g., Waterlow [51]). Evidence supporting such assertions is, however, elusive. Younger children tend to become agitated during weight and height measurement under field conditions [36]. This may have a negative impact on the precision and accuracy of height and weight measurements. Anthropometric indicators that include a height component assume that height cannot be lost.

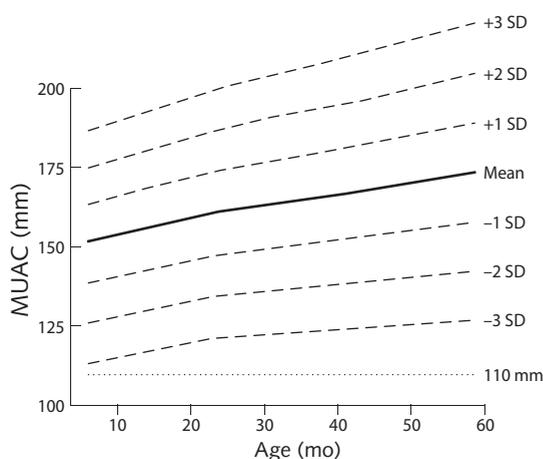


FIG. 1. Mid-upper-arm circumference-for-age (MUAC/A) growth reference curves for males and females aged between 6 and 59 months. MUAC/A growth reference curves presented in this figure are taken from de Onis et al. [47]

This assumption has not been tested in children, but it has been demonstrated to be invalid in adults in famine situations and in labor camps providing minimal “starvation” rations [45]. It should also be noted that weight may vary throughout the day, depending on factors such as hydration and the contents of the gastrointestinal tract, and that heavy parasitism with *Ascaris lumbricoides* may bias weight measurements upwards. Davis [37] reported that MUAC/H measured by a QUAC stick was both reproducible and accurate. This finding was confirmed by Sommer and Loewenstein [29]. Velzeboer et al. [36] tested the reliability (i.e., precision) of five minimally trained community health volunteers in rural Guatemala measuring W/H, H/A, W/A, MUAC, and MUAC/A. They reported that, under field conditions, intra-observer reliability was highest for W/A, followed by MUAC, MUAC/A, H/A, and W/H, and that inter-observer reliability was highest for W/A, followed by MUAC, MUAC/A, W/H, and H/A. Velzeboer et al. [36] also reported that under field conditions, minimally trained workers made fewer and smaller errors with MUAC than with W/A or W/H, even when they were not required to calculate indicator values by looking up values in tables or by plotting data on growth charts.

Feeney [9] reported that, with minimally trained community-based volunteers in a CTC program, the majority of errors were made in recording MUAC values (e.g., 104 mm recorded as 140 mm) rather than in deciding whether MUAC values fell above or below a threshold value. This study was undertaken in Ethiopia and required volunteers to work with a numbering system unfamiliar to them (using Roman rather than Amharic numerals). Recording errors did not have operational consequences, since referral for admission was determined by the subject’s position with regard to a threshold value. A companion study found that when the volunteers were asked to classify children according to whether or not their MUAC fell below a fixed threshold of 110 mm, they made very few errors [9]. Feeney [9] and Spector [52] both identified pressure from carers to pull the MUAC strap tighter in order to facilitate admission as a source of a systematic downward bias in MUAC measurements made by community-based volunteers observed in a CTC program in Ethiopia. Such errors act to increase sensitivity at the cost of specificity.

Sensitivity, specificity, and predictive value

Loewenstein and Phillips [38] and Sommer and Loewenstein [29] reported that MUAC/H was strongly predictive of death at 1, 3, and 18 months after measurement. Kielmann and McCord [27] reported that W/A was predictive of death at 6 and 12 months after measurement in Indian children. Chen et al. [24] examined the associations between anthropometric indica-

tors and subsequent mortality in Bangladeshi children. All indicators were negatively associated with mortality (i.e., the risk of death increased with decreasing values of the indicator). MUAC/A and W/A were the best predictors of death and W/H was the worst predictor. Trowbridge and Sommer [53], analyzing a subset of the data reported by Chen et al. [24], reported that MUAC alone performed better than MUAC/H and that MUAC adjusted for age (i.e., MUAC/A) was no more sensitive in relation to specificity than MUAC alone. Briend and Zimicki [22], using the same data as Sommer and Loewenstein [29] in a study to validate the use of MUAC as an indicator of risk of death within 1, 3, and 6 months of measurement in Bangladeshi children, reported that MUAC alone performed better in terms of both sensitivity and specificity than all other anthropometric indicators studied in the same and different populations. They confirm that correcting MUAC for age or height did little to improve sensitivity and specificity. This study demonstrates dramatic increases in sensitivity at high levels of specificity for shorter follow-up periods. In the context of case detection, short follow-up corresponds to frequent measurement, which is likely to be easier to achieve with simple, acceptable, and low-cost indicators measured by community-based volunteers than with less simple, less acceptable, and more expensive indicators measured by centralized screening teams [18]. Briend and Zimicki [22] examined the power of W/A, W/H, H/A, MUAC, and MUAC/A for predicting death in children hospitalized with diarrhea in a Dhaka hospital and reported that W/A, MUAC, and MUAC/A predicted death better than H/A and W/H. MUAC was the best univariate predictor of short-term mortality. This study also examined the possibility that combinations of indicators might have higher predictive power and found no combination of indicators that outperformed MUAC alone. Briend et al. [23] reported that MUAC, as an indicator of risk of death within 1 month of measurement in Bangladeshi children, was almost twice as sensitive as other anthropometric indicators at the same specificity and that only slight improvements in sensitivity could be achieved by using a diagnostic algorithm that used MUAC and selected clinical signs. Alam et al. [19], examining the use of MUAC, MUAC/A, MUAC/H, H/A, W/H, and H/A for predicting death 3 and 6 months after measurement in Bangladeshi children, reported that sensitivity at high levels of specificity was highest for MUAC and MUAC/A, intermediate for W/A, H/A, and MUAC/H, and lowest for W/H. Briend et al. [48] reported that MUAC without correction for age or height was superior in terms of sensitivity and specificity to W/A, H/A, and W/H in Senegalese children. Smedman et al. [28] reported that H/A, but not W/H, was a significant predictor of mortality in Bangladeshi children. Vella et al. [30] tested the predictive power of W/A, H/A, W/H, and MUAC in Ugandan children

and found that in relation to specificity, MUAC was the most sensitive predictor of mortality within 12 months of measurement, followed by W/A, H/A, and W/H. In multivariate predictive models, MUAC was found to increase the predictive power of other indicators, whereas other indicators did not improve the predictive power of MUAC. Berkley et al. [49] reported that MUAC and W/H had similar predictive power with regard to mortality in a large inpatient cohort of Kenyan children. In summary, the most consistently reported observation is that W/H is the least effective predictor of mortality and that, at high specificities, MUAC is superior to H/A and W/A.

Marasmus and kwashiorkor

A problem with relying on a single anthropometric indicator for malnutrition is that the predominant form of severe malnutrition is marasmus in some contexts and kwashiorkor in others [16]. This problem is usually addressed by using an anthropometric indicator to define marasmus and the presence or absence of bipedal edema to define kwashiorkor [51]. Kahigwa et al. [54] reported substantial agreement between two clinical officers in a Tanzanian hospital for identification of edema. Hamer et al. [34] reported that trained registered and auxiliary nurses in a tertiary-level referral hospital in Gambia performed poorly at identifying bipedal edema, and it was observed that the nurses spent insufficient time depressing tissues. Simoes et al. [32] reported good agreement between the clinical diagnosis of malnutrition made by trained nurses and by a reference pediatrician in primary-care settings in Ethiopia. This suggests that, as with all clinical assessment, careful and practical training of workers is required to achieve reasonable levels of sensitivity and specificity for detecting cases of kwashiorkor.

W/H-based indicators used alone (i.e., without examination for bipedal edema) are poor at detecting cases of kwashiorkor, because the weight of retained fluid tends to mask what would otherwise be low W/H values. Sandiford and Paulin [55] reported that MUAC used alone was more sensitive and more specific than either W/H and W/A used alone as a test for bipedal edema in Malawi. Berkley et al. [49] reported that MUAC used alone performed better than W/H used alone at identifying children with bipedal edema and skin and hair changes associated with kwashiorkor in Kenya. Currently available data suggest that the use of MUAC may, to some extent, compensate for the potentially poor performance of minimally trained community-based volunteers in identifying bipedal edema by clinical examination.

The use of anthropometry in young children

Anthropometric measurements are difficult to per-

form on young children. Children under 6 months of age weigh only a few kilograms. To obtain sufficiently accurate measurements of weight, children aged less than 6 months should be weighed on specialist pediatric scales that are graduated in units of 10 g rather than on conventional hanging scales that are graduated in units of 100 g. This requires the provision and maintenance of suitable scales. The length of children less than 6 months old can be measured with conventional height boards, but very small infants are difficult to handle and great care needs to be exercised when measuring them. For these reasons, admission of younger children to therapeutic feeding programs tends to be based on subjective criteria, such as visible severe wasting and assessments of risk factors. The use of MUAC in this context is also problematic, since, in contrast to older children, there are no data suggesting an association between MUAC and mortality that is independent of age in this age group. Moreover, internationally recognized reference curves remain unavailable for this age group [47].

The use of anthropometry in adolescents

The use of anthropometry in adolescents is subject to similar problems as in young children. Weight measurement in adolescents requires physician scales. Height measurement in adolescents requires height boards capable of measuring heights of 2 m or above. This requires the provision and maintenance of suitable scales and height boards. The interpretation of anthropometric measures in adolescents is complicated by changes in body shape, body composition, and musculature that occur during puberty. The use of MUAC without correction for age in this age group is also problematic due to changes in musculature

during puberty and because, in contrast to younger age groups, there are no data suggesting an association between MUAC and mortality that is independent of age in this age group. Adjusting MUAC for age is likely to be needed in this age group.

Summary

Table 2 summarizes the data presented above according to whether specific indicators exhibit the key properties outlined in the conceptual and methodologic framework. Within this framework, MUAC or MUAC/H measured with the QUAC stick plus the presence of bipedal edema are the indicators most suited to screening and case detection for malnutrition in the community. MUAC/H appears to offer no significant advantage over MUAC alone, which is the simpler and cheaper measure. There also remains some doubt as to whether the QUAC stick can be used by minimally trained community-based volunteers without supervision. It is important to note that W/H, which is the commonest indicator used for screening and case detection of malnutrition in the community, is, when reviewed within the conceptual and methodologic framework used in this report, one of the least useful indicators in this context.

The fact that MUAC is simple, objective, quantitative, precise, and accurate means that a referral by a community-based volunteer can be treated as an admission entitlement, with all referrals automatically admitted upon presentation of a valid referral slip. Referral slips can be numbered in such a way as to identify the source of referral and prevent fraud. Suitable books of slips are already available at low cost and are sold as “cloakroom

TABLE 2. Capability of common indicators with regard to key properties of case-detection methods for screening and case detection of malnutrition in the community

Property	Indicator						
	Clinical	W/A	H/A	W/H	MUAC	MUAC/A	MUAC/H
Simplicity	No	No	No	No	Yes	No	Yes (by QUAC stick only)
Acceptability	No	No	No	No	Yes	Yes	Yes (by QUAC stick only)
Cost	No	No	No	No	Yes	Yes	Yes (by QUAC stick only)
Objectivity	No	No	No	Yes	Yes	No	Yes
Quantitativeness	No	Yes	Yes	Yes	Yes	Yes	Yes
Independence of age	Yes	No	No	No	Yes	No	Yes
Precision (reliability)	No	Yes	No	No	Yes	Yes	Yes (by QUAC stick only)
Accuracy	No	No	No	No	Yes	No	Yes
Sensitivity	NA	Yes	No	No	Yes	Yes	Yes
Specificity	NA	Yes	No	No	Yes	Yes	Yes
Predictive value	NA	Yes	No	No	Yes	Yes	Yes

W/A, weight-for-age; H/A, height-for-age; W/H, weight-for-height; MUAC, mid-upper-arm circumference; MUAC/A, mid-upper-arm circumference-for-age; MUAC/H, mid-upper-arm circumference-for-height; QUAC, Quaker arm circumference

tickets” or “raffle tickets (see **fig. 2**). Remeasurement of MUAC at admission will allow such a referral and admission system to be monitored in order to identify problems with particular volunteers. Since each referral and admission has a unique number that can identify the source of referral, and case finders have a defined catchment area, it would be relatively easy to monitor did-not-attend (DNA) rates through a routine admissions-monitoring system.

Selecting an appropriate indicator threshold

Using an anthropometric indicator such as MUAC in case definitions of malnutrition requires that the indicator be measured and the value of the indicator compared with a threshold value. Individuals for whom the indicator falls below the threshold value are classified as malnourished. With banded MUAC straps such as those proposed by Shakir and Morley [40] and Shakir [41], the threshold can be color-coded on the strap, providing a simple-to-use, instantaneous, and unambiguous indicator as to whether a child falls above or below the case-defining threshold.

The factors that influence the choice of threshold value are the sensitivities, specificities, and predictive values for mortality associated with threshold values. **Figure 3** shows the relationship between MUAC and mortality, expressed in deaths per 1,000 child-years, as reported in separate studies by Briend and Zimicki [22], Briend et al. [23], Alam et al. [19], Pelletier et al. [56], and Vella et al. [30]. Mortality increases exponentially with declining MUAC, with small increases in mortality at intermediate MUAC values (i.e., between 110 and 130 mm) and large increases in mortality at

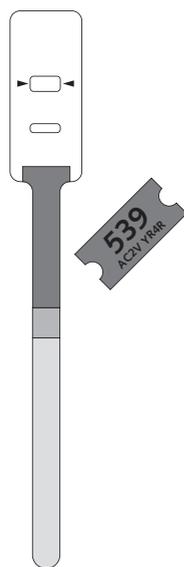


FIG. 2. Banded mid-upper-arm circumference (MUAC) strap and cloakroom/raffle ticket referral slip

MUAC values below 110 mm. There is little between-study variation in the observed relationships, despite the fact that these studies were undertaken by different teams in different locations at different times, with varying lengths of follow-up and inconsistent censoring of accidental deaths. The available data on the relationship between MUAC and mortality suggest that there is little justification in setting the case-defining threshold below about 110 mm. As shown in **figure 1**, this threshold is equal to or more extreme than 3 z-scores below the mean of the sex-combined MUAC/A reference distribution for children aged 7 months or older and equal to or more extreme than 4 z-scores below the mean of the sex-combined MUAC/A reference distribution for children aged 39 months or older [47].

A proposed case definition

Currently available data suggest that the case definition

MUAC < 110 mm OR the presence of bipedal edema,

with MUAC measured with the use of color-banded straps, is suitable for use by minimally trained community-based volunteers with limited schooling and low levels of numeracy and literacy.

It should be noted that this proposed case definition applies only to children aged between 6 months

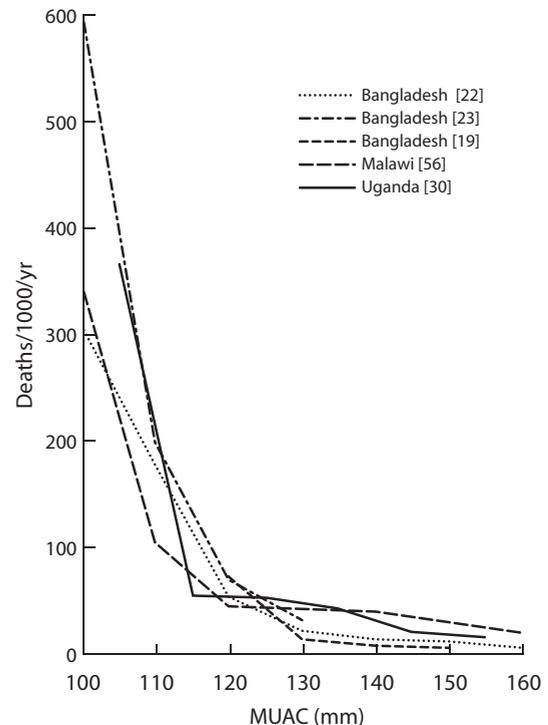


FIG. 3. Observed relationship between mid-upper-arm circumference (MUAC) and child mortality in five studies: Briend and Zimicki [22], Briend et al. [23], Alam et al. [19], Pelletier et al. [56], and Vella et al. [30]

and 5 years. Height may be used as a proxy for age. In this case, the proposed case definition applies only to children between 65 and 110 cm in height, with eligibility ascertained by a simple marked stick. These height thresholds are conventional and may not be appropriate in settings where infantile stunting is common. In such settings, local H/A data could be used to decide suitable height thresholds.

Triage, response, and appropriate resource utilization

The primary aim of most programs treating severe malnutrition is to prevent mortality. For such programs, therefore, the most useful case definition will be one that can identify individuals who are at high risk of dying if they remain untreated but would be likely to survive if treated in an appropriate nutritional support program. Currently available data indicate that MUAC is one of the best predictors of mortality, but children selected for treatment because they have extremely low values of MUAC may die even when treated. Admitting such children would then be an inappropriate use of resources. The use of a MUAC case definition should, therefore, be examined with regard to clinical triage. The triage categories and outcomes for programs treating malnutrition are shown in **table 3**.

The intensity of intervention that is required for children with extremely low values of MUAC is also of interest. If children with extremely low values of MUAC do well when treated with low-intensity interventions, such as being admitted to a supplementary feeding program (SFP), then treating them with a comparatively high-intensity intervention, such as therapeutic feeding in an OTP, would be an inappropriate use of resources. This question is of particular interest in smaller children, usually defined as those under 12 months of age or of height ≤ 75 cm (i.e., the approximate H/A reference median for 12-month-old children), where the use of case definitions based on unadjusted (i.e., for age or height) MUAC values is the cause of some controversy.

The two questions of interest for CTC implementation are the following:

- » Do smaller children with extremely low values of MUAC do well in OTP?
- » Do smaller children with extremely low values of

TABLE 3. Triage categories for programs treating malnutrition

Triage category	Response to intervention	Triage outcome
Not malnourished	Intervention not indicated	Do not admit
Malnourished (treatable)	Will benefit from intervention	Admit
Malnourished (untreatable)	Will not benefit from intervention	Do not admit

MUAC do well in SFP?

A natural experiment in a CTC program in Northern Ethiopia in 2003 provides answers to these questions for smaller children without bipedal edema and with a W/H greater than 70% of the median of the reference population. When this program started in February 2003, children with the case definition MUAC < 110 mm AND (age > 12 months OR height > 75 cm) AND W/H $> 70\%$ were admitted to the OTP. In March 2003, the case definition was changed, on the strong advice of an acknowledged international expert on malnutrition, to MUAC < 110 mm AND height > 75 cm AND W/H $> 70\%$. The effect of this change was to exclude, among children with MUAC below 110 mm, the smaller ones (i.e., those whose height was ≤ 75 cm) from admission to the OTP. This change in case definitions created a natural experiment with two comparable groups of children with MUAC below 110 mm, with height ≤ 75 cm, with W/H greater than 70% of the reference median, and without bipedal edema being admitted initially to OTP and then to SFP. This was noted during a program review in November 2003 and allowed a comparison of the responses of smaller children with extremely low values of MUAC admitted to OTP and SFP. Summary data from the natural experiment are presented in **table 4**.

There is some doubt regarding the accuracy of age reporting in the OTP arm of the natural experiment. Examination of the individual records together with the similarity in the distributions of heights between the two groups suggests preferential reporting of age as 13 months in the OTP arm. This may have been due to deliberate misreporting of age by carers or deliberate misrecording of age by program staff in order to facilitate admission of younger children into the more

TABLE 4. Summary of data arising from a natural experiment allowing comparison of response to treatment of children with MUAC < 110 mm, height ≤ 75 cm, W/H $> 70\%$ of the reference median, and without edema in OTP and SFP

Variable	Experimental arm	
	OTP	SFP
No. of subjects	42	56
No. of survivors	40	46
No. of deaths	0	8
No. lost to follow-up or defaulted	2	2
Age range (median)	12–36 mo (16 mo)	6–36 mo (14 mo)
Height range (median)	62–72 cm (66 cm)	54–75 cm (67 cm)
MUAC range (median)	82–109 mm (104 mm)	85–109 cm (102 mm)
Sex ratio	54% male	57% male

MUAC, mid-upper-arm circumference; W/H, weight-for-height; OTP, outpatient treatment program; SFP, supplementary feeding program

intensive OTP program. It is likely, therefore, that the distributions of ages are similar in both arms of the natural experiment.

Table 5 shows a crude analysis of the survival data in the two arms of the natural experiment. The effect observed in this crude analysis remains statistically significant after adjustment for age at admission split into less than 13 months of age and 13 months of age or older (Mantel-Haenszel $\chi^2 = 3.86$, $df = 1$, $p = .0494$). This analysis is compromised by probable inaccurate reporting and/or recording of age. The effect observed in the crude analysis remains statistically significant after adjustment for height (as a proxy for age) at admission split into above or below the overall median height at admission of 66.15 cm (Mantel-Haenszel $\chi^2 = 4.89$, $df = 1$, $p = .0269$).

Figure 4 shows the results of an analysis of weight gains in grams per kilogram per day observed in the two arms of the natural experiment. Smaller children with MUAC less than 110 mm responded well (in terms of both survival and weight gain) to the high-intensity intervention (OTP) but did not respond well to the low-intensity intervention (SFP). Treating such children with a high-intensity intervention such as therapeutic feeding in an OTP is likely, therefore, to be an appropriate use of resources. The findings of this natural experiment suggest that smaller children (i.e., those aged below 12 months or whose height is ≤ 75 cm) with MUAC < 110 mm should be admitted to programs treating severe malnutrition.

It should be noted that the two arms of the natural experiment were sequential rather than concurrent. It is possible, therefore, that the observed differences were due, in some part, to seasonal factors such as changes in the incidence of malaria. The protocol for the OTP included weekly examination by a clinical officer as well as systematic treatment with antibiotics and malaria prophylaxis at the start of the treatment episode. None of these services were provided by the

TABLE 5. Crude analysis of survival data from a natural experiment allowing comparison of response to treatment of children with MUAC < 110 mm, height ≤ 75 cm, W/H $> 70\%$ of the reference median, and without edema in OTP and SFP

Exposure	Outcome		
	Died	Survived	Total
SFP	8	46	54
OTP	0	40	40
Total	8	86	94

MUAC, mid-upper-arm circumference; W/H, weight-for-height; OTP, outpatient treatment program; SFP, supplementary feeding program

Fisher-Irwin exact test: $p = .0094$ (one-sided); $p = .0191$ (two-sided)
 Risk difference = 14.81%; 95% confidence interval, 3.15% to 26.47%
 z-test: $z = 2.17$
 $p = .0149$ (one-sided); $p = .0299$ (two-sided)

SFP. If children during the later (SFP) arm of the study had been admitted to OTP, they would, therefore, have been considerably more likely to receive timely and appropriate treatment and prophylaxis. The OTP arm ran during the period of high malaria incidence following the short (*Belg*) rains. The SFP arm ran for 7 months, with 2 months during the period of high malaria incidence at the end of and following the long (*Meher*) rains. It is likely, therefore, that the differences observed in the natural experiment were due, in large part, to differences in program intensity rather than to seasonal factors.

Implications of changing to MUAC-based case-selection methods

The most commonly used case definition for therapeutic feeding programs is W/H $< 70\%$ of reference median OR the presence of bipedal edema. Changing this to MUAC < 110 mm OR the presence of bipedal edema may have significant implications for program size, particularly in contexts where marasmus is the predominant form of severe malnutrition. Anecdotal evidence from Ethiopian CTC programs suggests that use of the MUAC-based case definition is likely to result in larger programs than use of the W/H-based case

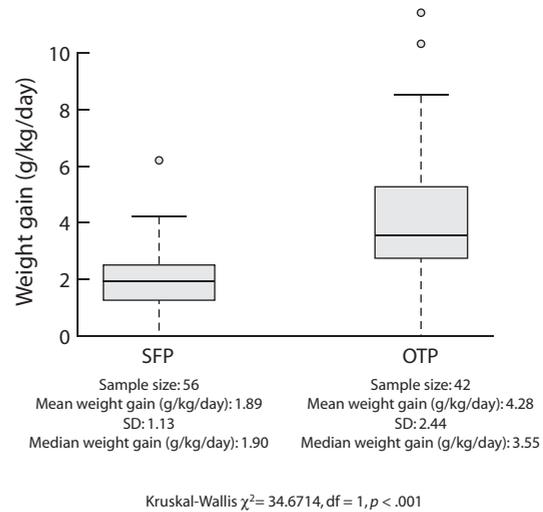


FIG. 4. Observed weight gains (g/kg/day) from a natural experiment allowing comparison of response to treatment of children with mid-upper-arm circumference (MUAC) < 110 mm, height ≤ 75 cm, W/H $> 70\%$ of the reference median, and without edema in outpatient treatment programs (OTP) and supplementary feeding programs (SFP).

W/H weight-for-height; MUAC, mid-upper-arm circumference; OTP, outpatient therapeutic program; SFP, supplementary feeding program

The central horizontal line in the boxes represents the median; the ends of the central boxes represent the upper and lower quartiles; the “whiskers” extend to 1.5 times the interquartile range; and the plotted points represent outliers.

definition. This was tested by a simple computer-based simulation. More than 200 datasets from nutritional anthropometry surveys that collected data on sex, weight, height, MUAC, and edema were obtained from international nongovernmental organizations. These datasets were restructured to ensure compatible coding between them and combined into a single large dataset representing more than 210,000 children between 65 and 110 cm in height. The prevalence of malnutrition in the combined dataset according to standard W/H-based case definitions is summarized in **table 6**.

The following case definitions were applied to all children in the combined dataset:

The W/H-based case definition was (MUAC < 125 mm AND W/H < 70% of the reference median) OR edema. The MUAC-based case definition was MUAC < 110 mm OR edema. The W/H-based case definition includes a MUAC measurement in order to simulate a two-stage screening procedure with a reasonably sensitive MUAC screen as the first screening stage. **Figure 5** shows in graphical form the result of applying these case definitions to the combined dataset. The MUAC-based case definition resulted in a larger program than the W/H-based case definition:

- » Number of malnourished children identified by the MUAC-based case definition: 5,484;
- » Number of malnourished children identified by the W/H-based case definition: 3,678.

The overall need in the combined dataset was estimated as the number of children identified as severely malnourished by either case definition [57]. The MUAC-based and W/H-based case definitions selected many of the same children. When the MUAC-based case definition is used, the number of excluded low-W/H children is small relative to estimated overall need:

- » Estimated overall need (i.e., number of children identified as malnourished by either the MUAC-based or the W/H-based case definition): 5,867;
- » Number of malnourished children excluded by the MUAC-based case definition: 383 (6.53%).

When the W/H-based case definition is used, however, the number of excluded low-MUAC children is large relative to the estimated overall need:

- » Estimated overall need (i.e., number of children identified as malnourished by either the MUAC-based or the W/H-based case definition): 5,867;
- » Number of malnourished children excluded by the W/H-based case definition: 2,189 (37.31%).

Figure 6 shows the age profiles of the children excluded by the two case definitions. The age profile of the excluded low-W/H children differs from the age profile of the excluded low-MUAC children. The children excluded by the W/H-based case definition tend to be younger and, hence, at higher risk of mortality than those excluded by the MUAC-based case definition.

These results assume programs with 100% coverage of case-finding activities and 100% uptake of services. Such assumptions are unrealistic, since no case-finding method is likely to achieve 100% coverage of case-finding activities, and no program is likely to achieve 100% uptake. Case-finding activities using a MUAC-based case definition are likely to have a higher coverage (as a result of simplicity, acceptability, low cost, and effective use of community-based volunteers and program staff) than case-finding activities using a W/H-based case definition. Programs using a MUAC-based case definition are likely to have a higher uptake (as a result of minimizing the problems of rejected referrals, crowding, and long waiting times) than programs using a W/H-based case definition. The results presented in **figure 5** are, therefore, subject to considerable bias. The relative difference in the sizes of the two programs is likely to be larger, the proportion of children excluded by the W/H-based case definition is likely to be larger, and the proportion of children excluded by the MUAC-based case definition is likely to be smaller than the figures presented in **figure 5** suggest.

Adopting a MUAC-based case-detection method will require changes to the way epidemiologic and needs-

TABLE 6. Prevalence of malnutrition in the combined dataset according to case definitions based on W/H z-score and the presence or absence of bipedal edema

Malnutrition category	Case definition	Prevalence
Global	W/H z-score < -2.00 and/or bipedal edema	11.70%
Moderate	W/H z-score < -2.00 without bipedal edema	9.10%
Severe (marasmus)	W/H z-score < -3.00 without bipedal edema	1.30%
Severe (kwashiorkor)	Bipedal edema	1.30%

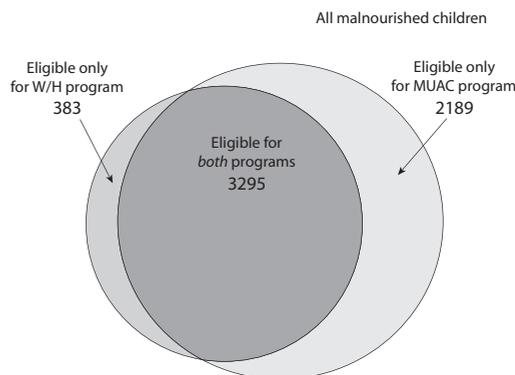


FIG. 5. Number of children selected from the combined dataset using two different case definitions. Weight-for-height (W/H) program: (MUAC < 125 mm AND W/H < 70% of the reference median) OR edema. Mid-upper-arm circumference (MUAC) program: MUAC < 110 mm OR edema. Overall need (labeled as “All malnourished children”) is the number of children identified by either case definition.

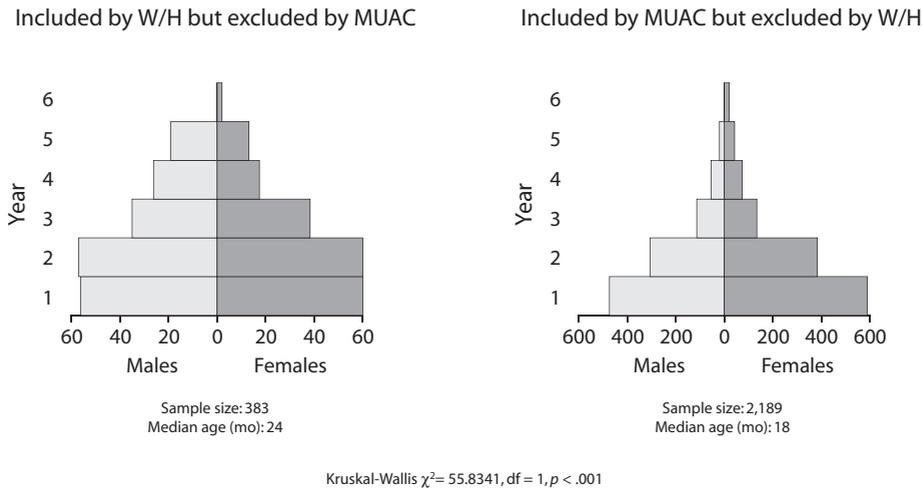


FIG. 6. Age profiles of children excluded by two different case definitions. W/H, weight-for-height; MUAC, mid-upper-arm circumference

assessment surveys are carried out. At present, these surveys estimate prevalence and need using slightly different variants of the W/H indicator. As need becomes defined by MUAC rather than by W/H, these surveys will need to collect MUAC in addition to weight and height for the purpose of needs estimation.

Monitoring and discharge criteria

Data from the natural experiment in an Ethiopian CTC program demonstrate that MUAC does respond to treatment (figure 7), but there are no good reasons to assume that an indicator that is suited to case detection will also be well suited to monitoring the progress of patients in a program or for deciding whether or not a patient may be discharged from a program [17]. At present there are no compelling data to suggest a move away from a weight-based indicator toward a MUAC-based indicator for monitoring and discharge. It should be noted, however, that height boards are often unavailable in primary health-care centers in developing countries. This means that using W/H for monitoring and discharge is problematic. Retaining W/H for monitoring and discharge also raises the problem that some children will be admitted on the basis of MUAC who are already above the W/H discharge criterion. Current practice in CTC programs for such cases is to monitor weight and to

- » Discharge a patient as *cured* after a minimum of 2 months in OTP if MUAC > 110 mm, edema has been absent for a minimum of 2 weeks, sustained weight gain has occurred, and the patient is “clinically good”;
- » Discharge a patient as a *nonresponder* after a minimum of 4 months in OTP if weight is stable and all available treatment options (e.g., home visits, inpatient stabilization, hospitalization, antiretroviral

treatment (ART) programs, and tuberculosis treatment programs) have been pursued.

These monitoring and discharge criteria may be applied to all cases. The advantage of this approach is that it requires that only weight be monitored, and suitable scales are usually available in primary health-care centers in developing countries that have growth-monitoring programs. Monitoring weight alone does

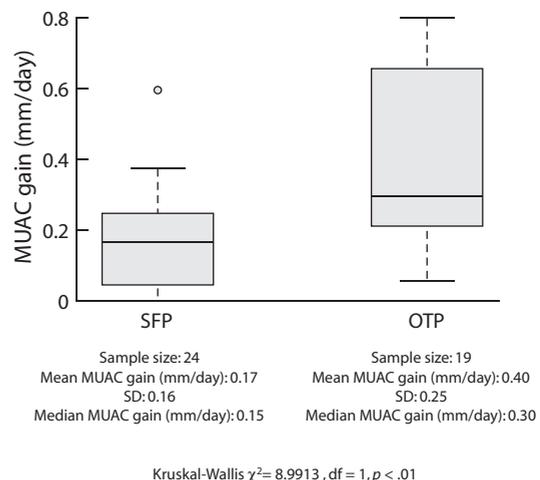


FIG. 7. Observed mid-upper-arm circumference (MUAC) gains (mm/day) from a natural experiment allowing comparison of response to treatment of children with MUAC < 110 mm, height ≤ 75 cm, weight-for-height (W/H) > 70% of the reference median, and without edema in outpatient treatment programs (OTP) and supplementary feeding programs (SFP).

The central horizontal line in the boxes represents the median; the ends of the central boxes represent the upper and lower quartiles; the “whiskers” extend to 1.5 times the interquartile range; and the plotted points represent outliers.

not differ greatly from monitoring W/H, because height changes little during recovery, and changes in W/H are due mainly to changes in weight rather than height; and because when W/H is monitored, a single height measurement, usually taken at admission, is often used throughout the treatment episode.

An alternative approach that also requires that only weight be monitored would be to use percentage weight gain:

$$\frac{\text{Current weight} - \text{Weight at admission}}{\text{Weight at admission} \times 100}$$

as a discharge criterion. With this approach, patients would be discharged once their percentage weight gain exceeded a cutoff value based on their weight at admission (or weight at loss of edema for patients presenting with marasmic kwashiorkor). Preliminary analysis of data from CTC programs in Malawi and

Ethiopia suggests that a cutoff of 15% would result in approximately 50% of discharges meeting or exceeding 80% of the W/H reference median, and that a cutoff of 18% would result in approximately 50% of discharges meeting or exceeding 85% of the W/H reference median. Percentage weight gain could be combined with a MUAC cutoff. For example:

Discharge as cured if MUAC ≥ 115 mm AND percentage weight gain ≥ 15%

The calculation of percentage weight gain could be simplified by the use of a lookup table. For example, **table 7** shows discharge weights for admission weights based on a 15% weight gain.

There are aspects of CTC programs (e.g., the concentration on maximizing program coverage and community-based delivery of services) that are more typical of “public health” or “mass treatment” inter-

TABLE 7. Example of a look-up table for calculating percentage change (15% in this table) in weight (kg)

Weight at													
Admission	Discharge												
4.0	4.6	7.0	8.1	10.0	11.5	13.0	15.0	16.0	18.4	19.0	21.9	22.0	25.3
4.1	4.7	7.1	8.2	10.1	11.6	13.1	15.1	16.1	18.5	19.1	22.0	22.1	25.4
4.2	4.8	7.2	8.3	10.2	11.7	13.2	15.2	16.2	18.6	19.2	22.1	22.2	25.5
4.3	4.9	7.3	8.4	10.3	11.8	13.3	15.3	16.3	18.7	19.3	22.2	22.3	25.6
4.4	5.1	7.4	8.5	10.4	12.0	13.4	15.4	16.4	18.9	19.4	22.3	22.4	25.8
4.5	5.2	7.5	8.6	10.5	12.1	13.5	15.5	16.5	19.0	19.5	22.4	22.5	25.9
4.6	5.3	7.6	8.7	10.6	12.2	13.6	15.6	16.6	19.1	19.6	22.5	22.6	26.0
4.7	5.4	7.7	8.9	10.7	12.3	13.7	15.8	16.7	19.2	19.7	22.7	22.7	26.1
4.8	5.5	7.8	9.0	10.8	12.4	13.8	15.9	16.8	19.3	19.8	22.8	22.8	26.2
4.9	5.6	7.9	9.1	10.9	12.5	13.9	16.0	16.9	19.4	19.9	22.9	22.9	26.3
5.0	5.8	8.0	9.2	11.0	12.7	14.0	16.1	17.0	19.6	20.0	23.0	23.0	26.5
5.1	5.9	8.1	9.3	11.1	12.8	14.1	16.2	17.1	19.7	20.1	23.1	23.1	26.6
5.2	6.0	8.2	9.4	11.2	12.9	14.2	16.3	17.2	19.8	20.2	23.2	23.2	26.7
5.3	6.1	8.3	9.5	11.3	13.0	14.3	16.4	17.3	19.9	20.3	23.3	23.3	26.8
5.4	6.2	8.4	9.7	11.4	13.1	14.4	16.6	17.4	20.0	20.4	23.5	23.4	26.9
5.5	6.3	8.5	9.8	11.5	13.2	14.5	16.7	17.5	20.1	20.5	23.6	23.5	27.0
5.6	6.4	8.6	9.9	11.6	13.3	14.6	16.8	17.6	20.2	20.6	23.7	23.6	27.1
5.7	6.6	8.7	10.0	11.7	13.5	14.7	16.9	17.7	20.4	20.7	23.8	23.7	27.3
5.8	6.7	8.8	10.1	11.8	13.6	14.8	17.0	17.8	20.5	20.8	23.9	23.8	27.4
5.9	6.8	8.9	10.2	11.9	13.7	14.9	17.1	17.9	20.6	20.9	24.0	23.9	27.5
6.0	6.9	9.0	10.4	12.0	13.8	15.0	17.3	18.0	20.7	21.0	24.2	24.0	27.6
6.1	7.0	9.1	10.5	12.1	13.9	15.1	17.4	18.1	20.8	21.1	24.3	24.1	27.7
6.2	7.1	9.2	10.6	12.2	14.0	15.2	17.5	18.2	20.9	21.2	24.4	24.2	27.8
6.3	7.2	9.3	10.7	12.3	14.1	15.3	17.6	18.3	21.0	21.3	24.5	24.3	27.9
6.4	7.4	9.4	10.8	12.4	14.3	15.4	17.7	18.4	21.2	21.4	24.6	24.4	28.1
6.5	7.5	9.5	10.9	12.5	14.4	15.5	17.8	18.5	21.3	21.5	24.7	24.5	28.2
6.6	7.6	9.6	11.0	12.6	14.5	15.6	17.9	18.6	21.4	21.6	24.8	24.6	28.3
6.7	7.7	9.7	11.2	12.7	14.6	15.7	18.1	18.7	21.5	21.7	25.0	24.7	28.4
6.8	7.8	9.8	11.3	12.8	14.7	15.8	18.2	18.8	21.6	21.8	25.1	24.8	28.5
6.9	7.9	9.9	11.4	12.9	14.8	15.9	18.3	18.9	21.7	21.9	25.2	24.9	28.6

ventions than traditional center-based models of service delivery. In such interventions, adherence to stringent technical standards, service delivery, and the achievement of high coverage takes precedence over individual responses to the delivered intervention. From this perspective, it may be reasonable to adopt a fixed length of treatment episode for CTC programs. This approach does not differ much from current practice in programs using W/H or edema for admission. In such programs, patients admitted with edema but with a W/H percentage of median above 80% are, typically, retained in the program for a fixed period after loss of edema. Preliminary analysis of data from CTC programs in Malawi and Ethiopia suggests that an episode length of 60 days would result in approximately 50% of discharged patients achieving a weight gain of at least 15% at discharge.

