Technical Background Paper

Efficacy and effectiveness of community-based treatment of severe malnutrition

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Abstract

This review examines the effectiveness of rehabilitating severely malnourished children in the community in non-emergency situations. Thirty-three studies were examined and summarised for the period 1980-2005. The four main delivery systems were day-care nutrition centres, residential nutrition centres, primary health clinics, and domiciliary care with or without provision of food. Eleven (33%) were considered effective, that is mortality <5% and weight gain ≥5g/kg/day. Of the sub-sample of studies reported since 1995, eight out of thirteen (61%) were effective.

The conclusions are:-

- there is a long tradition of community-based rehabilitation
- all four delivery systems can be effective. It is unlikely that a single delivery system will suit all situations worldwide. The choice will depend on local factors
- high energy intakes (>150kcal/kg/day), high protein intakes (4-6g/kg/day) and provision of micronutrients are essential for success
- rehabilitation at home with family foods is more cost-effective than inpatient care. The cost-effectiveness of ready-to-use therapeutic foods vs 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 carers can make energy- and protein-dense food mixtures at home, then domiciliary care is probably the best delivery system for community-based care. If carers cannot make such foods, then provision of ready-to-use therapeutic foods may be an alternative but the cost to the health service, logistics of procurement and distribution, and sustainability need to be assessed.

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 physiological 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 hypoglycaemia, hypothermia, electrolyte imbalance, heart failure and untreated infection, and the 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 2-7 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 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:-

- 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 non-emergency situations is effective. Other aspects addressed include the coverage and cost of community-based rehabilitation, and a review of existing programmes 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 programmes in non-emergency situations.

Definitions and setting

These were set by the World Health Organization.

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 occurs at a primary health clinic, or in a community day-care or residential centre, in order to achieve catch-up growth.

Severe malnutrition refers to children <-3 SD weight-for-height and/or oedema.

The two indicators of effectiveness that were set for this review were mortality <5% and weight gain ≥5g/kg/day.

The context is a *routine health system* with primary health care provision and referral opportunities, in a *non-emergency setting*.

Treatment of severely malnourished children consists of a stabilisation phase followed by a rehabilitation phase and it is this latter phase that this review addresses. Supplementary feeding programmes for the prevention of malnutrition and treatment of mild/moderate cases are outside the remit of the review.

Methods

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

Results

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. This is addressed in the following section.

Effectiveness of community-based rehabilitation

Thirty-three studies were examined and the quality of many of these, especially the early studies, is unsatisfactory: often only sketchy information is provided and there is lack of methodological rigour. Sample sizes are 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, so estimates have been derived for several studies from other data presented, with consequent risk of error. Weight-for-age and Gomez grades are of limited value when assessing effectiveness of treatment as low weight-for-age can coexist

with normal weight-for-height, and rapid weight gain is only possible for children with a deficit in weight-for-height.

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

and each is considered below.

Day-care nutrition centres

Nutrition centres were first proposed fifty years ago by Bengoa [5,6]. He envisaged simple buildings where up to 30 mild or moderately malnourished children would attend for 6-8 hours/day, 6 days/week and receive 3 meals for about 3-4 months. Mothers would help cook and clean, and 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. Enrolment for 3-4 months was based on the time needed for mothers to learn, rather than on the time needed to rehabilitate children.

There have been no recent publications of day-care nutrition centres, which might indicate that their popularity has waned. Daily attendance by carers for several hours is a disincentive and high discontinuation rates attest to their limited acceptability.

Table 1 summarises data from six studies of day-care nutrition centres published between 1980-98 [7-12]. All provided cooked meals which were eaten on site. Effectiveness was low, the main reasons being that few meals were offered or they were of low energy and nutrient density, attendance was spasmodic, and there was limited opportunity for rapid weight gain as many enrolled children were not wasted. Two studies are notable for their high mortality. In Niger [11] an estimated 12% of day-care children died in the first two weeks, and in Brazil [12], two centres had mortality rates >40%. Only the programme in Bangladesh [10] was effective and this is described below. The default rate was quite high (12%) even though treatment was relatively short. It was partly community-resourced and sustainability proved difficult.

Bangladesh study by Fronczac et al [10]: Two nutrition centres in Dhaka for treating uncomplicated non-oedematous malnutrition were studied. The centres had been developed in the city's poorest areas in collaboration with local community nutrition councils who donated the facilities and maintained them. The centres were open for 8h daily and staffed by Urban Volunteers who received 2 months' additional training and supervision, through the Urban Health Extension Programme (UHEP) of the International Centre for Diarrhoeal Disease Research. The UHEP provided personnel, food and technical support. Each centre had 5 volunteers and a capacity of 25 children, giving a staff: patient ratio of 1:5. Each volunteer was trained for specific duties. A physician visited weekly and supervised the programme.

Children were given a high dose of vitamin A and immunised at admission, and given antibiotics if signs of infection were present. Three meals and two snacks were fed daily prepared from low cost, energy-dense, locally available foods, including stuffed paratha, lentils, halva, khichuri, potato and high-energy milk (1kcal/ml). Health education included causes and prevention of malnutrition, prevention and treatment of diarrhoea, immunisation, family planning, hygiene and child care. Mothers actively participated in meal preparation.

The mean weight-for-height of those who completed treatment increased from 73% to 83% in 4 weeks. This is consistent with a rate of weight gain of ~5g/kg/day. There were no reported deaths. Some 12% of children failed to complete treatment, the main reasons being that daily attendance by mothers disrupted care of other children and was an economic burden due to loss of wages. Female children attended less frequently than boys, suggesting that more inconvenience may be tolerated for the benefit of male children than for girls in this population.

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

The centres in this programme received malnourished children from the community, either by referral from clinics or from surveillance surveys, with an estimated coverage of 26%. In theory, these centres 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 maintenance, repair and security of the centres and volunteer community participation without external funding, and thus sustainability of community-resourced day-care programmes is questionable.

Residential nutrition centres

Day-care nutrition centres were considered impractical by Bengoa for sparsely populated rural areas where distance would preclude daily attendance. For these situations, residential centres were advocated. They were also considered suitable for severely malnourished children whose medical complications had been successfully treated in hospital but were not recovered in terms of their weight. Residential centres reached their zenith in the 1960s and 70s and their performance during that period has been evaluated and their effectiveness was deemed modest [13-15]. Residential centres have similar disadvantages to those of day-care centres if carers are required to reside with their children during rehabilitation.

Table 2 summarises four post-1980 studies of residential nutrition centres [16-20]. Those located within hospital compounds were excluded. No recent publications of residential nutrition centres were located. Two of the four studies achieved mean rates of weight gain >6g/kg/d, but one of these did not follow the WHO guidelines for the stabilisation phase and had a 22% case-fatality rate [20]. Thus only one centre was considered effective [18] and this is reviewed below. It may have limited external validity as the centre may have been better resourced than usual through its link with the Medical University of Southern Africa.

