Growth, morbidity, and mortality of children in Dhaka after treatment for severe malnutrition: a prospective study

Sultana Khanum, Ann Ashworth, and Sharon RA Huttly

ABSTRACT: Over 1300 severely malnourished children (<60% of US National Center for Health Statistics weight-for-height, with edema, or both) are admitted each year to the Children’s Nutrition Unit in Dhaka. Fatality during treatment is low and recovery is rapid. Our aim was to determine whether this initial success is sustained when children return home. A previous attempt to address this question was frustrated by the difficulty in tracing children after discharge because most are from slum settlements and families move frequently. This prospective study with fortnightly monitoring was therefore undertaken. The main outcomes of interest were anthropometric status, relapse, morbidity, and mortality. Children (n = 437) who had been treated for severe malnutrition when aged 12–59 mo and had reached the discharge criterion of 80% of weight-for-height, were followed for the next 12 mo. During follow-up, 7.5% were lost without trace, 0.6% relapsed, and 2.3% died. Morbidity was high, with a mean of seven episodes of diarrhea during the year. Outpatient visits for diarrhea occurred for 67% of children, and 58% had pneumonia (10% had pneumonia three times). After 12 mo, mean weight-for-height was 91% (−0.92 z score) but mean height-for-age remained at 84% (−4.14 z score). Weight gain, but not height gain, tended to be lower in children who experienced more diarrhea. Fever and cough were not associated with either weight or height gain. The high prevalence of illness highlights the need for continued accessible health care and for interventions to reduce disease acquisition. Am J Clin Nutr 1998;67:940–5.

KEY WORDS Severe malnutrition, protein-energy malnutrition, infection, diarrhea, follow-up, prognosis, recovery, morbidity, mortality, growth, relapse, Bangladesh, children

INTRODUCTION

With appropriate medical and dietary management, severely malnourished children can be rehabilitated successfully in just a few weeks (1, 2). An important question, however, is to what extent this recovery is sustained once children return home. Limited data show high postdischarge mortality and relapse for some centers (3–9). If many children relapse or die, any short-term success may seem futile, and indeed, there are anecdotal reports that staff motivation is often low in such situations because treatment seems a waste of effort and resources. The reasons why children relapse or die are not well understood. Morbidity and inadequate feeding are likely causes, especially if parents and caregivers have not been given specific guidance or medical care is inaccessible.

The Children’s Nutrition Unit in Dhaka, Bangladesh, has >1300 admissions for severe malnutrition each year. The criteria for admission are <60% of weight-for-height, or edema, or both, taking the median value of the National Center for Health Statistics (NCHS) as the reference population (10). The discharge criterion is 80% of NCHS weight-for-height. In 1987, 85% of those discharged after 2 y showed further improvement in their nutritional status and only 1% had died (11). Only 46% could be traced, however, and the fate of the untraced majority was thus unknown. Vital information on the prognosis of children treated at the unit was therefore lacking, and hence, this prospective study was planned.

We reported previously on the recovery of children at the unit in the short term, ie, from admission until attainment of 80% of weight-for-height. Briefly, in a controlled trial of three approaches to treatment (inpatient care, daycare, and domiciliary care preceded by 7 d of daycare), time to recovery was longest in the domiciliary group, with a median 35 d compared with 18 and 23 d in the inpatient and daycare groups, respectively (12). Domiciliary care, however, was the most popular with parents and the most cost-effective of the three treatments (institutional and parental costs combined). The children who completed treatment were followed for 12 mo and we present here details of their growth, morbidity, and mortality during this period.

SUBJECTS AND METHODS

Location

The Children’s Nutrition Unit was established by Save The Children Fund in 1975 and serves poor families residing within or near

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Dhaka. These families have few facilities, typically living in cramped, make-shift dwellings with mud floors and tin roofs. Water is collected from tube wells, or less frequently, from standpipes. Good sanitation is rare. Most parents are illiterate, particularly mothers.