As data from CTC programs become available, it will be possible to refine discharge criteria.

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Conclusions

Within the framework of analysis adopted for this report, subjective clinical assessment (i.e., visible severe wasting) performs worse than any anthropometry-based method. W/H-based case-detection methods perform worse (i.e., in terms of age independence, precision, accuracy, sensitivity, and specificity) than any alternative anthropometry-based method and are neither simple, cheap, nor acceptable. Currently available evidence indicates that MUAC is the best (i.e., in terms of age independence, precision, accuracy, sensitivity, and specificity) case-detection method for severe malnutrition and that it is also simple, cheap, and acceptable. It is recommended, therefore, that programs treating severe malnutrition move toward MUAC-based case-detection, referral, and admission criteria. There is no compelling evidence supporting a move away from using weight in combination with clinical criteria (e.g., loss of edema) for monitoring and discharge.

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Efficacy and effectiveness of community-based treatment of severe malnutrition

Ann Ashworth

Abstract

Background. There is a long tradition of community-based rehabilitation for treatment of severe malnutrition: the question is whether it is effective and whether it should be advised for routine health systems.

Objective. To examine the effectiveness of rehabilitating severely malnourished children in the community in nonemergency situations.

Methods. A literature search was conducted of community-based rehabilitation programs delivered by day-care nutrition centers, residential nutrition centers, primary health clinics, and domiciliary care with or without provision of food, for the period 1980–2005. Effectiveness was defined as mortality of less than 5% and an average weight gain of at least 5 g/kg/day.

Results. Thirty-three studies of community-based rehabilitation were examined and summarized. Eleven (33%) programs were considered effective. Of the subsample of programs reported since 1995, 8 of 13 (62%) were effective. None of the programs operating within routine health systems without external assistance was effective.

Conclusions. With careful planning and resources, all four delivery systems can be effective. It is unlikely that a single delivery system would suit all situations worldwide. The choice of a system depends on local factors. High energy intakes (> 150 kcal/kg/day), high protein intakes (4–6 g/kg/day), and provision of micronutrients are essential for success.

When done well, rehabilitation at home with family foods is more cost-effective than inpatient care, but the cost effectiveness of ready-to-use therapeutic foods

(RUTF) versus family foods has not been studied. Where children have access to a functioning primary health-care system and can be monitored, the rehabilitation phase of treatment of severe malnutrition should take place in the community rather than in the hospital but only if caregivers can make energy- and protein-dense food mixtures or are given RUTF. For routine health services, the cost of RUTF, logistics of procurement and distribution, and sustainability need to be carefully considered.

Key words: Community-based management, cost-effectiveness, domiciliary care, effectiveness of treatment, nutrition centers, rehabilitation, severe malnutrition

Introduction

Background

Severe malnutrition in children is commonly found in conjunction with gastroenteritis, pneumonia, and other infections. To preserve essential processes, severely malnourished children undergo physiologic and metabolic changes, which include reductions in the functional capacity of organs and slowing of cellular activities. Coexisting infections add to the difficulty of maintaining metabolic control. These profound changes put severely malnourished children at particular risk of death from hypoglycemia, hypothermia, electrolyte imbalance, heart failure, and untreated infection; the World Health Organization (WHO) guidelines for the management of severe malnutrition pay particular attention to preventing deaths from these causes [1, 2]. The initial stabilization phase focuses on restoring homeostasis and treating medical complications and usually takes 2 to 7 days of inpatient treatment. The rehabilitation phase focuses on rebuilding wasted tissues and may take several weeks.

Because of the relatively long duration of rehabilitation, families may request that their children

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be discharged early from hospital. Reasons include concern for the care of other family members and loss of earnings. Requests for early discharge may also come from hospital managers in response to bed shortages or budgetary constraints. Early discharge reduces the risk of hospital-acquired infections to which severely malnourished children are prone. Although early discharge may have benefits for the child and family, there is a high risk of death unless provision is made for continuity of care and supervision [3, 4]. The dangers associated with sending children home before they have recovered are that

- » They remain malnourished because their home diet is inadequate for catch-up growth;
- » Their immune function remains impaired and they are prone to repeated infections;
- » Continuing malnutrition and repeated infections lead to relapse and death.

Any strategy for community-based treatment must therefore include

- » A diet that will support catch-up growth and improve immune function;
- » Timely access to health care when infections arise;
- » Continuing care to assess progress, provide support, and take action when needed.

The main question to be addressed in this document is whether community-based treatment of severe malnutrition in nonemergency situations is effective. Other aspects addressed include the coverage and cost of community-based rehabilitation and a review of existing programs run by routine health services. Advice on the role of community-based management of severe malnutrition within routine health systems is provided, together with research needs. In humanitarian emergency settings, community-based management of severe malnutrition with ready-to-use therapeutic food (RUTF) is being actively promoted, and one purpose of this review is to consider whether this approach is applicable and feasible within routine health programs in nonemergency situations.

Definitions and setting

Definitions and setting were provided by WHO. *Community-based rehabilitation* (or community-based management) refers to treatment that is implemented at home with some external input, for example, from a health worker, or treatment that is given at a primary health clinic, a community day-care center, or a residential center in order to achieve catch-up growth. *Severe malnutrition* is defined by a weight-for-height z-score (WHZ) < -3 SD or the presence of edema. The two indicators of effectiveness that were set for this review were a mortality under 5% and a weight gain of at least 5 g/kg/day. The context is a *routine health system* with primary health-care provision and referral opportunities, in a *nonemergency setting*.

Treatment of severely malnourished children consists of a stabilization phase followed by a rehabilitation phase, and it is this latter phase that this review addresses. Supplementary feeding programs for the prevention of malnutrition and treatment of mild to moderate cases are outside the scope of the review.

Methods

A combination of database searches and hand-searching was used for studies published since 1980. The databases included Medline, Popline, PubMed, BIDS (CAB Abstracts), and the Cochrane Library. Dr. André Briend also requested published and unpublished material from 93 contacts.

Results

Effectiveness of community-based rehabilitation

The main question to be addressed is whether severely malnourished children can be rehabilitated in the community effectively, i.e., with low mortality and acceptable rates of weight gain. Thirty-three studies of community-based rehabilitation were examined. The quality of many of these, especially the early studies, is unsatisfactory: often only sketchy information is provided and there is a lack of methodologic rigor. Sample sizes were small in some studies and losses high, leading to potential bias. Only in the past few years has it become customary for authors to report rates of weight gain and so in this review, for several studies estimates of weight gain were derived from other data presented, with consequent risk of error. Weight-for-age (W/A) and Gomez grades, which were reported in some studies, are of limited value for assessing effectiveness of treatment, since low W/A can coexist with normal weight-for-height (W/H), and rapid weight gain is possible only for children with a deficit in W/H.

There are four main delivery systems for community-based rehabilitation: day-care nutrition centers, residential nutrition centers, primary health clinics, and domiciliary rehabilitation.

Day-care nutrition centers

Nutrition centers were first proposed 50 years ago by Bengoa [5, 6]. He envisaged simple buildings where up to 30 mildly or moderately malnourished children would attend for 6 to 8 hours per day, 6 days per week, and receive three meals daily for about 3 to 4 months. Mothers would help cook and clean and would learn about good feeding practices and child care. Bengoa gave high priority to teaching mothers about child-feeding and health care, as his long-term aim was prevention of malnutrition. The period of enrollment was

3 to 4 months which was considered the time needed for mothers to learn, rather than the time needed to rehabilitate children.

There have been no recent publications on day-care nutrition centers, which might indicate that their popularity has waned. Daily attendance by caregivers for several hours is a disincentive, and high discontinu-

ation rates attest to their limited acceptability.

Table 1 summarizes data from six studies of day-care nutrition centers published between 1980 and 1998 [7–12]. All provided cooked meals that were eaten on site. Effectiveness was low; the main reasons were that few meals were offered or they were of low energy and nutrient density, attendance was spasmodic, and

TABLE 1. Studies of community-based treatment of malnutrition in day-care centers

Authors Country Year published [ref]	Type of study	Age Admission criteria or severity of malnutrition	No. of children studied	Preliminary hospital treatment	Duration of treatment
					Food given out
Brown et al. Zaire 1980 [7]	CC	5–24 mo Only 29% < 85% W/H	106 pairs (con- trols were chil- dren in villages with no center)	No	12 wk 3 meals 6 days/wk (maize/legume gruel) Parents contributed fruits and veg- etables
Ojofeitimi and Teniola Nigeria 1980 [8]	O	9–48 mo	30	Yes (only for some)	12 wk 1 meal 1 day/wk
Stanton et al. Bangladesh 1987 [9]	O	18–48 mo MUAC < 12.5 cm Mean W/A 55% Mean W/H 78%	85	Yes (for 3 only)	3–5 wk 3 meals + 2 snacks 6 days/wk
Fronczak et al. Bangladesh 1993 [10]	O	6–59 mo MUAC 9–11.9 cm or W/H 60%–79%, nonedematous Mean W/A 51%	161	No	Mean 4 wk 3 meals + 2 snacks daily High-protein, high- energy family foods
Chapko et al. Niger 1994 [11]	RCT	5–28 mo WHZ < –2 SD or kwash- iorkor Median WHZ –3.16 SD	100 (a) 53 hospital (b) 47 NRC	Yes (median 7 days, then randomized to remain or transfer to NRC)	Mean stay: (a) 13 days hospital (b) 12 days NRC (a) 3 meals/day (b) 1 or 2 meals/ day Parents contributed food
Monte et al. Brazil 1998 [12]	O	53% < 18 mo Most used Gomez grades. Also social need Grade I 40% Grade II 47% Grade III 14% Only 27% < 80% W/H	1,399 (20 centers)	NR	Mean 8.7 mo Meals 5 days/wk

MUAC, mid-upper-arm circumference; NR, not reported; NRC, nutrition rehabilitation center; O, observational study; RCT, randomized, controlled trial; W/A, weight-for-age; W/H, weight-for-height; WHZ, weight-for-height z-score. **Bold** indicates programs within routine health services

a. Value derived by this reviewer from other data given by the authors.

there was limited opportunity for rapid weight gain, since many enrolled children were not wasted. Two centers are notable for their high mortality. In Niger [11] an estimated 12% of children in day-care nutrition centers died in the first 2 weeks, and in Brazil [12] two centers had mortality rates above 40%. Only the program in Bangladesh [10] was effective; this program

is described below. The default rate was quite high (12%), even though treatment was relatively brief. The program was partly community-resourced, and sustainability proved difficult.

Bangladesh study by Fronczak et al. [10]. Two nutrition centers for treating uncomplicated nonedematous malnutrition in Dhaka were studied. The centers had been developed in the city's poorest

Rehabilitation				Follow-up			
Mortality (%)	Relapse (%)	Weight gain or progress	Cost per child	Coverage (%)	Follow-up	Later mortality (%)	Later relapse (%)
NR	NR	Weight gain of center attendees not significantly different from that of controls matched for age and W/H	NR	NR	After 12 mo, no significant benefit in W/H for center attendees vs. controls	NR	NR
3.3	6.7	Mean weight gain 1.9 g/kg/day ^a Home-feeding advice was not implemented	NR	NR	Not done	NR	NR
1.2	NR	Median weight gain 3.3 g/kg/day ^a Median W/H (%): At entry 78 After 3 wk 83 After 5 wk 86	NR	NR	After 6 mo, median W/H was 83%	NR	NR
0	NR	Mean weight gain ~5 g/kg/day ^a Mean W/H (%): At entry 73 After 4 wk 83	\$140 for 4 wk + 5 follow-up home visits	26	After 12 mo, mean W/H was 93%	NR	2.5
(a) 24 (b) 12 (estimated from graph)	NR	No difference in W/H gain during treatment between the two groups	Hospital had 120% higher cost per patient-day	NR	After 6 mo, mean WHZ: (a) -1.0 SD (b) -0.3 SD (estimated from graph)	0-6 mo: (a) 41 (b) 33 (<i>p</i> = .17)	NR
13.8 ≥ 40 in 2 centers < 5 in 18 centers	NR	Distribution of weight gain: < 2 g/kg/day 79% 2-4 g/kg/day 16% > 4 g/kg/day 5%	NR	NR	Not done	NR	NR

areas in collaboration with local community nutrition councils, which donated the facilities and maintained them. The centers were open for 8 hours daily and staffed by urban volunteers who received 2 months of additional training and supervision through the Urban Health Extension Programme (UHEP) of the International Centre for Diarrhoeal Disease Research, Bangladesh (ICDDR,B). The UHEP provided personnel, food, and technical support. Each center had 5 volunteers and a capacity of 25 children, giving a staff to patient ratio of 1:5. Each volunteer was trained for specific duties. A physician visited weekly and supervised the program.

Children were given a high dose of vitamin A and immunized at admission, and they were given antibiotics if signs of infection were present. They were given three meals and two snacks daily prepared from low-cost, energy-dense, locally available foods, including stuffed paratha, lentils, halva, khichuri, potato, and high-energy milk (1 kcal/mL). Health education was provided on the causes and prevention of malnutrition, the prevention and treatment of diarrhea, immunization, family planning, hygiene, and child care. The mothers actively participated in meal preparation.

The mean W/H of those who completed treatment increased from 73% to 83% in 4 weeks. This is consistent with a rate of weight gain of approximately 5 g/kg/day. There were no reported deaths. Some 12% of children failed to complete treatment; the main reason was that daily attendance by mothers disrupted care of other children and was an economic burden due to loss of wages. Girls attended less frequently than boys, which suggests

that more inconvenience may be tolerated for the benefit of male children than for girls in this population.

In an earlier study of the Bangladesh program [9], the education program is described in more detail. Each lesson was pre-tested for interest and comprehension by mothers and for ease of presentation by staff. Informal participatory techniques were used, including storytelling, role-playing, discussions, pictures, and participant demonstrations. A demonstration garden was maintained. The mean rate of weight gain was estimated to be 3.3 g/kg/day; this rate was lower than that in the later study [10], probably because the children were less wasted.

The centers in this program received malnourished children from the community, either by referral from clinics or from surveillance surveys, with an estimated coverage of 26%. In theory, these centers would be suitable to rehabilitate severely malnourished children after initial hospital treatment. The reality, however, was that the community nutrition councils found it difficult to provide for the maintenance, repair, and security of the centers and volunteer community participation without external funding, and thus the sustainability of community-resourced day-care programs is questionable.

Residential nutrition centers

Day-care nutrition centers were considered impractical by Bengo for sparsely populated rural areas where distance would preclude daily attendance. For these situations, residential centers were advocated. They

TABLE 2. Studies of community-based treatment of malnutrition in residential centers

Authors Country Year published [ref]	Type of study	Age Admission criteria or severity of malnutrition	No. of children studied	Preliminary hospital treatment	Duration of treatment
					Food given out
Roy et al. India 1980 [16]	O	Grades I–III (Gomez) Grade I 5% Grade II 16% Grade III 79%	112	Yes (only for some)	Mean 5 wk Vegetarian family foods. No milk
Lamprey et al. Philippines 1981 [17]	O	Grades II and III (Gomez) Mean W/A 59% Mean age 32.5 mo	64	Yes (only for some)	Mean 10 wk (No feeding data)
MacIntyre et al. South Africa 1991, 1992 [18, 19]	O	Mean age 16 mo Mean W/A 64% Mean W/H 85%	73	Yes (majority) Mean 10 days in hospital	Mean 10 days 3 meals + 3 snacks High-energy, high- protein family foods
Ibekwe and Ashworth Nigeria 1994 [20]	O	Age < 60 mo Wellcome classification 66% kwashiorkor	803	No	Mean 5 wk 5 feeds Soya milk and soya bean mixes

NR, not reported; O, observational study; W/A, weight-for-age; W/H, weight-for-height. **Bold** indicates programs within routine health services
a. Value derived by this reviewer from other data given by the authors.

were also considered suitable for severely malnourished children whose medical complications had been successfully treated in hospital but who were not recovered in terms of their weight. Residential centers reached their zenith in the 1960s and 1970s; their performance during that period has been evaluated and their effectiveness deemed modest [13–15]. Residential centers have similar disadvantages to those of day-care centers if caregivers are required to reside with their children during rehabilitation.

Table 2 summarizes four post-1980 studies of residential nutrition centers [16–20]. Those located within hospital compounds were excluded. No recent publications of residential nutrition centers were located. Two of the four studies reported mean rates of weight gain of more than 6 g/kg/day, but one of these did not follow the WHO guidelines for the stabilization phase and had a 22% case-fatality rate [20]. Only the center in South Africa was considered effective and this is reported below [18, 19]. The success of this center may have limited external application, since it may have been better resourced than usual through its link with the Medical University of Southern Africa.

South Africa study by MacIntyre et al. [18, 19]. The Gold Fields nutrition center, 40 km from Pretoria and linked to the Medical

University of Southern Africa (now the University of Limpopo), was established in 1986 in response to the continuing high prevalence of malnutrition in the district. Of the children admitted, 81% had first been treated for an average of 10 days in hospital and were in a stable condition. Whenever possible, the children and caregivers resided at the center; otherwise they attended on a daily basis. The rehabilitation diet was based on high-energy, high-protein, low-cost family foods. The children were fed six times a day. The caregivers practiced feeding their children in a supportive and caring environment. To help overcome the problem of poverty, the mothers were taught income-generating skills and how to increase self-sufficiency by improving garden productivity, raising small livestock, and planting fruit trees. Teaching aids included posters, flip charts, videos, songs, and role plays. During their stay, the caregivers' attachment to their children increased, as did their awareness of their children's emotional needs. Staffing was multidisciplinary, and from the range of activities provided and the individual support given to caregivers, it is reasonable to assume that staffing levels were good.

The mean W/H at admission to the center was 85%, which increased to 89% after an average stay of 10 days. The mean weight gain was 42 g/day (approximately 6 g/kg/day). A child was discharged when weight gain was good and the caregiver could demonstrate that she was able to put into practice what she had been taught. In cases of extreme need, caregivers were given skim milk powder or peanut butter, as well as micronutrient supplements at discharge. All were given a growth chart. At follow-up,

Rehabilitation					Follow-up		
Mortality (%)	Relapse (%)	Weight gain or progress	Cost per child	Coverage (%)	Follow-up	Later mortality (%)	Later relapse (%)
1.8	0	Mean weight gain 29 g/day ^a In a subset (<i>n</i> = 46), grade III: At admission 79% At discharge 57%	3.3 Rs/day (1978 cost)	NR	After 3 mo, 13% of the subset were grade III	3.6	NR
4.3	NR	Mean weight gain 23 g/day Mean weight gain 2.6 g/kg/day ^a Mean W/A (%): At admission 59 At discharge 66	NR	0.1	After 8 mo, mean W/A was 68%	1.7	23
None	NR	Mean weight gain 42 g/day Mean weight gain 6.1 g/kg/day ^a Mean W/H (%): At admission 85 At discharge 89	NR	NR	After 12 mo, mean W/H was 99% Mean weight gain 1.1 g/kg/day ^a	None	4.0
21.8	NR	Mean weight gain 6–7 g/kg/day	NR	NR	NR	NR	NR

80% of caregivers could produce the chart, and 69% had attended a clinic or the center to check the child's progress. The mean W/H was 99% at follow-up, which on average was 12 months after discharge; however, 18% of the children at follow-up had not improved in W/H since discharge, or had deteriorated.

At follow-up, 74% of caregivers remembered the advice to add peanut butter, fat, or sugar to the child's cereal, and 74% had implemented this advice. Although 51% remembered the advice about frequent meals, only 26% followed it. Only 19% remembered the advice on hygiene. What the caregiver remembered or implemented, however, appeared to bear little relation to the child's nutritional status at follow-up. There was an increase of about 10% in the proportion of families who kept poultry and animals for milk, and 20% had vegetable gardens as compared with 7% at admission. Some 60% of caregivers told neighbors what they had learned at the center.

Primary health clinics

Seven studies of programs associated with primary health care facilities were identified; five of the programs were within health clinics and two were described as nutrition clinics (**table 3**). The services offered varied: four provided outpatient advice [21–24], two provided meals on a day-care basis [25, 27], and one provided residential rehabilitation [26]. Those considered effective were the day-care centers in Guinea Bissau [25] and the residential centers in Malawi [26]; these are described below. Clinics that provide outpatient advice depend on caregivers to rehabilitate the children at home, and it could be argued that these too are essentially home-based programs. In a pilot study in a rural health center in Jamaica, the WHO guidelines were implemented on an outpatient basis by clinic staff, who gave specific instructions to mothers of severely malnourished children for administering antibiotics at home and preparing starter and catch-up milk-based formulations [23]. The estimated rate of weight gain was 2.7 g/kg/day averaged over 5 months.

Guinea Bissau study of Perra and Costello [25]. This evaluation was performed in Gabu Region, where a health technician and a nurse visited villages every 3 to 4 months. In 1987, three nutrition rehabilitation centers were created inside two health centers and one district hospital and staffed by government auxiliary nurses with no medical supervision. If a severely malnourished child (< 60% W/A) was found in a village and there was a place at the clinic, the nurse met with the family and close relatives in the presence of the village health committee. This usually helped the family to make the decision to attend the rehabilitation center at the clinic. Since this was a day-care center, mothers from outlying districts had to find overnight lodgings for themselves and their children.

The nurses had 2 years of general training and 2 weeks of specific training on malnutrition and rehabilitation. Most children received antibiotics for 5 days, and the rehabilitation diet in the center consisted of three or four milk-based feeds daily. Additional feeds were taken to the home or the lodgings. The World Food Program (WFP) provided dried skimmed milk and oil and some of the sugar and rice. The families provided millet flour, rice, honey, cooking utensils, charcoal for cooking, and bed linen. Little information is given about the content of the education program.

The nurses spent 2 to 4 hours each day in the center, and the rest of their time was spent in other health-center activities.

The mean duration of rehabilitation was 13 weeks, and the mean weight gain was 37 g/day. On the basis of other data presented, this corresponds to a weight gain of about 6 g/kg/day. The mean W/A SD score improved from –4.5 to –2.8. The mortality rate during treatment was 4.8%, and few deaths occurred within 48 hours. About half of the late deaths were from AIDS, tuberculosis, or cerebral malaria. Following discharge, 15.8% of treated children died within 30 months, compared with 21.5% of those who could not be accommodated in the clinic (relative risk, 0.75; 95% confidence interval, 0.57–0.99). The postdischarge rate of relapse to severe malnutrition among treated children was 1.4%.

Compliance from families was excellent, and only 3% did not complete the treatment, despite the long period of rehabilitation. This was attributed, at least in part, to the initial village discussions and active community participation in the establishment and monitoring of the overall health-care program. These discussions, however, might also have led to self-selection bias as a result of which only those who felt able to attend for 13 weeks actually enrolled.

Malawi study of Brewster et al. [26]. The clinic-based component of this study was in three rural clinics in southern Malawi. All had inpatient facilities, and the mean stay was 19 days. The children were cared for by a nurse, with supervisory visits by a pediatrician every 2 to 4 weeks. Oral rehydration and intravenous fluids were used cautiously to avoid excess sodium and fluid loads. All children received antibiotics and a milk-based diet consisting of a starter formula (66 kcal and 1 g protein/100 mL) and then a catch-up formula (114 kcal and 4.1 g protein/100 mL) and enriched porridge (maize, soy, sugar, and oil) when appetite and edema improved. The ingredients came as a premix from the WFP. Six feeds per 24 hours were given, and the target energy intakes in the stabilization and rehabilitation phases were 79 and 170 kcal/kg/day, respectively. Electrolyte imbalances and micronutrient deficiencies were corrected by Nutriset's combined mineral vitamin (CMV) mix, but only during half of the study period.

The average age of the children at admission was 29 months, with a WHZ of –1.7 after loss of edema. The mean rate of weight gain from admission was 6.4 g/kg/day. Because all the children were losing edema during this time, this underestimates the true rate of tissue accretion. Provision of CMV was associated with lower mortality and faster rates of weight gain (6.1 vs. 4.7 g/kg/day) in the study overall. The authors reported a striking improvement in appetite and mood with the introduction of CMV. The proportion of children who left the facility without approval was 10%.

Domiciliary rehabilitation

Table 4 summarizes 16 reports of home-based rehabilitation [28–46], with one study reported as two separate papers for HIV-negative and HIV-positive children [42, 43]. Domiciliary rehabilitation has been the “growth area” as regards recent publications, and seven home-feeding trials of RUTF in sub-Saharan Africa have been reported. BP100 biscuits and Plumpy'nut are the commercially marketed RUTFs. Both are high-energy, high-protein products and contain minerals and vitamins appropriate for rehabilitating severely malnourished children. They are more energy-dense than F100 but have a similar nutrient to energy ratio.

BP100 is a 300-kcal biscuit that can be eaten dry or crumbled in hot water to make a porridge. Plumpy'nut is a peanut-based paste that has a 24-month shelf life and is resistant to bacterial contamination. It has a low osmolarity and can be eaten straight from the silver foil package or used to enrich home meals. Both BP100 and Plumpy'nut have been shown to be efficacious in clinical trials. In Sierra Leone, Navarro-Colorado and Laquière [47] found faster rates of weight gain with BP100 and F100 at alternate meals than with F100 alone (11.6 vs. 9.3 g/kg/day, $p = .05$), and in Senegal, Plumpy'nut supported faster growth rates than F100 (15.6 vs. 10.1 g/kg/day, $p < .001$) in a trial by Diop et al. [48]. Plumpy'nut has been used successfully for the domiciliary rehabilitation of severely malnourished children in emergency situations [49–54]. In all the RUTF studies in **table 4**, Plumpy'nut or a local version was used.

Of the 16 programs of home-based rehabilitation, 7 were considered effective according to the criteria set for this review. These were two home-based programs in Bangladesh in which no food was distributed [36, 39] and five programs with RUTF in Senegal, Malawi, Sierra Leone and Niger [40–42, 45, 46]. These are described below. Even with the same RUTF ration (175 kcal/kg/day), substantial differences in rates of weight gain were apparent: in Senegal, the mean rate with RUTF was 8 g/kg/day; in Malawi the mean rate was 5 g/kg/day in two studies [41, 42] and < 3.5 g/kg/day in a further two [43, 44], one of which was confined to HIV-positive children; and in Sierra Leone the mean rate was 12 g/kg/day [45]. With no sharing or infection, the expected rate of weight gain with an intake of 175 kcal/kg/day would be approximately 15 g/kg/day. In Niger, with a ration of two sachets of Plumpy'nut per day (1,000 kcal), the mean rate of weight gain was 10 g/kg/day [46]. Reducing the RUTF ration in Malawi lowered the rate of weight gain for HIV-negative children but not for HIV-positive children [42, 43]. In Bangladesh, rates of weight gain of 10 g/kg/day were achieved with home visits, even though no food was provided [39].

Bangladesh study of Khanum et al. [36–38]. The Children's Nutrition Unit in Dhaka was established in 1975 as a referral center for severe malnutrition, with approximately 1,300 admissions per year. It had 60 inpatient beds and day-care facilities for another 40 children, with a staff to patient ratio of 1:5, and was largely financed by Save the Children, UK. The admission criteria were W/H less than 60% and/or edema. In 1990, a home-visiting service was introduced and a cost-effectiveness trial was undertaken to compare inpatient care, day care, and day care for 1 week followed by home visits weekly for 1 month or until edema disappeared, and then fortnightly visits. Multivitamins and ferrous sulfate, but no food, were provided for those who received home visits. None of the groups received zinc. While at the unit, caregivers received 20 minutes of structured instruction each day on topics relevant to child feeding, disease prevention, and family planning. They also participated in cooking demonstra-

tions and actual practice of meal preparation. The domiciliary group received additional instruction during their week at the unit, particularly on what to feed, how much, and how often. The bowl and cup used in the practice sessions were given to the child to take home.

In the domiciliary group, mortality was 3.5% and the rate of weight gain from admission averaged 4 g/kg/day; however, because 98% of the children had edema, the true rate of tissue accretion is likely to have exceeded 5 g/kg/day, and hence treatment was considered "effective" in this review. The rate of weight gain for day-care patients and inpatients was 6 and 11 g/kg/day, respectively. Despite the slower rate of weight gain, domiciliary care was the most cost-effective treatment. Infection, poor appetite, and nonadherence to dietary advice adversely affected weight gain at home. Infections were reported in 38% of study weeks. The authors concluded that better weight gain and improved resistance to infection might have been achieved if children sent home early had continued to receive potassium and magnesium, and if all children had been given zinc. Financial constraint was the main reason for not adhering to the feeding advice. Day care was the least liked option and had a 17% discontinuation rate. Parents preferred domiciliary care, despite their poverty and the substantially higher parental costs. Neighbors took an interest in the home visits and appeared to assimilate the advice given to the target child's family, suggesting that domiciliary care may have wider impact as a result of a "ripple effect."

A trusting relation with the designated home visitor was established during the week of day care, which created an unbroken chain of support. The home visitors were very motivated and were carefully selected and trained. They gave feasible advice, were sympathetic and supportive rather than castigating, and involved fathers and grandparents in decision-making. Including older members helped to break taboos that might otherwise have impeded treatment. The home visitors were trained to weigh and examine children and differentiate minor from major illnesses so that they could refer back when necessary. After the trial, early discharge with home visits became a routine service, and parents were offered a choice of inpatient care, day care, or domiciliary care. Mothers of recovered children also acted as informal peer counselors to give help and encouragement to other mothers who were rehabilitating their children at home.

Bangladesh study of Ahmed et al. [39]. Severely malnourished children admitted to the Dhaka Hospital of the ICDDR,B were randomized after 7 days to domiciliary rehabilitation with home visits by health workers, domiciliary rehabilitation with clinic visits, or continued inpatient care. No deaths occurred in the domiciliary groups. The median time taken to reach 80% W/H was 20 days for children receiving domiciliary rehabilitation with home visits, 37 days for those receiving domiciliary rehabilitation with clinic visits, and 17 days for those receiving continued inpatient care. The rate of weight gain in the home-visited group averaged 10 g/kg/day, compared with 7.5 g/kg/day for the group making clinic visits and 12 g/kg/day for inpatients. The cost of domiciliary care was about one-third that of inpatient care.

No food was distributed. Considerable effort was made to identify specific high-energy, high-protein, low-cost foods to promote for home-feeding. These were khichuri and halva, and the mothers practiced preparing these foods before going home. Zinc syrup, folic acid, multivitamins, and iron supplements were provided. The Dhaka Hospital has a well-established health and nutrition education program for mothers, which includes many aspects of child care.

