

CATCH-UP GROWTH IN CHILDREN WITH SEVERE ACUTE MALNUTRITION: COMPARISON OF TWO THERAPEUTIC FEEDING APPROACHES AT A DISTRICT HOSPITAL, SOUTH AFRICA

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ABSTRACT

Although the World Health Organisation (WHO) guidelines have proved to be effective in the treatment of severe acute malnutrition (SAM) in other countries, limited data is available in South Africa, especially in relation to HIV-infected children. This study aimed to describe the recovery of clinically stable children with SAM, 12–60 months of age, treated as in-patients at a specialised district hospital in KwaZulu-Natal, South Africa, using two WHO recommended treatment approaches. A prospective cohort with clinically stable SAM referred to Clairwood Hospital between August 2012 and September 2013 was followed from admission until discharge in this descriptive study. Children were nutritionally managed, after being stratified and randomly assigned to one of the two suggested nutritional treatment groups, F-100 or Ready-to-use Therapeutic Foods (RUTF). Of the total of 41 children admitted with SAM during the year,



35 children participated and 34 completed the study. About 56% were younger than 18 months and 73.5% HIV-infected. A mean growth velocity of 7.77g/kg/day (RUTF group) versus 6.11g/kg/day (F100 group) was observed ($p = 0.23$). Recovery was achieved in 88.8% ($n=15$) of children on RUTF, and 64.7% ($n=11$) in the F-100 group, within 2.7 and 4.4 weeks, respectively. The RUTF group recovered significantly ($p=0.02$) faster. HIV-infection in this study did not affect growth velocity. RUTF can be used as effectively as F-100 in the rehabilitation of SAM to achieve catch-up growth and similar recovery rates are possible in HIV-infected children if managed according to WHO guidelines.

Keywords: children; catch-up growth; HIV; in-patients; malnutrition; recovery

INTRODUCTION AND BACKGROUND INFORMATION

Malnutrition is a major risk factor contributing to the high burden of disease and mortality in young children (Black et al, 2008:243). Therefore, one of the eight Millennium Development Goals (MDGs) is to reduce child mortality by two-thirds between 1990 and 2015 (United Nations, 2013). The global mortality rate in children under the age of five years fell by an estimated 41% between 1990 and 2011 (UNICEF, 2012:7), with an estimated annual rate of reduction of 4.2% in South Africa between 2000 and 2011 (UNICEF, 2012:8). Despite that, the under-five child mortality rate remains at an estimated 47 per 1 000 live births in South Africa, with illnesses such as HIV/AIDS, childhood infections and malnutrition threatening progress towards reaching the MDGs (Nannan et al, 2012:34, 55).

In South Africa 3.6% of children were estimated to be severely malnourished in 2007 (UNICEF, 2007:15). Severe acute malnutrition (SAM) is classified by a weight-for-height z-score (WHZ) below -3 standard deviations (SDs) of the WHO standard, a mid-upper arm circumference (MUAC) of less than 11.5cm and bilateral pitting oedema (WHO, 2013:2). SAM incidence by district showed that KwaZulu-Natal (KZN) had one of the highest SAM rates in the country (Health Systems Trust, 2014:155). KZN also has the highest human immunodeficiency virus (HIV) prevalence among people of reproductive age in South Africa at more than 27%, which is complicating the development and treatment of SAM in children (HSRC, 2014:44). Yet, despite the difficulty to rehabilitate HIV-infected children with SAM, the WHO is currently recommending that similar therapeutic treatment approaches be followed for HIV-infected and uninfected children with SAM (WHO, 2013:6).

Good nursing care forms an integral part of the Protocol for the in-patient management of children with severe acute malnutrition in South Africa (WHO, 2013:53; Anthony, 2013:72, 73; Puoane et al, 2004:36). Although nutritionists/dietitians in the public health sector are widely trained in optimal approaches to manage SAM and thus ultimately responsible for the nutritional management, the reality is that in large parts of southern Africa nurses are, due to a lack of sufficient

nutritionists, responsible for the nursing care as well as the nutrition management of children presenting with SAM. In many settings, especially in rural areas, a dietitian is not always appointed or available and the WHO Nutritional Care Plans are implemented by nursing staff and doctors (Cobb & Bland, 2013:47). However, in a study in Hlabisa, South Africa, appropriate nutritional assessment was not always done due to a lack of equipment and time constraints resulting from excessive patient workloads. Training and retraining of nursing staff in SAM treatment protocols, especially regarding feeding regimens, should therefore be considered a priority (Puoane et al, 2004:37).

