

# Efficacy and effectiveness of community-based treatment of severe malnutrition

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## 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
<b>Monte et al.</b> <b>Brazil</b> <b>1998</b> [12]	<b>O</b>	<b>53% &lt; 18 mo</b> <b>Most used Gomez grades.</b> <b>Also social need</b> <b>Grade I 40%</b> <b>Grade II 47%</b> <b>Grade III 14%</b> <b>Only 27% &lt; 80% W/H</b>	<b>1,399</b> <b>(20 centers)</b>	NR	<b>Mean 8.7 mo</b>  <b>Meals 5 days/wk</b>

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 <sup>a</sup>  Home-feeding advice was not implemented	NR	NR	Not done	NR	NR
1.2	NR	Median weight gain 3.3 g/kg/day <sup>a</sup> 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 <sup>a</sup>  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	<b>Distribution of weight gain:</b> < 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	<b>Grades II and III (Gomez)</b>  <b>Mean W/A 59%</b> <b>Mean age 32.5 mo</b>	<b>64</b>	<b>Yes (only for some)</b>	<b>Mean 10 wk</b>  <b>(No feeding data)</b>
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 <sup>a</sup> 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 <sup>a</sup>  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 <sup>a</sup>  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 <sup>a</sup>	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
<b>Castillo et al.</b> <b>Chile</b> <b>1983</b> [21]	<b>O</b>	< 2 yr  WAZ < -3 SD if < 2 yr WAZ < -2 SD if < 1 yr	<b>313</b> <b>(a) 286 at 10</b> <b>health clinics</b> <b>(b) 27 at nutrition</b> <b>clinic</b>	<b>No</b>	<b>12 wk</b>  <b>No food given</b>
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	<b>In the subset (n = 274) of those &lt; -2 SD WAZ:</b> <b>(a) 31% reached -1 SD WAZ</b> <b>(b) 73% reached -1 SD WAZ</b>	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 <sup>a</sup> 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 <sup>a</sup> if grade III Mean weight gain 1.4 g/kg/day <sup>a</sup> 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 <sup>a</sup> Mean W/A (%): At entry 45 <sup>a</sup> After 13 wk 66 <sup>a</sup>	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 <sup>a</sup> WAZ: Cases      Controls At entry    -4.5      -4.1 After 3 mo -2.8      -3.6 <sup>a</sup>	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 <sup>a</sup>  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		Preliminary hospital treatment	Duration of treatment
		Admission criteria or severity of malnutrition	No. of children studied		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)
<b>Van Roosmalen- Wiebenga Tanzania 1988 [32]</b>	<b>O</b>	<b>At admission to hospital: 53% kwashiorkor 18% marasmic kwashiorkor 29% marasmus</b>	<b>475</b>	<b>Yes (all) (mean 19 days)</b>	<b>MCH services: home visits by health worker  No food given</b>
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 <sup>a</sup> 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 <sup>a</sup> (b) 0.9 <sup>a</sup> % 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
<b>Within 6–36 mo of discharge, 8% died and 13% relapsed</b>		<b>% &lt;90% W/H:</b> <b>At entry 88</b> <b>At hospital discharge 64</b> <b>After ≥ 12 mo 14</b>	N/A	<b>25–50</b>	<b>NR</b>	<b>NR</b>	<b>NR</b>
(a) 2.6 (b) 0	(a) 18.0 (b) 16.0	Mean weight gain 0–3 mo (g/kg/day): (a) 1.5 <sup>a</sup> (b) 1.3 <sup>a</sup> 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 $\geq 80\%$ 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 $\geq 80\%$ 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 Admission criteria or severity of malnutrition	No. of children studied	Preliminary hospital treatment	Duration of treatment
					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 $\geq$ –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  $\geq$  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  $\geq 3$  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  $\geq 5$  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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