South Africa study by McIntyre et al [18,19]: The Gold Fields nutrition centre, 40km 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 those admitted, 81% had first been treated for an average of 10 days in hospital and were in a stable condition. Whenever possible children and carers resided at the centre,

otherwise they attended on a daily basis. The rehabilitation diet was based on high-energy, high-protein, low cost family foods. Children were fed 6 times a day. Carers practised feeding their children and this was achieved in a supportive and caring environment. To help overcome the problem of poverty, 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, carers' attachment to their children increased, as did awareness of their children's emotional needs. Staffing was multidisciplinary and, from the range of activities provided and the individual support given to carers, it is reasonable to assume that staffing levels were good.

Mean weight-for-height at admission to the centre was 85% and this increased to 89% after an average stay of 10 days. The mean weight gain was 42g/day (~6g/kg/day). Children were discharged when weight gain was good and the carer could demonstrate that she was able to put into practice what she had been taught. In cases of extreme need, carers at discharge were given skim milk powder or peanut butter, and micronutrient supplements. All were given a growth chart. At follow-up, 80% could produce the card and 69% had attended a clinic or the centre for checking progress. The mean weight-for-height was 99% at follow up, which on average was 12 months after discharge, but 18% had deteriorated.

At follow-up, 74% of carers remembered the advice to add peanut butter, fat or sugar to the child's cereal, and 74% had implemented this advice. Although 51% remembered advice about frequent meals, only 26% followed it. Only 19% remembered the advice on hygiene. What the carer 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 families who kept poultry and animals for milk, and 20% had vegetable gardens compared with 7% at admission. Some 60% of carers told neighbours what they had learned at the centre.

Primary health clinics

Seven studies were identified of which six were within health clinics and one was a nutrition clinic **(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 centres in Guinea Bissau [25] and the residential centres in Malawi [26] and these are described below. Clinics that provide outpatient advice depend on carers rehabilitating the child at home, and it could be argued that these too are essentially 'home-based' programmes. In a pilot study in a rural health centre in Jamaica, the WHO guidelines were implemented on an outpatient basis by clinic staff giving specific instructions to mothers of severely malnourished children for administering antibiotics at home and preparing starter and catch-up milk-based formulations [23]. Estimated rates of weight gain were 2.7g/kg/d averaged over 5 months.

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

The nurses had 2 years' general training and 2 weeks' specific training on malnutrition and rehabilitation. Most children received antibiotics for 5 days and the rehabilitation diet in the centre was 3-4 milk-based feeds/day. Additional feeds were taken home or to the lodgings. The World Food Programme provided dried skimmed milk and oil, and some of the sugar and rice. Families provided millet flour, rice, honey, cooking utensils, charcoal for cooking, and bed linen. Little information is given about the content of the education programme. Nurses spent 2-4h each day in the centre and the rest of their time was spent in other health centre activities.

The mean duration of rehabilitation was 13 weeks and the mean weight gain was 37g/day. From other data presented, this approximates to a weight gain of ~6g/kg/day. The mean weight-for-age SD score improved from -4.5 to –2.8. Mortality during treatment was 4.8% and few deaths occurred within 48h. About half the late deaths were from AIDS, tuberculosis and 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 (RR 0.75, 95%CI 0.57-0.99). Post-discharge relapse to severe malnutrition among treated children was 1.4%.

Compliance from families was excellent and only 3% absconded 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 programme. These discussions, however, might also have led to self-selection bias by which only those who felt able to attend for 13 weeks actually enrolled.

b) 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 paediatrician every 2-4 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 comprising a starter formula (66kcal and 1g protein/100ml) and then a catch-up formula (114kcal and 4.1g protein/100ml) and enriched porridge (maize, soy, sugar and oil) when appetite and oedema improved. The ingredients came as a premix from the World Food Programme. Six feeds/24h were given and the target energy intakes in the stabilisation and rehabilitation phases were 79 and 170kcal/kg/day, respectively. Electrolyte imbalances and micronutrient deficiencies were corrected by Nutriset's Combined Mineral Vitamin (CMV) mix, but only during half the study period.

On average, children at admission were aged 29 months with a weight-for-height SD score of –1.7 after loss of oedema. Mean weight gain from admission was 6.4g/kg/day. Since all the children were losing oedema 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 4.7g/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 summarises sixteen reports of home-based rehabilitation [28-46], with one study being 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:energy ratio. BP100 is a 300kcal biscuit that can be eaten dry or crumbled in hot water to make a porridge. Plumpy'nut is a peanut-based paste with 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 & Laquière [47] found faster rates of weight gain with BP100 and F100 at alternate meals compared with F100 alone (11.6 vs 9.3g/kg/day, p=0.05), and in Senegal, Plumpy'nut supported faster growth rates than F100 (15.6 vs 10.1g/kg/day, p<0.001) 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 were used.

Of the sixteen reports of home-based rehabilitation, seven were considered effective according to the criteria set for this review. These were two home-based programmes in Bangladesh in which no food was distributed [36,39], and five studies with RUTF in Senegal, Malawi, Sierra Leone and Niger [40-42,45,46]. These are described below. Even with the same RUTF ration (175kcal/kg/day), substantial differences in rates of weight gain were apparent: in Senegal, the mean rate with RUTF was 8g/kg/day; in Malawi the mean rate was 5g/kg/day in two studies [41,42] and <3.5g/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 12g/kg/day [45]. With no sharing or infection, expected rates of weight gain with an intake of 175kcal/kg/day would be ~15g/kg/day. In Niger with a ration of 2 sachets Plumpy'nut/day (1000kcal), the mean rate of weight gain was 10g/kg/d [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 10g/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 centre for severe malnutrition with ~1300 admissions/year. It had 60 inpatient beds and day-care facilities for another 40 children, with a staff:patient ratio of 1:5, and was largely financed by Save the Children, UK. Admission criteria were weight-for-height <60% and/or oedema. In 1990, a home-visiting service was introduced and a cost-effectiveness trial was undertaken to compare i) inpatient care ii) day-care, and iii) day-care for one week followed by home visits weekly for one month or until oedema disappeared, and then fortnightly visits. Multivitamins and ferrous sulphate were provided for those home-visited, but no food. None of the groups received zinc. Whilst at the Unit, carers received 20 minutes structured instruction each day on topics relevant to child feeding, disease prevention and family planning. They also participated in cooking demonstrations and actual practice of meal preparation. The domiciliary group received additional instruction during their week at the Unit, particularly what to feed, how much, and how often. The bowl and cup used in the practice sessions were given for the child to take home.