Case fatality among admissions to the unit fell from 20% in 1976 to 7% in 1979 and has remained at 4–7% since 1980. There are 60 inpatient beds and, since 1984, a further 30 children can be accommodated in the daycare facility in simple surroundings. In 1990, domiciliary care through weekly home visits was initiated. Details of the medical care and dietary management were given previously (12).

Subjects

Children aged 12–59 mo who were admitted to the unit with severe malnutrition between December 1990 and November 1991 form the basis for this study, which was in two phases. First was the trial to compare the mortality and cost-effectiveness from admission to discharge of the three approaches to treatment (12). Second was the 12-mo follow-up. Children were excluded from the initial trial if they were aged < 12 or > 60 mo, were severely anemic (packed cell volume < 20%), were critically ill (eg, meningitis), had tuberculosis or congenital or metabolic disorders, or lived > 10 km from the unit. Allocation to treatment groups was made by daily rotation, ie, recruitment to each group occurred every third day. The initial sequence was randomly determined and neither the mothers nor the admission officers were aware of which treatment was available on a particular day. The numbers of children enrolled at admission into the inpatient, daycare, and domiciliary care groups were 200, 200, and 173, respectively. Completion rates differed, notably in the daycare group, which was unpopular, and the groups were 200, 200, and 173, respectively. All 437 children who completed the trial were entered into the follow-up study. Although the recovery times of the three groups differed, all entered the follow-up study with the same anthropometric status, namely, 80% of weight-for-height.

All three groups received health and nutrition education during treatment, but the amount and mode of instruction differed. Mothers or caregivers of inpatients and those attending daycare received 20 min of instruction and 20 min of practical guidance every day except Friday. The daycare group received slightly more days of instruction because of their longer recovery time. The domiciliary group attended these sessions but only during their initial week of daycare. Mothers and caregivers of the daycare and domiciliary care groups were given additional instruction on what to feed their children at home, how much, and how often. This included a practical exercise in which each caregiver prepared a meal for his or her whole family, keeping in mind the special needs of the malnourished child. Specific instruction was necessary because after the first week children in the domiciliary group were entirely dependent on home-prepared meals for their rehabilitation, and the daycare group were also expected to receive extra meals at home and all meals on Fridays. The domiciliary group was visited at home weekly for 1 mo and then twice a month until they reached 80% of weight-for-height. If necessary, mothers were reminded about the feeding instructions. Ad hoc advice was given if any deleterious practices were observed during the visit.

Protocol for the follow-up study

The main outcomes of interest in the 12-mo follow-up study were morbidity, growth, relapse, and mortality. We were also interested to see whether these outcomes might be affected by the initial group allocation, in view of the differing amounts and modes of instruction provided during treatment. During follow-up, the 437 children were visited at home every 2 wk by one of eight fieldworkers who were specially trained in research methodology for this study. The usual postdischarge service provided by the unit for children of this age is to see them fortnightly for 6 mo as outpatients and then monthly for a further 6 mo. The two main differences in the current study protocol were that 1) contact during months 6–12 was twice as frequent and 2) all visits took place at home. Because under routine conditions mothers may not keep all outpatient appointments and are visited at home only after missing two consecutive visits, the protocol is likely to have resulted in greater contact with unit staff than would normally prevail.

Ethical permission for the study was obtained from Save the Children Fund and the Bangladesh Medical Research Council. Each mother gave informed consent.

Morbidity

At each follow-up visit, mothers or caregivers were asked about the occurrence of specific morbidity signs and symptoms since the last visit. To aid recall, each month mothers were given a pictorial calendar that portrayed a well child and children with diarrhea, vomiting, cough, fever, eye infection, ear infection, and passing worms. Mothers were requested to record daily on the calendar whether the condition had been present or absent in the previous 24 h. All complied. Because most mothers could not read or write, a picture of a mosque was stamped on all Fridays, which was used as a benchmark to help check the days of illness. During the interviews, reported morbidity for the previous 2 wk was recorded on a precoded form, with the calendar aiding recall.