Senegal study of Diop et al. [40] and Malawi studies of Sandige

TABLE 3. Studies of community-based treatment of malnutrition in primary health clinics

Authors Country Year published [ref]	Type of study	Age Admission criteria or severity of malnutrition	No. of children studied	Preliminary hospital treatment	Duration of treatment
					Food given out
Castillo et al. Chile 1983 [21]	O	< 2 yr WAZ < -3 SD if < 2 yr WAZ < -2 SD if < 1 yr	313 (a) 286 at 10 health clinics (b) 27 at nutrition clinic	No	12 wk No food given
Husaini et al. Indonesia 1986 [22]	O	6–36 mo Grade III (Gomez) or edema but not severely ill	108 (nutrition clinic)	No (except for 2)	6 mo 12 clinic visits No food given
Bredow and Jackson Jamaica 1994 [23]	O	< 3 yr Grades II and III (Gomez) or edema	36 (rural clinic)	No	Mean 5.6 mo Mean of 6 clinic visits: weekly if ill, otherwise monthly Multivitamins and folic acid given for 1 mo
Jamal et al. Pakistan 1995 [24]	O	< 5 yr Grade III (Gomez)	135 (nutrition clinic)	No	Mean 13 wk Weekly or fortnightly clinic visits No food given
Perra and Costello Guinea Bissau 1995 [25]	CC	6–47 mo < 60% W/A	1,038 (a) 354 cases (b) 684 untreated controls (2 rural clinics + hospital clinic)	No	Mean 13 wk Case patients attended clinics' day-care centers 3–4 meals/day in center + home food WFP food given (milk, sugar, oil)
Brewster et al. Malawi 1997 [26]	O	Mean age 29 mo Edematous malnutri- tion	373 (3 rural clinics)	No	Mean 19 days Resided at clinic WFP premix given (milk, sugar, oil) + CMV
Colecraft et al. Ghana 2004 [27]	O	WHZ < -2 SD Mean WHZ -2.1 SD Mean age 13 mo	116 (3 urban clinics)	No	Mean effective duration 1.4 mo Attended clinic day- care centers 2 meals/day for 5 days/wk Mainly WFP foods (cereals, WSB)

CC, case-control study; CMV, combined mineral vitamin mix; NR, not reported; O, observational study; WFP, World Food Program; WSB, wheat/soy blend; W/A, weight-for-age; W/H, weight-for-height; WHZ, weight-for-height z-score. **Bold** indicates programs within routine health services

a. Value derived by this reviewer from other data given by the authors

Rehabilitation					Follow-up		
Mortality (%)	Relapse (%)	Weight gain or progress	Cost per child	Coverage (%)	Follow-up	Later mortality (%)	Later relapse (%)
NR	NR	In the subset (n = 274) of those < -2 SD WAZ: (a) 31% reached -1 SD WAZ (b) 73% reached -1 SD WAZ	NR	NR	Not done	NR	NR
16.6	Yes	In a subset (n = 49): Mean weight gain 12 g/day Mean weight gain 1.7 g/kg/day ^a After 6 mo, 24% were > 90% W/H	NR	NR	Not done	NR	NR
2.7	0	Mean weight gain 2.7 g/kg/day ^a if grade III Mean weight gain 1.4 g/kg/day ^a if grade II Mean W/A (%): At entry 62 After 5.6 mo 73	\$14 for medicines	NR	NR	NR	NR
1.5	NR	Mean weight gain ~25 g/day ^a Mean W/A (%): At entry 45 ^a After 13 wk 66 ^a	NR	NR	NR	NR	NR
(a) 4.8 (b) 11.9	(a) 0 (b) NR	Mean weight gain 37 g/day Mean weight gain ~6.0 g/kg/day ^a WAZ: Cases Controls At entry -4.5 -4.1 After 3 mo -2.8 -3.6 ^a	NR	33	Up to 18 mo, significant benefit in W/A vs. controls, but not significant from 18 to 36 mo	0-9 mo: (a) 9 (b) 11	1.4
7.5	NR (overestimated because includes initial treatment phase)	Mean weight gain 6.4 g/kg/day (underestimated because includes resolution of edema)	NR	NR	Not done	NR	NR
8.6	NR	Mean weight gain ~1.2 g/kg/day ^a Mean WHZ (SD): At entry -2.1 After 4 mo -1.6 Home diets did not improve	NR	NR	After 2-4 mo, mean WHZ -1.3 SD (estimated from graph)	1.7	NR

TABLE 4. Studies of community-based treatment of malnutrition at home, with or without provision of food

Authors Country Year published [ref]	Type of study	Age Admission criteria or severity of malnutrition	No. of children studied	Preliminary hospital treatment	Duration of treatment
					Food given out
Verkley and Jansen Kenya 1983, 1986 [28, 29]	O	< 5 yr ≤ 65% W/A Mean age 23 mo Mean W/H ~80%	32	No	6 mo Food + home visits if failed to attend clinic Maize, milk, and oil premix monthly
Gueri et al. Trinidad 1985 [30]	O	< 5 yr Grades II and III (Gomez) Mean age 25 mo	86 (a) 59 (b) 27	No	16 wk (a) Food + ≥ 8 home visits/mo (b) Food (less than above) + 1 visit/mo Milk, sugar premix + oil separately
Glatthaar et al. South Africa 1986 [31]	RCT	7–36 mo ≤ 72% W/A or ≤ 79% W/A + edema or W/H <95% Mean age 18 mo	140 (a) 65 (b) 75 controls	No	3 mo (a) 6 home visits (b) No visits (controls) No food except to 17% (severe cases)
Van Roosmalen- Wiebenga Tanzania 1988 [32]	O	At admission to hospital: 53% kwashiorkor 18% marasmic kwashiorkor 29% marasmus	475	Yes (all) (mean 19 days)	MCH services: home visits by health worker No food given
Heikens et al. Jamaica 1989 [33]	RCT	3–36 mo <80% W/A no edema Mean W/A 66% Mean W/H 83% Mean age 15 mo	82 (a) 39 (food) (b) 43 controls	No	3 mo (a) Food + 1 home visit/mo for 3 mo (b) 1 home visit/mo Food was specially pre- pared catch-up for- mula (equiv F135)
Fernandez-Concha et al. Peru 1991 [34]	O	Grades II and III (Gomez) Mean W/H ~88% Mean age 18 mo	54	No	12 mo Home visits by doctor and nurse in wk 1, then weekly clinic visits No food given
Heikens et al. Jamaica 1994 [35]	RCT	3–36 mo <80% W/A Mean W/A 59% Mean W/H 81% Mean age 11 mo	79 (a) 40 stayed in hospital until recovery (b) 39 discharged early	Yes (all) (a) mean 40 days (b) mean 18 days	Assessed at 6 mo post- discharge a) Inpatient (b) Milk/sugar/oil mix for 3 mo + folate + multivitamins + monthly home visits

Rehabilitation				Follow-up			
Mortality (%)	Relapse (%)	Weight gain or progress	Cost per child	Coverage (%)	Follow-up	Later mortality (%)	Later relapse (%)
0	NR	Mean weight gain ~1 g/kg/day ^a At admission, mean W/A 61% After 6 mo, mean W/A 66%	Ksh 496/- (1982 prices)	NR	After 4 mo, mean W/A 65% After 10 mo, 68%	3.1	NR
(a) 0 (b) 0	0	Mean weight gain (g/kg/day): (a) 1.1 ^a (b) 0.9 ^a % grade III: (a) (b) At entry 17 14 After 16 wk 8 0	Cost to the center: (a) \$227 (b) \$55	NR	After 4 mo, % grade III: (a) 13% (b) 0%	NR	(a) 3.4 (b) 0
(a) 11.7 (b) 5.4 controls		Mean W/H (%): (a) (b) At entry 81 82 After 3 mo 88 87	NR	NR	After 9 mo, W/H: (a) 91% (b) 91%	(a) 0 (b) 0	(a) 10 (b) 18
Within 6–36 mo of discharge, 8% died and 13% relapsed		% <90% W/H: At entry 88 At hospital discharge 64 After ≥ 12 mo 14	N/A	25–50	NR	NR	NR
(a) 2.6 (b) 0	(a) 18.0 (b) 16.0	Mean weight gain 0–3 mo (g/kg/day): (a) 1.5 ^a (b) 1.3 ^a Mean W/H z-score: (a) (b) At entry -1.9 -1.8 After 3 mo -1.4 -1.6 (estimated from graph)	NR	NR	After 3 mo, mean WHZ: (a) -1.8 (b) -1.6 (estimated from graph)	None	(a) 7.7 (b) 7.0
1.8 (14 if severe)	7.4	% W/A: Grade II Grade III At entry 87 13 After 3 mo 47 2 After 12 mo 19 0	\$21	NR	Not done	NR	NR
(a) 0 (b) 2.6	NR	Mean weight gain (early rehabilitation) (g/kg/day): (a) >7 (b) ~1.1 Mean WHZ (a) (b) At entry -2.0 -1.9 At discharge -0.5 -1.2 6 mo postdischarge -0.5 -0.8	NR	NR	After 36 mo, mean WHZ: (a) -0.5 (b) -0.7	None	None

continued

TABLE 4. Studies of community-based treatment of malnutrition at home, with or without provision of food (continued)

Authors Country Year published [ref]	Type of study	Age		Preliminary hospital treatment	Duration of treatment
		Admission criteria or severity of malnutrition	No. of children studied		Food given out
Khanum et al. Bangladesh 1994, 1997, 1998 [36–38]	RCT-S	12–59 mo < 60% W/H and/or edema Mean W/A 48% Mean W/H 67% Mean age 25 mo	437 (a) 173 inpatients (b) 134 in day care (c) 130 discharged early	Yes (all) (c) 7 days	Until ≥80% W/H and edema-free Mean no. of days taken: (a) Inpatient 18 (b) Day care 23 (c) Domiciliary 35 No food given
Ahmed et al. Bangladesh 2002 [39]	RCT	6–60 mo < –3 SD WHZ and/or edema	225 (a) 75 inpatients (b) 75 with home visits (c) 75 with clinic visits	Yes (all) (b) and (c) 7 days	Until ≥ 80% W/H and edema-free Median no. of days taken: (a) 17 (b) 20 (c) 37 No food given Multimicronutrients given
Diop et al. Senegal 2004 [40]	RCT	6–59 mo < –3 SD WHZ or edema	47 At home: (a) local RUTF (b) imported RUTF	Yes (all) Mean stay ~7 days	Until reached 85% W/H RUTF + clinic visits twice/mo RUTF 175 kcal/kg/day
Sandige et al. Malawi 2004 [41]	RCT-S	12–60 mo < –2 SD WHZ or edema Mean WAZ -3.6 SD Mean WHZ -2.1 SD 61% had edema Mean age 28 mo	260 At home: (a) 135 local RUTF (b) 125 imported RUTF	Yes (all except 33) Mean stay 12 days and then sys- tematic allocation	16 wk or reached > –0.5 W/H RUTF + clinic visits twice/mo RUTF 175 kcal/kg/day
Manary et al. Malawi 2004 [42]	RCT-S	> 12 mo HIV negative Mean WAZ -3.4 SD Mean WHZ -1.9 SD Mean age 29 mo	282 At home: (a) 69 RUTF (b) 96 small ration RUTF (c) 117 CSB + MMN	Yes (all) Mean stay 11–14 days and then sys- tematic allocation	Until 100% W/H or assessed at 16 wk Food + clinic visits twice/mo (a) RUTF 175 kcal/kg/ day (b) RUTF 500 kcal/d (c) CSB+MMN
Ndekha et al. Malawi 2005 [43]	RCT-S	12–60 mo HIV positive Mean WHZ: (a) –2.0 (b) –2.8 (c) –1.8 Mean age 25 mo	93 At home: (a) 20 RUTF (b) 28 small ration RUTF (c) 45 CSB + MMN	Yes (all) Mean stay 11–14 days and then systematic allocation	Until 100% W/H or assessed at 16 wk Food + clinic visits twice/mo (a) RUTF 175 kcal/kg/ day (b) RUTF 500 kcal/d (c) CSB + MMN

Rehabilitation				Follow-up			
Mortality (%)	Relapse (%)	Weight gain or progress	Cost per child	Coverage (%)	Follow-up	Later mortality (%)	Later relapse (%)
(a) 3.5 (b) 5.0 (c) 3.5	(a) 0 (b) 0 (c) 0	Mean weight gain (g/kg/day): (a) Inpatient 11 (b) Day care 6 (c) Domiciliary 4 (all are underestimates, since they include resolution of edema)	Cost to center to rehabilitate (a) \$156 (b) \$59 (c) \$29	NR	After 12 mo, mean W/H (%) (a) 91 (b) 91 (c) 91	(a) 3.4 (b) 1.5 (c) 1.5	(a) 1.2 (b) 0.7 (c) 0
(a) 1.3 (b) 0 (c) 0	NR	Mean weight gain (g/kg/day): (a) 11.9 (b) 9.9 (c) 7.5 (a) vs. (b) not significantly different	Cost to center to rehabilitate (a) \$76 (b) \$21 (c) \$22	NR	NR	NR	NR
2.1	NR	Mean weight gain (g/kg/day): (a) 7.9 (b) 8.1 Difference not significant	NR	NR	NR	NR	NR
Died or relapsed: (a) 3 (b) 2.5		Mean weight gain over 4 wk (g/kg/day): (a) 5.2 (b) 4.8 Difference not significant Mean WHZ: At entry -2.1 At exit -0.2	Food cost (a) \$22 (b) \$55	NR	After 6 mo, mean-WHZ was -0.6. There were no group differences	NR	9
Died or relapsed: (a) 4 (b) 12 (c) 19		Mean weight gain after 4 wk (g/kg/day): (a) 5.1 (b) 3.1 (c) 3.1	NR	NR	After 6 mo, mean WHZ was -0.5. There were no group differences	NR	NR
(a) 15 (b) 14 (c) 9	0 11 22	Mean weight gain over 4 wk (g/kg/day): (a) 3.2 (b) 3.1 (c) 2.4	Food cost (a) \$33 if locally produced	NR	NR	NR	16

continued

TABLE 4. Studies of community-based treatment of malnutrition at home, with or without provision of food (*continued*)

Authors Country Year published [ref]	Type of study	Age		Preliminary hospital treatment	Duration of treatment
		Admission criteria or severity of malnutrition	No. of children studied		Food given out
Ciliberto et al. Malawi 2005 [44]	Non-ran-domized trial	10–60 mo <–2 SD WHZ or edema Mean WHZ (SD): (a) –2.5 (b) –2.2 Mean age 23 mo	1,178 (a) 186 inpatients (b) 992 at home + RUTF	Yes (some) (a) Mean stay 22 days (b) 35% had preliminary stay (mean 11 days)	8 wk (a) 50 kg CSB + MMN to take home on discharge (b) local RUTF (175 kcal/kg/day) + clinic visits twice/mo
Navarro-Colorado and McKenney Sierra Leone 2003 [45]	RCT	12–60 mo W/H < 70%	95 (a) 50 inpatients (b) 45 at home + RUTF	Yes (all)	Weekly supply of RUTF
Gaboulaud Niger 2004 [46]	O	6–59 mo WHZ < –3 SD or edema or MUAC < 11 cm WHZ < –4 SD (%): (a) 22 (b) 1 (c) 25 Median age 18 mo	2,209 (a) 794 inpatients (b) 354 at home + RUTF (c) 1,061 mixed	a) whole stay b) no stay c) preliminary stay mean 10 days	Until ≥ -2 SD WHZ Weekly supply of RUTF (1,000 kcal/day) + biscuits for family

CC, case-control study; MUAC, mid-upper-arm circumference; NR, not reported; O, observational study; RCT, randomized, controlled trial; RCT-S, systematic allocation; RUTF, ready-to-use therapeutic food; CSB + MMN, corn/soy blend plus multimicronutrients; W/A, weight-for-age; W/H, weight-for-height; WAZ, weight-for-age z-score; WHZ, weight-for-height z-score. **Bold** indicates programs within routine health services

a. Value derived by this reviewer from other data given by the authors.

et al. [41] and Manary *et al.* [42]. In Senegal and Malawi, local RUTF was made from milk powder, oil, peanut butter, sugar, and CMV (Nutraset's combined mineral vitamin mix). The rates of weight gain with locally made RUTF and imported Plumpy'nut were similar [40, 41]. Although both programs provided a fortnightly ration equivalent to 175 kcal/kg/day, the rates of weight gain were higher in Senegal than in Malawi (8 vs. 5 g/kg/day). In Malawi, fever was significantly associated with weight gain and was reported for 5% of study days. Manary *et al.* compared three feeding rations [42]. Rates of weight gain fell and deaths or relapses increased in the groups allocated one-third of the ration of RUTF or the prodigious fortnightly ration of 34 kg of maize/soy flour. Much of the ration was thought to be shared [55].

In HIV-positive children given RUTF, the rates of weight gain were slower and mortality was higher than in HIV-negative children [41–43], but nevertheless, 59% of HIV-infected children achieved more than 90% W/H [41]. Locally made RUTF has a higher solute load than imported RUTF because sugar replaces dextrimaltose, but diarrhea was not reported as a problem with local RUTF in these programs.

Sierra Leone study of Navarro-Colorado and McKenney [45]. The rates of weight gain in children discharged early with weekly rations of RUTF were similar to those in children who stayed as inpatients (12 vs. 13 g/kg/day). The rates of weight gain at home

were much higher in Sierra Leone than in Malawi (12 vs. 3–5 g/kg/day). This is attributed to careful training of caregivers in Sierra Leone before they go home and effective stabilization and transition phases in a therapeutic feeding center (C. Navarro-Colorado, personal communication, 2005).

Niger study of Gaboulaud [46]. The mean rate of weight gain in the rehabilitation phase in children given two sachets of RUTF per day (1,000 kcal) to eat at home was 10 g/kg/day as compared with 20 g/kg/day for inpatients. The children were monitored weekly. In addition to RUTF, the children were given vitamin A, folic acid, and albendazole. The criteria for home treatment were that children have no edema, be clinically well with a good appetite, and be over 12 months of age. The mean institutional cost per child in 2002, when 0.5% of children were treated at home with no inpatient phase, was €105; in 2004, when 49% of children were rehabilitated at home with no inpatient phase, it was €91.

Comments on the criteria used

The criteria used in this review (mortality < 5%, rate of weight gain ≥ 5 g/kg/day) work well if they are applied to the specific period of rehabilitation. They are less satisfactory for studies in which progress is assessed after several months, as it is not possible to separate

Rehabilitation					Follow-up		
Mortality (%)	Relapse (%)	Weight gain or progress	Cost per child	Coverage (%)	Follow-up	Later mortality (%)	Later relapse (%)
(a) 5.4 (b) 3.0	11 6	Mean weight gain over 4 wk (g/kg/day): (a) 2.0 (b) 3.5	NR	NR	After 6 mo, mean-WHZ (b) -0.5	NR	3
(a) 2.0 (b) 2.2		Mean weight gain (g/kg/day): (a) 13.4 (average duration, 33 days) (b) 11.9 (average duration, 40 days)		NR			
(a) 17.5 (b) 1.7 (c) 0		Mean weight gain (g/kg/day): (a) 20.2 (average duration, 15 days) (b) 9.8 (average duration, 29 days) (c) 10.1 (average duration, 35 days)	NR by group €91–105	NR	NR	NR	NR

what might be reasonably considered “rehabilitation” from “follow-up.” Rapid weight gain only occurs when children are wasted. When children approach a normal W/H, their rates of weight gain fall to 1 to 2 g/kg/day. A low rate of weight gain over a long period may thus mask a good rate of weight gain during rehabilitation. Furthermore, the longer the study period, the more chance the child has to relapse or die. Caution is therefore needed when attempting to interpret studies where progress is assessed after actual treatment has ended, and “effectiveness” in some studies may have been misclassified. One could argue that the rate of weight gain considered to be effective should be relaxed for children being rehabilitated at home if mortality is low. One might, for example, lower the rate to ≥ 3 g/kg/day, but such slow rates of improvement may not motivate caregivers to adhere to the feeding advice. There is little justification for relaxing this criterion for programs that provide food, because of the added cost of providing food for longer periods.

The weight gain criterion of ≥ 5 g/kg/day can also be problematic if a large proportion of children are

edematous at the start of rehabilitation, as in the studies of Brewster et al. [26] and Khanum et al. [36]. The severity of edema was taken into account when assessing these studies. Not all studies, however, report the prevalence of edema, and the rate of tissue gain may be higher than the measured rate of weight gain if the latter includes edema loss.

Some may question whether a mortality criterion of $< 5\%$ is appropriate, especially for HIV-positive children. Life-threatening conditions and comorbidities are treated before children proceed to community-based rehabilitation, and deaths should therefore be rare. The mortality criterion of $< 5\%$ is less satisfactory if the study population includes children with end-stage AIDS. Such information is lacking in the studies reviewed. Nevertheless, all programs with acceptable rates of weight gain also had low case-fatality rates, with one exception [20], which was in a community not affected by HIV/AIDS at the time of the study. The criteria, although not perfect in all settings, provide a good working definition of effectiveness.

Comments on delivery systems for community-based rehabilitation

In this review, 33 studies of community-based rehabilitation programs have been examined. Six programs were in day-care nutrition centers, 4 were in residential nutrition centers, 7 were clinic-based, and 16 were domiciliary. Eleven (33%) were considered effective according to the criteria set for this review. Of these, two were delivered through nutrition centers (Bangladesh day care and South Africa residential), two through health clinics (Guinea Bissau and Malawi), and seven were domiciliary; of the seven domiciliary programs, two provided no food (Bangladesh), four provided 175 kcal/kg/day of RUTF (Malawi, Senegal, and Sierra Leone), and one provided 1,000 kcal/day of RUTF (Niger). Thus, all four delivery systems can be effective. These have several features in common, which are discussed later.

Of the 13 community-based programs published in the last 10 years, 8 (62%) were effective. Of these, two were delivered through health clinics where the patients received meals (Guinea Bissau and Malawi), and six were domiciliary (one provided no food and five provided RUTF).

The reasons for the ineffectiveness of some *day-care and residential centers* include the following:

- » Intermittent attendance due to distance, opportunity cost, and competing demands on caregivers;
- » Too few meals provided;
- » Meals not sufficiently energy-dense;
- » Children not fed *ad libitum*;
- » Nosocomial infections;
- » Persisting electrolyte and/or micronutrient deficiencies that impair immune function and limit growth;
- » W/A entry and discharge criteria: nonwasted, stunted children may be enrolled and they grow slowly.

The following are possible reasons for the ineffectiveness of some *domiciliary programs using family foods*:

- » Abject poverty: families may be too poor to implement the feeding advice given;
- » Advice too vague or unrealistic, or conflicts with cultural beliefs;
- » Advice not memorable and no opportunity to learn through supervised practice;
- » Too few meals: caregivers may have insufficient time or fuel to prepare frequent meals, especially if the child's food requires separate cooking;
- » Meals not sufficiently energy-dense: no purposive modification of family meals or promotion of specific foods;
- » Recurrent infections: poor appetite or withholding food during illness may lead to low intakes; poor living conditions expose children to pathogens;
- » Persisting electrolyte and/or micronutrient deficiencies: early discharge from hospital may lead to discontinuation of supplementation, especially with zinc;

- » Fathers and other influential members may not be involved: they often control families' finances.

The following are possible reasons for the ineffectiveness of *domiciliary programs that provide RUTF or other food*:

- » Sharing: special feeding for one child out of several in a family may conflict with traditional beliefs;
- » Too few meals: for foods that need cooking, caregivers may have insufficient time or fuel to prepare frequent meals;
- » Meals not energy-dense: too much water may be added when food is cooked or reconstituted;
- » Recurrent infections: poor appetite or withholding food may lead to low intakes; poor living conditions expose children to infections;
- » Persisting electrolyte and/or micronutrient deficiencies (unlikely with RUTF);
- » Substitution: foods intended as supplements may replace other foods, and the net increase in intake may be negligible;
- » Fathers and other influential family members are not involved: they often influence families' eating habits.

Conclusions regarding the effectiveness of community-based rehabilitation

The following conclusions are drawn from these studies:

- » All four delivery systems can be effective (day-care and residential nutrition centers, health clinics, and domiciliary care with or without food);
- » The proportion of effective studies has increased in recent years. Overall, only 33% of programs were effective, but in the last 10 years the proportion of successful studies has increased to 62%, as an increasing proportion of programs have promoted energy- and protein-dense foods and have provided micronutrients;
- » Day-care and residential centers are inconvenient for many caregivers;
- » Domiciliary rehabilitation with a ration of RUTF sufficient to meet the needs for catch-up growth (175 kcal/kg/day or 1,000 kcal/day) was effective in five of the seven studies in sub-Saharan Africa, although rates of weight gain varied widely; a one-third ration of RUTF was not effective;
- » Domiciliary rehabilitation with home or clinic visits but no provision of RUTF or other food was effective in Bangladesh;
- » Provision of milk, sugar, and oil for rehabilitation at home was ineffective in Trinidad and Jamaica, and provision of maize, milk, and oil premix or maize and soy flour was ineffective in Kenya and Malawi. Even large amounts given to meet family needs (72 kg/month) did not achieve effectiveness in Malawi;
- » Community-based care must advocate frequent feeds of energy- and protein-dense foods and provide

micronutrients. This can be achieved at home from home-made mixtures of foods that families can afford, or by providing RUTF.

Conditions for successful program implementation

The successful programs share several features:

- » All showed awareness of the basic principles of treatment of severe malnutrition;
- » Most went beyond the narrow confines of rehabilitation and addressed the wider social, economic, and health issues that face poor families; some promoted community participation and action and integrated rehabilitation with poverty-alleviation activities;
- » All aimed to provide a high-energy, high-protein intake. They did this by advocating frequent meals (at least five daily) and specific food mixtures that families could afford, or by providing RUTF;
- » Those not providing RUTF made considerable efforts to teach mothers about child-feeding in a memorable way, used a variety of teaching methods, and provided opportunities for mothers to practice preparing children's meals;
- » Center-based programs were less than 4 weeks in duration;
- » Staff were motivated and carefully trained.

Notably, all successful programs had external support. The Bangladesh day-care program received UHEP support consisting of personnel, food, and technical assistance. The Gold Fields residential program in South Africa was linked to the Medical University of Southern Africa, which may have better access to resources than rural district hospitals. In Guinea Bissau and Malawi, the clinics received food from the WFP, and in addition Malawi received CMV from Nutriset. The domiciliary programs in Bangladesh, Sierra Leone, and Niger were linked to nongovernmental organizations (Save the Children, ICDDR,B, Action Against Hunger, and Médecins Sans Frontières), and Nutriset provided RUTF in Malawi and Senegal.

Coverage and cost of community-based rehabilitation

Data on coverage are limited (**tables 1–4**). The reported rates of coverage ranged from 0.1% to 33%. These rates are much lower than those reported in emergency settings where there is active case-finding by nongovernmental organization outreach workers [53].

Cost data are also sparse (**tables 1–4**). The most comprehensive cost-effectiveness study is that of Khanum et al., in which the costs to attain 80% W/H were compared for three delivery systems in a controlled trial [36–38]. The institutional costs consisted of capital costs and operational costs; the latter included salaries, utilities, laboratory tests, medical supplies, and food. Parental costs included wage loss, transport, and

children's food at home. Domiciliary rehabilitation was the most cost-effective, the institutional costs being half the cost of day-care treatment and one-fifth the cost of inpatient treatment. Domiciliary care has also been found to be cost-effective in a more recent study in Bangladesh [39], being nearly one-quarter the cost of inpatient rehabilitation.

In the Bangladesh programs, families used their own foods. No comparable cost-effectiveness trials have been reported with RUTF to answer the question whether it is more cost-effective to treat a child at home with RUTF (donated to, or purchased by, the health system) than to continue to treat the child in hospital. Neither have there been randomized trials of the cost-effectiveness of domiciliary care with home foods versus RUTF. Minimum costs, however, can be estimated from the cost of the RUTF itself. On average, 11 kg of RUTF was needed to rehabilitate a child in Malawi [41]. If imported Plumpy'nut was used, the cost was \$55 per child [41]. If the RUTF was locally produced, the cost was about \$22 per child. The equivalent amount for HIV-infected children was 22 kg of RUTF [43] at a cost of \$110 per child for imported RUTF and \$44 for locally produced RUTF. These are substantial costs for some health systems to accommodate. For example, the cost per child of imported RUTF exceeds the health expenditures per person for almost all countries in sub-Saharan Africa (**table 5**).

Hospitals typically discharge children after 1 or 2 weeks when they show signs of clinical improvement rather than when they attain a target W/H. In such situations, where children are discharged after a minimum stay, community rehabilitation will be an additional cost. Where children normally remain in hospital for longer than 1 or 2 weeks, there may be a cost advantage in discharging them earlier for rehabilitation elsewhere [37, 39]. Whether there would be cost savings with early discharge plus the provision of RUTF in routine health services has yet to be determined, although there is some indication from Médecins Sans Frontières in Niger that this may be so in emergency settings [46].

TABLE 5. Health expenditure per person in sub-Saharan Africa (1997–2000)

Expenditure (US\$)	No. of countries
> 60	4
34–60	2
12–34	11
< 12	18
Data not available or population < 1.5 million	13

Source: World Development Report 2004. Washington, DC, USA: World Bank

Existing community-based programs within routine health systems

Several of the community-based programs included in this review used regular health staff, but the programs were not to scale and were more of a pilot nature in a single center or clinic. Some depended on free supplies from sources such as the WFP and Nutriset or support from nongovernmental organizations. Programs were therefore sought that were within local or national health systems and were independent of external support, and that included at least three centers or clinics for treating severe malnutrition. Only four met these criteria; they are shown in boldface type in **tables 1–4** and are described below. Programs were also sought in which there had been handover of nongovernmental organization community-based programs to routine health services. Several partial handovers were located, most notably in Malawi, but in none was there complete handover; all used Plumpy'nut or a local equivalent, and their sustainability is not known.

Brazil. A network of 35 day-care nutrition centers was established during 1992–94 in the State of Ceará operating under the direction of the state health secretariat [12]. At evaluation in 1996, only 20 were functioning as nutrition centers; 9 had never opened and 6 had been redirected as health centers. None was following WHO case-management guidelines. Caseloads were low, and 12 centers assisted fewer than 50 children per month. This was partly due to an inadequate referral system resulting from lack of integration of the centers with other health programs. The centers used Gomez grades as entry criteria, and a considerable proportion of the children were already above 80% W/H at entry. Children were kept in the program for 8 months on average in the misguided expectation of reaching Gomez grade I. This led to considerable waste of resources and disillusionment of staff, who were unaware that the children's low Gomez grades were due to stunting.

Recommendations for improving the program were standardized entry and exit criteria using W/H; improved integration with other health programs, so that more children would be referred; implementation of WHO case-management guidelines and performance indicators; and a shift in emphasis to home-based care, in which center staff would provide weekly home visits after 1 week of day care.

Philippines. By 1980, 250 residential nutrition centers (nutrihuts) had been built through the Philippine Nutrition Program for treatment of moderate or severe malnutrition [17]. Details are limited, but on evaluation of 24 centers, 11 were not functioning. There was a 24% discontinuation rate among children enrolled.

Chile. In the early 1980s, 10 health clinics of the metropolitan health service of Santiago provided an "infant malnutrition control program," which included

treatment of uncomplicated malnutrition on an outpatient basis [21]. Few details are given, but the program integrated both curative and preventive services, with an emphasis on low-income families and intersectoral activities.

Tanzania. After the initial phase of treatment at Mbozi Hospital in the southwestern highlands, severely malnourished children were referred back for community care after an average hospital stay of 19 days [32]. Each child received two notes, one for the local health worker and one for the "ten-cell" leader with a request to help with the follow-up. This method of referral was considered a weakness of the system, since 28% of children had not been registered 12 months after discharge. Of those who did register at Mother and Child Health (MCH) clinics, 76% were seen more or less regularly and/or visited at home. The overall program aimed to provide information and feedback to village and district leaders to help promote community participation and action and to build capacity. As a result, women's groups and church leaders regularly organized meetings and seminars in their villages covering child health and nutrition topics and developed projects to promote vegetable gardens and orchards. Primary school teachers organized simple nutrition surveys using pupils to help collect information. Training for teachers, refresher training for health workers, and supervision of follow-up by doctors from the hospital helped to build trust and respect. Efforts were made to avoid being dismissive and critical of traditional healers, and the program aimed for open-mindedness, exchange of knowledge, and mutual respect.

Only limited data are available for assessing the effectiveness of three of these four programs, but it would appear that none of the programs was effective, except possibly the Tanzanian program. The programs were very varied in their operational structure and shared few characteristics. Sustainability is questionable in the Brazilian day-care and Filipino residential programs, since about half of the centers were not functioning.

Some countries routinely receive supplies from the WFP, and it could be argued that these should be considered routine health systems and included in this section. Supplies are not guaranteed, however, and problems can arise when they are withdrawn. Ghana is one such case where withdrawal is being considered. Day-care centers attached to clinics have been operating in Ghana since the 1970s. In the evaluation of Colecraft et al. [27], the choice of foods used at the centers was dictated by food aid, which, although it was an important resource, limited the learning opportunities for caregivers to improve child-feeding because they could not access these foods in their communities. Children's home diets did not improve with center participation.

Many factors are likely to explain why community-based programs run by routine health systems were

largely ineffective, but the underlying reasons are diets with a low energy and nutrient density and failure to provide frequent meals and ad libitum feeding.

Role of community-based rehabilitation within routine health systems

Any future community-based management of severe malnutrition within routine health systems is likely to be delivered mostly by clinics and implemented at home. Caregivers need prior training for home rehabilitation in order to avoid gaps in treatment. For those being discharged early, hospitals will therefore need to take responsibility for equipping caregivers for home rehabilitation. After discharge, responsibility for continuing care could pass to clinics.

Clinics

The strategy of Integrated Management of Childhood Illness (IMCI) is designed to provide an integrated approach to child health by improving health-worker skills, improving care-seeking and other family practices, and strengthening health systems [56]. Coverage of national health worker training, however, has stagnated at less than 10% in most countries due to insufficient investment and health system constraints, and little progress has been made in improving care-seeking or strengthening health systems [57, 58]. Consequently, many countries continue to have under-resourced, poorly functioning district health systems, and improvements in health-worker performance are urgently needed [59]. Growth-monitoring and nutrition counseling are particularly weak and, as regards malnutrition, there is little integration between curative and preventive services. Because of time constraints, the nutrition component of the IMCI training is sometimes reduced or not attempted. Thus, curative care may overshadow effective preventive measures at the clinic level, and staff may not be equipped to give specific advice for effective rehabilitation at home.

Hospitals

Within IMCI, children are expected to be referred to hospital if they have visible severe wasting and/or edema. Not all accept referral. In Bangladesh, for example, only 14% of sick children referred to Matlab hospital actually complied [60]. The reasons for non-compliance included competing demands at home, perceptions about disease severity, fear of the hospital, perceptions about the quality and costs of hospital care, and the costs of transport. Among those who sought treatment at the Dhaka Hospital of ICDDR,B, prolonged inpatient rehabilitation is unpopular, and 38% refused to go to the Centre's residential nutrition unit [61]. Distance from the hospital is a constraint in some communities; for example, in rural Bolivia and Amazonia attendance at the hospital may entail a three-

day walk or river journey. These examples suggest there may be a role in some settings for community-based management of uncomplicated severe malnutrition without prior referral, as well as community-based rehabilitation after early discharge. Within IMCI there is no specific treatment for children with moderate wasting, but these children would benefit from the same advice as that given for home rehabilitation of severe cases (frequent feeds of energy- and protein-dense foods plus micronutrients, and psychosocial stimulation), and they should be included in rehabilitation programs, since timely action might prevent them from deteriorating further.

Currently, the treatment of severely malnourished children in most hospitals in developing countries is poor. Many die in hospital, and survivors recover slowly and may acquire infections during their stay, thus prolonging recovery. Inappropriate treatment is the main reason for poor outcomes, but understaffing, lack of essential supplies due to dysfunctional health systems, and unhygienic, overcrowded wards are also responsible. Many of these problems could be addressed given the political will and resources. Keeping hospital treatment to a minimum might relieve overcrowding and lessen the burden on staff. On the other hand, shortening the hospital stay might cause more families to comply with referral advice, leading to an increase in admissions. Overburdened, poorly resourced hospitals usually have feeder clinics that are also poorly functioning. This presents a problem, since early discharge without continuity of adequate care is a death sentence for many children [3, 4, 11, 62, 63]. Hospitals with a policy of early discharge and no system of follow-up are usually unaware of high postdischarge mortality. Failure of a child to appear at an outpatient clinic is easily misinterpreted as due to parental indifference and irresponsibility rather than to the death of the child. Early discharge therefore needs to be linked with effective community-based care, and at present there are many countries where this will be nonexistent.

Community-based rehabilitation

There are three main options for community-based rehabilitation: short-stay day care or residential nutrition centers with intensive rehabilitation; rehabilitation at home, with home or clinic visits; and rehabilitation at home with RUTE, with home or clinic visits. The advantages and disadvantages of these options are summarized in **box 1**.

There are strengths and weaknesses in all three options, and it is unlikely that a single system will be applicable for all situations worldwide. Some options may be better suited to urban families than to scattered rural populations, or to mothers working for a wage than to those at home, or to food-insecure communi-

BOX 1. Advantages and disadvantages of different forms of community-based treatment of severe malnutrition	
Short-stay day-care or residential nutrition centers (< 4 weeks)	
<i>Advantages</i>	<i>Disadvantages</i>
Supervised feeding with high chance of success	Requires high prevalence of malnutrition or a center attached to a clinic
Opportunity for teaching mothers	High institutional cost for stand-alone center
Potential for preventing malnutrition in the long term	Burdensome to caregivers, with risk of defaulting
Circumvents poor primary health-care system	Low coverage
	Risk of creating a parallel system rather than an integrated one
Treatment at home (no food provided)	
<i>Advantages</i>	<i>Disadvantages</i>
Cost-effective	Families must have food resources
Liked by caregivers; few defaulters	Caregiver must be at home full-time
Teaches mothers about child-feeding	Requires formative research to develop advice
Family foods for rehabilitation also form the basis for good complementary foods	Requires clinic nearby or community health workers to monitor progress and provide timely treatment for ill children
Potential to prevent malnutrition in the long term by teaching mothers to prepare good food mixtures, and to feed frequently and responsively	Need to provide micronutrient supplements
Potential ripple effect	Requires motivated staff and good communicators
Responsive to fluctuating numbers	
Treatment at home with RUTF	
<i>Advantages</i>	<i>Disadvantages</i>
Independent of home resources	High institutional cost
Needs no cooking	Little opportunity to learn about good child-feeding practices and malnutrition prevention
Liked by caregivers and children; few defaulters	Requires clinic nearby or community health workers for monitoring progress, treating illnesses, and distributing RUTF
Responsive to fluctuating numbers	Requires efficient transport and distribution networks
Avoids need for formative research as to which home foods to promote	Risk of dependency
Avoids need for intensive teaching of caregivers about what foods to give	Requires quality control measures if RUTF is locally made
RUTF contains electrolytes and micronutrients	
Free supplies may provide inducement for clinic attendance	

ties, or to families living with HIV/AIDS, or to social contexts that preclude women leaving home. Health-system infrastructure, accessibility, and staff competencies must also be taken into account. For successful rehabilitation, the system chosen should

- » Achieve intakes that will promote catch-up growth and improve immune function;
- » Provide timely treatment of infections and close monitoring of progress.

Ideally the system should integrate both the treatment and the prevention of malnutrition.

Day-care and residential nutrition centers. The low coverage and high opportunity cost of day-care and residential nutrition centers will make these the least favored option in many settings. Nevertheless, such centers could be “halfway houses” between hospital and home. For example, attendance for 1 week could boost weight gain and provide practical education sessions for mothers and caregivers and precede rehabilitation at home. The center could monitor progress during

home rehabilitation by providing home visits and/or having children return to the center for assessment. Centers could also receive moderately wasted children from the community and treat uncomplicated severe malnutrition. In urban areas with very high numbers of severely malnourished children, treatment at well-resourced nutrition centers could be an alternative to hospital admission if staff were sufficiently trained. The centers should be integrated into the child health services and could be attached to a clinic.

Rehabilitation at home. Children rehabilitated at home need to be monitored, either through home visits or at a clinic. Clinics should play a key role in community-based rehabilitation, as they are the most sustainable delivery channel. The IMCI strategy envisages clinics as pivotal in preventing malnutrition and in case-finding, referral, and monitoring. With appropriate training and resources, clinic staff could deliver community-based rehabilitation for severely malnourished children after early discharge from hospital, and

for children with “uncomplicated” severe malnutrition, and moderately malnourished children referred from hospital or identified during routine growth-monitoring. Collins advocates rehabilitation at home with no prior stabilization phase for children with “uncomplicated” severe malnutrition, i.e., those who are clinically well and alert and have a good appetite [52, 53]; others, however, consider that a short period of stabilization and close observation may speed subsequent recovery at home.

From a practical standpoint, the main weakness of many home-based rehabilitation programs is that caregivers are never instructed adequately about feeding at home, and it may be difficult in understaffed hospitals for staff to assign the necessary time for teaching caregivers before discharge. Furthermore, few, if any, hospital and clinic staff have been trained to give the specific advice required for effective rehabilitation at home. To be effective, advice must be based on formative research and be feasible, culturally appropriate, memorable, and standardized for all child contacts in the locality.

Introducing community-based rehabilitation into routine health systems

Currently there is little experience on which to draw, but the rapid transformation that can be achieved when severely malnourished children are rehabilitated correctly can be a powerful motivator, and malnutrition has been used as the catalyst to building human resources within routine health systems [53, 64]. In South Africa, malnutrition was the lens through which hospital staff were able to pinpoint inappropriate ward practices, identify weaknesses in the health system, make plans, and implement them effectively [64]. As capacity-building progresses, the aim could be to expand from hospital-based to community-based rehabilitation, and then sequentially to convert community-based rehabilitation from a vertical intervention into an integrated horizontal program that encompasses both preventive and curative elements.

Key tasks in an integrated program are likely to include the following:

- » Collecting hospital data to assess the situation and advocate for action (e.g., the percentage of deaths among severely malnourished admissions and among nonsevere admissions, the rate of weight gain in the rehabilitation phase, the discontinuation rate, and acceptable duration of inpatient treatment);
- » Collecting data about foods available at home for children admitted with severe malnutrition, seasonal changes, distance to the clinic, and determinants of severe malnutrition;
- » Raising the profile of malnutrition among hospital and clinic staff;
- » Planning actions to reduce deaths from malnutrition;

- » Building capacity to improve hospital treatment;
- » Planning actions for early discharge (if appropriate in the setting);
- » Undertaking formative research to develop specific educational messages for home rehabilitation;
- » Building capacity of clinic staff and supervisors so they can deliver home rehabilitation;
- » Providing clinics with essential drugs, electrolyte and mineral solutions, and equipment (e.g., weighing scales);
- » Implementing community-based rehabilitation;
- » Evaluating its effectiveness;
- » Rewarding achievement (e.g., public recognition);
- » Building capacity to prevent malnutrition (e.g., early detection, improvement of prenatal nutrition, breastfeeding support, complementary feeding, hygiene, health-seeking behaviors, etc.);
- » Mobilizing the community (e.g., peer counselors, hearth model);
- » Making linkages with other sectors (e.g., literacy, water and sanitation, income generation, agronomy).

Community-based rehabilitation will require careful planning and additional resources, including nutrition educators. Some health services will need considerable initial inputs to start the process, and systems need to be in place to deal with staff turnover and arrival of untrained staff. Data gathering, formative research, and help with training could be done in partnership with academic institutions. Provision of RUTF might speed up the implementation process, but its cost, the logistics of procurement and distribution, sustainability, and the consequences of withdrawal would need to be carefully considered.