The WHO Ten Steps for the facility-based/hospital management of SAM are divided into three phases: the initial stabilisation phase, the rehabilitation phase, and the follow-up phase (WHO, 1999:2). This protocol is still considered to be the gold standard for the management of children with SAM and adherence to this protocol has shown a reduction in case fatality rates in a number of countries (Puoane et al, 2004:37). Wide-scale implementation and monitoring of this approach have been initiated, with KZN one of the first provinces in South Africa to adopt the approach (KwaZulu-Natal Department of Health, 2011:13).

During the initial phase, the child is stabilised by reversing metabolic abnormalities. Feeding is also initiated with the objective of treating or preventing hypoglycaemia by administering F-75 formula as a starter formula. This milk-based formula consists of full cream milk powder, sugar, oil, and an added mineral mix (Ashworth et al, 2003:39). It contains 75kcal/100ml and 0.9g of protein/100ml, and the total energy intake should be approximately 100kcal/kg/day (Ashworth et al, 2003:17). Once the child is clinically stable, a more vigorous approach is required in order to recover the lost weight. During this rehabilitation phase, F-100, a high energy, milk-based formula, consisting of full cream milk powder, sugar and oil with additional minerals and vitamins, is recommended. It contains 100kcal/100 ml and 2.9g of protein/100 ml. The F-75 formula should be replaced with an equal amount of F-100 for two days before gradually increasing the volume. After transition, the total energy can be increased to 150–220kcal/kg/day (WHO, 1999:15, 21).

This WHO management protocol can be used in a clinical setting with in-patients as well as in rehabilitation centres after the stabilisation phase is completed (WHO, 1999:v). With the correct management of SAM, it is possible to reduce case fatality rates to a level of less than 5% (Ashworth et al, 2003:5). However, findings from one of the earlier surveys in Malawi have revealed that the case fatality rate may be significantly higher for HIV-infected children with SAM, with a reported mortality of 28% in that particular study (Kessler, 2000:52). Fergusson et al (2009:515) have shown similar rates of weight gain in HIV-infected and HIV-uninfected children during nutritional recovery, although HIV-infected children presented with a higher mortality rate.

In 2007 the WHO, the World Food Programme, the United Nations Systems Standing Committee on Nutrition, and the United Nations Children's Fund (UNICEF)

issued a joint statement introducing Ready-to-use therapeutic food (RUTF) for the treatment of SAM in uncomplicated cases and at community level (WHO, 2014:4). RUTF is a nutrient-dense food, enriched with minerals and vitamins, and similar to F-100 in nutrient composition. It has a low water activity that inhibits microbial growth and can therefore be kept unrefrigerated for extended periods of time. RUTF generally has a peanut butter base in a vegetable oil mixture, and in contrast to some F-100 versions, does not require any preparation before it is given to the child to eat (Briend, 2001:S176). RUTF is recommended during the transition once the patient is stabilised, when the new diet is introduced and the patient is being prepared for the rehabilitation phase. The number of feeds and their timing remain exactly the same during this transition with either RUTF or F-100. It is recommended that children who are going to continue treatment as out-patients be transitioned to RUTF rather than F-100. If a child is going to remain in a facility/hospital for the rehabilitation phase, RUTF or F-100 can be offered. Children eating the RUTF should be offered as much water to drink as they will take, during and after eating some of the RUTF (WHO, 2013:43).

Results from studies in central Africa suggest that RUTF may be a better choice than F-100 in promoting weight gain in a supervised setting (Ciliberto et al, 2005:868; Diop et al, 2003:304). RUTF is accessible in all public health facilities in South Africa, on the RT-9 government contract. Despite the widespread availability of both F-100 and RUTF in South Africa, limited data is available on the recovery of children treated according to the WHO guidelines. It was recently reported that most dietitians, although not evidence-based, rather followed expert opinion and include commercial formulas instead of adhering to the WHO protocol (Biggs, 2012:179). Earlier data from Puoane et al (2004:35) indicate that correct choice and administration of feeding regimens may play a role in recovery. Recent data is, however, lacking. The research questions for this study included the following: Can clinically stable children with SAM recover and achieve catch-up growth using either RUTF or F-100 as core nutrition supplement; and can HIV-infected children with SAM achieve a similar rate of weight gain as uninfected children during the rehabilitation phase in high HIV prevalence settings?