Diarrhea was defined as the mothers’ reporting of “patla paikhana,” the local word for liquid stools. This term also has a connotation of frequency and 90% of mothers using this term reported at least three liquid stools in 24 h. An episode was considered new when at least two diarrhea-free days elapsed since the previous episode. Children were examined for infection by the fieldworker and the presence of illness recorded. Children were referred to the unit’s outpatient department if major illnesses were suspected, eg, diarrhea with moderate to severe dehydration, pneumonia, ear or throat infections, unexplained and repeated episodes of fever, lack of weight gain for two consecutive visits, or loss of appetite for ≥ 2 d. Outpatient records of children referred or who attended independently for consultation were linked to derive total attendances per child during the year.

Growth

Each month children were weighed, without clothes, by using portable electronic scales (20 kg × 10 g; Soele, Murnhardt, Germany), which were calibrated daily. Length or height was measured to the nearest 0.1 cm with a locally made, portable length-height board that was interchangeable for recumbent and standing measurements. Standard techniques were used (13). For children < 2 y of age, recumbent length was measured. Length or height was measured twice and the mean value taken. A difference < 0.5 cm between measurements was considered acceptable.

Relapses and mortality

Children were considered to have relapsed if they became edematous or were < 60% of weight-for-height. They were readmit-
TABLE 1

Completion rates for 12-mo follow-up and reasons for noncompletion according to initial treatment group

<table>
<thead>
<tr>
<th>Reason</th>
<th>Inpatient care (n = 173)</th>
<th>Daycare (n = 134)</th>
<th>Domiciliary care (n = 130)</th>
<th>Total (n = 437)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Completed follow-up</td>
<td>68.3</td>
<td>82.9</td>
<td>81.6</td>
<td>76.7 [335]</td>
</tr>
<tr>
<td>Lost (no trace)</td>
<td>11.5*</td>
<td>3.7</td>
<td>6.1</td>
<td>7.5 [33]</td>
</tr>
<tr>
<td>Excluded (tuberculosis)</td>
<td>1.8</td>
<td>0.7</td>
<td>0.0</td>
<td>0.9 [4]</td>
</tr>
<tr>
<td>Excluded (incomplete follow-up)</td>
<td>13.3*</td>
<td>9.7</td>
<td>8.5</td>
<td>10.8 [47]</td>
</tr>
<tr>
<td>Readmitted to unit</td>
<td>1.7</td>
<td>1.5</td>
<td>2.3</td>
<td>1.8 [8]</td>
</tr>
<tr>
<td>Died</td>
<td>3.4</td>
<td>1.5</td>
<td>1.5</td>
<td>2.3 [10]</td>
</tr>
</tbody>
</table>

* n in brackets. 
* Significantly different from other groups, P = 0.003 (chi-square test).

Data analysis

Data were subjected to range and consistency checks and analyzed by using SPSS/PC+, version 4 (SPSS Inc, Chicago). The ANTHRO software package (Centers for Disease Control and Prevention, Atlanta) was used to obtain anthropometric indexes. Analysis of variance (ANOVA) and chi-square tests were used to test for statistical significance. A value < 0.05 was accepted as significant.

Children were expected to receive 24 morbidity visits during the 12-mo follow-up. Children who completed < 18 visits (75%) were excluded from the analysis. An appropriate adjustment was made for those who completed 18–23 visits to yield morbidity measures for 1 y. Children who received ≥18 morbidity visits were found to have also completed all 12 of the expected anthropometric measurements.

RESULTS

Three hundred thirty-five children (77%) completed ≥18 morbidity visits and were thus included in the analyses (Table 1). Emergency readmissions (1.2%), relapses (0.6%), and mortality (2.3%) were low and did not differ among the three treatment groups. Losses and intermittent follow-up were more frequent in the domiciliary care group than in the other two groups. Losses of children from the domiciliary care group were older at the start of follow-up because they were older at admission (29 mo compared with 25 and 26 mo for the inpatient and daycare groups, respectively), and their recovery time was longer (see Introduction).