Research needs

- » Comparative trials are needed of the cost-effectiveness of different approaches to delivery of community-based rehabilitation, e.g., home foods versus RUTF;
- » Operational research is needed to determine the effectiveness of scaling-up community-based rehabilitation in routine health services in nonemergency settings, and barriers;
- » In home-based rehabilitation, the optimum frequency of visits (at home or at the clinic) to achieve low mortality and rapid recovery needs to be determined;
- » Determination of the cost effectiveness of community-based rehabilitation with RUTF versus inpatient rehabilitation would help guide policy decisions on early discharge;
- » Efficient systems of transfer from hospital to clinic that avoid gaps in treatment need to be identified and tested. The onus of responsibility also needs delin-

eating, including whether the hospital relinquishes responsibility for the child during community-based rehabilitation;

- » Some children fail to achieve rapid weight gains with home-based rehabilitation. Research is needed to determine whether these children or their families share certain characteristics that could be used to identify them as at high risk and in need of additional care;
- » Feeding advice given at home visits may produce a “ripple effect” among neighboring families and influence their infant care and feeding practices. This potential benefit of home visits warrants investigation;
- » The extent to which community-based rehabilitation can activate capacity-building and strengthen nutrition activities within clinics warrants investigation;
- » Instruction of mothers and caregivers about child-feeding and health promotion should be provided in hospital, especially if home rehabilitation is envisaged. A basic curriculum and effective systems for teaching mothers need to be identified and tested.

Conclusions

There are strong justifications for establishing community-based management of severe malnutrition within routine health systems. Community-based management could benefit children by reducing exposure to hospital-acquired infections and providing continuity of care after discharge. It could benefit families by reducing the time caregivers spend away from home and the risk of possible neglect of siblings, and by reducing opportunity costs. It could benefit the health system through capacity-building and be the catalyst for strengthening nutrition activities within clinics. It could provide closer integration of curative and preventive services. It could lower costs if fewer cases are referred to hospital or if children are discharged sooner than is currently the case. If services improve

and are more convenient for families, then uptake and coverage may increase.

There is a long tradition of community-based rehabilitation, and all four delivery systems (day-care nutrition centers, residential nutrition centers, primary health clinics, and domiciliary care with or without provision of food) can be effective. Since local conditions differ, it is unlikely that a single delivery system will suit all situations worldwide. The choice will depend on local factors. The key to rapid weight gain is provision of high energy intake (> 150 kcal/kg/day), high protein intake (4–6 g/kg/day), and micronutrients. When done well, rehabilitation at home with family foods is more cost-effective than inpatient care. The cost-effectiveness of ready-to-use therapeutic foods versus family foods has not been studied.

Where children have access to a functioning primary health-care system and can be monitored, the rehabilitation phase of treatment of severe malnutrition should take place in the community rather than in hospital. If caregivers can make energy- and protein-dense food mixtures at home, then domiciliary care is probably the best delivery system for community-based care. RUTF has several advantages for children, caregivers, and health staff, but its cost, the logistics of procurement and distribution, and its sustainability need to be carefully considered. It may be the best short-term option for food-insecure households. Cost-effectiveness trials and operational research will help guide future policy decisions regarding the choice of family foods versus RUTE.

With 60% of child deaths associated with malnutrition and the global commitment to reducing child mortality by two-thirds by 2015 (Millennium Development Goal 4), it is clearly a moral imperative to commit additional resources to improving hospital treatment of severe malnutrition and establishing community-based rehabilitation and prevention programs.

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Key issues in the success of community-based management of severe malnutrition

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Abstract

Background. Acute malnutrition is an underlying factor in almost 50% of the 10 to 11 million children under 5 years of age who die each year of preventable causes. Inpatient treatment for severe acute malnutrition is associated with high opportunity and economic costs for affected families and health service providers. Community-based therapeutic care attempts to address these problems and to maximize population-level impact through improving coverage, access, and cost-effectiveness of treatment.

The community-based therapeutic care model. Community-based therapeutic care programs provide effective care to the majority of acutely malnourished people as outpatients, using techniques of community mobilization to engage the affected population and maximize coverage and compliance. People with severe acute malnutrition without medical complications are treated in an outpatient therapeutic program with ready-to-use therapeutic food and routine medication. Those suffering from severe acute malnutrition with medical complications are treated in an inpatient stabilization center according to standard World Health Organization protocols until they are well enough to be transferred to the outpatient therapeutic program.

Impact of community-based therapeutic care programs. Twenty-one (21) community-based therapeutic care programs were implemented in Malawi, Ethiopia,

and North and South Sudan between 2000 and 2005. These programs, which treated 23,511 cases of severe acute malnutrition, achieved recovery rates of 79.4% and mortality rates of 4.1%. Coverage rates were approximately 73%. Of the severely malnourished children who presented, 76% were treated solely as outpatients. Initial data indicate that these programs are affordable, with the cost-effectiveness of emergency community-based therapeutic programs varying from US\$12 to US\$132 per year of life gained.

Key words: Community-based management, community therapeutic care, ready-to-use therapeutic foods, severe childhood malnutrition

Introduction

Malnutrition remains a major public health problem throughout the developing world and is an underlying factor in over 50% of the 10 to 11 million yearly deaths of children under 5 years old from preventable causes [1–4]. However, although the importance of undernutrition (low weight-for-age) is commonly acknowledged, the importance of acute malnutrition is seldom, if ever, mentioned. This is a serious omission; acute malnutrition is an extremely common condition, associated with high rates of mortality and morbidity and requiring specialized treatment and prevention interventions. Approximately 9% of sub-Saharan African children and 15% of South Asian children suffer from moderate acute malnutrition [5, 6], and approximately 2% of children living in developing countries suffer from severe acute malnutrition (defined as severe wasting [$< 70\%$ weight-for-height or < -3 SD] or edema [7] or a mid-upper-arm circumference [MUAC] of < 110 mm) [6]. This is equivalent to approximately 60 million children suffering from moderate acute malnutrition and 13 million suffering from severe acute malnutrition at any one time. In India alone, approximately 6 million children under 5 (2.8%)

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are severely wasted [8, 9], and in many poor countries, such as Malawi, severe acute malnutrition is the most common reason for pediatric hospital admission [10]. Although the data are imprecise, it is known that the risk of mortality in acute malnutrition is directly related to severity, with moderate wasting associated with an annual mortality rate of 30 to 115 per 1,000 [11–14] and severe wasting associated with a rate of 73 to 187 per 1,000 [11]. Our analysis indicates that this is equivalent to over 1.5 million child deaths associated with severe acute malnutrition and 3.5 million with moderate acute malnutrition every year. This analysis is summarized in **table 1** [6].

This article describes a community-based model for addressing acute malnutrition called community-based therapeutic care (CTC). CTC is a public health intervention based on the principles of coverage, access, and cost-effectiveness. The model attempts to maximize population-level impact by focusing on providing effective therapeutic care to the majority of acutely malnourished people as outpatients, using techniques of community mobilization to engage the affected population and maximize coverage and compliance. Wherever possible, programs build on local capacity and existing structures and systems, helping to equip

communities to deal with future periods of vulnerability. The CTC model treats people suffering from severe acute malnutrition by using a combination of three treatment modalities—inpatient therapy, outpatient therapy, and supplementary feeding—according to the clinical and anthropometric characteristics at presentation. Ideally, those with moderate acute malnutrition and no medical complications are supported by a supplementary feeding program (SFP) that provides dry take-home rations. SFPs are common in humanitarian operations but rarely exist in developmental settings. Those with severe acute malnutrition with no medical complications are treated in an outpatient therapeutic program (OTP). The patient attends an OTP site weekly or fortnightly to receive ready-to-use therapeutic food (RUTF), a course of oral broad-spectrum antibiotics, anthelmintic treatment, folic acid, and, if appropriate, vitamin A, measles vaccination, and anti-malarial drugs. People who are acutely malnourished and have additional serious medical complications are treated in an inpatient stabilization center (SC) until they are well enough to be transferred into the OTP. The inpatient protocols used in CTC are essentially the same as those recommended by the World Health Organization (WHO) [7], with the exception of the

TABLE 1. Analysis of the worldwide burden of acute malnutrition

Region	Under-5 population in 2000 (thousands)	Prevalence of wasting (%)		Wasted children (no. of thousands)		Annual mortality (no. of thousands)		
		Moderate or severe	Severe	< -2 z-scores W/H total	< -3 z-scores W/H total	Between -2 and -3 z-scores W/H ^a	< -3 z-scores W/H ^b	< -2 z-scores total
Sub-Saharan Africa	106,394	10	3	10,639	3,192	565,768	421,767	987,535
Middle East and North Africa	44,478	7	2	3,113	890	168,942	117,546	286,489
South Asia	166,566	15	2	24,985	3,331	1,644,950	440,201	2,085,151
East Asia and Pacific	159,454	4	—	6,378	—	484,528	—	484,528
Latin America and Caribbean	54,809	2	0	1,096	—	83,273	—	83,273
CEE/CIS and Baltic States	30,020	4	1	1,201	300	68,416	39,668	108,084
Industrialized 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	2,209	671,290	291,918	963,208
Total	707,584			60,228	13,139	3,577,241	1,736,132	5,313,373

W/H, weight-for-height; CEE/CIS, Central and Eastern Europe/Commonwealth of Independent States

a. Moderate mortality rate: 76/1,000/year for children with < 80% W/H or -2 z-scores [11].

b. Severe mortality rate: 132/1,000/year for children with MUAC < 110 [11].

Source: UNICEF [6]

admission and discharge criteria and the dietary protocols in the transition phase.

Background

Over the past 50 years, the case fatality rates for severe malnutrition treated in health facilities in most developmental settings have remained largely unchanged at 20% to 30% for marasmus and up to 50% to 60% for kwashiorkor [15]. By contrast, for the past 30 years, management protocols implemented in specialist units have achieved case fatality rates on the order of 1% to 5% [16–18]. Case fatality rates achieved by humanitarian agencies treating acute malnutrition during emergencies have also improved greatly over the past 15 years and are now frequently under the 10% level stipulated in the international Sphere standards for humanitarian interventions [19–22].

The reasons for the slow translation of scientific knowledge into impact are largely due to a combination of socioeconomic factors and disregard by the medical community of the fact that severe acute malnutrition is a major killer. This disregard is evident in most standard medical textbooks, which to date, contain little on the management of severe acute malnutrition. The treatment of severe malnutrition occupies a unique position between clinical medicine and public health. The causes of primary acute malnutrition are essentially poverty, social exclusion, and loss of entitlement [23], and the vast majority of cases can be treated by economic development and public health measures designed to increase dietary quantity and quality alone, with no need for clinical input. The serious physiologic consequences of acute malnutrition, such as reductive adaptation, marked immunosuppression, and concurrent infection, generally appear late in the evolution of the condition and become increasingly severe as the condition progresses. Historically these conditions have formed the focus of text books and guidelines on the treatment of severe malnutrition because treatment has always been centralized and cases have presented late. Acute malnutrition that has progressed to the stage where there are concurrent life-threatening complications must be treated on an inpatient basis. However, inpatient treatment is associated with major opportunity and economic costs for the affected families and health service providers alike. These costs are often unaffordable, and the results have been that inpatient therapeutic programs often have low coverage, low recovery, high mortality rates, and high default rates.

The community-based management of severe acute malnutrition is an attempt to achieve sustainable impacts at a population level by taking the socioeconomic realities into account, balancing the potentially conflicting demands and ethics of clinical and public health.

The CTC model

CTC is based upon the fundamental principle that all people whose lives are at risk from malnutrition should receive appropriate care and assistance. The provision of care should be impartial, targeted solely on the basis of need. It should be delivered without discriminating between or within affected populations and should not favor any particular side in conflicts or disputes. In practice, this principle translates into a commitment and obligation to provide the largest possible proportion of the acutely malnourished population with access to appropriate care in a timely fashion for as long as necessary. The core operating principles are thus the following:

Maximum coverage and access. Programs should be designed to achieve the greatest possible coverage and make services accessible for the highest possible proportion of a population in need. CTC aims to reach the entire severely malnourished population.

Timeliness. Programs should catch the majority of cases of acute malnutrition before additional medical complications occur on top of the simple malnutrition. In humanitarian situations, CTC programs aim to start case-finding and treatment before the prevalence of malnutrition escalates.

Appropriate care. Programs should provide simple, effective outpatient care for those who can be treated at home and inpatient care for those who require inpatient treatment in order to survive.

Care for as long as it is needed. Programs should be designed to help ensure that people can stay in the program until they have recovered, and CTC aims to ensure that appropriate services continue to be available for as long as acute malnutrition is present in the population.

Implementing these principles in practice requires program priorities, design, and resources to be tailored to the particular circumstances of the program.

The conceptual basis for a community-based approach

CTC is founded on three important premises. The first is that if malnourished people gain access to nutritional care early in the evolution of their condition and remain in a nutritional program until they have recovered, then success rates are high. Conversely, if people gain access to care late or if they are deterred from staying in a nutritional program for as long as they need to, then success rates are limited.

The basis of this understanding is that malnutrition is the result of a complex interaction of economic, social, political, nutritional, and public health factors. The clinical course of malnutrition is a gradual decline in nutritional status from normal adaptation toward metabolic complication, immunosuppression, infec-

tion that further compounds the metabolic derangement, increased immunosuppression, more infection, and eventual death. The severity of the condition is primarily a function of the stage of its evolution. As these changes progress, treatment must become increasingly intensive (and costly) if it is to succeed, and units treating severe acute malnutrition are frequently confronted by extremely ill patients who require intensive medical and nursing care. However, most of these units are in the poorest parts of the poorest countries in the world and have severe resource and staff constraints. In addition, the caregivers of the malnourished patients almost always come from the poorest families and have great demands on their time and cannot afford to leave home for long periods to stay with their malnourished children during treatment.

However, if the condition is caught in the early stages, the technical aspects of treatment are simple: all that is required is a balanced diet of sufficient quantity and quality in terms of protein, carbohydrate, fat, and micronutrients. The composition of such diets is now well researched. They are relatively cheap to produce, and so long as the patient has appetite they are easy to administer, making success rates high and the cost per treatment low. In practice, this means that the actual clinical treatment of severe malnutrition is not the only crucial aspect of a successful program. Instead, finding and treating cases of acute malnutrition early in the progression of their condition, before the metabolic and immunologic aspects of the condition become marked, are the major determinants of success.

The second premise underpinning CTC is that in order to present early and comply with treatment, people must understand, accept, and participate in the programs. To be sustainable and effective, community-based programs must involve the target populations. This is a major shift in attitude from clinically orientated inpatient programs, wherein professional health-care workers provide health care to a largely passive clientele. In practice, there are several important features of program design that are required to promote participation. The first is to minimize barriers to access. Physical and logistical barriers to presentation can be overcome by providing access to services close to where the target population lives. In the developmental setting, this involves delivering the OTP for the severely malnourished through the front-line primary health-care structures, such as local clinics, health posts, or temporary extended program of immunization (EPI) vaccination points. In humanitarian responses, it often involves creating new temporary OTP access points.

Social and cultural barriers to access, although more subtle, are equally important. These must be overcome by a range of measures. Foremost is the need for service providers to make initial investments into understanding the sociocultural milieu in which CTC programs will operate. These investments are not nec-

essarily expensive or particularly time-consuming, but they have to be planned properly and have sufficient appropriate resources allocated to them. It is important to realize that within any given society, marked socio-cultural differences exist, be they between town and country, educated and noneducated, or employed and peasant. Even in Ministry of Health health-care systems that employ "local" staff, there will still be sociocultural issues that need to be explored if issues of vital importance to the target population are to be adequately addressed in program design. Reducing sociocultural barriers also requires sensitization of the population to ensure that people understand the services that are available to them, and consultation to enable people to participate in program development and implementation. This is vital in order to ensure that issues of importance to potential program clients are factored into program design. In particular, it is essential that program designs take into account the socioeconomic barriers (opportunity costs) of attendance to enable people to access treatment easily and stay in treatment with minimal costs to them and their families.

The third premise underlying CTC is that in order for programs to move toward sustainability, there must be up-front investment in social mobilization to ensure that key stakeholders can benefit from the positive feedback and kudos that successful individual cures generate. The positive feedback that is required if programs are to generate sufficient and self-perpetuating motivation of community-based volunteers will only occur when communities feel some responsibility for service implementation. The nature of acute malnutrition offers unrivalled potential for this to happen, and there is no other condition that is potentially so devastating to families but so easily treated with simple, understandable measures (food) delivered by the families themselves. This is a vital advantage that community-based programs treating severe acute malnutrition have that can enable these programs to succeed where they have failed for most other conditions. However, this potential must be cultivated right from the start of programs. This requires appropriate resources and extensive engagement with the communities, key stakeholders, and local health-care providers to build understanding, trust, and participation among all groups and to ensure that programs are designed to reflect the priorities, constraints, and resources of the target population.

This focus on engagement and building the understanding and participation of communities and local stakeholders distinguishes community-based models from the more usual health extension and outreach services. Treatment models based on this extension concept, such as "home treatment" and "ambulatory care," start with a medical focus and aim to extend services out from treatment centers into the community. The programs are therefore designed more from the

perspective of the health-care providers and, as such, in many contexts, have more difficulty in fostering sufficient understanding and participation to ensure the sustainable system of early presentation that must occur if these programs are to succeed over the long term. The decision over whether to employ community-based or extension models of treatment should be based upon an analysis of context-specific factors.

The impact of CTC programs

Early CTC programs investigated the feasibility of the community-based treatment of severe acute malnutrition in humanitarian responses. The first programs were implemented in 2000/01, and to date we have monitoring data including outcomes from 23,511 cases of severe acute malnutrition presenting to 21 CTC programs implemented in Malawi, Ethiopia, and North and South Sudan between 2001 and 2005. These programs achieved recovery rates of 79.4%, mortality rates of 4.1%, and default rates of 11.0% [21, 24, 25]. The transfer and nonrecovery rates were 3.3% and 2.2%, respectively. Of the severely malnourished children who presented, 76% were treated solely as outpatients, and this figure has increased in the more recent programs. These results exceed international standards for therapeutic care; in particular, the mortality rates are less than half of the Sphere Project minimum standards and four to five times lower than those usually achieved by hospitals providing inpatient care to cases of severe acute malnutrition [22]. These results are presented in **table 2**.

The rates of weight gain in OTP programs were between 4 and 5 g/kg/day, lower than those recommended by the Sphere standards and lower than those seen in well-functioning therapeutic feeding centers (TFCs). The mean length of stay in these OTP programs was correspondingly longer, between 40 and 50 days. These slower rates of recovery have not resulted in increased mortality rates or increased default rates, a result supporting the view that treatment in OTP results in little, if any, increased risk to the malnourished child and few opportunity costs to caregivers. This is very different from center-based care, in which the congregation of children in centers results in a greatly increased risk of exposure to foreign pathogens and many opportunity costs to caregivers. Under these circumstances, rapid recovery is essential in center-based programs if low mortality and low default rates are to be obtained.

CTC program coverage

Coverage is a vital determinant of the impact of any health intervention. **Figure 1** demonstrates the importance of coverage as an indicator of impact. Programs with high coverage but low cure rates will meet a higher proportion of need in a population than those with

low coverage but high cure rates. In order to maximize impact, programs must have both high coverage and high cure rates. The importance of coverage has recently been acknowledged with the addition of coverage indicators to the second edition of Sphere [22]. This stipulates therapeutic feeding program coverage standards of 50% for rural populations, 75% for urban populations, and 90% for camp populations as a key indicator of program performance.

As part of the 6-year CTC research and development program jointly implemented by Valid International and Concern Worldwide, we have developed a new method for assessing coverage with greater precision [26] (see below). We have used this technique to assess nine CTC programs operating in rural environments. The average coverage in these programs was 73%, substantially higher than the 50% coverage standard for rural populations stipulated in the second edition of the Sphere standards [22], and considerably higher than coverage rates reported for humanitarian center-based therapeutic feeding programs [27, 28]. These data are presented in **table 3**.

Nonemergency CTC programs

Achieving long-term improvements in the treatment of severe acute malnutrition on a large scale requires that community-based management of severe acute malnutrition be implemented from existing Ministry of Health structures as a standard part of the primary health-care package. The first two large programs implemented in stable situations, those in Dowa District in Malawi and South Wollo in Ethiopia, have now been operating for 2 to 3 years. From the start, these programs implemented OTP through the local Ministry of Health clinics but supported this implementation with mobile teams consisting of nongovernmental organization staff. In Malawi the program used a combination of local missionary and church organizations and Ministry of Health hospitals for stabilization centers. In Wollo the stabilization

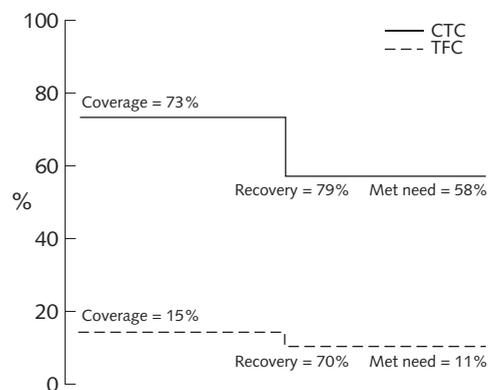


FIG. 1. The relationship between coverage, cure rate, and impact in the treatment of severe acute malnutrition.

TABLE 2. Outcomes for severely malnourished children under 59 months of age presenting to CTC programs between September 2000 and December 2005 (N = 23,511)^a

Country and region	Period	No. with SAM treated (OTP + SC) ^b	Direct OTP admissions (%)	Cover-age (%) [*]	Outcomes for OTP and SC combined					Non-recovery	Comment**	Rate of weight gain (g/kg/day)	Length of stay
					Recovery	Default	Death	Transfer ^c	—				
Ethiopia–Hadiya ^d	Sep 00–Jan 01	170	100	—	85.0	4.7	4.1	—	6.5				
N Sudan–Darfur	Aug 01–Dec 01	806	?	30–64	81.4	10.1	2.9	5.6	—		6.6 (M), 1.8 (K)	25 (M), 35 (K)	
N Sudan–Darfur	Sep 02–May 03	446	69	> 60	65.1	6.5	7.9	20.5	—		5.7		
Malawi–Dowa	Aug 02–Dec 03	1,671	19	73	69.4	15.0	8.9	3.0	2.8		5.9 (M), 5.0 (K)	35	
Malawi–Dowa	Jan 04–Dec 04	1,553	45	72	72.4	16.2	7.2	4.1	0.2		5.7	46	
Malawi–Dowa	Jan 05–Jul 05	1,696	63	—	80.5	12.5	4.2	2.7	0.1		5.8	45	
Malawi–Nkhotakota	July 03–Nov 03	105	27	—	58.9	27.8	10.0	3.3					
Malawi–Nkhotakota	Mar 04–Dec 04	501	55	—	61.9	23.2	8.9	1.4	4.6				
Malawi–Nkhotakota	Jan 05–Jul 05	1,021	70	—	76.7	16.3	6.0	0.9	—				
Ethiopia–South Wollo	Feb 03–Dec 03	590	95	78	74.6	9.7	7.5	—	8.3		4.5 (M)/4.0 (K)	80	
Ethiopia–South Wollo	Jan 04–Dec 04	1,359	92	—	82.7	4.2	4.9	—	8.2		3	82	
Ethiopia–South Wollo	Jan 05–May 05	856	96	77	83.4	6.0	4.6	—	5.6		3.2	85	
Ethiopia–Wolayita	Apr 03–Dec 03	194	24	—	69.6	5.2	7.3	10.5	—	4 registered on closure			
Ethiopia–Wolayita ^e	Aug 03–Dec 04	460	91	—	83.9	5.4	1.9	8.9	—	No SC data available			
Ethiopia–Wolayita	Jan 05–Jun 05	245	100	—	92.9	5.6	1.6	—	—				
Ethiopia–Sidama	Sep 03–Aug 04	1,497	85	78	84.8	5.9	1.2	2.9	5.2		6.8 (M)/5.5 (K)	45 (M), 41 (K)	
Ethiopia–Hararge	Apr 03–Jan 04	232	99	81	85.8	6.0	4.9	3.3	—	49 registered on closure			
South Sudan–BEG	Jun 03–Jan 04	610	92	—	73.4	17.3	1.4	4.2	3.7	39 registered on closure			
South Sudan–BEG	Apr 04–Dec 04	439	80	82	76.8	8.7	4.8	3.0	6.7				
South Sudan–BEG	Jan 05–Jun 05	387	88	—	61.5	14.5	2.5	4.5	16.5				
South Sudan–BEG	Jul 03–Nov 03	696	71	—	81.8	15.4	1.4	1.4	—	58 registered on closure			
Ethiopia–Hararge	Mar 04–Oct 04	1,086	89	56	76.0	18.0	2.0	3.7	0.4	241 registered on handover	6.6 (M)/4 (K)	44 (M), 38 (K)	
Ethiopia–Hararge	Mar 04–Oct 04	381	93	56	69.5	24.3	2.4	3.7	—	7 registered on handover	6.0 (M)/2.0 (K)	60 (M), 44 (K)	
Ethiopia–West Hararge	Feb 04–Oct 04	1,377	71	61	88.0	6.8	3.4	1.1	—				

	Feb 04–Oct 04	539	?	—	90.4	2.4	1.4	3.4	2.4	
Ethiopia–Wollayita	Feb 04–Oct 04	539	?	—	90.4	2.4	1.4	3.4	2.4	
North Sudan–West Darfur	Aug 04–Jul 05	1,684	97	75	80.0	13.9	1.4	5.0	-	
North Sudan–West Darfur	Sep 04–May 05	115	86	—	58.6	36.2	3.4	—	1.4	
North Sudan–North Darfur	Dec 04–Sep 05	172	90	—	65.7	12.9	7.9	—	13.6	
Ethiopia–Awassa	Jun 05–Oct 05	353	92	—	95.0	3.9	1.1	0.0	0.0	
Niger–Maradi	Aug 05–Dec 05	2,270	96	—	87.7	4.3	2.6	4.6	0.4	
Total		23,511			79.4	11.0	4.1	3.3	2.3	

SAM, severe acute malnutrition; OTP, outpatient therapeutic program; SC, stabilization center; TFC, therapeutic feeding center; M, marasmus; K, kwashiorkor

a. This table presents the latest available monitoring data from CTC programs supported by Valid International. As such, it is constantly updated, and for some programs data may be missing or incomplete.

b. For ongoing programs, total treated includes children still registered in the program and for closed programs those still registered on closure. For data up to the end of the year, the total does not include children registered in the program at the end of the year, as they are included in the next years data

c. This represents transfers out of the program to another agency (TFC) or a hospital that is not supported by the organization.

d. This was the only OTP program with little mobilization or community engagement.

e. No SC data were available, and therefore transfer percentage includes those transferred to SC.

* Calculated using centric quadrant sampling design and “optimally biased sampling” and using a recent period coverage calculation

** Children still registered on programme closure are not included in the outcome calculations

TABLE 3. Coverage results from CTC programs 2001–2005

Program	Agency	Year	Coverage (%)	Method
North Sudan	Save the Children – UK	2001	30–64	Indirect
North Sudan	Save the Children – UK	2003	> 60	Indirect
Malawi	Concern	2003	73	CSAS
Ethiopia	Concern	2003	78	CSAS
Ethiopia	Save the Children – US	2003	78	CSAS
Ethiopia	Care	2004	56	CSAS
Ethiopia	International Medical Corps	2004	61	CSAS
Malawi	Ministry of Health	2004	73	CSAS
South Sudan	Concern	2004	82	CSAS
Darfur	Concern	2004	75	CSAS
Ethiopia	Ministry of Health	2005	77	CSAS

CSAS, centric systematic area sampling

center was situated in the local hospital and has been run from the start by local Ministry of Health staff with minimal nongovernmental organization support. For over a year, the Wollo program, covering two districts with a total target population of 469,280 (and an under-5 target population of 84,469), has been transitioning toward being implemented solely by the Ministry of Health staff of the pre-existing clinics and hospitals. Nongovernmental organization inputs have been progressively reduced and now support only the purchase and transport of RUTE, intermittent monitoring/research inputs, and 8 of the original 35 outreach workers. The Ministry of Health has been responsible for the implementation of OTP through their clinics and has continued to run the inpatient stabilization center operating in the district hospital. The outcomes up to May 2005 are presented in **table 4**. These data indicate that recovery rates have remained unchanged during this transition and still exceed international standards. In January 2005, 9 months into this transition, the program coverage rate for severely malnourished children, estimated by the centric systematic area sampling (CSAS) method, was 77.3% (95% confidence interval, 72.0% to 82.2%),* similar to the rate of 77.5% (95% confidence interval, 65.7% to 86.2%) obtained in June 2003 at a time when Concern Worldwide, an international nongovernmental organization, was implementing the program.*

Similar results have been obtained from the Dowa District program in Malawi. In Dowa the program was

* Feleke T. CTC program coverage in Kalu and Dessie Zuria Woredas, South Wollo Ethiopia. 2005 Oxford, UK: Valid International.

TABLE 4. Outcomes from the clinical cards of severely malnourished children presenting to the CTC program in Wollo Ethiopia, February 2003–May 2005 ($N = 2,498$)^a

Outcome	Overall		Implemented by NGO		Implemented by MoH	
	23 Feb 03–8 May 03		23 Feb 03–23 Apr 04		1 May 04–8 May 05	
Recovered	2,023 (81)		737 (80)		1,286 (82)	
Died (in OTP or SC/hospital)	135 (5)		58 (6)		77 (5)	
Defaulted	148 (6)		67 (7)		81 (5)	
Nonrecovered ^b	192 (8)		63 (7)		129 (8)	
Total	2,498 (100)		925 (100)		1,573 (100)	

CTC, community-based therapeutic care; NGO, nongovernmental organization; MoH, Ministry of Health; OTP, outpatient therapeutic program; SC, stabilization center

a. 307 clinical record cards were missing

b. The nonrecovered children were those children who failed to achieve discharge criteria after 4 months in the program. Initially these children were discharged to SFP when that program was still in operation. Later, after the SFP ended, these children were discharged home. Before being discharged as nonresponders, children were tested in hospital for chronic treatable conditions such as tuberculosis, and home visits were conducted.

initially implemented by Concern Worldwide, largely through Ministry of Health health centers. In June 2003, Concern Worldwide started a gradual process of handing over day-to-day responsibility for the program to district-level Ministry of Health staff. At present Concern still supplies the RUTF and one outreach supervisor and provides monitoring and supervision visits. By May 2005, 2 years into this handover process, program outcomes still exceeded international standards for therapeutic feeding programs (table 5). The coverage rates for severely malnourished children have also remained high. In June 2004, the program coverage assessed by a CSAS survey was 72.2% (95% confidence interval, 66.4% to 78.0%),* similar to the value of 73.64% (95% confidence interval, 66.0% to 81.3%) obtained during the first CSAS survey implemented in March 2003 at the height of the Concern Worldwide support. **

* Wegerdt, J. Selective nutrition program coverage survey report: Dowa District, Malawi. June 2004. Sadler, K. and Myatt, M. 2004 Oxford, UK: Valid International.

** Feleke T. and Myatt, M. Feeding program coverage survey for severely malnourished children in Dowa and Mchinji Districts, Malawi. 2003 Oxford, UK: Valid International.

CTC is a new technique, and there has been little time to look at the transition of these programs into complete Ministry of Health control. Further data collection and analysis of the factors that facilitate integration of CTC into primary health-care delivery is required. However, initial impressions from CTC programs operating since 2002/03 have highlighted several factors that facilitate these programs being run as an element of standard health-care delivery. The simplicity of the OTP protocols, and the ease with which they can be taught to local clinic staff and implemented, are important. It is vital to keep these protocols as simple and as fast to implement as possible if busy clinic staff are to adopt them. Integrating the provision of CTC into annual District Implementation Plans with sufficient budgets for the logistics of RUTF transport, supervision, refresher training, and monitoring is also important if local health systems are to manage these programs. Building understanding and participation among local people is also vital and has a range of important benefits. Improved passive case-finding, with more appropriate and earlier presentation at clinic, occurs when people understand what acute malnutrition is and when and where to seek help. Early and appropriate presentation decreases

TABLE 5. Outcomes for severely malnourished children presenting to the Dowa District CTC program, June 2003–March 2005 ($N = 3,584$)

Outcome	SC		OTP		Overall outcome from SC and OTP	
	Count	%	Count	%	Count	%
Recovered to SFP	1,695	—	2,714	—	2,714	—
Recovered	1,695	84.1%	2,714	80.8%	2,714	75.7%
Died	148	7.3%	65	1.9%	213	5.9%
Defaulted	52	2.6%	484	14.4%	536	15.0%
Transferred	121	6.0%	90	2.7%	121	3.4%
Nonrecovered	—	—	4	0.1%	4	0.1%
Total	2,016	—	3,357	—	3,584	100%

CTC, community-based therapeutic care; OTP, outpatient therapeutic program; SC, stabilization center; SFP, supplementary feeding program

staff time spent on screening and improves the clinical effectiveness of the OTP protocols, thereby increasing the impact of the program. Improved results at clinics in turn lead to better staff morale and further improvements. Decentralization fostering easier access and earlier presentation also reduces the number of cases with complications and has a similar positive effect on impact and morale. Facilitation of community-based screening and the use of MUAC for both screening and admission decreases the number of people who are wrongly referred from village-level screening. This reduces negative feedback from those being inappropriately referred, thereby improving program acceptability and the appropriate presentation and uptake of services.

The cost of CTC programs

To date, cost data are available for the first three CTC programs implemented by Concern Worldwide. All were emergency programs, set up rapidly by an international nongovernmental organization in response to a nutritional crisis. Comparisons of the cost of these programs with the costs for Therapeutic Feeding Center programs operated by international nongovernmental organizations indicated that for each admission, the costs to the agency were similar for the two approaches, but the costs to the malnourished patient's family were substantially less for CTC [24, 25]. After 3 years of transition toward local Ministry of Health control, the costs of two of these programs, those in Malawi and in Ethiopia, have now been analyzed. Preliminary analysis of these cost data indicates that the cost-effectiveness of emergency/transition CTC programs is comparable to that of other mainstream child-survival interventions, such as provision of vitamin A, oral rehydration therapy for diarrheal disease, and treatment of acute respiratory tract infection [29]. The cost for each year of life gained in two established CTC programs varied between \$12 and \$132. The cost depended on the density and prevalence of severe acute malnutrition, the numbers of acutely malnourished treated, the infrastructure present, accessibility of the program, and the maturity of the emergency intervention [30]. The development of local production of RUTF using new cheaper recipes based upon locally available grains and pulses should further reduce costs.

To our knowledge, the only other cost data comparing community-based treatment of severe malnutrition with center-based care were obtained in Bangladesh in the mid-1990s. In these programs, the cost of community-based rehabilitation was approximately 25% of the cost of inpatient care (US\$150 per patient for inpatient care as compared with US\$37 for community-based care) [31]. In this study, however, the community-based programs did not provide any nutritional supplements for those treated in the community. With the addition

of approximately \$35.00 to \$52.50, the cost of 10 to 15 kg of RUTF, which is the average amount required to obtain a cure in OTP, the cost of the community-based programs would still have been less than half that of the inpatient programs. With the move to local production of RUTF from local crops (see below), these RUTF costs will be reduced substantially.

Community engagement

The quality of engagement with target communities is a vital determinant of the success of a community-based program. Community mobilization is crucial for effective early case-finding, and early case-finding and the quality of OTP service provision are the two most important determinants of case fatality rates, program coverage, and the impact of the program.

We use the term "community mobilization" to refer to a range of activities that help implementers understand the affected communities, build relationships with them, and foster their participation in program activities. The objective is to enhance the immediate program impact while creating a platform for comprehensive community mobilization over the longer term. Fostering community participation at the beginning of the program also facilitates integration with other longer-term programs in other sectors, such as health, food security, and so forth.

Although community mobilization is a continuous process, it is usefully conceptualized as being divided into five areas. These are presented in **figure 2**.

Assessing community capacity

To be effective, community-based programs must be tailored to the context in which they operate and this requires mechanisms to ensure that information gathered during the assessment of the affected community guides program design and planning. Inputs into making the initial assessment more comprehensive are usually rewarded with greater sensitization of the population and more profound mobilization. It is particularly important to have information on community structures (both formal and informal), key stakeholders (traditional authorities, traditional and western health practitioners, civil society, etc.), literacy levels, terms used to define malnutrition, who is responsible for children, who makes key decisions on household resource allocation, attitudes to health and malnutrition, health seeking behavior, and formal and informal means of communication used.

Community sensitization

Community sensitization aims to raise awareness of the program, promote understanding of its methods, and lay the foundations for community ownership in the future. Sensitization messages should provide essen-

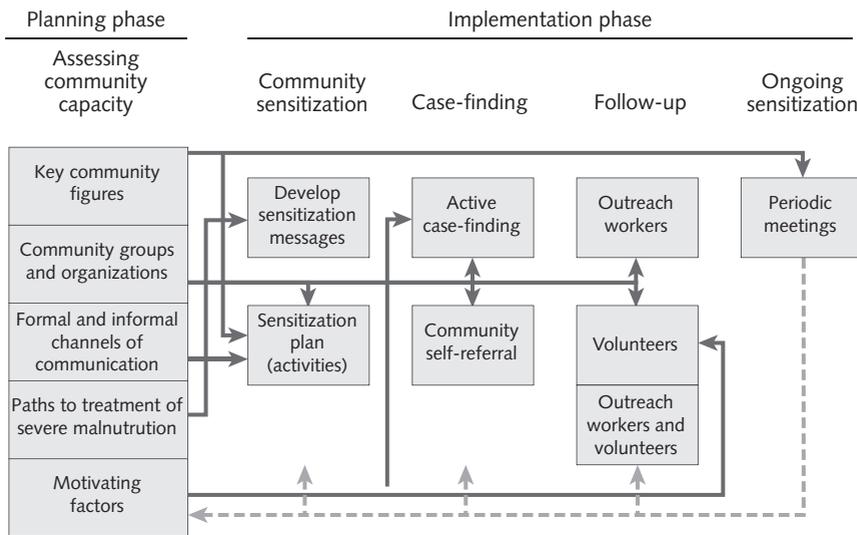


FIG. 2. Stages in community mobilization

tial information about the program's aims, methods, and actors. In particular, people must know what the program will mean to them in practice: what it will do, where it will operate, who will implement it, how people can access it, and what accessing the program will mean to individuals. Messages must be formulated and disseminated with the active involvement of key stakeholders in a language that local people understand. Messages should be as brief as possible and must be tailored to the target population, using local concepts and understanding of malnutrition and local terms to describe it. Visual aids and fliers posted in key places and disseminated to key stakeholders (traditional leaders, teachers, community health workers, etc.) can enhance the effectiveness of this process.