In the domiciliary group, mortality was 3.5% and the rate of weight gain from admission averaged 4g/kg/day, but since 98% had oedema the true rate of tissue accretion is likely to have exceeded 5g/kg/day and hence treatment was considered 'effective' in this review. Gains for day-care and inpatients were 6 and 11g/kg/day respectively. Despite the slower rate of weight gain, domiciliary care was the most cost-effective treatment. Infection, poor appetite and non-adherence to dietary advice adversely affected weight gains at home. Infections were reported in 38% of study weeks. The authors concluded that better weight gains 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. Neighbours took an interest in the home visits and appeared to assimilate the

advice being given to the target child's family, suggesting that domiciliary care may have wider impact due to 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 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 they could refer back when necessary. Following the trial, early discharge with home visits became a routine service and parents were offered a choice of inpatient, day-care or domiciliary care. Mothers of recovered children also acted as informal peer counsellors to give help and encouragement to other mothers rehabilitating their children at home.

Bangladesh study of Ahmed et al [39]. Severely malnourished children admitted to the Dhaka Hospital of ICDDRB were randomised after 7 days to a) domiciliary rehabilitation with home visits by health workers b) domiciliary rehabilitation with clinic visits, or c) continued inpatient care. No deaths occurred in the domiciliary groups and the median time taken to reach 80% weight-for-height was 20 days with home visits, and 37 days and 17 days respectively for the clinic and inpatient groups. The rate of weight gain in the home-visited group averaged 10g/kg/day, compared with 7.5g/kg/day for clinic visits and 12g/kg/day for inpatients. Domiciliary care was about one-third the cost 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 mothers practised 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 programme for mothers, which includes many aspects of child care.

Senegal study of Diop et al [40] and Malawi studies of Sandige 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 (Nutriset's combined mineral vitamin mix). Rates of weight gain with locally-made RUTF and imported Plumpy'nut were similar [40,41]. Although both studies provided a fortnightly ration equivalent to 175kcal/kg/day, rates of weight gain were higher in Senegal than in Malawi (8 vs 5g/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/relapses increased in the groups allocated one-third of the ration of RUTF, or the prodigious fortnightly ration of 34kg of maize/soy flour. Much of the ration was thought to be shared [55].

In HIV-positive children given RUTF, rates of weight gain were slower and mortality higher than in HIV-negative children [41-43], but nevertheless 59% of HIV-infected children achieved >90% weight-for-height [41]. Locally-made RUTF has a higher solute load than imported RUTF because sugar replaces dextrimaltose, but diarrhoea was not reported as a problem with local RUTF in these studies.

Sierra Leone study of Navarro-Colorado & McKenney [45]
Rates of weight gain in children discharged early with weekly rations of RUTF were similar to those who stayed as inpatients (12 vs 13g/kg/day). 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 carers in Sierra Leone before going home and effective stabilisation and transition phases in a therapeutic feeding centre (C. Navarro-Colorado, personal communication 2005).

Niger study of Gaboulaud [46]
Rates of weight gain in the rehabilitation phase in children given 2 sachets RUTF/day (1000kcal) to eat at home were 10g/kg/day compared to 20g/kg/day as inpatients. Children were monitored weekly. In addition to RUTF, children were given vitamin A, folic acid and albendazole. Criteria for home treatment were no oedema, clinically well with

good appetite and >12m of age. Mean institutional cost/child in 2002 when 0.5% of children were treated at home with no inpatient phase was 105Euro and in 2004 it was 91Euro when 49% of children were rehabilitated at home with no inpatient phase.

Comments on the criteria used

The criteria used in this review (mortality <5%, rate of weight gain ≥5g/kg/day) work well if they are applied to the specific period of rehabilitation. They are less satisfactory for studies where progress is assessed after several months as it is not possible to separate what might be reasonably considered 'rehabilitation' from 'follow-up'. Rapid weight gain only occurs when children are wasted. When children approach a normal weight-for-height, their rates of weight gain fall to 1-2g/kg/day. A low rate of weight gain derived over a long period may thus mask a good rate of weight gain during rehabilitation. Also 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 rehabilitating at home if mortality is low. One might, for example, lower the rate to ≥3g/kg/day, but such slow rates of improvement may not motivate carers to adhere to the feeding advice. There is little justification for relaxing this criterion for programmes that provide food, because of the added cost of providing food for longer.

The weight gain criterion of ≥5g/kg/day can also be problematic if a large proportion of children are oedematous at the start of rehabilitation, as in the studies of Brewster et al [26] and Khanum et al [36]. Oedema severity was taken into account when assessing these studies. Not all studies, however, report the prevalence of oedema and the rate of tissue gain may be higher than the measured rate of weight gain if the latter includes oedema loss.

Some may question whether a mortality criterion of <5% is appropriate, especially for HIV-positive children. Life-threatening conditions and co-morbidities 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 studies 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.

Conclusions regarding the effectiveness of community-based rehabilitation

In this review, thirty-three studies of community-based rehabilitation have been examined. Six evaluated day-care nutrition centres, four were residential nutrition centres, seven were clinic-based, and sixteen were domiciliary. Eleven (33%) were considered effective using the criteria set for this review. Of these, two were delivered through nutrition centres (Bangladesh day-care and South Africa residential), two through health clinics (Guinea Bissau and Malawi), and seven were domiciliary, two of which provided no

food (Bangladesh), four provided 175kcal/kg/d of RUTF (Malawi, Senegal and Sierra Leone) and one provided 1000kcal/d of RUTF (Niger). Thus all four delivery systems can be effective. These have several features in common, which are discussed in section 3.2.

Taking the community-based studies published in the last ten years, eight out of thirteen (61%) were effective. Of these, two were delivered through health clinics where they received meals (Guinea Bissau and Malawi), and six were domiciliary (one provided no food and five provided RUTF).

Reasons for the ineffectiveness of some *day-care and residential centres* include:-
- intermittent attendance due to distance, opportunity cost, and competing demands on carers
- too few meals provided
- meals not sufficiently energy-dense
- children not fed ad libitum
- nosocomial infections
- persisting electrolyte/micronutrient deficiencies that impair immune function and limit growth
- weight-for-age entry and discharge criteria: non-wasted, stunted children may be enrolled and they grow slowly.

Possible reasons for the ineffectiveness of some *domiciliary programmes using family foods* are:-
- 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: carers 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/micronutrient deficiencies; early discharge from hospital may lead to discontinued supplementation, especially of zinc
- fathers/other influential members may not be involved: they often control families' finances.

Possible reasons for the ineffectiveness of *domiciliary programmes that provide RUTF or other food* are:-
- 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, carers 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/micronutrient deficiencies (unlikely with RUTF)
- substitution: foods intended as a supplement may replace other foods and the net increase in intake may be negligible
- fathers/other influential family members are not involved: they often influence families' eating habits.