Growth

Mean weight and height gains during the follow-up period were not significantly different in the three groups (Table 2). The gains in weight were sufficient to improve the children's mean weight-for-height from 80% at the start of follow-up to 91% of the NCHS median at the end of the year (ie, from z score –1.60 to −0.92). During the same period, mean weight-for-age improved from 60% to 67% of the NCHS median (or from a z score −3.70 to −3.08). Improvement was not restricted to the youngest children. Weight gains were greater in the first semester of follow-up than in the second (Figure 1). No change was seen in mean height-for-age during the year, although children aged ≥48 mo at the start of follow-up had a small positive gain in contrast with those aged < 48 mo, in whom the change was slightly negative.

Morbidity

The percentage of days for which children were reported to have diarrhea, cough, or fever is shown in Table 3. A high number of episodes of diarrhea was reported (mean: 7; range: 0–30) and 92% of children experienced some diarrhea during the year. Cough with fever was reported for 96% of children. Cough and fever were reported less frequently in children who had been treated in the domiciliary care group (P < 0.03, ANOVA).

Illness was recorded in 35% of the fieldworkers’ fortnightly examinations and almost one-half of these cases were referred to the unit. Diarrhea and fever were the most common problems

TABLE 2

Mean weight and height gains during the follow-up period according to initial treatment group

<table>
<thead>
<tr>
<th></th>
<th>Inpatient care (n = 118)</th>
<th>Daycare (n = 111)</th>
<th>Domiciliary care (n = 106)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight (kg)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>At start of follow-up</td>
<td>7.73 ± 1.81</td>
<td>7.46 ± 1.89</td>
<td>7.83 ± 2.00</td>
</tr>
<tr>
<td>Gain in 1 y</td>
<td>2.15 ± 1.12</td>
<td>2.39 ± 0.98</td>
<td>2.47 ± 1.13</td>
</tr>
<tr>
<td>Height (cm)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>At start of follow-up</td>
<td>73.3 ± 8.1</td>
<td>72.4 ± 8.4</td>
<td>74.4 ± 9.7</td>
</tr>
<tr>
<td>Gain in 1 y</td>
<td>6.4 ± 2.6</td>
<td>7.2 ± 2.3</td>
<td>7.3 ± 2.3</td>
</tr>
</tbody>
</table>

* x ± SD. There were no significant differences among groups (ANOVA).
diagnosed. No difference in morbidity on examination was found among the three groups. Outpatient attendance at the unit for diarrhea, fever, and pneumonia (as diagnosed by a physician) is shown in Figure 2. No significant differences in attendance were found among the three groups and the data were combined for presentation. The high attendance rates are striking and show that 67% of children attended with diarrhea (24% at least three times), 73% attended with fever (26% at least three times), and 58% attended with pneumonia (10% three times).

**Effect of morbidity on growth**

The effect of these high morbidity rates on the children’s growth was investigated. Children were classified according to the number of days that they experienced diarrhea, fever, or cough, and their mean 12-mo weight and height gains compared. Weight but not height gain tended to be lower ($P = 0.08$, ANOVA) in those children who experienced more diarrhea (Table 4). Fever and cough were not associated with either weight or height gain (data not shown).

**DISCUSSION**

As far as we are aware, this is the first study to provide detailed morbidity information after treatment for severe malnutrition and offers potential explanations for the high rates of relapse and mortality that have been observed elsewhere. Of note are the similar outcomes, with few exceptions, during follow-up in the three treatment groups. Thus, although differences in time to recovery were marked (12), once the children had reached this stage no group was significantly disadvantaged thereafter. This is an important finding for the choice of treatment in severe malnutrition, and strengthens the earlier conclusions that domiciliary care is a feasible and suitable option. The unit now offers this treatment option routinely and it continues to be popular with parents.