The messages should be disseminated through channels of communication that are familiar to the community. These might be formal or informal, traditional or modern. Our experience is that informal channels tend to be particularly useful. It is also important to consult and involve key community figures, community organizations, and groups such as volunteer networks and women's associations. In particular, our experiences indicate that it is crucial to involve traditional health practitioners. These practitioners are often the first tier in health-seeking behavior and can therefore help identify cases at an early stage. They are also recognized in their communities and can potentially help facilitate dissemination of information, thereby improving program uptake. Conversely, excluding them from the process can lead to resentment and negative feedback. There is, however, a risk associated with involving traditional health practitioners: some traditional practices can have a negative impact and there is a danger that, by association with a CTC program, such practices could be acknowledged and validated. Decisions on the

channels of communication and on engagement with different actors can therefore only be made based upon an understanding of the local community dynamics.

Our experiences indicate strongly that it is inadvisable to use financial rewards to motivate community sensitization. People who are paid for delivering messages may not necessarily be convinced of the message or convincing while communicating it. If material benefits are offered, communities often put forward the more powerful and privileged to do the work, and more motivated, interested, and credible people may be excluded.

Community sensitization is an ongoing process. Much of the activity takes place early in the program, but it should be continually reinforced throughout the program in order to be effective. The process should be seen as a constant dialogue in which communities can periodically voice their views and suggest alternative courses of action. Channels of communication must be set up through which feedback from the target population can influence program design and implementation. There are many examples where such feedback has proved essential in increasing coverage and compliance in CTC programs.

Case-finding: the identification of severely malnourished children in the community

In order to be able to provide the largest possible proportion of the acutely malnourished population with access to care, a program needs to be very effective at identifying people who need care and admitting them to the program. To reduce the barriers to access, screening must take place in the community using a simple, low-cost method that is easy for community-based volunteers to use and is accepted as fair and transparent

by the population.

Traditionally, therapeutic feeding programs use weight-for-height percentage of median (WHM) and/or the presence of bilateral pitting edema as admission criteria, while at the same time screening in the community uses mid-upper-arm circumference (MUAC) and WHM measurements (fig. 3). First, potential cases are identified by using a sensitive MUAC threshold (e.g., 130 mm) or by the presence of bilateral pitting edema; second, children with MUAC below the threshold are weighed and measured and their WHM calculated. Children with WHM below an admission threshold (usually 70% WHM) and those with bilateral pitting edema are referred for admission. In this scheme, all children who are referred and arrive at a center are admitted. This two-stage community screening can be a lengthy and resource-intensive process. Normally it requires three people to perform and record the necessary measurements accurately. They need to be literate and numerate, equipped with scales, height boards, electronic calculators, and WHM tables, and skilled in using WHM. The team often needs a vehicle to transport the workers and their equipment to screening sites. In some cases, it may be possible to store equipment locally, but skilled staff still need transport of some kind (car, donkey, bicycle, etc.) to reach screening areas. These requirements tend to limit both the particular areas and the frequency of screening activities. This can reduce coverage and referral numbers.

In early CTC programs, a two-stage screening method using WHM and MUAC was used. Outreach workers and volunteers referred children with MUAC

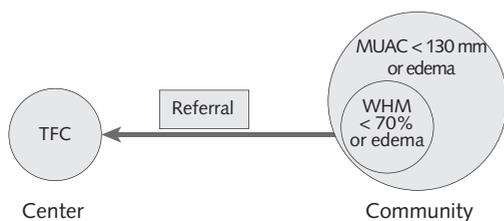


FIG. 3. Screening and admission in a traditional therapeutic program. TFC, therapeutic feeding center

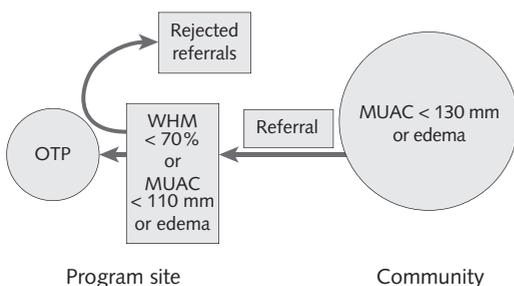


FIG. 4. Two-stage screening using weight-for-height percentage of median (WHM), mid-upper-arm circumference (MUAC), and edema. OTP, outpatient therapeutic program

below a sensitive threshold or with bilateral pitting edema to the distribution points. Children who were referred and arrived at a distribution point were weighed and measured and their WHM was calculated. Children with WHM below the admission threshold or with bilateral pitting edema were admitted into the program. Children with WHM above the admission threshold and without bilateral pitting edema were rejected (fig. 4).

In practice, this scheme resulted in a large number of children being referred by MUAC only to be rejected at the distribution site by WHM. This caused problems in the community. The caregivers of rejected children were dissatisfied with having to walk for up to 3 hours to the site only to be told that their children would not be admitted. As a result, they were unwilling to return to the program even when their children's condition deteriorated. In some cases they actively disparaged the program, thus reducing presentation and program uptake. Local leaders who had supported the program also became disillusioned. Taken together, this dissatisfaction among the local community eroded the prestige and devalued the work of the community volunteers and outreach workers. Morale and performance among outreach workers and community volunteers declined, and there was a negative effect on the number of admissions, frequency of early presentation, program coverage, and program impact. We have also seen the WHM admission criteria cause problems for CTC programs operating in nonemergency contexts. Frequently, ongoing programs such as growth-monitoring, maternal and child health, and other community nutrition programs use a different indicator of malnutrition that includes a weight but not a height component. Maternal and child health programs, for instance, tend to use a weight-for-age (WFA) indicator. This can create confusion among program staff and among program clients over the significance of the different nutritional indices. This again creates resentment and hinders sectoral linkages

CTC programs now recommend the use of MUAC as the only criterion for referral and admission to OTP (fig. 5). This helps ensure that all children who are referred by outreach workers or volunteers and arrive at a distribution point are admitted (see Myatt et al., this issue, pp. S7–23).

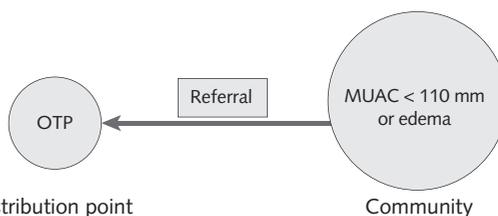


FIG. 5. Recommended screening and admission method for outpatient therapeutic program (OTP)

The change from the use of WHM to MUAC for screening and admission has many practical benefits that allow programs to achieve high coverage and treat many more patients:

- » It strengthens the interface between the program and the beneficiary community. MUAC is simple to measure and allows community volunteers to refer children for admission directly to the program. Many more people are directly exposed to the activity of curing malnourished children, and this is a powerful and effective motivational motor;
- » It is a one-stage process in which referral entitles admission. This avoids the reduced coverage caused by confusion and disillusionment that result from a two-stage process when children are referred but not admitted;
- » It is a simple, low-cost method, so other service providers can also screen and refer using MUAC without greatly increasing their workload. Linkages between the CTC program and other sectors and services are therefore facilitated. Confusion caused by using different weight-based indicators that select completely different children (e.g., weight-for-age and weight-for-height in growth-monitoring and mother and child health (MCH) programs) is avoided;
- » Distribution points function more efficiently. Delays and crowding are reduced because people do not need to be re-screened for admission;
- » Comparative studies have shown that, when used by community health workers who have little training, MUAC is subject to fewer errors than weight-for-height;
- » Last but not least, MUAC is a more sensitive indicator of mortality risk associated with malnutrition than WHM. It is therefore a better measure for the identification of children most in need of treatment.

There are situations where WHM should still be used for admission to programs. They include places where national strategy dictates and where other agencies working in the area are using it and program linkages need to be fostered. In these cases, compensation should be offered to those turned away in order to minimize the negative effects on program coverage described above.

The rationale for the use of MUAC in CTC programs is explored in other background papers for this consultation [32].

Active case-finding

If sufficient initial resources are put into sensitization, self-referrals from the community will provide the mainstay of case-finding. However, in order to maximize coverage, we have found it important to supplement self-referral with continual active case-finding. The case-finding process should be adapted to the program context. In a development context, program

sustainability is more important than attaining immediate high coverage, and a volunteer-based system is usually more appropriate. In an emergency response, rapid high coverage is the priority, and paid outreach workers are often employed to work with volunteers. Two approaches to active case-finding can be used: periodic screening and focal points.

Volunteers. There are two major challenges facing volunteer-based case-finding systems. These are choosing volunteers who are representative of their communities and motivating volunteers to perform their roles without financial incentives. Developing effective methods to achieve this has been central to the past 4 years of CTC research and development.

A unique strength of CTC programs is their high potential to motivate mothers, volunteers, and health-care workers. In center-based approaches the treatment of acute malnutrition, responsibility for care, and therefore the kudos associated with cure, is placed with health professionals; families and caregivers rarely understand the techniques used and rarely feel part of the process. By contrast, in CTC programs, the vast majority of cases of severe acute malnutrition are treated by simple, understandable care delivered by the caregivers themselves. Treatment rapidly creates marked changes in the mood, appearance, and activity of the malnourished child, and these positive changes are obvious to parents, health-care workers, and the wider communities alike. This provides extremely positive feedback to caregivers and anyone who has felt or has been seen to be associated with that cure. This ability to engage and motivate people is absolutely crucial and, in the authors' opinions, is probably the most important feature that has underlain the success of CTC to date.

The positive feedback associated with a community-based cure of severe acute malnutrition is an extremely powerful motivating force that both stimulates demand and uptake of CTC and motivates volunteers to support the programs. If nurtured and used appropriately, this motivation can encourage mothers and traditional practitioners to refer children to CTC and motivate volunteers to case-find and monitor problematic cases. In addition, linking local health-care workers to the successful treatment of individuals motivates these workers and enhances their credibility among the local people. The sustained high coverage and early presentation seen in the first Malawian and Ethiopian CTC programs indicate that it is possible to set up a positive self-sustaining cycle in which people and communities are motivated to present early for treatment; this promotes high cure rates, which enhance the credibility of the program and anyone associated with it, which in turn promotes further early presentation (**fig. 6**).

Active case-finding by volunteers has several advantages. Volunteers are usually local people who are familiar with the area, its population, and their customs

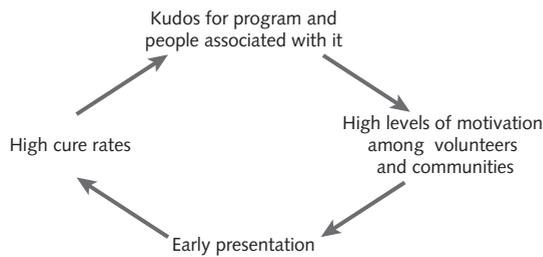


FIG. 6. Positive cycle promoting sustainable case-finding

and are known by the community members. Crucially, designing outreach strategies around volunteers motivated by the positive reinforcement associated with a successful program requires fewer financial resources. This means that over the long term, RUTF and basic oral medications are the only additional resources required to implement OTP through Ministry of Health clinics. In Malawi and Ethiopia, where the first CTC programs have been operating since 2002/03, purchase and transport of RUTF are the only substantive elements of external support still provided by Concern Worldwide.

There are several generic techniques that aid successful volunteer-based systems. These are to ensure that volunteers feel connected to and gain kudos and recognition from successful treatments in OTP; to identify members of the community who are already motivated and engaged in community activities and to find ways other than financial or material incentives of recognizing volunteer contribution (e.g., offering refresher training, organizing social gatherings with food, giving certificates, etc.). It is also vital not to expect too much from individual volunteers, all of whom must make their living and therefore have little time to devote to unpaid community activities. In practice, this often means having large numbers of volunteers, each of whom covers only a small area. This takes some initial investment in selection and training, but thereafter, the system can become to a large extent sustainable with only small investment to maintain motivation and organization.

Selection of volunteers. Facilitating the community to select volunteers is a more participatory approach. However, this can have drawbacks. The most common problem is the tendency for communities to select young, literate men and people related to community leaders. Alternatively, the program implementers from the Ministry of Health or nongovernmental organizations can identify and recruit volunteers. For this to work, it is important that unnecessary or inappropriate criteria, such as “literacy,” that separate volunteers from the program’s target population be avoided [25]. In practice, we have found that a compromise whereby the community selects the volunteers, with the implementer monitoring the process and encouraging the

active participation of groups, particularly women who may otherwise be excluded, is usually the most appropriate method.

Positive caregivers. It is important to complement this approach by identifying “positive caregivers” from within the program clients. In most CTC programs, the energy and commitment of these mothers has proved invaluable in assisting with active case-finding and on occasion with following up and supporting other caregivers. Using a technique similar to the positive deviance approach and the hearth model, we have found that staff can easily identify successful mothers or caregivers. However, since most positive caregivers are mothers with household responsibilities, their range of activity is usually limited to their own village.

Existing Ministry of Health volunteers. It has also proved possible to integrate Ministry of Health volunteers (e.g., growth monitoring volunteers, community health volunteers, village health committees) in CTC case-finding if they are familiar with the area, people, and customs. These pre-existing volunteers have knowledge of health issues and usually have standing in the community, with villagers willing and accustomed to seek their assistance. However, health volunteers are often fully occupied with their Ministry of Health work, and case-finding for the CTC program may be an unrealistic additional burden. It is important to maintain realistic expectations of volunteers’ contributions to the program.

Outreach workers. Outreach workers are paid to perform community outreach activities. Literacy is not a requirement, but it can facilitate the referral process. The advantage of employing outreach workers is that case-finding tends to be more organized. The salary may be the primary income source for the worker and his or her household, and it encourages focus. In humanitarian operations, paid outreach workers are a feasible and affordable option; however, employing outreach workers is relatively costly, and in long-term programs this cost is usually unsustainable. For that reason, most nonemergency CTC programs employ few if any paid outreach workers.

During the development of CTC, even for emergency programs, our focus has progressively moved away from paid outreach workers toward a more volunteer-orientated system. Finding and treating cases of acute malnutrition is usually a traditional function of informal community support mechanisms, and the introduction of a paid system can undermine this, creating problems over the longer term. We have found in several emergency programs that a volunteer system can produce rapid coverage without eroding vital informal support mechanisms.

Combining outreach workers and volunteers. There are some potential drawbacks to working exclusively with volunteers. The volunteers’ agricultural or other income-generating activities often limit the extent of

their involvement, and they may be less accountable to the program because they are not on the payroll. In practice, combining volunteers with a very few paid outreach workers is often an appropriate solution, particularly at the start of programs. In humanitarian responses, this combination usually facilitates a more rapid expansion of the program and its coverage. In larger developmental programs, mobile outreach workers can be responsible for a large catchment area, while volunteers cover smaller areas and communities. For example, it is often more feasible to engage women as volunteers at a village level while paid outreach workers cover larger areas, facilitating coordination and providing volunteers with a focal person with whom to discuss issues arising from their work or the community. In other situations, such as urban settings, where volunteers and paid outreach workers potentially come from the same communities, a combination of the two might be more difficult and could have the potential to promote conflict. In these settings, a volunteer-only model or an extension-worker model might be more appropriate. Context-specific sociological enquiry will be needed to make appropriate decisions. Our experiences suggest that even if paid outreach workers are used in larger numbers at the start, the program should move toward community volunteers as the mainstay of case-finding as soon as possible. In longer-term programming, a primarily volunteer system is often feasible from the outset.

The system for active case-finding through outreach workers and/or volunteers can also serve to follow up absentees and defaulters from OTP and SFP programs. This strategy has been tried successfully in several CTC programs.

Case-finding using focal points

Individuals in each village or cluster of villages can function as focal points to identify cases and be a link between the community and the program. Working with village focal points is a particularly useful approach in situations where the mobility of outreach workers and volunteers is limited, for instance by insecurity, geography, or logistic constraints. Contact between the program and a focal point in an isolated community can be maintained by exchange of messages in circumstances in which outreach workers and volunteers would have little or no access. When identifying people as focal points, consideration should be given to existing community members and structures and to dealing with health (e.g., traditional practitioners and village health committees) and the possible social implications of adding additional people to this system.

General considerations

Certain challenges are common in case-finding; the following are the most important.

Confusion about entry criteria. MUAC is often used to screen people for referral to OTP access points, where they are screened again for admission according to weight-for-height. In such cases, it is possible that people referred to OTP are not admitted because they do not meet the WHM criteria. This can cause hostility toward outreach workers and volunteers and refusal by mothers to comply with future referrals. To date, this has been the most common source of friction between CTC programs and beneficiary communities. In a system that uses both WHM and MUAC, case-finders (outreach workers or volunteers) should be trained to explain to caregivers that referral does not guarantee entry into the program. Our experience is that it is helpful to provide some form of compensation to the caregivers of children who are not admitted. This should be appropriate to the context and practical for the implementer—a bar of soap, for example. CTC programs are now moving toward MUAC criteria for both referral and admission in part to avoid this problem (see above).

Travel requirement. In widely dispersed communities, volunteers and outreach workers may have to travel long distances on foot each week to visit villages and individual houses. This needs careful consideration when the case-finding strategy is developed. Various factors have to be taken into account: the size of the area and nature of the terrain, the number of case finders involved, and the capacity of the implementing agency to reward them. In general, volunteer systems work best if volunteers are not asked to travel outside of their villages. It may be possible to combine existing mobile health workers, such as MCH coordinators, with outreach workers.

Coordination. In situations where many nongovernmental organizations are working in an area, volunteers may be working alongside other volunteers who are supported by a different agency. This is particularly common in large emergency responses. Approaches to active case-finding should be coordinated to avoid counterproductive activity and conflicting messages. For example, a strategy based on unpaid volunteer case finders can be threatened if a neighboring agency introduces payment, as unpaid volunteers are likely to be discouraged and demotivated.

Communities during humanitarian interventions. The concept of “community” in CTC is that of people that identify themselves with common ideas, beliefs, and practices. In practice, the sense of community is based more upon internal factors such as shared ideas and relationships than it is upon external manifestation such as home villages, landmarks, cultural sites, etc. The evidence for Darfur clearly demonstrates that communities, in this broad sense, can endure social disruption, and if appropriately approached, they can potentially be incorporated into community-based responses [33].

Protocols and procedures

Selection of patients for outpatient therapeutic care

Outpatient care for severe acute malnutrition

There is now good evidence that severely malnourished children who are not suffering from additional serious medical complications can be successfully treated with outpatient therapeutic care alone. Monitoring data presented in **table 2** demonstrate that 76% of cases of severely malnourished children (defined according to criteria of < 70% WHM [7] or MUAC < 110 mm), presenting to the first 21 CTC programs operating in Malawi, Ethiopia, Sudan, and Niger, received only outpatient care. The overall outcomes from these programs exceeded all international standards and were better than those obtained in the only comparable series of severely malnourished children treated at more conventional therapeutic feeding centers (TFCs) [34].

More detailed data are now available from an analysis of the clinical record cards of the first 1,400 severely malnourished children admitted into the CTC program in Dowa District, Malawi. The Dowa program was set up in June 2002 as a humanitarian program implemented by Concern Worldwide and the Ministry of Health. Initially the program tried to follow the Malawi national protocols that stipulated inpatient care for all severely malnourished children. At the same time, the program implemented a policy of early discharge and outpatient treatment in the recovery phase. However, the inputs into community mobilization soon increased program coverage to over 70%, and this high coverage resulted in many more severely malnourished children presenting to the program than could be treated by the inpatient capacity available in Dowa. Therefore, the program was forced to treat a substantial number of severely malnourished children solely as outpatients. In addition, many caregivers, aware that there was outpatient treatment available, refused admission into the inpatient centers.

Table 6 presents the outcomes of children suffering from severe malnutrition, disaggregated according to whether they received only outpatient treatment or a combination of initial inpatient treatment followed

by early discharge into outpatient treatment. A direct comparison between these two groups is inappropriate, since the children admitted into inpatient care were usually those whom the staff considered to be most sick. However, **table 6** clearly demonstrates that severely malnourished children, including those with grade 1 or 2 edema, who are not suffering from additional serious medical complications can be treated successfully with outpatient treatment alone.

Classification of acute malnutrition

The addition into international protocols of the outpatient treatment for severe acute malnutrition without an inpatient initial phase for stabilization requires a change to the existing WHO classification of acute malnutrition. The existing WHO classification has only two categories: severe malnutrition and moderate malnutrition, defined according to anthropometry and the presence of bilateral pitting edema. This classification was operationally useful when there were only two modes of treatment available: inpatient therapeutic care for people with severe acute malnutrition and outpatient supplementary feeding for those with moderate acute malnutrition. However, the addition of a new mode of outpatient treatment for the severely malnourished requires the division of the severe acute malnutrition category into either “severe acute malnutrition *without* complications” for severely malnourished patients who can be treated successfully using outpatient treatment alone, or “severe acute malnutrition *with* complications” for those who require inpatient treatment [35]. The moderate classification remains the same. This revised classification as it applies to severe acute malnutrition is presented in **figure 7**.

In community-based programs, this division of severe acute malnutrition is important to provide a basis for patient flow through the system and for guiding staff in their decision whether a patient needs inpatient or outpatient treatment. The additional “severe acute malnutrition *without* complications” category, combined with direct admission into outpatient therapeutic programs, avoids many possible negative consequences for patients and the program. If patients with “severe acute malnutrition *without* complications” are

TABLE 6. Outcomes (percentage of children) from clinical cards for first 1,400 severely malnourished children treated in Dowa CTC (N = 1,400)

Outcome	All ^a		Edema +		Edema ++		Edema +++		No edema	
	Direct (n = 347)	Indirect (n = 1,053)	Direct (n = 138)	Indirect (n = 94)	Direct (n = 31)	Indirect (n = 335)	Direct (n = 0)	Indirect (n = 258)	Direct (n = 19)	Indirect (n = 69)
Recovered	85.3	84.0	83.3	81.9	90.3	86.3		82.6	68.4	82.6
Defaulted	12.7	8.4	15.2	10.6	6.5	8.7		7.4	21.1	4.3
Died	2.0	7.7	1.4	7.4	3.2	5.1		10.1	10.5	13.0

CTC, community-based therapeutic care

+ = grade 1; ++ = grade 2; +++ = grade 3

a. Includes children diagnosed as having edema but where grade of edema was not specified

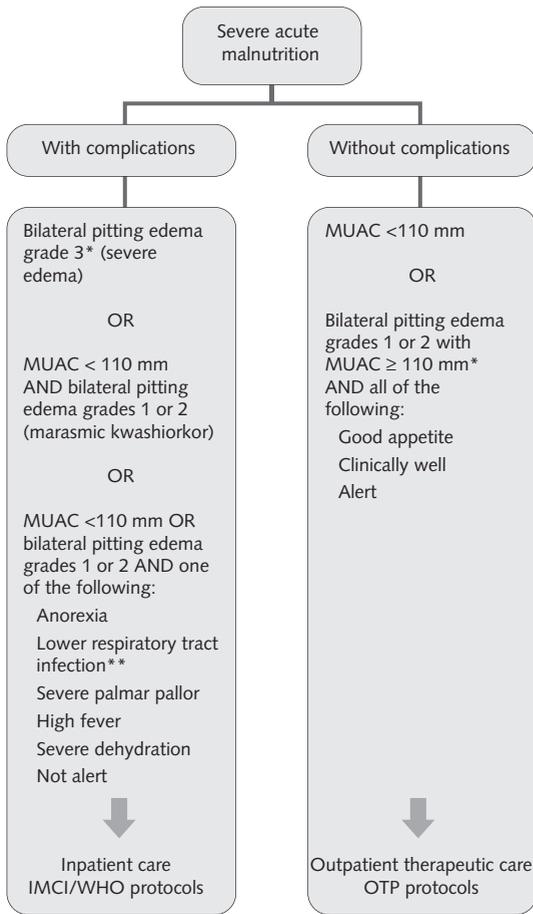


FIG. 7. Classification of severe acute malnutrition used in CTC programs for children between 6 and 59 months of age or 65 to 110 cm in height as a proxy of age. OTP, outpatient therapeutic program

admitted into inpatient centers, they are unnecessarily exposed to additional risk of infections. The caregiver, usually the mother, has to spend a substantial period away from her family, including her other children. This may result in increased malnutrition among the other children and undermine the economic activity and food security of the household. It is also usually unpopular with people and discourages early presentation and encourages default. The inappropriate use of inpatient care also has important resource implications, with space and resources in resource-intensive inpatient centers allocated to patients who do not need inpatient care, thereby reducing the program's impact and increasing its costs. On the other hand, if cases of

* Grade 1 is mild edema on both feet and ankles; grade 2 is moderate edema on both feet and lower legs, hands, or lower arms; grade 3 is severe, generalized edema, including both feet, legs, hands, arms, and face.

** Integrated Management of Childhood Illness (IMCI) criteria for the diagnosis of LRTI are listed in table 10.

severe acute malnutrition *with* complications are not admitted into inpatient care, morbidity and mortality will increase.

This classification will help harmonize the criteria for severe acute malnutrition used in humanitarian therapeutic feeding programs with those included in the integrated management of childhood illness (IMCI) guidelines for more stable situations. At present, there are marked discrepancies between humanitarian practice as recommended by the WHO and the IMCI guidelines. Humanitarian guidelines use WHM (or z-scores) and presence of edema as criteria for admission into therapeutic feeding. By contrast, WHM has never been recommended by the WHO for community screening. Instead, the IMCI guidelines assess weight-for-age but base admission into hospital upon the presence of “visible severe wasting,” severe palmar pallor, or edema of both feet. Attempts have been made to introduce WHM into community screening [36], but these have never been widely accepted. The classification in figure 7 will not only improve the sensitivity and specificity with which those requiring specialized support are chosen, it will also simplify the interface between humanitarian and developmental programs and decrease confusion between WHM and WFA among primary health-care workers and the people they serve. This will help reduce barriers to the integration of humanitarian programs with ongoing primary health care and should improve continuity between humanitarian responses and ongoing Ministry of Health services. Replacing “visible severe wasting” with a more quantifiable MUAC <110 mm criterion will also improve discriminatory power and decrease subjectivity in the referral of severely malnourished patients into treatment programs. Edema occurs in both this classification and the IMCI criteria. The only change is to include moderate edema (grades 1 and 2) as a criterion for outpatient programs and only severe edema (grade 3) as a criterion for inpatient admission.

Protocol and procedures for OTP

OTP provides treatment and rehabilitation for children with severe malnutrition and with no additional serious medical complications (see fig. 7). Depending on the effectiveness of the community mobilization, active case-finding, and the public health environment where the program is operating, the proportion of children with severe acute malnutrition who present at a stage when they require inpatient care is only 10% to 15%. This means that in a well-designed program, approximately 85% to 90% of severely malnourished children presenting for treatment can be admitted directly into the OTP and treated solely on an outpatient basis. The other 10% to 15% require initial inpatient care before being discharged into the OTP during the recovery phase (see below). Our experiences indicate that the

proportion of cases that can be successfully treated as outpatients is directly related to the quality of mobilization and active case-finding.

Patients in the OTP receive routine medicines for severe malnutrition and 200 kcal/kg/day of RUTF to eat at home. They attend the OTP every week or every 2 weeks for a medical checkup, to receive additional medical treatments if needed, and to receive a supply of RUTF to last until their next appointment.

Planning

An OTP is implemented through multiple decentralized access points. Existing health structures are appropriate and are used wherever possible. If these do not exist, an OTP can be run from a temporary shelter under a tree or in a community building, potentially in coordination with mobile EPI or MCH clinics. It is important that the site and timing of OTP clinics be made in consultation with the target population (see above).

The basic OTP protocols are very simple. They involve basic clinical assessment and the prescription of oral antibiotics and require a clinical staff member, ideally a nurse. Our experience is that most nurses can become proficient in implementing the protocols with 1 or 2 days of formal training, supplemented by initial on-the-job support and mentoring. Supervisory visits should be built into the monitoring and management schedules for new areas starting OTP. If numbers are high, in particular during emergencies and at program start-up, additional support staff will be needed to perform height and weight measurements, treat children, and supervise the program. This support is most easily provided by a dedicated mobile team that rotates around OTP distribution sites. The move away from

the use of WHM toward the use of only MUAC for screening and admission criteria will greatly simplify the implementation of OTP and substantially reduce staff requirements.

During a nutritional emergency, the OTP should always be run alongside an SFP. The OTP and SFP should be close to each other but separated sufficiently to avoid the OTPs being disturbed by crowds attending the SFP.

Treatment protocols

Admission criteria. The initial CTC programs used admission criteria based on WHM, MUAC and the presence of bilateral pitting edema. However, more recently in order to improve the admission and screening procedures and facilitate community mobilization (see above), we abandoned the use of WHM in favor of the OTP admission criteria presented in **table 7**.

Before admission, all patients are assessed by a clinically trained health worker. This assessment includes a history of the presenting condition taken from the mother or caregiver and a medical examination to rule out complications that require inpatient care. The examination includes checks for edema, appetite, vomiting, temperature, respiration rate, anemia, superficial infections, alertness, and hydration status. The appetite is assessed by giving the child some RUTF to try and seeing whether the child eats it freely. Care should be taken to provide sufficient time and a calm environment to allow the child to try the RUTF in his or her own time. This may take some time, but it is a vital step in the process of deciding whether the child is suitable for direct admission into outpatient care. The health worker must observe the child eating the

TABLE 7. OTP admission criteria

New admissions: children 6–59 mo old or height 65–110 cm as a proxy of age	MUAC < 110 mm Bilateral edema grade + or ++ AND MUAC > 110 mm Do not meet SC admission criteria
Other admissions	Admissions that do not fulfill above criteria (e.g., teenagers, adults) or anthropometric criteria for admission (e.g., second twin ^a , clinically very wasted, moderate cases with complications and needing closer monitoring in OTP after stabilization)
Choice	Caregiver refuses inpatient care despite advice (though these are treated as new admissions)
Inpatient discharges	From inpatient care (SC/TFC/NRU/hospital) after “stabilization” treatment ^b
Readmission/relapse	Previously discharged cured and again fulfils OTP criteria.
Returned	After defaulting from OTP ^c

OTP, outpatient therapeutic program; MUAC, mid-upper-arm circumference; SC, stabilization center; TFC, therapeutic feeding center; NRU, nutrition rehabilitation unit; RUTF, ready-to-use therapeutic food

a. In the case of twins when one is severely acutely malnourished and the other is not, both should be registered and admitted to the OTP, because sharing between the twins can be assumed. The nonmalnourished twin should be given RUTF but not the routine medicines.

b. In addition, infants less than 6 months of age who have been discharged from the SC can be admitted to the OTP in this category so that their weight and general medical condition can continue to be monitored. They do not, however, receive RUTF.

c. Returned defaulters are admitted back into the program to complete their treatment if, on return, they have not yet reached the criteria for discharge from the OTP.

RUTF before the child can be accepted for outpatient treatment. A child who continues to refuse to eat is referred for inpatient care until appetite returns. The child's appetite should be tested at all subsequent OTP appointments.

All information from the medical check is recorded on the child's OTP card (an example is given in **annex 1**). Children who have no major medical complications and are able to eat the RUTF are admitted directly into the OTP.

Nutritional treatment. OTP provides 200 kcal/kg/day of RUTF to each patient. The caregiver is taught to give RUTF to the child in small amounts frequently (up to eight times a day). Health workers emphasize the need for the child to consume the entire RUTF ration before eating other foods. If the mother is still breastfeeding, she is advised to give the RUTF after breastmilk. Health workers emphasize that the RUTF is both a medicine and a food that is vital for the recovery of the child. They also explain that children who are eating RUTF must be given water to keep them adequately hydrated (see **annex 2**).

In humanitarian programs, a ration of corn-soya blend (CSB) flour is also given to the caregiver. CSB is provided not for the severely malnourished child, but for the other children in the family, to minimize sharing of the RUTF. CSB is provided every 2 weeks as part of the supplementary feeding program; the amount may vary from 1,000 to 1,200 kcal per beneficiary.

Evidence is now emerging that in stable situations this supplementary ration is not necessary. The Malawi and Ethiopian CTC programs were both started as emergency programs combined with an SFP and a CSB ration for the caregivers; however, during the transition to longer-term programs within the primary health-care infrastructure, these supplementary rations have been stopped. **Tables 5** and **6** indicate that both programs have maintained their recovery rates after the end of this ration, and coverage rates have also remained high. In developmental situations where there are not high levels of food insecurity we now recommend implementing OTP in the absence of supplementary rations. In humanitarian programs designed to serve highly food-insecure populations, we continue to provide supplementary rations.

Medical treatment. Routine medicines are given to all children admitted to the OTP. Treatment is based on the principles of inpatient treatment, using the drugs available on the Essential Drug List in the country of operation (see **annex 3**). The protocol has been adapted so that, where possible, medicines are given as a single-dose treatment. This helps to avoid problems with compliance. For drugs such as amoxicillin or sulfadoxine and pyrimethamine (Fansidar) that require more than one dose, the first dose is given in front of the health worker, and the remaining doses are given by the mother at home.

Health education. The OTP provides an opportunity to talk over important health messages with clients. When a child is first admitted to the program, it is essential to ensure that information about how to give RUTF, how to take the antibiotic at home, and basic hygiene are understood by the main caregiver. We have developed some key messages, which are presented in **annex 2**. To avoid overloading the caregiver with new information, no other health education messages are given on the first visit. Where ever possible, soap is given to all OTP caregivers every 2 weeks to facilitate hygiene, in particular hand washing before feeding RUTF.

Discharge criteria. We previously based OTP discharge criteria on WHM, the absence of edema, and a good clinical condition. However, the WHM criterion proved problematic for those few children who were admitted because of MUAC less than 110 mm but who had on admission a WHM of more than 80%. We discharged these children after a minimum stay of 2 months when they were clinically well and edema was absent. The move to admission criteria based on MUAC alone requires that the previous WFM discharge criteria be changed across all CTC programs. At present, we propose a system based on weight, absence of edema, length of stay in the program, and clinical condition (**table 8**). Using only weight to monitor and discharge patients is easier than including height; it removes any confusion caused by using a different indicator than what is used in longer term growth monitoring programs, and it requires only a set of scales.

Percentage weight gain discharge criterion. An alternative discharge criterion that also requires only weight to be monitored is the percentage weight gain: (current weight – weight at admission)/weight at admission $\times 100$. With this approach, patients would be discharged once their percentage weight gain exceeded a cut off value based on their weight at admission (or lowest weight after loss of edema for patients presenting with marasmic kwashiorkor). Preliminary analysis of data from CTC programs in Malawi and Ethiopia suggests that a cut off value of 15% would result in approximately 50% of discharges meeting or exceeding 80% of the W/H reference median and that a cut off value of 18% would result in approximately 50% of discharges meeting or exceeding 85% of the W/H reference median. Percentage weight gain could be combined with a MUAC cutoff. For example: discharge as cured if MUAC ≥ 115 mm AND percentage weight gain $\geq 15\%$. The calculation of percentage weight gain could be simplified by the use of a look-up table (see Myatt et al., this issue, pp. S7–23).

Fixed length of stay discharge criterion. There are aspects of CTC programs (e.g., the concentration on maximizing program coverage and community-based delivery of services) that are more typical of "public health" or "mass treatment" interventions than tradi-

tional center-based models of service delivery. In such interventions, adherence to stringent technical standards, service delivery, and the achievement of high coverage take precedence over individual responses to the delivered intervention. From this perspective, it may be reasonable to adopt a fixed length of treatment for CTC programs. This approach does not differ much from current practice in programs using W/H or edema for admission. In such programs, patients admitted with edema but with a W/H percentage of median above 80% are, typically, retained in the program for a fixed

period after loss of edema. Preliminary analysis of data from CTC programs in Malawi and Ethiopia suggests that an episode length of 60 days would result in approximately 50% of discharged patients achieving at least a 15% weight gain at discharge.

A comparison of potential discharge criteria is presented in **table 9**. As data from CTC programs become available, it will be possible to refine discharge criteria. It is likely that a combination of the above will prove suitable for discharge criteria.

TABLE 8. Current OTP discharge criteria

Discharged cured	Minimum stay of 2 mo in the program, MUAC >110 mm, no edema for a minimum of 2 wk, evidence of sustained weight gain ^a , and patient is “clinically well” ^b
Defaulted	Absent for 3 consecutive weeks ^c
Died	Died during time registered in OTP
Transferred to inpatient care	Condition has deteriorated and requires inpatient therapeutic (SC/TFC/NRU) or hospital care
Nonrecovered	Has not reached discharge criteria after a minimum of 4 mo in OTP if weight is stable and all available treatment options (e.g., home visits, inpatient stabilization, hospitalization, ART programs, tuberculosis treatment programs) have been pursued ^d

OTP, outpatient therapeutic program; MUAC, mid-upper-arm circumference; SC, stabilization center; TFC, therapeutic feeding center; NRU, nutrition rehabilitation unit; ART, antiretroviral treatment; SFP, supplementary feeding program

- Sustained weight gain is a gain in weight every week for 3 consecutive weeks. In humanitarian programs, all OTP discharges are sent to the SFP where they stay for a minimum of 2 months (longer if they have not attained the SFP discharge criteria by that time).
- Where an SFP is included, all OTP discharges should be sent to the SFP, where they stay for a minimum of 2 months (longer if they have not attained the SFP discharge criteria by that time).
- After the second “no show,” potential defaulters should be followed up by a home visit to ascertain the reasons for the absence.
- Before this time, children must have been followed up at home and, where possible, should have been transferred to SC inpatient care for investigation. An OTP action protocol helps health workers identify reasons for nonresponse (see **annex 4**). Discharged nonrecovered children should be sent to the SFP if this is in operation. When possible, they should be put in contact with community-based support organizations operating in their villages. They can be readmitted to the OTP if they fulfill entry criteria again and are therefore once more at high risk of death.