The conclusions drawn from these studies are:-

- all four delivery systems can be effective (day care and residential nutrition centres, health clinics, and domiciliary care with and without food)
- the proportion of effective studies has increased in recent years. Overall only 33% of programmes were effective but in the last 10 years this has increased to 61%, as an increasing proportion of programmes have promoted energy- and protein-dense foods and have provided micronutrients
- day-care and residential centres are inconvenient for many carers
- domiciliary rehabilitation with a ration of RUTF sufficient to meet the needs for catch-up growth (175kcal/kg/day or 1000kcal/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/oil for rehabilitation at home was ineffective in Trinidad and Jamaica, and maize/milk/oil premix or maize/soy flour was ineffective in Kenya and Malawi. Even large amounts to meet family needs (72kg/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 programme implementation

The successful programmes 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 5), specific food mixtures that families could afford, or by providing RUTF
- those not giving 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 practise preparing children's meals
- centre-based programmes were <4 weeks' duration
- staff were motivated and carefully trained.

Notably, all had external support. The Bangladesh day-care programme received UHEP support comprising personnel, food and technical assistance. The Gold Fields residential programme 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 via the World Food Programme and in addition Malawi received CMV from Nutriset. The domiciliary programmes in Bangladesh, Sierra Leone and Niger were linked to NGOs (Save the Children, ICDDRB, Action Against Hunger and Médecins Sans Frontières) and Nutriset provided RUTF in Malawi and Senegal.

Coverage and cost of community-based rehabilitation

Coverage data are limited (Tables 1-4). Reported coverage ranged from 0.1% to 33%. These rates are much lower than those reported in emergency settings where there is active case-finding through NGO 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% weight-for-height were compared for three delivery systems in a controlled trial [36-38]. The institutional costs comprised capital costs and operational costs: the latter included salaries, utilities, laboratory tests, medical supplies and food. Parental costs included wage loss, transport and child's food at home. Domiciliary rehabilitation was the most cost-effective, the institutional costs being half the cost of day-care 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 studies, families used their own foods. No comparable cost-effectiveness trials have been reported with RUTF to answer the question as to whether it is more cost-effective to treat a child at home with RUTF (donated to, or purchased by, the health system) than for the child to remain in hospital. Neither have there been randomised trials of the cost-effectiveness of domiciliary care with home foods vs RUTF. Minimum costs, however, can be estimated from the cost of the RUTF itself. On average, 11kg of RUTF was needed to rehabilitate a child in Malawi [41]. If imported Plumpy'nut was used, this cost $55/child [41]. If the RUTF was locally produced the cost was about $22/child. The equivalent amount for HIV-infected children was 22kg RUTF [43] at a cost of $110/child for imported RUTF and $44 if locally produced. These are substantial costs for some health systems to accommodate. For example, the cost/child for imported RUTF exceeds the health budget/person of almost all countries in sub-Saharan Africa.

Health expenditure per person in sub-Saharan Africa (1997-2000)

Expenditure (US $)	Number of countries
>60	4
34-60	2
12-34	11
<12	18
Data not available or population <1.5million	13

Source: World Development Report 2004

Hospitals typically discharge children after 1-2 weeks when they show signs of clinical improvement rather than when they attain a target weight-for-height. 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 1-2 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 + 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].

Existing community-based programmes within routine health systems

Several of the community-based studies included in this review used regular health staff but the studies were not to scale and were more of a pilot nature in a single centre or clinic. Some depended on free supplies from sources such as the World Food Programme and Nutriset, or support from NGOs. Programmes were therefore sought that were within local or national health systems and were independent of external support, and comprised at least three centres or clinics for treating severe malnutrition. Only four met these criteria and these are shown in bold in Tables 1-4 and are described below. Programmes were also sought in which there had been handover of NGO community-based programmes 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 34 day-care nutrition centres was established during 1992-94 in the State of Ceará and these operate under the direction of the state health secretariat [12]. At evaluation in 1996, only 20 were functioning as nutrition centres: 9 had never opened and 6 had been redirected as health centres. None was following WHO case-management guidelines. Caseloads were low and twelve assisted <50 children per month. This was partly due to an inadequate referral system resulting from lack of integration of the centres with other health programmes. The centres used Gomez grades as entry criteria and a considerable proportion of children were already >80% weight-for-height at entry. Children were kept in the programme 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 programme were a) standardised entry and exit criteria using weight-for-height, b) improved integration with other health programmes so that more children would be referred, c) implementation of

WHO case-management guidelines and performance indicators d) a shift in emphasis to home-based care in which centre staff would provide weekly home visits after one week of day-care.

Philippines: By 1980, 250 residential nutrition centres (nutrihuts) had been built through the Philippine Nutrition Program for treatment of moderate or severe malnutrition [16]. Details are limited, but on evaluation of 24 centres, 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 programme', which included treating uncomplicated malnutrition on an outpatient basis [22]. Few details are given but the programme 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 south western 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 as 28% of children had not been registered 12m after discharge. Of those who did register at MCH clinics, 76% were seen more or less regularly and/or visited at home. The overall programme aimed to provide information and feedback to village and district leaders to help promote community participation and action, and build capacity. As a result, women's groups and church leaders regularly organised meetings and seminars in their villages, including child health and nutrition topics, and developed projects to promote vegetable gardens and orchards. Primary school teachers organised 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 programme aimed for open-mindedness, exchange of knowledge and mutual respect.

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

Some countries routinely receive supplies from the World Food Programme 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 centres 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 centres was dictated by food aid which, although being an important resource, limited the learning opportunities for carers to improve child feeding as they could not access these foods in their communities. Children's home diets did not improve with centre participation.

Many factors are likely to explain why community-based programmes run by routine health systems were largely ineffective, but 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 management 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. Carers need prior training for home rehabilitation so as to avoid gaps in treatment. For those being discharged early, hospitals will therefore need to take responsibility for equipping carers 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]. National health worker training, however, has stagnated at <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]. Consequently many countries continue to have under-resourced, poorly functioning district health systems, and improvements in health worker performance are urgently needed [58]. Growth monitoring and nutrition counselling 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 oedema. Not all accept referral. In Bangladesh, for example, only 14% of sick children referred to Matlab hospital actually complied [59]. Reasons for non-compliance included competing demands at home, perceptions about disease severity, fear of hospital, perceptions about the quality and costs of hospital care, and the costs of transport. Of those who sought treatment at the Dhaka Hospital of ICDDRB, prolonged inpatient rehabilitation is unpopular and 38% refused to go to the Centre's residential nutrition unit [60]. Distance from hospital is a constraint in some communities; for example in rural Bolivia and Amazonia, attendance at hospital may entail a 3-day walk or river trip. 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 they would benefit from the same advice as 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 programmes, as timely action might prevent them 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, 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 mean more families will 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 as early discharge without continuity of adequate care is a death sentence for many children (3,4,11,61,62). Hospitals with a policy of early discharge and no system of follow-up are usually unaware of high post-discharge mortality. Failure of children to appear at outpatient clinics is easily misinterpreted as parental indifference and irresponsibility, rather than to the death of the children. Early discharge therefore needs to be linked with effective community-based care, and at present there are many countries where this will be non-existent.