After 1 y, the children’s weight-for-height averaged 91% of the NCHS median, representing a substantial gain from 80% of the median at the start of follow-up, equivalent to a gain of 0.68 in the $z$ score. The rate of weight gain averaged 1 g · kg$^{-1}$ · d$^{-1}$, which is much slower than during the treatment period but was sufficient for them to attain a mean weight-for-height comparable with that of their peers in the community (14). The mean height-for-age remained at 84% of the NCHS median ($z$ score: $-4.14$) throughout follow-up. It is possible that their weight-for-height deficit prevented the triggering of catch-up in height. Walker and Golden (15) observed that most Jamaican children recovering from malnutrition only began to increase in height after they had attained 89% of weight-for-height, and others have also noted that catch-up in weight precedes catch-up in height (16–18). There is substantial evidence that although catch-up in height is possible, it is often not achieved when stunted children remain in an adverse environment (19, 20). Their peers in the slums of Dhaka are stunted to a similar degree (14).

Children who experienced more diarrhea had lower than average weight gain. It is therefore likely that the high prevalence of diarrhea morbidity constrained growth. Many studies have shown an adverse effect of diarrhea on growth (21–28), with enterotoxigenic *Escherichia coli* having the most pronounced effect on short-term weight gain, and shigella having the greatest effect on linear growth (29). In the present study it was not

| TABLE 3 |
| Morbidity reported by parents according to initial treatment group

<table>
<thead>
<tr>
<th></th>
<th>Inpatient care ($n = 118$)</th>
<th>Daycare ($n = 111$)</th>
<th>Domiciliary care ($n = 106$)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Diarrhea</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Percentage of time reported (%)</td>
<td>9.5 ± 10.6</td>
<td>9.3 ± 10.0</td>
<td>7.4 ± 9.1</td>
</tr>
<tr>
<td>Number of episodes</td>
<td>7.3 ± 6.8</td>
<td>7.1 ± 6.1</td>
<td>5.7 ± 5.5</td>
</tr>
<tr>
<td>Episode duration (d)</td>
<td>4.9 ± 2.0</td>
<td>4.8 ± 2.2</td>
<td>4.6 ± 1.5</td>
</tr>
<tr>
<td>Fever (no diarrhea, no cough)</td>
<td>10.7 ± 7.1</td>
<td>10.1 ± 10.4</td>
<td>7.3 ± 7.3$^2$</td>
</tr>
<tr>
<td>Cough (no diarrhea, no fever)</td>
<td>25.0 ± 16.6</td>
<td>25.0 ± 15.2</td>
<td>15.0 ± 10.2$^2$</td>
</tr>
<tr>
<td>Fever and cough</td>
<td>12.6 ± 15.2</td>
<td>12.6 ± 15.0</td>
<td>7.5 ± 10.0$^2$</td>
</tr>
</tbody>
</table>

$^1$ $\bar{x}$ ± SD. Daily morbidity logs were kept by parents for 12 mo.

$^2$ Significantly different from other groups, $P < 0.03$ (ANOVA).
possible to separate diarrhea by causative agent, but in 85% of diarrheal episodes the stool was watery and without blood. This suggests that most diarrheal episodes were not caused by shigella. Equally high incidence rates were reported in community-based studies in rural Bangladesh (30) and elsewhere (31–35).

Micronutrient deficiencies may have contributed to an increased susceptibility to infection by impairing immune function. Home diets were essentially vegetarian and no food or micronutrient supplements were provided during follow-up, apart from vitamin A every 6 mo. During the treatment period, no zinc was provided because we reasoned that this might introduce bias because zinc supplementation could not be supervised in the domiciliary group, whereas consumption was guaranteed in the other two groups. Previous studies in this unit have shown zinc to enhance recovery (36). Micronutrient deficiencies, either preexisting or acquired during the year, may thus have contributed to the high prevalence of morbidity. Micronutrient deficiencies may also have constrained linear growth in these children, the most likely being zinc, iron, calcium, and possibly iodine.