AIM AND OBJECTIVES

The aim of this study was to compare the recovery of clinically stable children with SAM, between the age of 12 and 60 months, treated with either F-100 or RUTF as the core nutrition supplement. The objectives were: to describe recovery as defined by growth velocity and timeframe to recovery in the two treatment groups; describe changes in weight and MUAC; and compare outcomes of HIV-infected versus uninfected children.

METHODOLOGY

Study design and subjects

Purposive sampling was used in this quantitative, descriptive study. Children with SAM between the age of 12 and 60 months referred from neighbouring hospitals in eThekweni district to Clairwood Hospital, were admitted to a prospective cohort. From a total of 42 children with SAM admitted, 35 participants were included in this descriptive study between August 2012 and September 2013. All participants initially had a WHZ <-3 standard deviations (equal to the -3 line on the Height/length for age chart in the Road to Health booklet). They also presented with a MUAC <11.5cm. Patients in the sample, however, had to be clinically stable (no hypoglycemia, dehydration or shock) with no oedema, and passed the standardised appetite test (WHO, 2013:40), which implied that they were in the rehabilitation phase and ready for more aggressive nutrition support with either F-100 or RUTF. Children with WHZ \geq -3SD and/or MUAC \geq 11.5 cm and thus presented with moderate acute malnutrition, or those with poor appetite, poor response to stimuli and/or oedema and who refused either of the two recommended supplements were excluded and managed outside the scope of this study. Parents or legal guardians of all children who qualified according to the inclusion criteria were subsequently approached, invited to participate, and had to provide written, informed consent. A monitoring sheet was developed to record relevant demographic, clinical and nutritional data from patient folders.

Ethical considerations

Ethical approval for the study was obtained from the Research Ethics Committee, Human (REC-H), Nelson Mandela Metropolitan University (H12-RTI-HIV-005). Approval for the research at Clairwood Hospital was obtained from the Department of Health KwaZulu-Natal Research Committee and the Chief Executive Officer (CEO) of Clairwood Hospital.

Intervention

Thirty-five children were stratified according to age, gender and HIV status, and subsequently randomly assigned with randomisation tables to either the RUTF (n=17) or the F-100 (n=18) group. The F-100 group received quantities sufficient to meet their nutrient requirements for full catch-up growth (175–200kcal/kg/day) as recommended by the WHO together with an appropriate ward diet. Participants were monitored until discharge.

The RUTF group received similar amounts in a quantity sufficient to meet their nutrient requirements for full catch-up growth (175–200kcal/kg/day), until discharge,

together with an appropriate ward diet. The appetites of all the children were tested, and any child who passed the test, being able to consume 75% of prescribed RUTF, qualified to participate (Kimani & Sharif, 2009:17).

Children in the F-100 group were given 3 hourly feeds in accordance with the WHO protocol (Ashworth et al, 2003:19). The quantity of feeds for each child was guided by the weight of the child and calculated from the given range in the WHO table. The total volume of feeds depended on how much of the supplement the child tolerated. The feeds were given by a nurse or the caregiver under supervision of a nurse, in addition to the hospital diet.

Children in the RUTF group were given RUTF in proportion to a child's weight in accordance with the same WHO protocol as described for the F-100. The Food and Agriculture Organisation of the United Nations formula (100ml of F-100 = 18.5g of RUTF) was used to calculate and convert the volume F-100 required in millilitres to grams of RUTF (Kimani & Sharif, 2009:60). This ensured that the children in the F-100 group received the same nutrients as children in the RUTF group.