TABLE 9. Comparison of discharge criteria for MUAC-only admission

Criterion	Positive	Negative
Fixed length of stay	Easy to do—no calculation or numeracy required No equipment needed Can evolve with CTC into a more public health approach (i.e., community-run, flexible where access is poor)	Need to elaborate for children with HIV who recover slowly Discharge is not linked to response to the treatment
Percent weight gain	Discharge is linked to the response to treatment Standard for all admissions—no elaboration needed for children with HIV Weight is being monitored anyway for calculation of RUTF, drugs, and clinical monitoring	Requires numeracy
Minimum length of stay with percent weight gain and MUAC barrier	Allows sufficient time for immune recovery Makes sure children are out of the high-risk category for MUAC Acts as an “alert” for children not discharged at end of minimum length of stay period (to trigger further investigations)	Requires numeracy to calculate percent weight gain Requires another MUAC cutoff on bands Will increase length of stay for some children and therefore increase average length of stay for the program.

MUAC, mid-upper-arm circumference; CTC, community-based therapeutic care; HIV, human immunodeficiency virus; RUTF, ready-to-use therapeutic food

Follow-up

Children's progress is monitored on a weekly basis at the distribution site. If access is difficult or the capacity of health services is limited, monitoring may be carried out on a fortnightly basis. CTC experience to date has found that routine home follow-up between clinic visits is not required to achieve good program outcomes. However, follow-up is necessary for children who are losing weight or whose medical condition is deteriorating, children whose caregivers have refused admission to the SC, and for children during the first 2 weeks after admission into the OTP. The need for follow-up is identified by the health worker after discussion with the caregiver. The health worker liaises with outreach workers or volunteers (by direct contact or by sending a message) to arrange a home visit to children in these high-risk groups. Action protocols for use in the OTP clinic and by outreach workers, designed to formalize this process, are presented in **annex 4**.

All absences in OTP should be followed up by outreach teams, volunteers, or key community figures. It is important to gain an understanding of the reason for absence and to encourage return. The absentee should not be reprimanded, as this can discourage return.

Detection and management of nonresponders. The OTP action protocol (see **annex 4**) is used to help health workers decide action that needs to be taken for those children who are not responding to treatment. Action includes assessment of both the child's medical condition and the child's care environment. When additional medical investigation and treatment seems necessary, children are referred, whenever possible, to a district/tertiary-level health facility. When an adequate social/care environment for recovery is lacking, the CTC approach actively encourages links between the CTC program and other sectors, such as general food distribution, health education, home-based treatment for HIV/AIDS, food security, and water and sanitation.

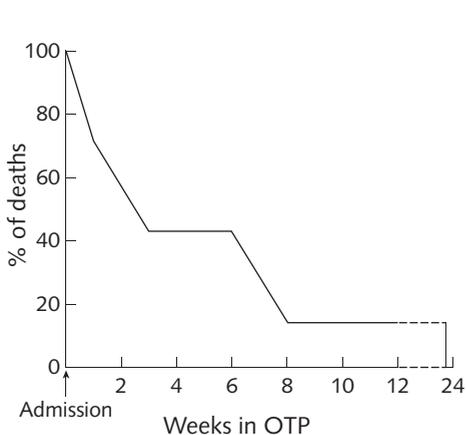


FIG. 8. Timing of deaths after direct admission into outpatient therapeutic program (OTP) in Dowa, Malawi ($n = 7$)

Advocacy for beneficiaries to be enrolled in general ration programs for example, can form an important part of ensuring that the social, care, and food-security environment at home supports nutritional recovery. Information gained from caregivers in the OTP program may help those providing social, food, and agricultural support to understand the needs of the population in the area.

Children during the first 2 weeks after admission into the OTP. The monitoring data presented in **table 2** and the OTP outcome data from Malawi indicate that among children under 5 years of age, who were acutely malnourished (according to standard WHO criteria) but not suffering from severe medical complications, mortality in OTP is in the region of 2%. In Malawi, among the first 1900 clinical records analyzed to date, 9 out of 409 children (2.2%) directly admitted to OTP died. Approximately half of these deaths occurred in the first 2 weeks after admission. These data are presented in the Kaplan–Meier plot in **figure 8**.

In Malawi, 30 out of 941 children (3.2%) discharged from the SC into the OTP died. Twelve (40%) of these deaths occurred in the first week after discharge from the SC. These data are presented in the Kaplan–Meier plot in **figure 9**.

These data are difficult to interpret, as there are many unknowns. The causes of death in the OTP, the proportion of patients who were voluntarily discharged from the SC when caregivers took very sick children home to die, the proportion of deaths that could have been avoided with more prolonged inpatient care in the SC, and the proportion of children who would have acquired infections and died had they been kept longer in the SC are all unknown. It is clear, however, that mortality tends to occur in the first 4 weeks after discharge from the SC to the OTP and thereafter is extremely low. This has implications for follow-up, and the CTC action protocol (see **annex 4**) now indicates

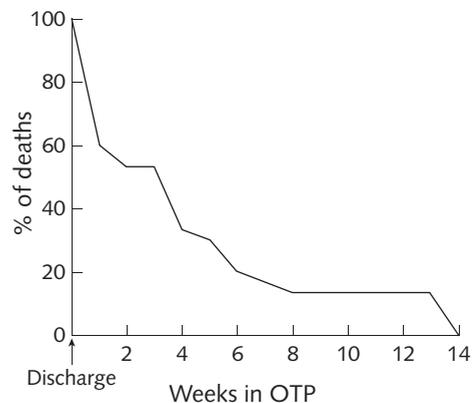


FIG. 9. Timing of deaths after early discharge from the stabilization center (SC) into outpatient therapeutic program (OTP) in Dowa, Malawi ($n = 30$)

that all children must be followed up at home during the first 2 weeks after discharge from inpatient care. Ideally, CTC programs should allocate all OTP admissions to the care of named community volunteers or outreach workers and develop a structured plan for their follow-up during the first 2 weeks in the OTP.

Follow-up after discharge. Follow-up after discharge from a CTC program is not routinely done. However, a study in Malawi found that most children discharged from the Dowa CTC program maintained their nutritional status approximately a year after discharge. In this study, 1,490 eligible families were contacted approximately a year after the child was discharged from the program. The median time between discharge and the invitation to participate in the study was 15.5 months (inter quartile range, 10.5–23.3). At follow-up, 148 of these children did not appear, the families of another 99 children refused to participate in the study, and 69 children (4.6%) had died. Very few of the 1,102 HIV-negative children re-measured had relapsed into acute malnutrition: 2% had a WFH less than 80% of the National Center for Health Statistics (NCHS) median, 0.6% had edema, and 7.8% a MUAC less than 125 mm. In contrast, a greater proportion of the 28 HIV-positive children had relapsed into acute malnutrition; 14% had had a WFH less than 80% of the NCHS median, 7.1% had edema, and 32.1% had a MUAC less than 125 mm.* As programs move toward routine HIV testing, a system of structured follow-up post discharge should be instituted for all patients who are HIV positive.

Protocol and procedures for stabilization care

In programs with effective mobilization and active case-finding, around 10% to 15% of children presenting with severe acute malnutrition require inpatient care. This ability of community-based programs to reduce the proportion of cases requiring inpatient admission is a major benefit of community-based models. It means that inpatient units can remain small (we try to limit them to a maximum of 30 patients), staff in these units can devote more attention to their patients, the problems of hygiene and cross-infection are decreased, and the infrastructural and staffing demands are greatly reduced. Avoiding the necessity of inpatient care has also proved to be extremely popular among most program clients [37].

Children admitted into the inpatient element of CTC programs, the SC, receive phase 1 inpatient care that follows closely the treatment guidelines laid out by the World Health Organization [7]. The admission and

discharge criteria and transition protocols are the only substantive differences.

Admission and discharge criteria for the inpatient stabilization phase

Admission criteria. Patients are admitted to the inpatient stabilization phase either directly or, more commonly, by referral from the OTP because of severe malnutrition with complications or from the SFP because of moderate malnutrition with medical complications. As with the admission criteria for OTP, the criteria for SCs are now moving away from WHM in favor of MUAC only. These are presented in **table 10**.

Discharge criteria. Appetite is the main indicator that determines when a child is ready to move out of inpatient care. As detailed in the WHO manual, the return of appetite indicates that infections are under control, the liver is able to metabolize the diet, and other metabolic abnormalities are improving. This usually occurs after 2 to 7 days [7]. Children make the transition to RUTF directly from F75 without the use of F100. The process takes approximately 2 days: the first day to get the child used to eating the RUTF, the second day to assess and ensure that the child is eating at least 75% of the prescribed quantity of RUTE. Discharge criteria from SC are presented in **table 11**.

At discharge, the child and caregiver are advised to return to their nearest OTP access point after 1 week and given a ration of 200 kcal/kg/day to last them until their next OTP appointment. They are also given any remaining medications and instructions on how to use them. Key education messages regarding the correct use of RUTF and basic hygiene are discussed with the caregiver (see **annex 2**).

Monitoring and evaluation

CTC programs collect data to monitor the treatment of individuals, the appropriateness of the program design, the effectiveness of the program, and the coverage of the program. These data consist of quantitative data on patient outcomes and program coverage and qualitative data taken from consultation with affected communities and stakeholders at various stages of the program. The aim of this monitoring is to provide useful information that can form the basis for decisions to adjust program design to better tailor implementation to the context-specific factors. We do not discuss the requirements for monitoring of materials, drugs, staff time, etc., as these do not differ from standard primary health-care programs.

As CTC integrates with existing health services, most data will be collected by busy front-line health staff and analyzed by district health offices before being fed back to the front-line clinics. Data requirements must therefore be as simple as possible and easy to manage if data are to be collected accurately. Systems need to

* Bahwere P, Joshua MC, Sadler K, Tanner C, Piwoz E, Guerrero S, Collins S. Integrating HIV services into a community-based therapeutic care (CTC) programme in Malawi: an operational research study. 2005. Unpublished work.

TABLE 10. SC admission criteria

New admissions: children 6–59 mo old or height 65–110 cm as a proxy of age	Anthropometry/edema	Bilateral pitting edema grade +++ (severe edema) Edema grade + or ++ AND no appetite/severe medical complications (see below)
		MUAC < 110 mm AND bilateral pitting edema grades + or ++ (marasmic kwashiorkor)
		MUAC < 110 mm OR bilateral pitting edema grades + or ++ ^a and no appetite/severe medical complications (see below).
	Appetite	No appetite or unable to eat test dose of RUTF
	Severe medical complications	Intractable vomiting
		Fever > 39°C or hypothermia < 35°C
		Lower respiratory tract infection according to IMCI guidelines for age: 60 breaths/min for < 2 mo 50 breaths/min for 2–12 mo 40 breaths/min for 1 to 5 yr 30 breaths/min for > 5 yr
		Any chest indrawing
		Severe anemia (severe palmar pallor)
		Extensive superficial infection requiring IM treatment
Very weak, apathetic, unconscious, convulsions		
Severe dehydration based on history and clinical signs		
Choice	Caregiver refuses outpatient care	
Referral ^b	From OTP due to: Deterioration in medical condition Increase in edema Weight loss 3 wk or static weight 5 wk Nonrecovery after 3 mo in OTP	
Readmission/relapse	Previously discharged and again fulfils criteria	

SC, stabilization center; MUAC, mid-upper-arm circumference; RUTF, ready-to-use therapeutic food; IMCI, integrated management of childhood illness; IM, intramuscular; OTP, outpatient therapeutic program; CTC, community-based therapeutic care

+ = grade 1; ++ = grade 2; +++ = grade 3

a. When CTC programs include supplementary feeding for children with moderate acute malnutrition, children with MUAC < 125 mm and medical complications are admitted to inpatient care. Moderately malnourished children admitted because of additional medical complications are treated according to IMCI protocols and do not receive the standard WHO protocols for severe acute malnutrition. They do receive RUTF.

b. Transfer is according to the Action Protocol for OTP (see **annex 4**). Before admission, the reasons for nonrecovery in the OTP should be investigated by discussion with the caregiver at the program site and home visits by the outreach team.

TABLE 11. SC discharge criteria

Appetite ^a	Good (eats at least 75% of RUTF)
Medical complications ^b	Controlled
Edema	Resolving

SC, stabilization center; RUTF, ready-to-use therapeutic food

a. Appetite is assessed by feeding RUTF to the child over one day. It is considered to be “good” when the child is eating at least 75% of the prescribed quantity of RUTF for his or her body weight.

b. When the condition is chronic, the symptoms should be controlled by appropriate medical treatment in the outpatient setting.

be designed to minimize the demands placed on program staff while providing sufficient information for essential monitoring.

Monitoring individual treatment

In a CTC program, children move between the components (SC, OTP, and SFP) as their condition improves or deteriorates. They may also move between the decentralized OTP (and SFP) distribution sites if, for example, a new site is opened closer to a child’s home or if the population is mobile. It is therefore important to be able to track children between the program components and distribution sites. To allow this, the links between the SC, OTP, SFP and distribution sites have to be well managed.

Once a patient is in the program, health workers monitor individual patient progress, including data on clinical examinations, reported illness, medicines received, anthropometric measurements, appetite, attendance, and follow-up. In addition, there are action protocols for referral and follow-up visits to ensure that a child's progress is monitored in a structured way and that specific problems trigger an appropriate response.

The following are important elements in the system to track and monitor individuals:

- » Clear, systematic patient identification numbering;
- » Simple recording of routine medical, nutritional, and follow-up data kept in the OTP clinic filing system;
- » Mechanisms in place for regular review of clinical record cards;
- » Effective channels for the exchange of information on individual children between components and between the program and the community.

Patient monitoring cards

CTC Clinical Record Cards and Ration Cards are used to monitor individuals within the program. A sample clinical record card is shown in **annex 1**. The clinical record cards are kept at the OTP site where the child is treated so that they can be referred to if the child returns to the site outside distribution days. The OTP clinics store the cards in the following groups:

- » Patients attending the program;
- » Transfers awaiting return. This ensures that transfers are not overlooked and that follow-up takes place if they do not return. On return, monitoring continues with the use of the same card;
- » Defaulters awaiting return. On return, monitoring can continue on the same card;
- » Recovered patients. The cards of children who have recovered are usually kept separately because they are so many. It is useful to have these at the site to check the records of any relapses.
- » Deaths.

Health workers should examine the clinical cards at monthly meetings to identify children with static weight, weight loss or those not recovered after three months. In cases of nonresponse, they should combine this clinical information with social data obtained from home visits to the patient's house. These meetings should also include a review of deaths occurring in the OTP and SC in order to identify problems in the use of treatment and action protocols. These can be used as teaching examples to improve practice and may also be used to identify the need to modify protocols.

Each caregiver receives a ration card to take home. This contains important information about the child and his or her progress in the program (weight, height, ration received). This is the caregiver's record of the child's progress in the program. It can be presented at any clinic visit to inform health workers of the child's

progress.

A system should be set up to ensure that each patient receives a unique registration number when he or she is first admitted into the SFP, OTP, or SC. To ensure that children at greatest risk (cases of acute malnutrition with complications and severe acute malnutrition) can be tracked, children admitted into the SC and OTP retain their full number as they are transferred between program elements until they are finally discharged from the CTC program. The number does not change, even when the patient is admitted to an SFP during the final stage of the path to recovery or relapses in the OTP and is referred to a SC. By contrast, in humanitarian programs implementing an SFP, a child who enters the program at the SFP and whose condition deteriorates is allocated a new number when he or she is admitted to the OTP or SC.

To facilitate tracing and follow-up in the community, all access points where patients enter the program should follow this numbering system. The number should be quoted on all records concerning the child, i.e., on SC, OTP, and SFP cards and registration books, ration cards, transfer slips, and identity bracelets.

Identity bracelets

On admission to the CTC, all children should receive an identity bracelet with their patient number written in indelible ink. The bracelet is cut off and destroyed upon discharge.

Exchange of information

It is important that the system be able to easily exchange information on individual children between the different elements and between the program and the community.

Transfers to inpatient care. Contact between program components (often managed by different agencies) needs to be established to ensure that children are admitted and referred with adequate information to ensure correct medical and nutritional treatment.

SC deaths and defaulters. If a child is transferred from OTP to SC, his or her card remains in the OTP file. If that child does not return to the OTP site after 1 to 2 weeks, information should be sought from the SC team where possible, or through outreach workers or volunteers visiting the child's home. If a child dies in the SC or defaults, the SC team should pass this information to the OTP site so that the card can be completed and the case recorded in the Therapeutic Program Report.

OTP absences and defaulters. Children who are absent or default from the OTP should be followed up by outreach workers or volunteers and the child and caregiver encouraged to return to complete treatment. If they do not return, the reason for defaulting should be recorded on the card to help health workers to understand the family's circumstances and avoid further absences. In

some cases, the information can help health workers to modify protocols (e.g., children to be allowed to attend every 2 weeks rather than weekly).

Deaths. If a child dies in the SFP, OTP, or SC, a record is kept of symptoms, suspected diagnosis (for OTP and SFP this is collected by outreach workers or volunteers), and management. This information should be recorded on the child's card, as it can help to identify problems in treatment and action protocols.

Nonrecovered patients: Information collected by outreach workers or volunteers during follow-up visits is important for the analysis of underlying causes of non-recovery. Information received by the health worker, along with that reported by the caregiver, should be recorded as additional information on the card. This is used for further discussion with the caregiver and to inform decisions about referral for further medical investigations.

Monitoring and increasing program appropriateness

Perception of the program by the target population and the clients should be monitored regularly and program design and implementation adjusted accordingly. This helps to match program delivery with consumer demand and concerns and has proved invaluable in many CTC programs for increasing coverage and decreasing default rates. Regular feedback strengthens the community's sense of ownership of the program and helps motivate volunteerism.

Two kinds of community-level monitoring can be used: focus group discussions and key informant interviews.

Focus group discussions

Focus group discussions involve small groups of unrelated people who are brought together to discuss specific topics. The interaction among participants is analyzed, and a record is made of individual opinions and collective ideas formed during debate. (Focus group discussions are not intended as a tool to rapidly conduct multiple interviews, develop consensus, or make decisions.)

Our experience suggests that community-based programs should consider using focus group discussions in the following situations:

- » There is a gap in communication or understanding between groups or categories of people, or between program staff and the target community;
- » Issues relating to complex behavior, motivation, or perceptions (e.g., traditional treatments for malnutrition) need to be unraveled and analyzed;
- » Ideas emerging from a group or community are needed;
- » Information is needed to prepare for a large-scale study (e.g., a nutrition or coverage survey or a socio-cultural study).

Focus group discussions should be avoided in the following situations:

- » The situation is emotionally charged, and the drawing out of information is likely to cause or intensify conflict (e.g., during intergroup conflict);
 - » The researcher cannot ensure the confidentiality of sensitive information;
 - » Statistical projections or numerical data are needed;
 - » Other methodologies can produce better information.
- Our experience indicates that focus group discussions are particularly useful to shed light on the following questions:
- » *Coverage:* whether there are individuals or groups in the community who could be in the program but are not; the reasons why and how this could be changed;
 - » *Access:* whether there are barriers preventing people from accessing the program and what might be done about them;
 - » *Recovery:* whether caregivers perceive changes in children treated in the program and whether anything can be done to strengthen the recovery process;
 - » *Service delivery:* whether beneficiaries are happy with the CTC services they receive and the means of delivery, and whether they could be improved;
 - » *Cultural appropriateness:* whether the program is culturally sensitive or doing anything inappropriate;
 - » *Lessons learned:* what should be done differently and what should be replicated in future programs.

Interviews with key community members

A more comprehensive picture of the community perspective is obtained by also conducting structured or semi-structured interviews with key community members. These key informant interviews can help to explore particular issues, often barriers to access and the ways in which community leaders and civil society can help to reach more people.

This combination of focus group discussions and key informant interviews can establish a feedback cycle in which community members can raise issues that are then taken to people in the program who can make changes. This feedback process helps to tailor the program to the context, strengthens community ownership, and in so doing helps maintain the positive feedback to communities that is necessary if a volunteer-based mobilization strategy is to become truly sustainable.

Monitoring and increasing program effectiveness

Routine program data

CTC programs monitor effectiveness through the collection, analysis, and presentation of quantitative process indicators on four areas of program activities:

- » Number of admissions disaggregated according to type of presentation (marasmus, kwashiorkor, etc.);

- » Number of exits disaggregated according to outcome;
- » Total number of patients in the program;
- » Average weight gain and length of stay.

It is important to keep data collection as simple as possible in order to allow busy primary health-care staff to implement the system. In our opinion, the above data represent the minimum information needed for effective program monitoring. However, in some circumstances, particularly humanitarian operations, it may be necessary to collect additional information on the gender or age distribution, place of origin, displaced versus resident status, whether the household is receiving general food distribution, etc., according to reporting needs and the context of the program.

These routine data are collected on a weekly basis and aggregated together in simple tally sheets that are compiled into weekly and monthly reports. During compilation, the data are reorganized so that new therapeutic admissions can be separated out to avoid double counting. Humanitarian programs tend to compile the tally sheets in a computerized database, and this has been extremely useful in the collection of the current evidence base on CTC. However, in developmental settings, manual compilations and basic graphs are as functional and more appropriate.

Categories and definitions

Admissions and exits. Each OTP site collects information on the children treated there. All severely malnourished children who arrive at the OTP sites are registered. Children transferred to the SC, either immediately or after some time in the OTP, are recorded as transfers. When the child returns to the OTP from the SC, the child is recorded as “from SC,” not as a new admission. Severely malnourished children presenting directly to the SC are registered as new admissions. When they arrive at the OTP after discharge they are also recorded as “from SC.” This avoids double counting of new cases of severe malnutrition between the programs. Data from the OTP and SC can be easily compiled on a monthly basis to yield overall outcomes.

Admission and exit categories and definitions are given in **tables 12 and 13**.

Additional information

Other information is collected routinely to complement the data on admissions and exits and allow deeper analysis. Some of this can be included at the end of tally sheets. We recommend the following information.

Cause of death. When a child dies in the SFP, OTP, or SC, a record is kept of symptoms, suspected diagnosis, and management. In the OTP and SFP, this information is collected, when possible, by outreach workers or

TABLE 12. Admission and exit categories: SC

Category	Definition
Admissions	
New admissions	New cases that comply with admission criteria
Other new admissions	Admissions that do not fulfill age or anthropometric criteria for admission. Examples include infants, baggy pants, moderate cases with medical complications, and previous admissions returning after referral to hospital
Moved in from OTP	Children transferred to SC from OTP according to the action protocol
Exits^a	
Discharged to OTP ^b	Cases meeting program discharge criteria
Death	Cases who die while in the SC
Defaulter	A case is classified as a defaulter after being absent from the SC for two days. This provides time for follow-up after the first absence to allow transfer to OTP
Medical referral out of program ^c	When the medical condition of the child requires referral out of the SC to hospital

OTP, outpatient therapeutic program; SC, stabilization center; SFP, supplementary feeding program

- a. Where an inpatient facility is also offering TFC care for a proportion of children, e.g., due to the absence of an OTP in all areas, an additional exit category for discharged cured will need to be added.
- b. Though in this system children discharged to OTP should be considered a movement within the program rather than as a true exit, they are included as such here and subsequent reporting to allow the success of the SC to be monitored, i.e., the percentage of children stabilized successfully and discharged to OTP. These children will not be counted when overall therapeutic program outcomes are calculated (see **annex 3**).
- c. In other program components, medical referrals are not counted as exits from the program as the children can continue their nutritional treatment with RUTF. For SC this option is given as children may not be able to continue their treatment in the SC if referral is to another health facility.

TABLE 13. Admission and exit categories: OTP

Category	Definition
Admissions	
New admissions ^a	New cases that comply with admission criteria
Other new admissions	Admissions that do not fulfill age or anthropometrical criteria for admission. Examples include clinically very wasted moderate cases with complications that need closer monitoring in OTP after stabilization
Moved in from SC	Children discharged to OTP after stabilisation — includes both children previously registered in OTP and direct SC admissions
Moved in (returned after default)	Returned defaulters who, on return, have not yet reached program discharge criteria
Moved in from other OTP site	Children moved from another OTP site to continue treatment
Exits ^b	
Discharged cured	Cases meeting program discharge criteria
Death	Cases that die while registered in the program (including those referred to a health facility for medical treatment while remaining registered in OTP)
Defaulter	A case is classified as a defaulter on the third absence. This provides time for follow-up after the first absence to encourage return
Non-cured	Cases that do not meet discharge criteria after four months when all investigation and transfer options have been carried out; also medical referrals that do not return
Moved out to SC	Children who are transferred to the SC either when they first arrive at the OTP site or after deterioration during treatment in the OTP
Moved out to other OTP site ^c	Children moved to another OTP site to continue treatment

OTP, outpatient therapeutic program; SC, stabilization center; TFC, therapeutic feeding center; SFP, supplementary feeding program

- a. New admissions includes all children presenting to the OTP site who are transferred immediately to the SC; all children refusing transfer to the SC on presentation; and all children transferred from SFP to OTP due to deterioration in their condition. Direct admissions to the SC are recorded as “from SC” when they arrive in the OTP because they will already have been recorded as new cases of malnutrition in the SC.
- b. Medical referrals from OTP to a hospital or medical facility other than the SC for medical treatment or investigation are not recorded as exits. However, if they fail to return they are recorded as non-cured.
- c. These are not completely new admissions or full exits – they are movements between components or programs offering nutritional care for severe malnutrition. They are recorded on tally sheets and databases to help sites keep track of their numbers, ensure an accurate reflection of program activity, and improve tracking of cases across different sites and between OTP and SC. Even when different agencies are managing OTP and SC it is important that children moving from OTP to SC are not considered full exits as outcomes must be followed up. Moved to and from SC can also include children moved to or from TFCs if these are in operation.

volunteers. All of this information should be recorded on the child’s card. Compilation of this information routinely at the office level (using a simple report form or spreadsheet) can help to identify problems with treatment and action protocols and show where training and supervision are needed.

Reasons for default. This information is collected either by outreach workers or volunteers and recorded on the child’s card (or on a paper kept with the card) or through focus group discussions in the community. It can help identify trends in defaulting and identify adjustments to the program that should be considered (e.g., the need to open new sites to facilitate access).

Reasons for nonrecovery (non-cured). Routine review of this information can help to identify common problems of nonrecovery, such as tuberculosis, sharing food in the household or poor access to clean water. It can indicate the need for stronger sectoral links and advoca-

cacy for distribution of general rations, DOTS (directly observed treatment, short-course) tuberculosis programs, water and sanitation interventions, etc.

Other information (gender, age, displaced/resident/returnee status) may be required (for instance, by donors) and can be included at the end of tally sheets.

Weight gain and length of stay. The weight gained and length of stay of each child should be calculated monthly for new admissions to OTP who are discharged recovered. If a large number of children (more than 30) are discharged as recovered, a sample of cards can be taken.

Relapses (readmissions after discharge). A record of the number of readmissions helps program managers to understand the situation outside the program (interventions at the household level may be needed to address high readmission levels). It can also indicate that children are being discharged from the program

too early. The identification of relapses can never be exact, since it relies on the staff recognizing a child who returns. However, the decentralized nature of OTP means that usually there are relatively few OTP cases at each site, and this helps the staff to recognize children even after several months. In addition, caregivers retain their OTP cards on discharge and can use them to identify their children in the event of relapse.

Number of children transferred from OTP to SC/TFC (scenario 1 only). These data are collected separately in scenario 1 as a record of the proportion of children requiring stabilization care.

Monitoring program coverage

Until recently, coverage was estimated by an adaptation of the WHO Expanded Program on Immunization (EPI) coverage survey method [38, 39]. This method uses a two-stage cluster sampling approach and a sampling procedure called probability proportional to size (PPS). Sample-size restrictions imposed by the fact that severe malnutrition is a relatively rare condition mean that such survey estimates tend to lack useful precision. In addition, PPS sampling locates the bulk of data collection in the most populous communities. This may leave areas of low population density, often those communities that are likely to be distant from health facilities, feeding centers, and distribution points, unsampled. It is these areas where coverage is likely to be lowest, with the result that PPS surveys may evaluate coverage as being adequate even when coverage is poor or nonexistent in many areas outside of urban centers [40]. As part of the CTC program, we have developed a new direct method of assessing coverage [26]. This method is simple and rapid to implement, provides a useful level of precision, and allows examination of the geographic distribution of coverage. It also provides an estimation of prevalence.

This survey method involves dividing the survey area into non overlapping squares of equal area (quadrats) and sampling the community or communities located closest to the center of each quadrat. During sampling, the method uses an active case-finding approach to find cases of acute malnutrition. This involves the surveyor asking community health workers, traditional birth attendants, traditional healers, and other key informants to take them to see “children who are sick, thin, have swollen legs or feet, or are attending a feeding program” and then asking the mothers of confirmed cases to help identify other cases. It is important to use the local terms for thin, wasted, edema, kwashiorkor, baggy-pants, sickness, feeding program, wrist-band, etc. These local terms should have been ascertained during the social enquiry that preceded the start of the program. It is important that the case-finding method used finds all, or nearly all, cases in the sampled communities and in previous surveys; we have used cap-

ture–recapture methods with different case-finding approaches to verify that this is the case [26].

We calculate two estimates of coverage from the data: the *point coverage* estimate and the *period coverage* estimate. The period coverage estimate is equivalent to the coverage estimation traditionally used by international agencies to estimate coverage in humanitarian operations [39] and is the measure quoted in this paper.

Period coverage is calculated using the following formula:

$$\frac{\text{number of respondents attending OTP}}{\text{number of cases not attending the OTP} + \text{number of respondents attending the OTP}} \times 100$$

Point coverage is calculated using the following formula:

$$\frac{\text{number of cases attending the OTP}}{\text{total number of cases}} \times 100$$

These are calculated for each quadrat as well as for all quadrats together.

The use of both period and point coverage estimations minimizes bias associated with program effectiveness and mortality, and a comparison of the two provides a useful perspective on program effectiveness. The period coverage estimate shows how well the program has been doing in the recent past, whereas the point coverage estimate shows how well the program is doing at the time of the survey. The difference between the two measures is that the numerator in the period coverage calculation includes children who were admitted into the program as severely malnourished but who at the time of the survey, although not recovered sufficiently to meet discharge criteria, no longer had a WHM of less than 70% or an MUAC under 110 mm. The numerator in the point coverage includes only those children who are still severely malnourished at the time of survey. Increasing the rate at which children recover tends to reduce the point coverage estimation, because, as edema resolves quicker and WHM remains below 70% for a shorter period, the numerator is decreased in comparison with a less effective program where children remain severely malnourished for longer. The extreme scenario is of a hypothetical program providing an instantaneous cure that would always have a point coverage of zero. The period coverage is less affected by rate of recovery, but it tends to overestimate coverage because it excludes from the denominator severely malnourished children outside of the program who died during the recent past while including children who were severely malnourished in the recent past in the numerator.

Coverage data are plotted as a mesh map and as a histogram. **Figure 10** presents an example of a cover-

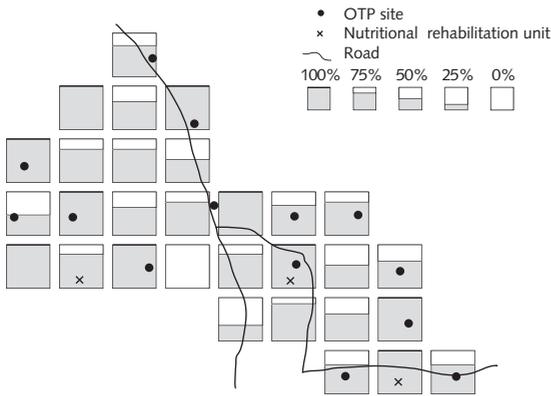


FIG. 10. Spatial distribution of per-quadrat period coverage in the Dowa community-based therapeutic care (CTC) program

age survey mesh map, taken from Dowa District in 2003. Full grey squares represent 100% coverage and empty squares represent 0% coverage. The approximate locations of the nutritional rehabilitation units in the district are marked, and thin black lines indicate the approximate location of major roads. **Figure 11** presents the same data as a histogram. The specific details of this method have been published elsewhere [25, 26].

Interpreting coverage survey results

There are three components to evaluating coverage:

Overall coverage. Overall coverage is the coverage estimate calculated for all squares together. To date the average coverage rate for CTC programs operating in rural areas has been approximately 70% [24, 25].

Coverage in each square. Coverage should be similar in each square and is an indicator of how equitable the program is. A program should aim for even and high coverage across the entire program area. If there are squares with low or zero coverage, it may be necessary to modify the program to avoid excluding children in these areas, e.g., by increasing outreach activities

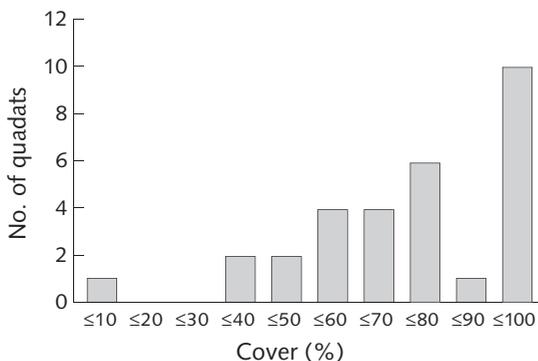


FIG. 11. Distribution of per-quadrat period coverage in the Dowa community-based therapeutic care (CTC)

and/or opening new distribution points in low- or zero-coverage squares.

Difference between the period and point estimations. Differences between these two estimates may have more than one explanation and can be difficult to interpret. A period coverage estimate that is considerably higher than the point coverage estimate could be caused by premature relaxation of outreach activities; alternatively, it may be because the uncovered cases are difficult to recruit or retain in the program. An important advantage of implementing coverage surveys is the contact that it brings between program staff and people who, for one reason or another, are not accessing the program. Asking the mothers of uncovered cases why their children are not in the program may help explain a difference between the point and period coverage estimates and can provide important information on how the program can be adapted to improve coverage. We are currently developing methods to better link this social enquiry with the coverage survey method.

MUAC-based coverage surveys

A major advantage of the move toward MUAC-only screening and admission criteria is that it will allow us to move toward MUAC-only surveys that do not assess WHM. This will simplify the mechanics of implementing surveys, speed up the process, and reduce transport needs and costs.

Therapeutic products for use in community-based programs

Since the 1960s, the high cost and poor success rates of hospital inpatient treatment have prompted much debate over whether hospitals are the best place to treat such patients [41, 42]. In the 1970s, these concerns prompted moves to demedicalize the treatment of severe acute malnutrition and change the locus of treatment from hospitals to the community, into simpler nutrition rehabilitation centers (NRCs), the existing primary health care clinics, or the homes of those affected. These programs either treated early discharges from hospitals or admitted children directly from the community and aimed to increase the likelihood of successful long-term rehabilitation by providing care that was more appropriate and understandable to the local people [43]. The results of these early outpatient treatment programs have been variable. Some NRCs achieved low mortality and positive impacts on children’s growth while they were attending centers each day, but usually these benefits were not maintained after the children were discharged [44–46]. The requirement for children to attend each day and eat in the NRC also often proved unpopular with mothers, resulting in high default rates [47], and limited the

capacity for NRCs to meet all needs, resulting in low program coverage [48]. In other outpatient programs, mortality and relapse rates both during treatment and postdischarge have been higher [49, 50] and rates of weight gain lower than in hospitalized patients [51, 52]. In 2001, Ashworth reviewed studies of 27 such programs conducted during the 1980s and 1990s [53] (see Ashworth, this issue, pp. S24–48). Only 6 out of the 27 programs achieved case fatality rates of less than 5%, average weight gains of more than 5 g/kg/day, and relapse/readmission rates of less than 10%, taken as criteria of success. The most common shortcoming was an inadequate appreciation of the specific nutritional needs of malnourished children, in particular the need to provide energy- and nutrient-dense food during rehabilitation to allow for catch-up growth and recovery [53]. An important priority is for research to assess the efficacy, effectiveness, and cost-effectiveness of diets based on a mix of nutrient-rich, locally available foods with added micronutrients, especially zinc, for the recovery of severely malnourished children.

The recent development of ready-to-use therapeutic food (RUTF), a safe, energy-dense, mineral- and vitamin-enriched food, broadly equivalent in formulation to F100 [54], has greatly eased the difficulties associated with providing a suitable high-energy, nutrient-dense food that is safe to use in outpatient programs. To date, the commercial forms of RUTF are BP100, a compressed biscuit, and Plumpy'nut, an oil based-paste or spread developed in France [55]. The technology to make compressed biscuits is complicated and expensive and is not transferable to small-scale manufacturers in developing countries. By contrast, the production process for spreads is simple, and they can be made easily using basic technology that is readily available in developing countries [56, 57]. For that reason, CTC research has focused on the use of RUTF spreads. These are oil-based pastes with an extremely low water activity [58]. This prevents bacteria from growing in RUTF if accidentally contaminated and means that it can be kept unrefrigerated in simple packaging for several months. Because RUTF is eaten uncooked, heat-labile vitamins are not destroyed during preparation, and the labor, fuel, and water demands on poor households are minimized. In a clinical trial in severely malnourished children undertaken in Senegal, the energy intake (808 vs. 573 kJ/kg/day, $p < .001$), rate of weight gain (15.6 vs. 10.1 g/kg/day, $p < .001$), and time to recovery (17.3 vs. 13.4 days, $p < .001$) were all significantly greater in those receiving RUTF than in those receiving F100 [55].

Hitherto, RUTF has been made from peanuts, milk powder, sugar, oil, and a mineral/vitamin mix, according to the Plumpy'nut recipe developed by Nutriset. Until 2002, the only source of Plumpy'nut was Nutriset's factory in France. The cost was approximately US\$3,500 per metric ton, plus the cost of trans-

port from Europe. This cost has been an important barrier to the wide-scale uptake of CTC. However, recently, local manufacture of RUTF according to the Plumpy'nut recipe has started in several countries in Africa, resulting in a reduction in the price of about US\$1,000 per metric ton. This milk-powder-based recipe produces a product that is very well suited to the treatment of acute malnutrition; however there are several features that decrease its suitability as a candidate for widespread local production and extensive use in community-based programs. Milk powder is expensive and often must be imported; in the local production of RUTF in Malawi, the cost of milk powder represents over half the cost of the final product. Peanuts are also notorious for being contaminated with aflatoxin, and this greatly complicates the quality control of small-scale production. In some populations there is also considerable concern about allergic reactions to peanuts.