Despite the high prevalence of infection, mortality (2.3%) was very low during the year of follow-up. Of the 10 deaths, only 1 was associated with malnutrition. Eight of the children who died were girls. Disproportionate mortality among girls is well-documented in Bangladesh (37). In Tanzania, 8% of malnourished children treated in hospitals died within 1 y and the death rate was 41% in those who left during treatment (7). In Zaire, 19% of those aged ≤4 y died during the first year after discharge, after an average inpatient stay of 10 wk (8). In Niger the figure was 18% (4). Although postdischarge mortality in nutrition rehabilitation centers has been claimed to be low (3), high mortality has been reported in the Philippines (12%) (9), Nigeria (15%) (38), and southern Africa (38%) (39).

Eight children in the present study were readmitted, of these, three were malnourished, giving a relapse rate of 0.6%. This, again, is very low in contrast with some centers where postdischarge relapse rates ranging from 13% to 30% have been reported (3, 6, 7, 9). Reasons for the low mortality and relapse rates in our study unquestionably include access to skilled medical care, availability of essential drugs, the practical instruction that mothers had received at the unit during the initial treatment period, and the fact that they were aware of the consequences of illness and used the available health services when needed. During the year, 90% of the children visited the unit at least once with an illness. Of those who attended, 53% received antibiotics at least once. Thus, the demand on resources, both human and financial, was considerable.

The main purpose of the fortnightly home visits and medical checks was to collect reliable postdischarge morbidity data. Ethical concerns, however, necessitated referral of those who were sick, and referral criteria were therefore defined. Dietary advice was given for those with poor weight gain. The usual follow-up service provided by the unit for children of this age is for them to be seen fortnightly for 6 mo as outpatients and then monthly. It is possible that the fortnightly home visits may have led to more timely referral than would occur under routine conditions, and hence, reduced relapses and mortality to rates below those that would normally prevail. We think this unlikely, however, because in routine conditions mothers are always encouraged to bring their sick children to the outpatient clinic at any time. Furthermore, mothers and caregivers are always instructed to feed their children during illness. This is taught during the initial health education sessions regarding good feeding practices.

Only 33 children (7.5%) were lost without trace. Several were lost when five slum areas were demolished without notice. It is not clear why losses and incomplete follow-up were higher among children who had been treated as inpatients. The fact that those who completed follow-up did not differ in any of the measured variables from those who were excluded from the analysis or who could not be traced implies that both the internal and external validity of the study was not greatly affected by these losses.

This study revealed high morbidity, improved weight-for-height, and persistent stunting in the children followed. The high prevalence of infections, particularly diarrhea and pneumonia, indicates a need for improved living conditions and continuation of medical support through accessible facilities with well-trained personnel, and home visits if required. Supplementation with micronutrients may be warranted to improve immune function and enhance linear growth. Income generation could also assist in diversifying diets and improving living conditions, together with improved educational opportunities. Thus, further improvement of anthropometric status seems possible.

We thank the 437 families who patiently recorded their children’s morbidity daily and graciously received the fieldworkers in their homes fortnightly for a whole year to answer our many questions. We thank our diligent and for-bearing fieldworkers and Tanvir Ahmed and Mohammad Mostafa, the data managers.

TABLE 4
Weight gain and height gain according to time spent with diarrhea

<table>
<thead>
<tr>
<th>Days with diarrhea</th>
<th>Weight gain $^1$</th>
<th>Height gain $^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>kg/m²</td>
<td>cm/yr</td>
</tr>
<tr>
<td>No diarrhea (n = 25)</td>
<td>2.27 ± 1.20</td>
<td>6.72 ± 2.43</td>
</tr>
<tr>
<td>1–20 (n = 129)</td>
<td>2.52 ± 1.12</td>
<td>7.15 ± 2.14</td>
</tr>
<tr>
<td>21–42 (n = 85)</td>
<td>2.26 ± 1.04</td>
<td>7.33 ± 2.79</td>
</tr>
<tr>
<td>&gt; 42 (n = 87)</td>
<td>2.14 ± 1.01</td>
<td>6.48 ± 2.41</td>
</tr>
</tbody>
</table>

$^1$ Weight and height gains were adjusted for child age.

$^2$ Trend toward significant difference according to diarrhea morbidity, $P = 0.08$ (ANOVA).