Community-based rehabilitation: There are three main options:
a) short-stay day-care or residential nutrition centres with intensive rehabilitation
b) at home, with home or clinic visits
c) at home with RUTF, with home or clinic visits.
Their advantages and disadvantages are set out below:

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

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 communities, 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 prevention of malnutrition.

Day-care and residential nutrition centres: their low coverage and high opportunity cost will make these the least favoured option in many settings. Nevertheless, such centres could be a 'half-way-house' between hospital and home. For example, attendance for 1 week could boost weight gain and provide practical education sessions for mothers and carers and precede rehabilitation at home. They could monitor progress during home rehabilitation by providing home visits and/or having children return to the centre for assessment. Centres 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, well-resourced nutrition centres could be alternatives to hospital admission if staff were sufficiently trained. The centres should be integrated into the child health services and could be attached to a clinic.

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 them as pivotal in preventing malnutrition, case-finding, referral, and monitoring. With appropriate training and resources, clinic staff could deliver community-based rehabilitation for a) severely malnourished children after early discharge from hospital, b) 'uncomplicated' severe malnutrition, and c) moderately malnourished children referred from hospital or identified during routine growth monitoring. Collins advocates rehabilitation at home with no prior stabilisation phase for 'uncomplicated' cases of severe malnutrition i.e. clinically well, alert, and a good appetite [52,53], but others consider that a short period of stabilisation and close observation may speed subsequent recovery at home.

From a practical standpoint, the main weakness in many home-based rehabilitation programmes is that carers 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 carers 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 standardised 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 transformations 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 [53,63]. 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 [63]. As capacity building progresses, the aim could be to expand from hospital-based to community-based rehabilitation, and then sequentially convert community-based rehabilitation from a vertical intervention into an integrated horizontal programme that encompasses both preventive and curative elements.

Key tasks in an integrated programme are likely to include:-

- collect hospital data to assess the situation and advocate for action (e.g. % dying among severely malnourished admissions and among non-severe admissions; rates of weight gain in the rehabilitation phase; discontinuation rate; acceptable inpatient duration)

- collect data about foods available at home for children admitted with severe malnutrition, and seasonal changes; distances to clinic; determinants of severe malnutrition

- raise the profile of malnutrition among hospital and clinic staff

- plan actions to reduce malnutrition deaths

- build capacity to improve hospital treatment

- plan actions for early discharge (if appropriate in the setting)

- undertake formative research to develop specific educational messages for home rehabilitation

- build capacity of clinic staff and supervisors so they can deliver home rehabilitation

- provide clinics with essential drugs, electrolyte/mineral solution, and equipment (e.g. weighing scales)

- implement community-based rehabilitation

- evaluate its effectiveness

- reward achievement (e.g. public recognition)

- build capacity to prevent malnutrition (e.g. early detection; improve prenatal nutrition, breastfeeding support, complementary feeding, hygiene, health-seeking behaviours etc)

- mobilise community (e.g. peer counsellors, hearth model)

- make linkages with other sectors (e.g. literacy, water/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, logistics of procurement and distribution, sustainability, and 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 vs RUTF.

- Operational research is needed to determine the effectiveness of scaling-up community-based rehabilitation in routine health services in non-emergency 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.

- Cost-effectiveness of community-based rehabilitation with RUTF vs inpatient rehabilitation would help guide policy decision 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 delineating, 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 if these children or their families share certain characteristics that could be used to identify them as high risk and in need of additional care.

- Feeding advice given at home visits may produce a 'ripple effect' among neighbouring 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 carers 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. It 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 carers 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 centres, residential nutrition centres, primary health clinics, 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 intakes (>150kcal/kg/day), high protein intakes (4-6g/kg/day) and micronutrients. Rehabilitation at home with family foods is more cost-effective than inpatient care. The cost-effectiveness of ready-to-use therapeutic foods vs 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 carers 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, carers and health staff but its cost, logistics of procurement and distribution, and 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 vs RUTF.

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 programmes.

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List of Abbreviations used in Tables 1-4

wt/ht = weight-for-height
wt/age = weight-for-age
MUAC = mid-upper arm circumference
NR = not reported
O = observational study
CC = case control study
RCT = randomised controlled trial
RCT-S = systematic allocation

* value derived by this reviewer from other data given by the authors.
Bold denotes programmes within routine health services.

Table 1. Day Care Nutrition Centres

AUTHOR; COUNTRY; YEAR PUBLISHED (Ref)	TYPE OF STUDY	AGE; ADMISSION CRITERIA and/or SEVERITY OF MALNUTRITION	CHILDREN STUDIED	PRELIMINARY HOSPITAL TREATMENT	DURATION OF TREATMENT / FOOD GIVEN OUT	MORTALITY (%)	RELAPSE (%)	REHABILITATION — WEIGHT GAIN OR PROGRESS	COST PER CHILD	COVERAGE (%)	FOLLOW-UP	LATER MORTALITY (%)	LATER RELAPSE (%)
Brown et al. Zaire 1980 (ref 7)	CC	5-24 months Only 29% <85% wt/ht	106 pairs (controls were children in villages with no centre)	6	12 wks 3 meals @ 6d/wk (maize/legume gruel) Parents contributed fruits and vegetables	NR	NR	Weight gain for centre attenders not significantly different from controls matched for age and wt/ht.	NR	NR	After 12m, no significant benefit in wt/ht for centre attenders versus controls	NR	NR
Ojofeitimi & Teniola, Nigeria 1980 (ref 8)	O	9-48 months	30	4for some only	12 wks 1 meal @1d/wk	3.3	6.7	Mean wt gain 1.9g/kg/d * Home feeding advice was not implemented	NR	NR	Not done	NR	NR
Stanton et al. Bangladesh 1987 (ref 9)	O	18-48 months MUAC <12.5cm Mean wt/age 55% Mean wt/ht 78%	85	4for 3 only	3-5 wks 3 meals + 2 snacks @6d/wk	1.2	NR	Median wt gain 3.3g/kg/d* Median wt/ht :- At entry 78% After 3 weeks 83% After 5 weeks 86%	NR	NR	After 6m, median wt/ht was 83%	NR	NR
Fronczak et al. Bangladesh 1993 (ref 10)	O	6-59 months MUAC 9-11.9cm or wt/ht 60-79%, non-oedematous Mean wt/age 51%	161	6	Mean 4 wks 3 meals + 2 snacks daily High-protein, high-energy family foods	0	NR	Mean wt gain ~5g/kg/d * Mean wt/ht :- At entry 73% After 4 weeks 83%	US$ 140 for 4 wks+ 5 follow-up home visits	26	After 12m, mean wt/ht was 93%	NR	2.5
Chapko et al. Niger 1994 (ref 11)	RCT	5-28 months Wt/ht <-2SD or kwashiorkor Median wt/ht –3.16 SD	100 a) 53 hospital b) 47 NRC	4median 7 days, then randomised to remain or transfer to NRC	Mean stay: a) 13 days hospital b) 12 days NRC. a) 3 meals/d b) 1 or 2 meals/d Parents contributed food.	a) 24 b) 12 (estimated from graph)	NR	No difference in wt/ht gain during treatment between the two groups	Hospital had120% higher cost per patient day	NR	After 6m, mean wt/ht a) -1.0 SD b) -0.3 SD (estimated from graph)	0-6m:- a) 41 b) 33 (p=0.17)	NR
Monte et al. Brazil 1998 (ref 12)	**O**	**53% < 18 months Most used Gomez grades. Also social need. Grade I: 40% Grade II: 47% Grade III: 14% Only 27% <80% wt/ht.**	**1399 (20 centres)**	**NR**	**Mean 8.7 months Meals@5d/wk**	**13.8 ≥40% in 2 centres <5% in 18 centres**	**NR**	**Distribution of wt gain:- <2g/kg/d 79% 2-4g/kg/d 16% >4g/kg/d 5%**	**NR**	**NR**	**Not done**	**NR**	**NR**