Alternative recipes have been developed that use locally available grains and legumes with a greatly reduced content or absence of milk powder and without peanuts [59], and are currently being field tested. These recipes should greatly decrease the cost of RUTF and ultimately should make local production at district level a more viable option. At present, in Malawi, a local hospital is producing RUTF in sufficient quantities to supply their own and a neighboring district. This arrangement maximizes the cost efficiency with which any funding put into the system is converted into benefit, providing cheaper RUTF, an income source for the hospital, and potentially increased income for selected farmers' groups, such as farmers associations connected with HIV support groups who produce crops for RUTF.

Those suffering from acute malnutrition are the poorest people in the world, and there will always be a need for external welfare support to provide them with care. However, treating acute malnutrition with RUTF made locally from local crops and delivered through community-based programs offers the potential to maximize the efficiency with which this financial support is used. This is a priority area for research and development.

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Annex 1. OTP card

ADMISSION DETAILS: OUTPATIENT THERAPEUTIC PROGRAMME

Name					Reg. N°				
	District				Village				
Age (months)		Sex	M	F	Date of Admission				
Admission	Direct from Community		From SFP	From SC	Readmission (Relapse)		SC Refusal		
Total Number in Household		Twin	Yes	No	Distance to home (hrs)				
General Food Distribution									
General Ration: HH Registered?	Yes	No	If yes, when last received a ration?						
Admission Anthropometry									
Weight (kg)		Height (cm)		WHM (%)		MUAC (mm)			
Admission Criteria	Oedema	MUAC <110mm	<70% WHM	Other (specify)					
History									
Diarrhoea	Yes	No	Stools / Day			1-3	4-5	>5	
Vomiting	Yes	No	Passing Urine			Yes	No		
Cough	Yes	No	If oedema, how long swollen?						
Appetite	Good	Poor	None	Breastfeeding			Yes	No	
Reported Problems									
Physical Examination									
Respiration Rate (# min)	<30	30 - 39	40 - 49	50+	Chest Retractions			Yes	No
Temperature (°C)					Conjunctiva			Normal	Pale
Eyes	Normal	Sunken	Discharge	Dehydration			None	Moderate	Severe
Ears	Normal	Discharge	Mouth			Normal	Sores	Candida	
Lymph Nodes	None	Neck	Axilla	Groin	Disability			Yes	No
Skin Changes	None	Scabies	Peeling	Ulcers / Abscesses	Extremities			Normal	Cold
Routine Admission Medication									
admission:	Drug	Date	Dosage		Drug	Date	Dosage		
	Vitamin A				Anti Malarial				
	Amoxycillin								
2nd visit:	Mebendazole				Measles				
Other Medication									
	Drug	Date	Dosage		Drug	Date	Dosage		

Annex 2. Key education messages for the OTP

- » RUTF is a food and medicine for very thin children only. It should not be shared.
- » Sick children often do not like to eat. Give small regular meals of RUTF and encourage the child to eat often (if possible eight meals a day). Your child should have _____ packets a day.
- » RUTF is the only food sick/thin children need to recover during their time in OTP.
- » For young children, continue to put the child to the breast regularly.
- » Always offer plenty of clean water to drink while eating RUTF.
- » Use soap for child's hands and face before feeding if possible.
- » Keep food clean and covered.
- » Sick children get cold quickly. Always keep the child covered and warm.
- » With diarrhoea, never stop feeding. Give extra food and extra clean water.

Notes

The carer should be asked to repeat back to check the messages have been correctly understood. These key messages can be supplemented with more detail and more messages if time allows.

Annex 3. Routine medicines in OTP element of CTC

Name of Product	When	Age / Weight	Prescription	Dose
Vitamin A*	At Admission (except children with oedema)	< 6 months	50 000 IU	Single dose on admission
		6 months to < 1 year	100 000 IU	
		≥ 1 year	200 000 IU	
		DO NOT USE WITH OEDEMA		
Amoxicillin	At admission	All beneficiaries	(see protocol)	3 times a day for 7 days
Anti-malarial (follow National protocol)	At admission in malarial areas	All beneficiaries	(see protocol)	Single dose on admission. (When using ACT treat only Paracheck positive cases)
FOLIC ACID**	First visit	All beneficiaries	5 mg	Single dose on first visit
MEBENDAZOLE***	Second visit	< 1 year	DO NOT GIVE	NONE
		12–23 months	250 mg	Single dose on second visit
		≥ 2 years	500 mg	
MEASLES VACCINATION	At admission and discharge	From 6 months	(standard)	Once on admission and once on discharge

* Vitamin A: Do not give if child has already received in last one month. Do not give to children with oedema until discharge from OTP.

** Folic acid: Give on second visit if Fansidar is used as the antimalarial.

*** Mebendazole: or other antihelminth according to national guidelines e.g. Albendazole: 12–23 months 200mg, ≥ 2 years 400mg; both can be re-given after 3 months if signs of re-infection.

Ferrous sulfate: not to be given routinely. Where anaemia is identified according to IMCI guidelines treatment with ferrous sulfate should begin in the recovery phase of the programme and not before and given according to WHO guidelines. For severe anaemia refer to inpatient care.

Annex 4. Action protocols for follow-up

Sign	Referral to SC / TFC / Hospital	Outreach Visit
Oedema	Grade +++ or ++ or with complications	Oedema persisting
	Marasmic Kwashiorkor	
	Increase in oedema	
Appetite/Anorexia	No appetite or unable to eat	Eats < 75% of the RUTF a week by third visit
Vomiting	Intractable	General medical deterioration
Temperature	Fever: > 39°C	
	Hypothermia: < 35°C	
Respiration rate (rr)	> 60 respirations/minute for under 2 months	
	> 50 respirations/minute from 2 to 12 months	
	> 40 respirations/minute from 1 to 5 years	
	> 30 respirations/minute for over 5-year-olds	
	Any chest in-drawing	
Anaemia	Severe palmar pallor	
Superficial infection	Extensive infection requiring IM treatment	
Alertness	Very weak, apathetic, unconscious	
	Fitting/convulsions	
Hydration status*	Severe dehydration based on history & clinical signs	Moderate dehydration based on history & clinical signs
Weight changes		Below admission weight on week 3
	Weight loss for 3 consecutive weighings	Weight loss for 2 consecutive weeks
	Static weight for 5 consecutive weighings	Static weight for 3 consecutive weeks
General		During first 2 weeks in OTP
		Absent from OTP for 2 weeks
		Refused Transfer to SC
Not recovering	If not recovered after 3 months, refer to hospital for investigation	

* Diagnosis of dehydration in severely malnourished can be difficult as many of the usual signs are unreliable. The main diagnosis comes from the History, wherein the most useful features are history of diarrhoea/fluid loss, reduced urine flow and recent change in appearance with sunken eyes are the most reliable [7].

Local production and provision of ready-to-use therapeutic food (RUTF) spread for the treatment of severe childhood malnutrition

Mark J. Manary

Abstract

Background. Ready-to-use therapeutic food (RUTF) spread has been shown to be very effective in the rehabilitation of severely malnourished children and facilitates home-based therapy of these children.

Objective. To describe how RUTF spread can be manufactured on a variety of production scales.

Principles of production. RUTF spread is an edible lipid-based paste that is energy dense, resists bacterial contamination, and requires no cooking. The primary production principles include grinding all ingredients to a particle size < 200 microns, producing the food without the introduction of water, and embedding the protein and carbohydrate components of the food into the lipid matrix. The most widely used RUTF spread is a mixture of milk powder, sugar, vegetable oil, peanut butter, vitamins, and minerals.

Scale of production. RUTF spread can be produced in quantities sufficient to treat several hundred children using a planetary mixer in a clinic. Production of larger quantities of RUTF spread can be achieved in partnership with local food companies. Production sufficient to meet the needs of several thousand children can be achieved with a dedicated production facility using technology appropriate for use in the developing world. Care must be taken to avoid aflatoxin contamination, and quality control testing of the product is essential.

Conclusions. RUTF spread can be safely and easily produced in small or large quantities in most settings worldwide. The local availability of the necessary ingredients limits its use in some settings, and further investigation of alternative ingredients is needed to overcome this limitation.

Key words: Food production, malnutrition, ready-to-use therapeutic foods, severe childhood malnutrition, therapeutic foods

Introduction

Home-based therapy for severe childhood malnutrition has been successful in a variety of settings over the last 5 years [1]. The recent success of home-based therapy has been seen in conjunction with the availability of a novel food, a spread form of ready-to-use therapeutic food (RUTF) [2–5]. RUTF is a generic term including different types of foods, such as spreads or compressed products suitable for feeding severely malnourished children. Among RUTFs, spreads are prepared with a simple technology that has already been successfully transferred to developing countries with minimal industrial infrastructure. Hence, this paper will refer only to RUTF spreads, although other technologies could possibly be transferred to countries with more advanced industrial capacities.

The RUTF spread is made of powdered ingredients embedded in a lipid-rich paste, resulting in an energy-dense food that resists microbial contamination [6]. This RUTF is a mixture of milk powder, vegetable oil, sugar, peanut butter, and powdered vitamins and minerals. As the name implies, RUTF does not need to be prepared in any way prior to consumption, making it practical for use where cooking fuel and facilities are limiting constraints. RUTF has a very low water activity, and thus it is impossible for significant bacterial growth to occur in these foods [7]. This allows locally produced RUTF to be safely stored at ambient tropical conditions for 3 to 4 months. RUTF has a very high energy density, about 23 kJ/g (5.5 kcal/g). By consuming just a few spoonfuls of RUTF five to seven times a day, a severely malnourished child can achieve sufficient nutrient intake for complete recovery. RUTF must be consumed with water, but no other foods are necessary for the rehabilitation of the malnourished child.

Although the spread form of RUTF may not be the

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only therapeutic food that does not require cooking, it is the only one considered in this article, because it is the only one that has been locally produced in the developing world with the use of modest technologies. The term "RUTF" in this article refers specifically to the spread form of RUTF.

Production principles of RUTF

RUTF is a homogeneous mixture of lipid-rich and water-soluble foods. The lipids exist as a viscous liquid, and small particles of protein, carbohydrate, vitamins, and minerals are mixed throughout this liquid. In order to achieve a homogeneous mixture, a specific mixing procedure must be followed. The lipid elements of RUTF are first stirred and often heated; the powdered ingredients are then slowly added to the lipids during vigorous stirring. Once all the powdered ingredients have been added, the entire mixture is stirred at higher speeds for several minutes. As long as the powdered ingredients do not have a particle size that is larger than 200 μm , the mixture does not readily separate. When mixtures are made with larger particles, RUTF must be stirred briefly by hand just prior to consumption to temporarily suspend the large particles in the mixture. The use of oils that are liquids at ambient temperature facilitates the mixing process. RUTF can be packaged from factory bowls or funnels, by hand (by simply pouring it), or by using a mechanical device. Successful RUTF production has been achieved in Malawi, Niger, and Congo with the use of these principles.

Ingredients

The formulation of RUTF was derived from F-100 and uses the same ingredients, with the addition of peanut butter [8]. Peanut butter changes the physical properties of the food to those of a viscous liquid product instead of a powder. A typical recipe for RUTF is given in **table 1**.

Milk powder. Local supplies of milk powder exist throughout the world; however, the milk itself is often imported. Standard commercial techniques to produce milk powder yield a product that is suitable for RUTF production.

Vegetable oil. Several types of oil made by standard

TABLE 1. A typical recipe for ready-to-use therapeutic food (RUTF)

Ingredient	% weight
Full-fat milk	30
Sugar	28
Vegetable oil	15
Peanut butter	25
Mineral-vitamin mix	1.6

commercial methods may be used in RUTF, including soy oil, cottonseed oil, rapeseed oil, and corn oil. Rapeseed oil and soybean oil have the advantage of providing a good balance of essential fatty acids.

Sugar. Commercial sources of granulated brown or white sugar can be used to make RUTF. The sugar must be ground into a fine powder, a product used in bakeries known as icing sugar or powdered sugar, to reduce the particle size to less than 200 μm .

Peanut butter. Peanut butter consists simply of peanuts that have been roasted and ground, without added oil, salt, or preservatives. In most areas of the world where peanuts are grown, there is a commercial food-processing company that makes peanut butter.

Powdered vitamins and minerals. This is a mixture of vitamins and minerals formulated to provide the same amount of micronutrients to the malnourished child as F-100, the standard therapeutic food. Currently it is available from a commercial supplier (Nutrisset, Malaunay, France). The content of the mixture is listed in **table 2**.

The World Food Program (WFP) and UNICEF have donated ingredients for the production of RUTF in Malawi. The WFP has donated milk, sugar, and oil, and UNICEF has donated powdered vitamins and minerals. The RUTF is then used by projects supported and approved by these organizations.

TABLE 2. Mineral and vitamin contents of 100 g of powdered mix

Ingredient	Quantity
Vitamins	
Vitamin A	57 mg
Vitamin D	1 mg
Vitamin E	1.25 g
Vitamin K	1.30 mg
Vitamin B ₁	37.5 mg
Vitamin B ₂	116 mg
Vitamin B ₆	37.5 mg
Vitamin B ₁₂	110 mg
Vitamin C	3.3 g
Biotin	4.1 mg
Folic acid	13 mg
Niacin	332 mg
Pantothenic acid	194 mg
Minerals	
Potassium	36 g
Magnesium	587 mg
Iron	704 mg
Zinc	717 mg
Copper	92 mg
Iodine	5 mg
Selenium	1.54 mg

Scale of production

A mechanical mixer is required for all RUTF production. Although hand-mixing of the ingredients is possible for very small quantities, the quality of the product that is made by hand-mixing is so inconsistent that it cannot be reliably used.

The procedure and equipment used to mix RUTF depend on the quantities of RUTF needed. If a few hundred kilograms of RUTF are needed each week, small-scale production is possible. Small-scale production requires a small room dedicated to food production that is free of rodents and other pests. A 40-L planetary bakery mixer, such as the MacAdams SM 401, can be used to prepare the RUTF (**fig. 1**). Such mixers will mix a 25-kg batch of RUTF. The ingredients are added by volume to the batch. The containers used to measure the ingredients need to be carefully chosen and calibrated by accurately weighing the ingredients. Oil and peanut butter should be added directly into the mixing bowl and combined at a mixing speed of 105 rpm until homogeneous. The Z-shaped kneader blade, rather than a wire whisk device, should be used to minimize the amount of air included in the mixture. The sugar, milk powder, and mineral and vitamin mixture are first hand mixed as dry powders in a dedicated plastic drum and then emptied into the electric mixing bowl. The RUTF is then mixed at 105 rpm for 6 minutes, 210 rpm for 6 minutes, and 323 rpm for 6 minutes. These mixing times are necessary to ensure homogeneity of the RUTF and to prevent separation during storage. RUTF can be poured or hand-packed into plastic bottles containing 250 g, a typical daily dose for a malnourished child.



FIG. 1. Standard planetary bakery mixer

If 500 to 1,500 kg of RUTF is needed each week, production is best achieved by partnering with a commercial food-processing company that has machinery that can efficiently mix, grind, and package RUTF. This equipment is commonly found in industrial bakeries or pastry factories. Several planetary mixers or a larger-capacity customized barrel mixer can be used. Whole peanuts can be mixed in with the other ingredients, and this mixture is then run through the same grinder used to make peanut butter. A mechanical or pneumatic semiautomatic device that will fill a container with a prescribed amount can package the RUTF (**fig. 2**).

If more than 3,000 kg of RUTF is needed each week, an industrial production facility dedicated to RUTF will be required. This can be part of a larger food-processing company that has technical expertise in food production or a nongovernmental organization formed specifically for the purpose of making RUTF. The machinery required for large-scale production is custom-designed to mix batches of 200 to 500 kg and automatically package the product (**fig. 3**). Rather than typical “batch” production, the product can move continuously from the mixer to a grinder and then to a packaging device by the use of a series of mixing chambers. An operator is needed to add the ingredients to the initial mixing chamber and remove the final filled containers from the packaging device.

The scale of production will determine the methods of quality control and the cost. Quality control is more easily implemented at a lower cost with centralized, large-scale production. Economy of scale will come up for other aspects of RUTF production, and, if feasible, large-scale production should be considered as a long-term objective in countries where the level of severe malnutrition is high and where a sustained demand is likely. There are two resources that potential local producers can use to obtain technical assistance in establishing a production facility: Nutriset (Malaunay, France) and Valid International (Oxford, UK).

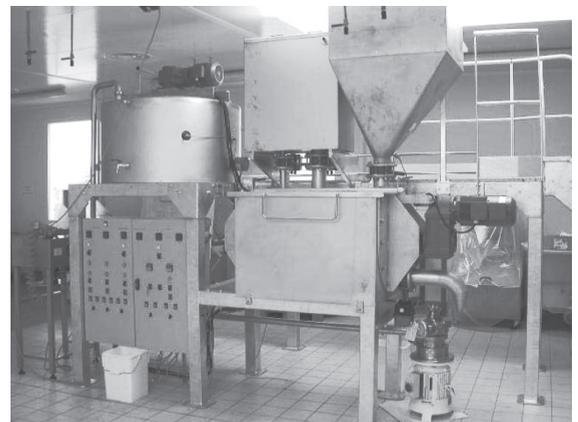


FIG. 2. Automatic packaging device for ready-to-use therapeutic food (RUTF)



FIG. 3. Single mixing and packaging unit for large-scale production of ready-to-use therapeutic food (RUTF)

Quality control

Choice of ingredients. Whatever scale of production is used, quality control is achieved by safe storage of the ingredients, adequate training and supervision of the production personnel, and testing of the product for composition and contaminants. Throughout the world, authorities set standards for food-production companies; those organizations involved in RUTF production should adhere to these standards [9]. The following are key issues in quality control:

Aflatoxin contamination. Aflatoxin is produced by an *Aspergillus* species of fungus that contaminates the peanuts after they have been harvested but before they have been ground into peanut butter. The fungus is ubiquitous; fungal growth can be curtailed by storing the peanuts in a cool, dry environment and can also be controlled by using chemical fungicides. Methods to prevent aflatoxin contamination have been described in detail elsewhere [10]. Peanuts should be purchased from a supplier that can ensure that steps to prevent contamination have been implemented during harvest and storage. Aflatoxin contamination is more likely in peanuts with black discoloration or with a shriveled, irregular appearance. Consumption of aflatoxin can result in hepatic oxidative stress and predispose to hepatic cancers. RUTF should conform to international standards for maximum aflatoxin content of 10 to 20 ppb [9]. Very high doses of aflatoxin can produce acute intoxication [11]. Moderate doses may depress child growth [12].

Bacterial contamination. The inherent microbiologic safety of RUTF allows it to be packaged under clean and dry, but not sterile, conditions. Care must be taken

to prevent the introduction of water into RUTF during production. Increasing the water content of RUTF allows bacteria and mold to grow within the food, promoting product degradation and exposing the malnourished child to potential pathogens. Water is most likely to be introduced from residue left on the mixing bowls and containers after they have been washed. Therefore, it is better to limit the number of times the implements of production are cleaned with soap and water and to simply dry-wipe them clean instead. Typically, implements need to be cleaned with soap and water only once a week. If the containers in which the RUTF is to be dispensed are first washed, care should be taken to see that they are completely dry.

Enteric bacterial contamination is most likely to occur from fecal contamination of stored ingredients or during the mixing process. Care should be taken to store the ingredients in areas that are free of rodents. Workers should wash and thoroughly dry their hands before manipulating the RUTF and wear clean plastic gloves, hair coverings, and protective coats during RUTF production. Milk and RUTF should be periodically checked for salmonella contamination by standard microbiologic methods in reliable laboratories.

Prevention of oxidation. Oxidation of the fatty acids contained in the RUTF and of some vitamins, mainly vitamins A and C, is the main factor limiting the storage life of RUTF. During production, some preventive measures should be taken to avoid initiating the oxidation process [13]. Although it is helpful to heat the oils during the mixing process to achieve a homogeneous mixture, heating to temperatures over 45°C accelerates the oxidation of the lipids, which reduces the period of time that the product is stable after production (shelf life). To prevent oxidation, it is also better to use airtight containers and containers filled as much as possible so that the quantity of oxygen within the container is minimized. The shelf life of locally produced RUTF without airtight packaging is 3 to 4 months. When RUTF is packaged in airtight foil envelopes under a nitrogen atmosphere (devoid of oxygen), the shelf life can be extended to 24 months.

Composition of RUTF. Errors may be made during the mixing process, resulting in RUTF with a substantially altered nutrient content. Errors are best avoided by careful training of the workers who mix the food, the use of convenient measures for the ingredients of batches of RUTF, and periodic compositional testing of RUTF. Measuring a single mineral, such as potassium, by atomic absorption [14] is an inexpensive, reliable way to monitor the vitamin and mineral content, since the minerals are added as a premixed product. If an atomic absorption spectrophotometer is not available, a colorimetric assay for vitamin C can be substituted [15]. Measuring fat and protein content ensures that the other ingredients are being added in appropriate amounts.

Quality control is achieved by adopting operating procedures that are internationally accepted as standards for food production: the Codex Alimentarius [9] and the Hazard Analysis and Critical Control Point Program (HACCP) [16]. These procedures prescribe the procurement of raw materials, storage of ingredients, mixing of ingredients, and storage of finished product. In addition to international standards, every nation of the world has a Bureau of Standards that regulates the production of food. These bureaus also prescribe operating standards, conduct inspections of factories, and issue licenses to produce food. Product testing is used to verify the quality of the production process and should be performed on every large batch of finished product, and certainly every week. In Malawi, finished product is tested weekly for contaminating microbes (salmonella, staphylococcus, total flora of aerobic mesophilic bacteria, coliforms, *Escherichia coli*, yeast, and mold), aflatoxin, and product composition (fat, protein, and potassium). Testing is best done locally so that it can be used to identify lapses in production quality in a timely manner. Batches of RUTF should not be sent to consumers without verification of product quality. Almost every nation of the world has a laboratory associated with its Bureau of Standards that can conduct the independent testing.

Costs and sustainability

The primary costs associated with RUTF production are those of the ingredients, since the production process is relatively simple. Certainly the costs and availability of ingredients must be assessed at a local level. Reliable comparative cost data concerning RUTF production are lacking. The author has produced RUTF in Malawi from 2002 to 2005, and specific figures for Malawi are cited as an example. Currently in Malawi the costs of the ingredients per kilogram of RUTF are as follows: milk US\$0.63, sugar US\$0.17, peanut butter US\$0.18, oil US\$0.18, and vitamins and minerals US\$0.26, for a total of about US\$1.40/kg. These costs include the transport of the ingredients to the factory. The cost of packaging is also significant; in Malawi it is about \$0.50/kg (in plastic bottles and cardboard boxes). Additional costs include labor, facility rental, and utilities. In Malawi the total cost of producing RUTF is about \$2.60/kg. The cost savings that can be realized by local production are from reduced transport of ingredients and finished products and lower tariffs.

The cost of RUTF, even when it is locally produced, and even if some cost savings can be expected in the future with a modified recipe, is beyond the reach of the poorest families, among whom malnutrition is most prevalent. RUTF-based programs will be sustainable only if RUTF is purchased by social welfare programs supported by governmental or nongovernmental

agencies. UN organizations, such as WFP and UNICEF, have donated ingredients in Malawi to lower the cost of producing RUTF, and this may be an option in other circumstances of crisis to make RUTF accessible to welfare programs.

The cost of the therapeutic food is just a portion of the total cost of rehabilitating a malnourished child. The expenses of maintaining inpatient units, staff to distribute the food and monitor the child's progress, and supplies needed to administer the feeding are considerable. It must be kept in mind that RUTF facilitates home-based therapy, which is less expensive than center-based therapy. Although the cost of RUTF may not be substantially less than that of foods used in center-based therapy (e.g., F-100), the overall cost of the therapeutic feeding endeavor may well be.

The notion that RUTF can be locally produced in circumstances of nutritional crisis is quite practical. The production process does not require large specialized machinery, nor do production workers require extensive training or skills that require a secondary school education. The advantages of local production in crisis situations are that production can be responsive to the dynamics of the crisis, and the amount of food produced can be controlled to meet the demands of the situation.

One notion about local production that is attractive is that locally grown peanuts, oil, and sugar can be purchased in the country in which they are being used and that this in some way will support the local economy. Although this is technically true, the economic impact of such local purchases is likely to be negligible, since the total amounts of peanuts, oil, and sugar used to make RUTF are not substantial when the scale of national agricultural outputs is considered.

This report considers only RUTF that is used for the treatment of childhood malnutrition. It is plausible, but not proven, that other formulations of RUTFs may prove very useful as food for malnourished HIV-infected adults, as supplemental food for vulnerable populations, and as complementary food for children at risk for the development of malnutrition. Local production of RUTFs for these other purposes could easily be done within the same factory using the same machinery. These potential other uses of RUTFs should be considered when establishing local production facilities, as several nutritional support programs may be supplied from one local production unit.

Formulations of RUTF without milk or the vitamin and mineral premix

The nutrient composition of RUTF is similar to that of F-100, the standard milk-based formula that has been demonstrated to be effective in the treatment of severe childhood malnutrition. RUTF contains significant

amounts of milk powder, which has traditionally been used successfully for refeeding malnourished children. Nutrient compositions similar to that of the current RUTF could be achieved without the use of milk, and these formulations might be less costly to produce. To date these recipes have been made in laboratories and kitchens on a very small scale. A soy-based spread, highly fortified with iron and minerals, was tested for the prevention of anemia and stunting in a few hundred Saharawi children 3 to 6 years of age and was found to be well accepted and effective [17]. It has been demonstrated that these alternative recipes can be effectively mixed, that they are palatable, and that the nutrient composition can be made similar to that of F-100 [18]. Effectiveness trials of alternative formulations of RUTF in the treatment of severe childhood malnutrition are needed before they can be considered as substitutes for the milk-based RUTE. An area of concern is the high level of nondigestible carbohydrates and antinutrients in alternative formulations in which milk powder is replaced by legumes to provide proteins in the recipe. Their low content of absorbable phosphorus is also a concern. It is quite possible that an adapted mineral supplement could compensate for the poorer availability of added minerals in food mixtures containing legumes, but comparative trials are needed to test this option.

The only vitamin and mineral premix with which there has been any substantial experience has 18 micronutrients and is formulated by a single producer in Europe (Nutriset). Given the amounts, range, and diversity of micronutrients needed for RUTE, there is

no combination of locally available, micronutrient-rich foods suitable for producing RUTF that can supplant this commercial product. Foods containing water cannot be used in RUTF recipes, which precludes the use of mineral-rich foods such as meat, organ meat, leaves, fruits, and vegetables, unless they are dried beforehand. Thus, local RUTF production is always likely to require the importation of a specialized micronutrient premix. Other commercial sources of a suitable micronutrient mix for RUTF are likely to emerge as the demand for this product increases.

Knowledge gaps and issues for future research

- » Alternative mineral and vitamin supplements adapted to RUTF prepared without milk need to be developed;
- » The effectiveness of recipes with a similar nutrient composition to that of F-100, but containing no milk, for therapeutic feeding of severely malnourished children needs to be evaluated;
- » The use and effectiveness of formulations of RUTF for supplemental feeding and other nutritional support programs need to be assessed;
- » Systematic cost comparisons and analyses of the different options of therapeutic feeding need to be performed;
- » Systematic cost comparisons of the different scales of production to meet local and regional needs for RUTF production need to be performed.

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The sustainability of community-based therapeutic care (CTC) in nonemergency contexts

Valerie Gatchell, Vivienne Forsythe, and Paul-Rees Thomas

Abstract

Background. Concern Worldwide is an international humanitarian nongovernmental organization that piloted and is now implementing and researching community-based therapeutic care (CTC) approaches to managing acute malnutrition. Experience in several countries suggests that there are key issues to be addressed at the international, national, regional, and community levels for community-based treatment of acute malnutrition to be sustainable.

National level. At the national level there must be demonstrated commitment to a clear health policy and strategy to address outpatient treatment of acute malnutrition. In addition, locally available, affordable ready-to-use therapeutic food (RUTF) must be accessible.

Regional level. At the regional level a functional health system and appropriate capacity for service provision are required. Integration of outpatient services should be viewed as a process with different levels of inputs at different phases depending on the capacity of the Ministry of Health (MOH). There is a need for indicators to facilitate scale-up and scale-back for future emergency response.

Community level. Strong community participation and active screening linked to health service provision at the local level is paramount for sustainable assessment and referral of severe acute malnutrition.

Future challenges to sustain community-based therapeutic care. Key challenges to the sustainable treatment of severe acute malnutrition include the development of locally produced RUTF, development of international standards on local RUTF production, the integration of outpatient treatment protocols into international health and nutrition guidelines, and further operational research into integration of community-based treatment of severe

acute malnutrition into health systems in nonemergency contexts.

Key words: Community-based therapeutic care, primary health care, severe malnutrition, sustainable nutrition programming

Introduction

Community-based therapeutic care (CTC) is a new approach for the management and treatment of severe acute malnutrition, which is defined as the presence of severe wasting (weight-for-height $< 70\%$ or < -3 SD of the median National Center for Health Statistics/World Health Organization [NCHS/WHO] reference) or edema or a mid-upper-arm circumference (MUAC) < 110 mm. Until 2001, emergency response to high levels of acute malnutrition was predominantly through therapeutic feeding centers (TFCs). TFCs are large inpatient centers where patients are admitted for 21 days or longer. The centers are resource-intensive and are often very far from those affected with acute malnutrition. Carers of malnourished children must often travel long distances to access the services, and coverage is low [1]. Additionally, congregation of sick and malnourished children in centers can enhance the spread of infection and increase morbidity and mortality.

To address some of the challenges of traditional TFCs, Valid International developed the concept of CTC. CTC is an innovative concept that mobilizes communities and supports local health services to rapidly and effectively treat those with acute malnutrition in their homes. A typical emergency-response CTC program is composed of four elements: community mobilization, an outpatient therapeutic program (OTP) for cases of severe acute malnutrition without medical complications, inpatient care for those with medical complications, and supplementary feeding for those with moderate malnutrition to prevent them from becoming severely malnourished.

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Since 2001, evidence for the effectiveness of CTC as an approach to the treatment of severe acute malnutrition in emergencies has been building through nongovernmental organization and government responses in Ethiopia, Malawi, South Sudan, North Sudan, and Niger [2, 3].

Concern Worldwide is an international, humanitarian, nongovernmental organization with experience developing and implementing CTC programs. Concern is also currently engaged in working directly with national governments to build their capacity in the community treatment of acute malnutrition and to support the adaptation of health and nutrition policy to incorporate CTC in several countries. On the basis of Concern's experience, there are several issues to be addressed for the outpatient treatment of severe acute malnutrition to be sustainable.

The purpose of this paper is to detail the evolution of the CTC approach from emergency situations to different contexts from the perspective of a nongovernmental organization, and to discuss key components required for CTC to be sustainable, on the basis of the experience to date of Concern Worldwide in Malawi, Ethiopia, South Sudan, North Sudan, Bangladesh, and Niger. The paper also highlights key challenges in moving forward sustainable and effective CTC.

The emergency CTC approach and modifications to different contexts

Over the past 3 years, the CTC approach to nutritional emergencies has evolved to address the treatment of severe acute malnutrition in transition contexts [3]. CTC programs in Ethiopia and Malawi were initially an emergency response to increased levels of acute malnutrition. However, as the overall food security and nutritional situation improved, the caseload decreased and the supplementary feeding component of the programs was dropped for longer-term health interventions, while Concern focused on the integration of the treatment of severe acute malnutrition at the basic health facilities. Therefore, in transition contexts, Concern's focus has included outpatient treatment of severe acute malnutrition in combination with referral services for complicated cases (stabilization services) built on strong community mobilization, health education, and wider support to strengthen the health system.

Additionally, high levels of severe acute malnutrition have been documented in subpopulations in nonemergency contexts, and the need for an effective outpatient approach to the treatment of severe acute malnutrition in such contexts is now being acknowledged. For example, in high-risk areas of Bangladesh and Rwanda, the levels of severe acute malnutrition are a cause for concern. In congested areas of Saidpur and Parbatipur, Bangladesh, Concern health teams

have documented a 5.6% prevalence of severe acute malnutrition (weight-for-height < 70% of the NCHS/WHO reference) among children 0 to 23 months of age ($n = 160$) and a 1.8% prevalence among children 24 to 59 months of age ($n = 274$), for an average of 3.2% among all children under 59 months of age ($n = 444$) [4]. Additionally, in Rwanda, the 2005 Demographic and Health Survey found a 0.9% prevalence of severe acute malnutrition (weight-for-height < -3 z-scores of the NCHS/WHO reference) nationally among children 0 to 59 months of age, although a 1.4% prevalence of severe acute malnutrition was documented in the South region and 2.5% in the Kigali Ville region [5].

The potential long-term application of a modified CTC approach to treat severe acute malnutrition in transitional and nonemergency situations has brought to the forefront the sustainability of the CTC services (OTP, stabilization care [SC], and community mobilization and screening). Sustainability in the context of this paper is defined as strengthening the capacity of the health systems to function effectively with minimal external input [6]. This definition accepts that many least-developed countries will require substantial contributions from external sources for a significant period of time; but this should not negate the goal of reducing dependence on external resources and enabling local capacity to control and be accountable for its own health services and system.

Several challenges exist in sustaining effective CTC services and in Concern's experience, and there are several requirements to sustain such activities.

Key requirements for sustainable provision of CTC service

Integration of CTC is defined in this paper as incorporating CTC components of OTP care, inpatient care, and community mobilization and outreach activities into national primary health care (PHC) systems. Integration of activities while maintaining the quality and effectiveness of services with minimal external support is vital to sustainability. Effective integration of CTC activities into the PHC system requires functioning systems and associated support at different levels:

- » *National policy level:* demonstrated commitment to a clear health policy and strategy to address outpatient treatment of severe malnutrition;
- » *Regional or district level:* functional regional or district health system and appropriate capacity for service provision;
- » *Community level:* strong community participation and active screening.

In many countries, external financial and programming support may still be required at one or all of these three levels, *especially during an emergency*. However, except for the cost of ready-to-use therapeutic foods

(RUTFs) and drugs, the CTC approach itself does not require significant inputs beyond those targeted for the development and support of health systems. When the cost of a CTC program is analyzed, it must be recognized that for an intervention to address severe malnutrition, the cost per recovered child may be high, but there are several indirect benefits to the PHC system, including capacity-building of staff and rehabilitation of health structures, that are not accounted for in a specific CTC cost analysis.

National level

National commitment and policy change

Fundamental to sustainable CTC programming is the commitment by national Ministries of Health as well as UN agencies to the methods, components, and principles of CTC for severe acute malnutrition, as demonstrated by outlined steps to adopt relevant principles and protocols within national policy. In countries where Concern is implementing or supporting CTC programs, successful integration of CTC activities into Ministry of Health PHC systems has been variable. Although there has been national-level support for implementation of CTC in a number of countries, the process of national policy change takes time; however, CTC implementation is informing and shaping the national policy debate in a number of countries.

In Ethiopia, following effective (as determined by standard program indicators of emergency nutrition programs in Sphere [7]) implementation of CTC by Concern and other nongovernmental organizations over a number of years, 34 *woreda* (district)-level health departments have adopted CTC as the best practice for the treatment of severe acute malnutrition, through the support of nine nongovernmental organizations in 2005.

Meanwhile, evidence from CTC programs has fed into the development of the National Nutrition Strategy slated for approval in 2006.

Transitional governments without such defined health policy or strategy, such as that of South Sudan, offer a different set of challenges, although they may allow quicker adoption of CTC protocols at a national level. In South Sudan, as in Ethiopia, policy and strategy development is being informed by evidence from the implementation of CTC over the last few years. Several nongovernmental organizations are working at the national level in South Sudan to establish assessment and treatment protocols for severe acute malnutrition following CTC principles and protocols, as well as advocating for their inclusion in PHC manuals.

A crucial issue in the rollout and sustainability of CTC is the inclusion of management of severe malnutrition as a core component within the minimum health services package, thus ensuring that staff train-

ing and supply of commodities will be addressed and planned for.

Another key requirement is the need to address health-financing policy issues to facilitate access to free treatment for severe acute malnutrition. Where health care is not free, governments must put in place strong policies and functional mechanisms that will reliably provide free treatment (medical consultation, inpatient care, and drugs) for patients presenting with severe acute malnutrition.

PHC system

The PHC system encompasses services provided by the Ministry of Health, nongovernmental organizations, and community structures. For the CTC approach to be sustainable, a PHC system needs to be in place, with adequate, accessible structures and staffing capacity able to provide basic health services. It is through these facilities that CTC activities should be provided.

In the majority of emergency contexts, ensuring functioning PHC facilities in which to integrate CTC services is challenging and often relies heavily on external resources. Implementing CTC in nutrition emergencies can support and strengthen the PHC structure, as opposed to previous emergency responses, which have traditionally focused on establishing parallel structures of service delivery [1].

In the experience of Concern, the process of integration is facilitated if links to existing PHC nutrition activities, such as growth-monitoring and promotion (GMP) programs, are established in the initial setup phase. Concern is in the process of linking these services in Malawi and Bangladesh; however, there are challenges, including the introduction of weight-for-height or MUAC to assess severe acute malnutrition in addition to weight-for-age.

Additionally, in order to increase coverage of treatment of severe acute malnutrition, it is necessary for other existing child health-focused interventions, such as outpatient consultation services and integrated management of childhood illness (IMCI) activities, to incorporate the assessment and treatment of acute malnutrition. In theory, such activities would become routine if incorporated into the basic package of health services (BPHS) at a policy level.

Nutrition reporting and monitoring system

Consistent and accurate reporting of severe acute malnutrition would allow for the early detection of a deteriorating nutrition situation and could foster timely scale-up of activities. However, in order for the PHC services to be responsive to changing levels of malnutrition over time, cases of acute malnutrition should be incorporated into existing health-management information systems. In contexts where health-management information systems are weak, the need to

monitor levels of severe acute malnutrition could be used as a catalyst for improving reporting systems. In other contexts, reporting formats exist yet are complicated and challenging for local health workers, and thus a simplified national format could allow for more accurate and effective reporting. To support this, global reporting formats and protocols, like those of IMCI, need to include standardized assessment criteria and treatment of acute malnutrition.