The RUTF amounts for each child were divided into two, and mixed into their morning and evening porridge, to make the product less viscous/sticky especially for the younger children. Children in the F-100 group received the porridge or ward diet after the F-100. The younger children were fed by a nurse or a caregiver, and the older children who were able to feed themselves did so under the supervision of a nurse. None of the children in the sample received breast milk, since breastfeeding, although recommended, was discontinued at the referring hospitals prior to admission to Clairwood Hospital. All supplements provided in this study were used as part of management of SAM at Clairwood Hospital prior to the research.

Procedures

Children were weighed using a calibrated Seca Paediatric scale with accuracy to the nearest 10g. All children were weighed without the nappy, clothing and shoes. The scale was placed on a hard surface; the child was placed in the middle and kept still until the measurement was completed (Gibson, 2005:252). Weekly weight changes were recorded over a period of 4–9 weeks.

A standardised measuring mat with an accuracy of 0.1cm was used to take height measurements. The measuring mat was placed on a flat surface in order to obtain accurate measurements. The researcher (dietitian) and a trained nurse worked together in taking and recording accurate height measurements every two weeks. The measurement was taken when the head was level with the headboard, and the end of the measuring mat was against a flexed heel. The measurement was taken at eye level (Gibson, 2005:247). Three height measures were taken, and the average was calculated and recorded.

The MUAC was measured by the researcher using a MUAC Child 11.5 Red measuring tape with accuracy to the nearest 1mm. It was measured on the left upper

arm, with the arm in a relaxed position along the side of the body. The measurement was taken at the midpoint between the acromion and the olecranon processes, with the measuring tape fitted snugly, but without making a dent in the upper arm (Gibson, 2005:290).

The rate of weight gain was calculated using the following formula:

$$\text{Weight gain in g/kg/day} = \frac{(W2 - W1) \times 1000}{(W1 \times \text{number of days from } W1 \text{ to } W2)}$$

Where: W1 = initial weight in kg; W2 = weight in kg on the day of calculation (Ashworth, 2003:19).

A monitoring sheet displaying all the measurements was developed by the researcher, which incorporated all variables to meet the aim and objectives. This was tested during a pilot study with three children with SAM, not included in the final study. All measurements were recorded on this monitoring sheet and captured on an Excel spreadsheet. Data was analysed by means of the Statistica software package (version 12). Data from the two treatment groups was compared. Frequencies and percentages were used to summarise and describe the categorical data. Means and standard deviations were used to summarise numerical data. Comparison of means was done using the Student t-test to determine statistical significance, and a p-value <0.05 was used to indicate statistical significance. Cohen's d was calculated to indicate practical importance of the p-values (Gravetter & Wallnau, 2009).

RESULTS

Of the 35 children who participated in the study, only one child died from diarrhoea and HIV-related complications. The child was in the F-100 group. The child was noted and excluded from the final comparison.

Of the total number of children (n=34) who completed the study, 56% (n=19) were male and 44% (n=15) were female. The mean age was 22.32 months (SD = 12.48), with the majority (56%) of the children between 12 and 18 months. No significant differences could be demonstrated between the F-100 and RUTF groups in terms of age, gender and HIV status.

A large percentage of children who participated in the study were HIV-infected, 13 (76%) in the F-100 group (n=17) and 12 (70%) in the RUTF group (n=17). Of the total sample, only 11.8% in the RUTF and 17.6% in the F-100 group, had Tuberculosis (TB). Less than 12% (n=2) of the children from both groups had no underlying disease.

Symptoms noted during the rehabilitation period included fever and cough in 11.8% (n=2) of the RUTF group and 23% (n=4) of the F-100 group, and diarrhoea in

5.9% (n=1) in each of the two intervention groups. Vomiting was reported in 23% of cases (n=4) in each of the groups. All these could have impacted on optimal intake of food and supplements. Both groups started their rehabilitation at a mean WHZ of -3.51 and a mean MUAC of 10.7 cm.