Table 2. Residential Nutrition Centres

AUTHOR; COUNTRY; YEAR PUBLISHED (Ref)	TYPE OF STUDY	AGE; ADMISSION CRITERIA and/or SEVERITY OF MALNUTRITION	CHILDREN STUDIED	PRELIMINARY HOSPITAL TREATMENT	REHABILITATION					COST PER CHILD	COVERAGE (%)	FOLLOW-UP		
					DURATION OF TREATMENT	FOOD GIVEN OUT	MORTALITY (%)	RELAPSE (%)	WEIGHT GAIN OR PROGRESS			FOLLOW-UP	LATER MORTALITY (%)	LATER RELAPSE (%)
RESIDENTIAL CENTRES														
Lamptey et al. Philippines 1980 (ref 16)	**O**	**Mean age 32.5 months Grades II & III (Gomez)** **Mean wt/age: 59%**	**64**	**4 for some only**	**Mean 10 wks** **(No feeding data)**		**4.3**	**NR**	**Mean wt gain 23g/d Mean wt gain 2.6g/kg/d *** **Mean wt/age:- At admission 59% At discharge 66%**	**NR**	**0.1%**	**After 8m, mean wt/age 68%**	**1.7**	**23**
Roy et al. India 1980 (ref 17)	O	Grades I - III (Gomez) Grade I 5% Grade II 16% Grade III 79%	112	4 for some only	Mean 5 wks Vegetarian family foods. No milk		1.8	0	Mean wt gain 29g/d * In a subset (n=46), Grade III:- at admission 79% at discharge 57%	3.3Rs/d (1978 cost)	NR	After 3m, 13% of the subset were grade III.	3.6	NR
McIntyre et al. South Africa 1992 (ref 18,19)	O	Mean age 16 months Mean wt/age 64% Mean wt/ht 85%	73	4 (majority) Mean 10 days in hospital	Mean 10 days 3 meals + 3 snacks High-energy, high-protein family foods		None	NR	Mean wt gain 42g/d Mean wt gain 6.1g/kg/d * Mean wt/ht:- At admission 85% At discharge 89%	NR	NR	After 12m, mean wt/ht = 99% Mean wt gain 1.1g/kg/d *	None	4.0
Ibekwe & Ashworth Nigeria 1994 (ref 20)	O	Age <60 months Wellcome classification 66% kwashiorkor	803	6	Mean 5 wks 5 feeds Soya milk and soya bean mixes		21.8	NR	Mean wt gain 6-7g/kg/d	NR	NR	NR	NR	NR

Table 3. Primary Health Clinics

AUTHOR; COUNTRY; YEAR PUBLISHED (Ref)	TYPE OF STUDY	AGE: ADMISSION CRITERIA or SEVERITY OF MALNUTRITION	CHILDREN ENROLLED STAFF:CHILD RATIO	PRELIMINARY HOSPITAL TREATMENT	REHABILITATION					COST PER CHILD	FOLLOW-UP			
					DURATION OF TREATMENT FOOD GIVEN OUT		MORTALITY (%)	RELAPSE (%)	WEIGHT GAIN OR PROGRESS		COVERAGE (%)	FOLLOW-UP	LATER MORTALITY (%)	LATER RELAPSE (%)
Husaini et al. Indonesia 1982 (ref 21)	O	6-36 months Grade III (Gomez) or oedema but not severely ill	108 (nutrition clinic)	6 except 2	6 months 12 clinic visits No food given		16.6	Yes	In a subset (n=49):- Mean weight gain 12g/d Mean wt gain 1.7g/kg/d* After 6m, 24% were >90% wt/ht	NR	NR	Not done	NR	NR
Castillo et al. Chile 1983 (ref 22)	**O**	**<2 years** **Wt/age <-3SD if <2years** **Wt/age <-2SD if <1year**	**313** **a) 286 at 10 health clinics** **b) 27 at nutrition clinic**	**6**	**12 wks** **No food given**		**NR**	**NR**	**In the subset (n=274) of those <-2SD wt/age:-** **a) 31% reached –1SD wt/age** **b) 73% reached –1SD wt/age**	**NR**	**NR**	**Not done**	**NR**	**NR**
Bredow & Jackson Jamaica 1994 (ref 23)	O	<3 years Grades II & III (Gomez) or oedema	36 (rural clinic)	6	Mean 5.6 months Mean 6 clinic visits: weekly if ill, otherwise monthly Multivitamins and folic acid given for1m		2.7	0	Mean wt gain 2.7g/kg/d*if grade III Mean wt gain 1.4g/kg/d* if grade II Mean wt/age:- At entry 62% 5.6m later 73%	$14 for medicines	NR	NR	NR	NR
Jamal et al. Pakistan 1995 (ref 24)	O	<5 years Grade III (Gomez)	135 (hospital OPD)	6	Mean 13 wks Weekly or fortnightly clinic visits No food given		1.5	NR	Mean wt gain ~25g/d* Mean wt/age:- At entry 45%* 13 weeks later 66%*	NR	NR	NR	NR	NR
Perra & Costello, Guinea Bissau 1995 (ref 25)	CC	6-47 months <60% wt/age	1038 a) 354 cases b) 684 untreated controls (2 rural clinics + hospital clinic)	6	Mean 13 wks Cases attended clinics' day-care centre 3-4 meals/d in centre + home food WFP food given (milk, sugar, oil)		a) 4.8 b)11.9	a) 0 b)NR	Mean gain 37g/d. Mean wt gain ~6.0g/kg/d* Wt/age SD score:- Cases Controls at entry -4.5 -4.1 3m later -2.8 -3.6*	NR	33	Up to 18m, significant benefit in wt/age versus controls, but not significant from 18-36m	0-9m:- a) 9% b)11%	1.4
Brewster et al. Malawi 1997 (ref 26)	O	Mean age 29 months Oedematous malnutrition	373 (3 rural clinics)	6	Mean 19 days Resided at clinic WFP premix given (milk, sugar, oil) + CMV		7.5 (overestimate as includes initial treatment phase)	NR	Mean wt gain 6.4g/kg/day (underestimate as includes resolution of oedema)	NR	NR	Not done	NR	NR
Colecraft et al. Ghana 2003 (ref 27)	O	Mean age 13 months Wt/ht <-2 SD Mean wt/ht -2.1 SD	116 (3 urban clinics)	6	Mean effective duration = 1.4months Attended clinics' day care centre 2 meals/day@5d/wk Mainly WFP foods (cereals, WSB)		8.6	NR	Mean wt gain ~1.2g/kg/d* Mean wt/ht:- At entry -2.1 SD 4m later -1.6 SD Home diets did not improve	NR	NR	After 2-4 m Mean wt/ht -1.3 SD (estimated from graph)	1.7%	NR