Training and capacity-building

Some nongovernmental organizations involved in CTC programming are taking a long-term look at the capacity development of staff in the PHC facilities to support CTC services. Although this is a step forward, because of the high turnover of facility staff the likelihood is that there will be a continual need for training at the facility level unless training is more formally institutionalized.

Training of health staff to implement CTC services requires national planning and support. To increase the institutional knowledge at all levels of health service (facility-based staff and extension or outreach workers), training in the principles of CTC, outpatient care, and management of complicated acute malnutrition needs to be incorporated into the existing medical and nursing curricula of health-training institutions.

In Ethiopia, Concern and UNICEF are advocating for and supporting the development of training in the principles and protocols of CTC as well as the management of complicated acute malnutrition in both the nursing and the medical curriculum at the national and regional levels. Additionally, Concern is working in South Sudan with UNICEF and another nongovernmental organization involved in PHC to include training on CTC protocols in the one-year nursing course. Other countries with experience in CTC and outpatient care for the management of severe acute malnutrition are not as advanced as Ethiopia and South Sudan in this regard. To build the capacity of health services to implement CTC, it is fundamental that these principles, protocols, and management issues be incorporated into health curricula at all levels for integration and sustainability.

RUTF

The development of RUTFs has allowed for the development of OTP care. In emergency programs, imported, commercially produced RUTFs are currently used; however, as the CTC approach is modified to address severe acute malnutrition in longer-term emergencies, postemergency contexts, or even developmental contexts, RUTF needs to be more easily accessible and affordable for the approach to be sustainable.

Local RUTF production. The CTC model promotes the local production of RUTF to increase economic

activity in the area or country of production and to increase access to and availability of RUTF by reducing cost. Local production of spread RUTFs is currently being developed by Valid Nutrition in partnership with Concern Worldwide in Ethiopia, Malawi, and Bangladesh and by the Peanut Butter Project in Malawi. Experience in the local development of RUTF has identified several challenges to the production and distribution of RUTF locally, including sourcing quality ingredients, licensing, and quality control.

The original RUTF spread recipe has five ingredients: peanut butter, vegetable oil, powdered sugar, dry skim milk, and a mineral and vitamin mix [8]. RUTF production in Ethiopia has been hampered by the difficulty of importing ingredients not available locally, particularly dry skimmed milk and the mineral-vitamin mix, highlighting the need to produce a RUTF from locally available ingredients [2]. Alternative RUTF recipes, nutritionally equivalent to that of the original peanut-based formula and using only locally or regionally available ingredients, are undergoing trials in Malawi and Ethiopia. Demand for RUTF in both countries is high, so if the trials are successful, the scale-up of production could reduce costs, although analysis of the most cost-effective location of production units within each country has not yet been undertaken. However, even if local RUTF becomes more accessible, there is still need for international donors to consider long-term support of the final RUTF product for programming.

In most countries the Ministry of Health transports drugs that are listed as essential on the national drugs list. However, like F-100 and F-75, milk-based diets [9] used in inpatient treatment of severe acute malnutrition, RUTF is a therapeutic product, and these are not on the essential drugs lists. Therefore, the Ministry of Health is not responsible for transportation of RUTF.

Licensing and quality assurance. The issue of national licensing and approval of local production needs to be researched in each context of proposed production so that delays and constraints are avoided. The classification of RUTF as a drug, nutritional supplement, or food has implications for its production and transport, and therefore it is crucial to establish its classification as early as possible. In Ethiopia RUTF is classified as a food and is being manufactured by a food producer. Currently this system is working adequately, but in order for RUTF to be included in the essential drug list in the future, it will have to be registered as a drug. In Ethiopia registration of a drug is a detailed and often time-consuming process, which has yet to begin for RUTF.

To facilitate the local production of RUTF, as either a drug or a food, there needs to be a network of laboratories accredited to test and analyze RUTF as part of a wider quality assurance program.

Regional level: Functional regional health system and appropriate capacity for service provision

The overall capacity required for a sustainable CTC program depends on the scale and the magnitude of the prevalence of severe malnutrition as well as the existing local capacity in the country or program area. To date, CTC has been implemented in emergency situations, and currently these programs are in the process of integrating CTC activities into the Ministry of Health. However, the level of input and the types of relationship among the nongovernmental organizations and the Ministry of Health partners for implementation are variable, depending on the context, the capacity of the Ministry of Health, and the pattern of malnutrition.

Integration as a process

The speed of integration and the ability to integrate a CTC program primarily led by an international nongovernmental organization depend on the structure and capacity of the Ministry of Health from the outset.

Experience in Malawi, Ethiopia, Niger, Sudan, and Bangladesh demonstrates the breadth of challenges of attempting to integrate CTC activities within different contexts. Key challenges to integration in different contexts where Concern has been working include the following:

- » In South Sudan, there was a lack of basic health services into which OTP and SC services could be integrated;
- » Because of outbreaks of disease such as malaria and poor coverage of basic health services, the CTC programs in Niger were characterized by caseloads in OTP and SC that were much higher than those seen in other countries with nutrition emergencies;
- » In developmental contexts such as Bangladesh with GMP programs, the standard index for assessing severe acute malnutrition is weight-for-age, not MUAC or weight-for-height. Data on height and MUAC are now also being collected in a pilot study in a small program area to assess severe acute malnutrition.

A challenge to integration in some of Concern's CTC programs has been the short-term funding mechanisms available from the donor community, which constrain the ability of a nongovernmental organization or government to build the capacity of the PHC services to implement CTC services.

Additionally, Concern's experience in several countries has demonstrated that the inclusion and full participation of the Ministry of Health right from the outset is crucial to longer-term integration, ownership of the service, and national sustainability. In Wollo, Ethiopia, Ministry of Health *worreda* administrative staff were seconded to Concern for on-the-job training in OTP supervision for 4 weeks. In addition, clinic staff

were seconded to Concern's mobile teams to build their capacity and understanding of assessment and outpatient treatment activities. In Malawi, clinical nursing staff along with CTC nutrition staff at the facility and regional levels were trained in wider CTC concepts. Wider understanding, conceptually and practically, of CTC programming at all levels of national health services from the onset of programming allows for easier integration. However, gaining full participation of the range of actors is often challenging in overstretched health systems.

Spectrum of inputs and capacity for CTC integration into the Ministry of Health

The composition of external inputs, in both scale and type, from a nongovernmental organization partner aiding the implementation of a CTC program, depends not only on the levels of severe and moderate malnutrition, but also on local capacities to manage and respond to the situation. Hence, two scenarios with comparable prevalences of acute malnutrition could have two different levels and types of external input.

In addition to the analysis of the context and prevalence of malnutrition, the required level of external input to implement CTC should be assessed through a comprehensive and participatory capacity assessment of the health facilities and system. Health capacity assessment is an essential component within the program analysis stage to analyze the type and scale of external support required.

Figure 1 demonstrates the spectrum of external inputs required to implement CTC based on the capacity and structure of the local or regional Ministry of Health PHC system to respond and the magnitude of the situation.

In emergency situations, levels of external inputs are most likely to be high. However, as emergency levels of malnutrition decline and the numbers of patients receiving outpatient care decrease, external support shifts from logistically heavy hands-on implementation toward a supervisory role. Supervision is regarded as stepping back from direct implementation to supporting implementation by the Ministry of Health by providing supervision, monitoring, and periodic training.

For example, in Wollo, Ethiopia, Concern has been implementing a CTC program with the Ministry of Health since 2003. When the levels of severe malnutrition declined, Concern began the transition period of withdrawing from the implementation of OTP services, handing over full implementation to the Ministry of Health. Additionally, the Ministry of Health seconded facility staff to Concern for mentoring on supervision of OTP activities and for training of community volunteers on community health promotion.

Theoretically, with Ministry of Health facilities independently implementing CTC services (OTP, SC,

and community mobilization), supervision evolves toward mentoring, whereby training or specific support is identified and requested by the Ministry of Health from the nongovernmental organization. In

this mentoring role, the nongovernmental organization partner can facilitate rollout of OTP, SC, and community mobilization activities throughout the region or country. Additionally, initial integrated sites can be

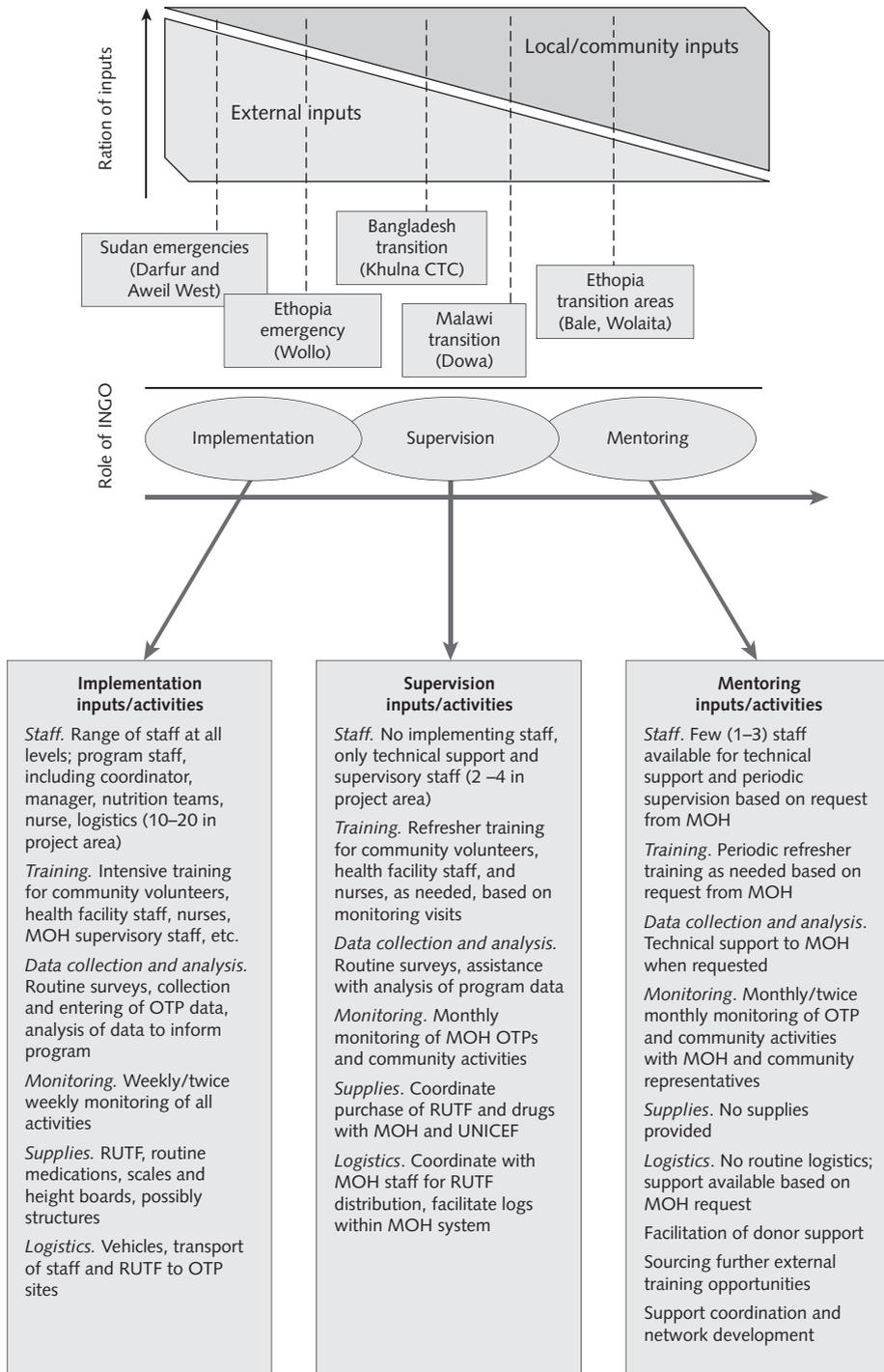


FIG. 1. Spectrum of inputs for community-based therapeutic care (CTC) activities in different contexts. INGO, international nongovernmental organization; MOH, Ministry of Health; OTP, outpatient treatment program; RUTF, ready-to-use therapeutic food

used to demonstrate that existing PHC systems can successfully provide OTP in conjunction with other services. Ultimately, the nongovernmental organization partners will alternate between different roles, depending on the change in both the prevalence of malnutrition and the local capacity.

Threshold levels for scale-up

An improved monitoring system such as that described above could be enhanced through the addition of regionally agreed-upon benchmarks to trigger expansion, scale-up, and scale-down of CTC activities and inputs.

In nonemergency situations, a small caseload of children in OTP can be handled by the Ministry of Health with mentoring support from a nongovernmental organization, as witnessed by Concern's program in Bale, Ethiopia. However, if caseloads increase beyond manageable levels in future nutritional emergencies, external support (human resources, training, and food resources) will increase proportionally.

To ensure a timely response to reported levels of acute malnutrition, there needs to be a national or regional plan for a response, detailing the practical commitment of stakeholders (Ministry of Health, nongovernmental organizations, and external donors) to specific program activities within outlined scenarios. Support of this system by the Ministry of Health, nongovernmental organizations, the World Food Programme (WFP), and UNICEF would further demonstrate their commitment to sustainability.

Community level: Community participation and active screening

Community participation is recognized as a key component of CTC [1]. As operational experience with CTC has grown, so has the understanding of the importance of broader community participation from the early stages of program design. Concern defines community participation in CTC as encompassing involvement in mobilization and awareness-raising activities, planning, decision-making, and management of interventions, and as active involvement in community outreach work, which includes active screening, follow-up of defaulters, and health-promotion activities.

Application of this broader definition of community participation fosters sustainability of CTC by empowering communities, promoting community ownership, and facilitating dialogue and interaction between the community and health-facility staff. Additionally, to enhance community participation and ownership, capacity-building at the community level with a medium- to long-term perspective should be built into CTC program design as a core component. This involves training and mentoring of community health committees and/or other community health institutions or networks by appropriately experienced

and skilled individuals. It also requires training and supervision of community outreach volunteers and health extension workers.

Program uptake is greatly affected by attitudes toward and relationships among the community and health facility providers. A positive outlook by the community on government health services is crucial. If government facilities have ceased to exist, or faith in the government health services is lacking, CTC program staff need to address this issue by supporting improvement in quality of care and then working toward reestablishing community confidence in these services.

Many communities support traditional healers or alternatives to government health services. Concern has found it essential that CTC program officials (from the Ministry of Health, nongovernmental organizations, or both) work with these practitioners to provide education on the signs of malnutrition and to support and encourage these alternative healers to refer malnourished children to the CTC program.

Active screening

Active screening, defined as the identification of acutely malnourished children and referral of them to the nearest health center implementing CTC, is an essential activity in achieving high CTC program coverage. In the initial phase of setting up emergency CTC, active screening and mobilization are conducted primarily by qualified staff of nongovernmental organizations and the Ministry of Health. However, as the program develops and the capacity of community volunteers and health extension workers is developed, the role of nongovernmental organization and Ministry of Health staff can shift to a supervisory one.

In order to support continued active screening, it is crucial for the wider community to be educated on the signs of malnutrition and for the community as a whole to take on greater responsibility to bring potentially malnourished children to the community volunteers or outreach workers for screening and referral to services. It has been well documented by international community health practitioners that sustaining active, voluntary community screening and outreach work is a key challenge in community health. CTC program planners and community committees need to work proactively to maintain volunteer motivation [10].

In order to facilitate sustained active screening by volunteers, it is crucial that the ratio of community volunteers to the target population be appropriate, realistic, and not overburdening. The numbers of volunteers should be determined by the operational context, in which the number of households covered is manageable and not more demanding than volunteers are willing to cover without payment.

In South Wollo, Ethiopia, Concern trained two community-elected volunteers (one male and one female) per *gott* (village) for outreach activities. The total

amount of time required for this work was no more than one day a month. However, the large number of volunteers in the program area (a total of 3,000) created a large demand for supervisory support and refresher training. Supervision of these volunteers is currently provided by 28 Outreach Supervisors employed by Concern, and to date the Ministry of Health has been unable to take over responsibility for this work.

In light of the lessons learned in South Wollo, Concern adopted a different approach when responding to the nutritional emergency in Bale. From the outset, the community-based therapeutic program was established within Ministry of Health structures and was managed by the district health authority. The health authority had full responsibility for the regular supervision of 750 volunteers, while Concern employed only four outreach supervisors to support this work for the initial 6-month phase.

As the critical emergency phase gives way to a more stable nutrition situation, the community screening and follow-up workload is reduced, and the role of the community volunteer may be adapted to the changed situation. In areas of both Ethiopia and Sudan, Concern has trained and supported community volunteers to address care and feeding practices and other health-promotion activities after the initial emergency response. Although facilitating volunteers to expand their knowledge and take on different activities can act as an important motivating factor, care must be taken not to overload the volunteer.

Challenges to moving forward

Based on Concern's experience in implementing CTC

and working with federal governments to integrate and adopt CTC into existing health services, several challenges have been identified for moving forward the sustainable treatment of acute malnutrition:

- » Increase local production of RUTF where CTC is being implemented, to increase the availability of the product;
- » Develop an international system of standards and mechanisms for quality control of RUTF production;
- » Integrate assessment and treatment of acute malnutrition in relevant international health and nutrition guidelines (e.g., WHO guidelines on treatment of severe malnutrition and IMCI guidelines);
- » Investigate and learn from previous experiences in the rollout and scale-up of other community health activities (e.g., IMCI);
- » At the project level, plan the development of future CTC interventions in response to nutrition emergencies with an integrated outlook through the Ministries of Health and with a longer-term vision to develop the capacity of PHC systems;
- » Further research and develop community-based treatment of severe acute malnutrition integrated into PHC systems in nonemergency contexts;
- » Develop a mechanism to ensure quality of non-governmental organization-supported CTC programs.

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Proceedings of the WHO, UNICEF, and SCN Informal Consultation on Community-Based Management of Severe Malnutrition in Children

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Introduction

About 10 million children worldwide are estimated to suffer from severe malnutrition (defined by the presence of severe wasting, bipedal edema, or both), which greatly increases the risk of mortality. Severe malnutrition is an important cause of death in infants and young children, but one that is increasingly open to successful management.

Prevention of severe, life-threatening malnutrition remains a priority, but even with expanded programs, a proportion of children will develop severe malnutrition and require treatment in the foreseeable future. Moreover, acute crises leading to high levels of malnutrition are likely to continue, and addressing the threats to survival under these conditions will continue to be a humanitarian concern. Effective interventions for the management of severe malnutrition with adequate coverage of affected populations could prevent hundreds of thousands of child deaths each year, thus contributing to the achievement of the Millennium Development Goals for the reduction of poverty and child mortality. Recently, new approaches to treatment have become available, which led to the meeting held by the World Health Organization (WHO) whose proceedings are published in this issue of the *Food and Nutrition Bulletin*.

The capacity to treat large numbers of severely malnourished children is lacking in most countries, particularly the poorest, where the problems are the

most extensive. Although facility-based (inpatient) treatment has proven effective in reducing case fatality rates, access to suitable health facilities is often limited, especially where it is most needed. This applies particularly to emergencies and is also true for non-emergencies in situations in which health resources are very limited. Furthermore, inpatient care requires the caretaker to stay in the health facility with the child for several weeks, which is often impractical and disruptive for the family.

Recent evidence from field programs has shown that management of severe malnutrition at home (community-based management) can be very effective and achieve high levels of coverage in target populations. This approach is based on early detection and assessment of severely malnourished children in the community and home-based care of those without complications; those with complications (notably evidenced by loss of appetite) will still need facility-based treatment. These procedures are considered to be effective for application both in emergencies and in nonemergencies where there is significant severe malnutrition. They may also have important potential for inclusion in broader health and nutrition programs—which include preventive measures—as a back-up when severe life-threatening malnutrition nonetheless occurs.

The meeting aimed to review recent experience and evidence and to update global recommendations for the management of severe malnutrition as an essential intervention toward achieving the Millennium Development Goals for the reduction of poverty and child mortality. Drawing on the information presented in the five background papers, reviews of these papers, and presentations of additional data from research and programs, the participants in the consultation examined the implications of these new developments for the management of severe malnutrition. The consultation identified areas of consensus that can be translated into evidence-based guidelines, as well as knowledge gaps that should be addressed by research.

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Objectives of the meeting

Overall objectives

1. To identify areas of consensus on the community-based management of severe malnutrition in children that can be translated into evidence-based global guidelines;
2. To identify knowledge gaps that should be addressed by research.

Specific objectives

1. To collect evidence on the feasibility, safety, and effectiveness of community-based approaches for treating severely malnourished children, considering published and unpublished research and field-based experience;
2. To identify areas of consensus that can be translated into global guidelines and knowledge gaps, particularly on the following points:
 - a) Identification of severely malnourished children in the community and their referral;
 - b) Dietary and medical protocols adapted for community-based treatment of severe malnutrition, including situations of high HIV prevalence;
 - c) Sustainability of community-based management of severe malnutrition in children;
 - d) Integration of programs for community-based management of malnutrition into the national health system and their scaling up.

The meeting focused on community-based management of severe malnutrition in children. The meeting did not make recommendations about the primary prevention of malnutrition. It did acknowledge, however, the importance of programs aiming at preventing malnutrition to reduce malnutrition-related mortality. The meeting did not discuss inpatient treatment of severe malnutrition, which has already been described in detail in existing WHO documents [1].

WHO will disseminate the findings widely among relevant stakeholders and develop guidelines for the management of severe malnutrition in children at the community level, as appropriate.

Nomenclature

The term “community-based management of severe malnutrition” was chosen for this meeting to be consistent with the existing WHO nomenclature in the field of child health.

Community-based management refers to treatments that are implemented with some external input, such as that provided by a health worker for diagnosing the condition, instituting treatment, and monitoring the condition of the child at home. For example, in

the community-based management of pneumonia, community workers with specific training are able to identify, prescribe antibiotics for, and monitor the treatment of children with pneumonia and to further identify severe cases for referral. In the treatment of severe malnutrition, a health worker is involved in identifying the severely malnourished child and in providing treatment that may include a mineral and vitamin supplement or a ready-to-use therapeutic food (RUTF).

Facility-based management refers to treatment in a hospital or center that provides skilled medical and nursing care on an inpatient basis.

Severe malnutrition is defined as severe wasting (weight-for-height < 70% or < -3 z-scores of the median National Center for Health Statistics [NCHS]/WHO reference value), the presence of bipedal edema (a sign of kwashiorkor), or both.

RUTF is a ready-to-use therapeutic food with a similar nutrient-to-energy ratio as F-100 (a milk-based therapeutic food).

Summary of presentations and discussions

Identification at the community level of severely malnourished children in need of treatment

As stated above, severe wasting is currently defined in terms of weight-for-height and/or bipedal edema, but the equipment and skills needed to measure weight-for-height may not be available at the community level. The consultation acknowledged that a mid-upper arm circumference (MUAC) of less than 110 mm is a suitable criterion to identify, at the community level, severely wasted children 6 to 59 months of age in need of treatment, since it is a good predictor of the risk of death among these children and is easier to measure than weight and height.

When ages are uncertain, height or length (from 65 to 110 cm) may be used as a proxy for age to identify children in the group from 6 to 59 months of age. A stick with markings at 65 and 110 cm can be used. The major risk of adopting a height or length cutoff is that young stunted children (more than 6 months old but under 65 cm in length) may be considered ineligible for measurement of MUAC. In practice, any severely malnourished child who has enough appetite and the adequate reflexes to eat RUTF is considered very likely to benefit from treatment.

At the facility level, weight-for-height, MUAC, and the presence of bipedal edema can be used independently for detection of severely malnourished children. Any child who has an MUAC less than 110 mm, a weight-for-height < 70% or < -3 z-scores of the median NCHS/WHO reference value, or bipedal edema should be admitted to a program for management

of severe malnutrition. Where growth-monitoring programs identify children with low weight-for-age, MUAC might also be measured, so that only those who have a low MUAC (< 110 mm) are referred to a therapeutic feeding program.

Community-level measurement of MUAC has been successfully employed in several countries, including Ethiopia, where it was used on a large scale. In South Wollo, Ethiopia, errors in MUAC measurements by 2,900 community volunteers leading to bias in admissions to therapeutic feeding programs were rapidly reduced by identifying the volunteers who referred children who did not need treatment and reinforcing the training of these volunteers.

Uncertainties persist regarding anthropometric criteria for admission of children under 6 months of age to a therapeutic feeding program. Low birthweight is often a key determinant of poor anthropometric status of these children. In the absence of information on birthweight, it is sometimes difficult to determine whether a child under 6 months of age is severely malnourished. Until better information becomes available, it was agreed that visible severe wasting and bipedal edema, should be used to determine whether a child under 6 months of age is severely malnourished. Research on the identification and dietary management of severe malnutrition in this age group was seen as a priority.

Management of severe malnutrition in the community

The evidence considered at the meeting was derived primarily from responses to recent emergencies in Sub-Saharan Africa. An important aim of the meeting was to consider how far this generally positive experience could be transferred to nonemergency situations, particularly those in which health resources are very limited.

Substantial experience, mainly in humanitarian emergencies, has been gained in the community-based management of severe malnutrition over recent years. Presentations from Malawi, Sudan, Niger, Ethiopia, and Bangladesh described the successful management of severe malnutrition in large numbers of children in the community, with high recovery rates, low case fatality rates, and high coverage. Malawi also reported a very low relapse rate for children 15 months after their discharge. The efficacy of such programs when basic principles of treatment are followed now seems well established, and there is also indication of high effectiveness. Still, the level of effectiveness would be better assessed if better estimates were available of the risk of mortality among untreated, severely malnourished children. This question should be explored by reexamining past studies of the relationship between nutritional status and survival.

Early detection and minimizing barriers to access in

order to promote early presentation of cases were seen as key to the success of therapeutic feeding programs in the community, because cases of severe malnutrition identified early are easier to treat and less likely to require inpatient treatment. Without active case-finding, many severely malnourished children are never identified because families do not seek care for them. The proportion of children who can be treated exclusively at the community level depends on the local situation and, according to the presentations made, may vary from 60% to 90%. Community-based and facility-based components of the treatment of severe malnutrition should be closely linked, so that children who are too ill to be treated at the community level or who are not responding to treatment can be referred to the facility level, and those receiving facility-based treatment who have regained their appetites can be transferred for continued care in the community.

In addition to the presence of severe edema and acute medical conditions, appetite is a crucial factor for differentiating between children who need care in a facility and those who can be cared for in the community. It was stressed that the conditions of the "appetite test" should be standardized.

RUTFs can be successfully used to treat severely malnourished children in the community. In contrast to milk-based therapeutic foods, RUTFs do not contain water and therefore bacteria cannot grow in them if they are accidentally contaminated; moreover, RUTFs, unlike milk-based foods, do not require refrigeration.

Data presented during the consultation suggest that it is not possible to attain the micronutrient content of F-100, a milk-based therapeutic diet, with local foods only. Nevertheless, studies from Bangladesh show that it is also possible to successfully treat severely malnourished children at home with a carefully designed diet of low-cost family foods together with a supplement of minerals and vitamins. These same mixtures of family foods also make good complementary foods and have the potential to prevent malnutrition in the long term.

The provision of RUTF in countries such as India or Bangladesh, where there are millions of severely malnourished children, will be challenging. In this case, treatment based on nutrient-rich family foods together with a supplement of minerals and vitamins might be an option. However, the consultation emphasized that the efficacy of local therapeutic diets should be tested clinically and that further research on the feasibility of this approach on a large scale is needed, along with research on the cost-effectiveness of nutritional rehabilitation with local diets or RUTF. The antinutrient content of some foods (e.g., phytates) was seen as a factor limiting the adequacy of local diets for nutritional rehabilitation of the severely malnourished.

Some outstanding issues in the community-based management of severe malnutrition remain, such as

provision of systematic antibiotic treatment and the need to provide food-insecure families with a food ration in addition to RUTF. These issues are likely to vary depending on context and need further research.

In order to be successful on a large scale, therapeutic feeding programs should be implemented through existing health-service delivery systems. Concern was expressed as to whether routine health systems have the capacity to implement and sustain such programs. The need was underlined to support the entire health system where health systems are dysfunctional. The creation of volunteer networks to identify severely malnourished children at the community level also raised some practical concerns, including the range of tasks that can be reasonably asked for and incentives that might be provided.

The participants strongly advocated the improvement of nutrition training at medical and nursing schools and the revision of textbooks, which currently give misleading information on the pathology and treatment of severe malnutrition.

The lack of clarity of nomenclature regarding the different types of malnutrition was highlighted as a difficulty that should be resolved. Severe malnutrition, unless clearly defined, is an inclusive term that can refer to a wide range of pathologies from wasting to stunting, obesity, and anemia. The consultation recommended that the issue of the nomenclature of nutrition disorders and nutrition interventions be urgently addressed to promote international consistency and facilitate advocacy.

Community-based management of severe malnutrition in the context of high HIV prevalence

The majority of HIV-positive, severely malnourished children will benefit from community-based treatment. However, experience from Malawi showed that the rates of weight gain and of recovery were lower among these children than among HIV-negative patients and that the case fatality rate was higher. Differences in weight gain were probably more closely related to a higher incidence of infections in HIV-positive patients, which undermined their appetite, than to family sharing of RUTF. The proportions of HIV-positive and HIV-negative children identified as requiring inpatient treatment for severe malnutrition according to the standard criteria did not differ.

Although strong linkages between community-based management of severe malnutrition and HIV/AIDS programs, such as voluntary counseling and testing, prophylactic cotrimoxazole to reduce the risk of *Pneumocystis carinii* pneumonia and other infections, and antiretroviral therapy, were seen as fundamental, it was less clear whether full integration of the programs at the delivery point was desirable.

Caring for HIV-positive people represents an extra

burden for the community, particularly among women and girls, resulting in additional physical, psychological, emotional, economic, and social stress. Assistance to women, such as support for their own health and care and provision of incentives, especially when they are enrolled as community volunteers, was highly recommended.

Sustainability and scaling up

The treatment of severe malnutrition has received increased attention at the national level over the past few years. Several representatives of Ministries of Health aired their interest in scaling up or implementing community-based management of severe malnutrition. Encouraging reports from Ethiopia, Malawi, and Niger illustrated how the capacity to manage severe malnutrition can be scaled up, notably by establishing national protocols, implementing community-based management, providing training and capacity-building for Ministry of Health staff, and providing RUTF.

Small-scale, well-run programs were seen as playing a useful role in demonstrating procedures and their benefits, thereby creating demand for larger-scale programs. UN agencies such as WHO, UNICEF, and the World Food Programme (WFP) should help governments to scale up programs. There is a need to advocate for the sustainability of funds for the treatment of severe malnutrition. The lack of continuity of funding for the treatment of severe malnutrition after an emergency often hampers the scaling up or even the maintenance of existing programs, although a large number of severely malnourished children still need treatment after the emergency is over. Scaling up could also be based on experiences from “learning sites” within research projects. In addition, further documenting the efficacy and effectiveness of community-based treatment of severe malnutrition is a crucial step toward the strengthening of evidence-based advocacy.

Within the process of scaling up, the overall context must be carefully considered. At the family level, underlying determinants of malnutrition, such as food insecurity and environment-related infections, should be taken into account. At the macro level, the functioning of the existing health system, which depends on the resources allocated to it, which in turn are contingent upon bilateral or multilateral support in many countries, will affect the implementation of community-based programs.

The participants discussed the levels of severe malnutrition that might trigger the implementation of community-based management. It was agreed that community-based treatment should be part of the routine health system in most developing countries. Malnutrition levels that trigger large-scale humanitarian interventions should be better defined. In this

regard, the response to a high prevalence of severe malnutrition can be viewed as dependent on the balance between external inputs and the capacity of the health system. In situations in which the capacity of the existing health system is low, external inputs and response would be relatively significant, whereas in an area with a strong health-system capacity, external support would be more limited.

Coordination and clear definition of the roles of the different stakeholders (UN agencies, nongovernmental organizations, and Ministries of Health), joint assessments of nutrition situations, harmonization of policies and guidelines, and development of standards for the production of RUTF were defined as essential factors for advocacy and mainstreaming treatment of severe malnutrition at the global, national, and local levels.

The following were identified as the most challenging issues for scaling up and sustainability:

- » Integration of treatment of severe malnutrition in existing health systems, especially when they function poorly;
- » Training and capacity-building of Ministry of Health staff;
- » Capacity of the Ministry of Health to monitor activities and the nutrition situation;
- » Community participation and mobilization;
- » Access to affordable RUTF or suitable local foods supplemented with vitamins and minerals;
- » Integration with other nutrition components, such as education.

Although the technology to produce RUTF at low cost can be easily developed, even in countries with limited industrial capacity, the cost of the product may still be too high in relation to available resources. Provision of RUTF should therefore be considered as a priority by food-aid projects and external donors. In order to facilitate the sustainability of community-based management of severe malnutrition, there is also a need for greater funding to support the primary health-care system. Cost recovery was seen as a major factor undermining the access of poor families to health care. The consultation recommended that treatment of severe malnutrition should be provided free of charge at both the facility and the community levels.

Conclusions and guiding principles

Treatment of severe malnutrition is critical for reducing child mortality, but despite the known efficacy of existing protocols, it has received insufficient attention as a public health intervention. The overall conclusion of the consultation is that community-based management of severe malnutrition is an effective intervention for the treatment of a large number of children suffering from severe malnutrition. It can achieve a low case fatality rate, provided adequate dietary and medical

treatment is delivered, close follow-up is ensured, and early detection is implemented at the community level. In order for these programs to be successful, efforts must be made to reduce barriers to access. Integration of such programs as part of the routine health system would have a major public health impact and contribute to the achievements of the Millennium Development Goals. This can only be accomplished by mainstreaming the management of severe malnutrition into international, national, and local health and development agendas.

The participants agreed on the following guiding principles for community-based management of severe malnutrition:

Identification of severely malnourished children in the community in order to provide for treatment

1. In addition to weight-for-height $< 70\%$ or < -3 z-scores of the median NCHS/WHO reference values and/or bilateral edema, MUAC < 110 mm can be used independently as a criterion for admission to a therapeutic feeding program for children aged 6 to 59 months. Children with MUAC < 110 mm should be admitted to a program for the management of severe malnutrition, regardless of their weight-for-height.
2. MUAC is a simple and practical tool that should be used by community workers to identify severely malnourished children.
3. In infants less than 6 months of age, it is recommended that "visible severe wasting" and/or edema, in conjunction with difficulties in breastfeeding, be used as criteria for admission to treatment until further studies are undertaken to develop more precise criteria.
4. High coverage (both temporal and spatial) of the programs, achieved through active case-finding activities, as established in the Sphere Project minimum standards [2], must be a key objective for therapeutic feeding programs.

Treatment of severely malnourished children in the community

1. It is desirable for programs for the management of severe malnutrition usually to have a community-based and a facility-based component, so that severely malnourished children with no complications can be treated in the community, while those with complications can be referred to an inpatient treatment facility with trained staff.
2. It is highly desirable to manage the treatment of severely malnourished children with no complications at home without an inpatient phase. These are severely malnourished children who are alert, have a good appetite, are clinically well, are not severely edematous, and have reasonable home-care circumstances.

3. Children with severe malnutrition who have mild or moderate edema and a good appetite but are not severely wasted can also be treated at home without an inpatient phase.
4. Children with severe malnutrition and complications should be referred to an inpatient treatment facility with trained staff. These patients include children who, in addition to being severely malnourished, have anorexia, severe edema, or both severe wasting (MUAC < 110 mm or weight-for-height < 70% or < -3 z-scores of the NCHS/WHO reference) and mild or moderate edema or who are clinically unwell.
5. For those treated as inpatients, after the complications of severe malnutrition are under control, treatment should normally be continued in the community. Children whose condition deteriorates at home should be referred for assessment and further treatment.
6. RUTFs are useful to treat severe malnutrition without complications in communities with limited access to appropriate local diets for nutritional rehabilitation.
7. When RUTF is given to children with severe malnutrition, 150 to 220 kcal/kg/day should be provided.
8. When families have access to nutrient-dense foods, severe malnutrition without complications can be managed in the community without RUTF by carefully designed diets using low-cost family foods, provided appropriate minerals and vitamins are given.
9. The efficacy of local therapeutic diets should be tested clinically.
10. Treatment of young children should include support for breastfeeding and messages on appropriate feeding practices for infants and young children.
11. Children under 6 months of age should not receive RUTF or solid family foods. These children need milk-based diets, and their mothers need support to reestablish breastfeeding. They should not be treated at home.
12. The criteria for the effectiveness of treatment should be a weight gain of at least 5 g/kg/day for severely wasted children (the rate of weight gain

was deliberately changed to a lower level than the Sphere minimum standards [2], which refer to inpatient treatment of severe malnutrition); low rates of case fatalities, defaults, and treatment failures; and lengths of stay during treatment.

Community-based management of severe malnutrition in the context of high HIV prevalence

1. The general principles and guidelines for the care of severely malnourished children in areas of high HIV prevalence do not fundamentally differ from those where HIV is rarely seen.
2. In areas where HIV prevalence is high, there should be unfettered access to HIV services (e.g., voluntary counseling and testing, cotrimoxazole prophylaxis, nutritional counseling, and antiretroviral therapy) and seamless articulation from the onset between levels of care (community, health center, and hospital) and between HIV treatment and malnutrition programs.
3. All therapeutic foods used, including RUTF, should be chosen to be appropriate for HIV-infected, severely malnourished children, on the basis of current scientific evidence.

Next steps

In follow-up of the meeting, WHO will lead a process to develop norms and standards and accompanying guidelines for policymakers and program managers on community-based management of severe malnutrition in children, including specifications of RUTF to facilitate production with local ingredients within countries. Further actions of partners will include the promotion of community-based management in selected countries, including technical assistance to introduce the approach into national health policy and health systems, and careful documentation of experiences in order to refine the implementation approach. The research questions identified in the consultation, such as the need for systematic antibiotic therapy, the identification and dietary management of severe malnutrition in children under 6 months of age, will be followed up.

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