Table 4. Domiciliary rehabilitation

AUTHOR; COUNTRY; YEAR PUBLISHED (ref)	TYPE OF STUDY	AGE: ADMISSION CRITERIA or SEVERITY OF MALNUTRITION	CHILDREN STUDIED STAFF:CHILD RATIO	PRELIMINARY HOSPITAL TREATMENT	DURATION OF TREATMENT / FOOD GIVEN OUT	MORTALITY (%)	RELAPSE (%)	WEIGHT GAIN OR PROGRESS	COST PER CHILD	COVERAGE (%)	FOLLOW-UP	LATER MORTALITY (%)	LATER RELAPSE (%)
Verkley & Jansen; Kenya 1983 (ref 28,29)	O	<5 years ≤65% wt/age Mean age 23 months Mean wt/ht ~80%	32	6	6 months Food + home visits if failed to attend clinic Maize, milk, and oil premix monthly	0	NR	Mean wt gain ~1g/kg/d* At admission, mean wt/age= 61% After 6m, mean wt/age = 66%	Ksh 496/- per child (1982 prices)	NR	After 4m, mean wt/age = 65%: After 10m=68%	3.1	NR
Gueri et al. Trinidad 1985 (ref 30)	O	< 5 years Grades II & III (Gomez) Mean age 25 months	86 a) 59 b) 27	6	16 wks a) Food + ≥8 home visits/m b) Food (less than above) + 1 visit/m Milk, sugar premix + oil separately	a) 0 b) 0	0	Mean wt gain: a) 1.1g/kg/d* b) 0.9g/kg/d* % grade III:- (a) (b) at entry 17% 14% after 16wks 8%. 0%	Cost to the centre: a)US$227 b)US$55	NR	After 4m, % grade III:- a) 13% b) 0%	NR	a)3.4 b) 0
Glatthaar et al. South Africa 1986 (ref 31)	RCT	7-36 months; ≤ 72% wt/age or ≤ 79% wt/age + oedema or wt/ht <95% Mean age 18 months	140 a) 65 b)75 controls	6	3 months a) 6 home visits b) No visits (controls) No food except to 17% = severe cases	a) 11.7 b) 5.4 controls		Mean wt/ht:- (a) (b) at entry 81% 82% after 3m 88%. 87%	NR	NR	After 9m, wt/ht:- a) 91% b) 91%	a) 0 b) 0	a) 10 b) 18
Roosmalen-Wiebenga Tanzania 1988 (ref 32)	**O**	**At admission to hospital:- 53% kwashiorkor 18% marasmic-kwash 29% marasmus**	**475**	**4 (all) (mean 19d)**	**MCH services: home visits by health worker** **No food given**	**Within 6-36m of discharge 8% died, and 13% relapsed.**		**% <90wt/ht:-** **at entry 88%** **at hospital discharge 64%** **after 12m or more 14%**	**N/A**	**25-50%**	**NR**	**NR**	**NR**
Heikens et al Jamaica 1989 (ref 33)	RCT	3-36 months <80% wt/age no oedema Mean wt/age 66% Mean wt/ht 83% Mean age 15 months	82 a) 39 (food) b)43 controls	6	3 months a) Food + 1 home visit/m for 3 months b) 1 home visit/m Food was specially prepared catch-up formula (equiv F135)	a) 2.6 b) 0	a) 18.0 b) 16.0	Mean weight gain 0-3m:- a) 1.5g/kg/d* b) 1.3g/kg/d* Mean wt/ht z-score:- (a) (b) at entry −1.9 −1.8 after 3m −1.4 −1.6 (estimated from graph)	NR	NR	After 3m, mean wt/ht:- a) −1.8 b) −1.6 (estimated from graph)	None	a) 7.7 b) 7.0
Fernandez-Concha et al. Peru 1991 (ref 34)	O	Grades II & III (Gomez) Mean wt/ht ~88% Mean age 18 months	54	6	12 months Home visits by doctor and nurse in week 1. Then weekly clinic visits No food given	1.8 (14% if severe)	7.4	% wt/age:- grade II grade III at entry 87% 13% after 3m 47% 2%. after 12m 19% 0%	$21/child	NR	Not done	NR	NR

Table 4. Domiciliary rehabilitation (continued)

AUTHOR; COUNTRY; YEAR PUBLISHED (ref)	TYPE OF STUDY	AGE: ADMISSION CRITERIA or SEVERITY OF MALNUTRITION	CHILDREN STUDIED STAFF:CHILD RATIO	PRELIMINARY HOSPITAL TREATMENT	REHABILITATION						FOLLOW-UP		
					DURATION OF TREATMENT FOOD GIVEN OUT	MORTALITY (%)	RELAPSE (%)	WEIGHT GAIN OR PROGRESS	COST PER CHILD	COVERAGE (%)	FOLLOW-UP	LATER MORTALITY (%)	LATER RELAPSE (%)
Heikens et al. Jamaica 1994 (ref 35)	RCT	3-36 month <80% wt/age Mean wt/age 59% Mean wt/ht 81% Mean age 11 months	79 a) 40 stayed in hospital until recovery b) 39 early discharge	4 (all) a) mean 40d b) mean 18d	Assessed at 6m post-discharge b) Milk/sugar/oil mix for 3m+folate + multivitamins + monthly home visits	a) 0 b) 2.6	NR	Mean wt gain (early rehabilitation) a) >7g/kg/d b) ~1.1g/kg/d Mean wt/ht z-score:- (a) (b) at entry –2.0 –1.9 at discharge –0.5 –1.2 6m post discharge –0.5 –0.8	NR	NR	After 36m, mean wt/ht z-score a) –0.5 b) –0.7	None	None
Khanum et al. Bangladesh 1994 (ref 36-38)	RCT-S	12-59 months <60% wt/ht and/or oedema Mean wt/age 48% Mean wt/ht 67% Mean age 25 months	437 a) 173 inpatient b) 134 day-care c) 130 early discharge	4(all) c) 7 days	Until ≥80% wt/ht and oedema-free. Mean days taken:- a) inpatient: 18 days b) day-care: 23 days c) domiciliary 35days No food given	a) 3.5 b) 5.0 c):3.5	a) 0 b) 0 c) 0	Mean wt gain:- a) inpatient: 11g/kg/d b) day-care: 6g/kg/d c) domiciliary 4g/kg/d (all are underestimates as these include resolution of oedema)	Cost to centre to rehabilitate a)$156 b)$59 c)$29	NR	After 12m:- mean wt/ht a) 91% b) 91% c) 91%	a) 3.4 b) 1.5 c) 1.5	a)1.2 b) 0.7 c) 0
Ahmed et al Bangladesh 2002 (39)	RCT	6-60 months <-3SD wt/ht and/or oedema	225 a) inpatient b)home visits c) clinic visits (75/group)	4(all) b) and c) 7d	Until ≥80% wt/ht and oedema-free. Median days taken:- a) 17 days b) 20 days c) 37 days No food given Multimicronutrients given	a) 1.3 b) 0 c) 0	NR	Mean weight gain:- a) 11.9 g/kg/d b) 9.9 g/kg/d c) 7.5 g/kg/d (a) vs (b) not significantly different	Cost to centre to rehabilitate a)$ 76 b)$ 21 c)$ 22	NR	NR	NR	NR
Diop et al Senegal 2004 (40)	RCT	6-59 months <-3 SD wt/ht or oedema	47 At home:- a)local RUTF b)imported RUTF	4(all) Mean stay ~7 days	Until reached 85% wt/ht RUTF + clinic visits twice/month RUTF175kcal/kg/d	2.1	NR	Mean weight gain:- a) 7.9 g/kg/d b) 8.1 g/kg/d Difference not significant	NR	NR	NR	NR	NR
Sandige et al Malawi 2004 (41)	RCT-S	12-60 months <-2 SD wt/ht or oedema Mean wt/age -3.6 SD Mean wt/ht -2.1 SD 61% had oedema Mean age 28 months	260 At home:- a)135 local RUTF b)125 imported RUTF	4(all) except Mean stay 12 days systematic allocation	16 wks or reached >-0.5 wt/ht RUTF + clinic visits twice/month RUTF175kcal/kg/d	Died/relapsed: a) 3 b) 2.5		Mean weight gain over 4 weeks:- a) 5.2 g/kg/d b) 4.8 g/kg/d Difference not significant Mean wt/ht z-score:- at entry –2.1 at exit –0.2	Food cost/child a) $22 b) $55	NR	After 6m:- Mean wt/ht was -0.6 Z. There were no group differences.	NR	9

Table 4. Domiciliary rehabilitation (continued)

AUTHOR; COUNTRY; YEAR PUBLISHED (ref)	TYPE OF STUDY	AGE: ADMISSION CRITERIA or SEVERITY OF MALNUTRITON	CHILDREN STUDIED STAFF:CHILD RATIO	PRELIMINARY HOSPITAL TREATMENT	DURATION OF TREATMENT FOOD GIVEN OUT	MORTALITY (%)	RELAPSE (%)	WEIGHT GAIN OR PROGRESS	COST PER CHILD	COVERAGE (%)	FOLLOW-UP	LATER MORTALITY (%)	LATER RELAPSE (%)
Manary et al Malawi 2004 (42)	RCT-S	>12 months HIV negative Mean wt/age --3.4Z Mean wt/ht --1.9Z Mean age 29 months	282 At home:- a)69 RUTF b)96 RUTF-S c)117 maize soy flour	4(all). Mean stay 11-14d and then systematic allocation	Until 100% wt/ht or assessed at 16wks Food + clinic visits twice/month a)RUTF175kcal/kg/d b)RUTF snack c) maize/soy flour + multimicronutrients	Died/relapsed: a) 4 b) 12 c) 19		Mean weight gain after 4 weeks:- a) 5.1 g/kg/d b) 3.1 g/kg/d c) 3.1 g/kg/d	NR	NR	After 6m:- Mean wt/ht was -0.5 Z. There were no group differences.	NR	NR
Ndekha et al Malawi 2005 (43)	RCT-S	12-60m HIV positive Mean wt/ht: a) -2.0 SD b) -2.8 SD c) -1.8 SD Mean age 25 months	93 At home:- a)20 RUTF b)28 RUTF-S c)45 maize soy flour	4(all). Mean stay 11-14d systematic allocation	Until 100% wt/ht or assessed at 16wks Food + clinic visits twice/month a)RUTF175kcal/kg/d b)RUTF snack c) maize/soy flour + multimicronutrients	a) 15 b) 14 c) 9	0 11 22	Mean weight gain over 4 weeks:- a) 3.2 g/kg/d b) 3 1 g/kg/d c) 2.4 g/kg/d	Food cost a) $33 if locally produced	NR	.NR	NR	16
Ciliberto et al Malawi 2005 (44)	Non-random trial	10-60m <-2 SD wt/ht or oedema+ Mean wt/ht: a) -2.5 SD b) -2.2 SD Mean age 23 months	1178 a)186 inpatient b)992 at home +RUTF	4 (some). a) Mean stay 22d b) 35% had prelim stay (mean 11d)	8 weeks a) 50kg maize/soy to take home on discharge b) local RUTF + clinic visits twice/m 175kcal/kg/d	a) 5.4 b) 3.0	11 6	Mean weight gain over 4 weeks:- a) 2.0 g/kg/d b) 3 5 g/kg/d	NR	NR	After 6m mean wt/ht b) -0.5 Z	NR	3
Navarro-Colorado & McKenney Sierra Leone (45)	RCT	Wt/ht <70%	100 a) inpatient b) home+ RUTF	4 (all)	Weekly supply of RUTF			Mean weight gain:- a) 13.4 g/kg/d (av duration 33d) b) 11.9 g/kg/d (av duration 40d)		NR			
Gabouland Niger 2004 (46)	O	6-59m Wt/ht <-3 SD or oedema Or MUAC<11cm Wt/ht <-4 SD:- a) 22% b) 1% c) 25% Median age 18 months	2209 a) 794 inpatient b) 354 at home+ RUTF c) 1061mixed	4 (2 groups) c) prelim stay (mean 10d)	Until ≥-2 SD wt/ht Weekly supply of RUTF (1000kcal/d) + biscuits for family	a) 17.5 b) 1.7 c) 0		Mean weight gain:- a)20.2g/kg/d (av duration 15d) b) 9.8g/kg/d (av duration 29d) c) 10.1g/kg/d (av duration 35d)	NR by group 91-105 euro/child	NR	NR	NR	NR

For abbreviations see page 26