Table 1: Recovery of sample by supplement group (n=34)

Variables	RUTF (n = 17)		F-100 (n = 17)		Mean Difference	Inferential statistics	
	Mean	SD	Mean	SD		t-test p-value	Cohen's d
MUAC: baseline (cm)	10.72	0.65	10.71	0.63	0.01		
MUAC: end (cm)	13.04	0.75	12.68	0.82	0.36		
MUAC: change (cm)	2.32	0.65	1.95	0.45	0.37	.070	0.66
WHZ: baseline	-3.51	0.51	-3.51	0.63	0.01		
WHZ: end	-0.40	1.26	-0.40	1.40	0.00		
WHZ: change	3.11	1.27	3.15	1.06	0.05	.912	0.04
Growth velocity (g/kg/d)	7.77	2.72	6.11	4.87	1.66	.227	0.43
Recovery to -1SD: Weeks	2.71	1.21	4.47	2.72	1.76	.020	0.85

Cohen's d interpretation intervals:

<0.20 *Not significant*
 0.20-0.49 *Small*
 0.50-0.79 *Medium*
 0.80+ *Large*

Rate of weight gain

For the purpose of the study 'poor growth velocity' or 'treatment failure' referred to weight gain of <5g/kg/day; 'moderate growth velocity' referred to weight gain of 5 to 10g/kg/day; and 'good growth velocity' referred to weight gain of >10g/kg/day (Ashworth et al, 2003:19).

The mean growth velocity was 7.77g/kg/day (SD=2.72) in the RUTF group and 6.11 g/kg/day (SD = 4.87) in the F-100 group. Both groups therefore experienced a moderate mean growth velocity, with no significant difference in the mean growth velocity over the intervention period between the groups (Table 1). Fourteen (82%) children in the RUTF group experienced a moderate growth velocity versus 10 (59%) in the F-100 group, but no significant difference could be shown. Only two children in the F-100 group and one child in the RUTF group experienced a good growth velocity of more than 10g/kg/day.

Time-frame to recovery

Recovery as outcome measure for the purpose of this study referred to a WHZ score of ≥ -1 SD of the WHO standard. Children in the RUTF group recovered in a mean of 2.7 weeks compared with 4.5 weeks in the F-100 group (Table 1). The RUTF group recovered significantly ($p=0.02$) faster and Cohen's d reflects that this finding is of large practical importance. Only 11.8% ($n=2$) never reached the target weight of -1 SD of the WHO standard in the RUTF group compared with 35.3% ($n=6$) in the F-100 group. A total of 88.2% ($n=15$) of children recovered in the RUTF group after the six week intervention period compared to 64.7% ($n=12$) in the F-100 group.

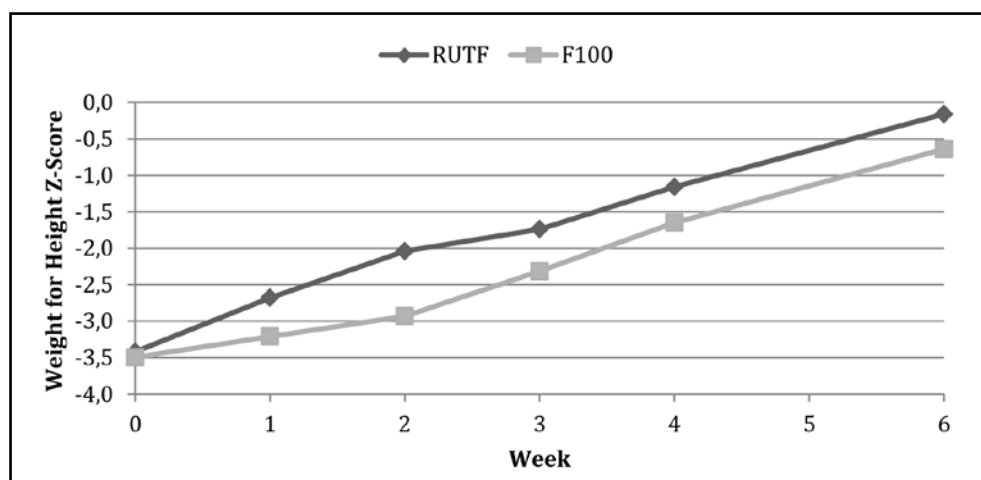


Figure 1: WHZ changes during the rehabilitation in two groups

Other anthropometry

Out of the 34 children participating in the study, no changes in height were observed within both the RUTF and F-100 groups in the six week period.

MUAC improved with a mean of 2.32 cm ($SD=0.65$) in the RUTF group compared with 1.95cm ($SD=0.45$) in the F-100, with no significant difference between the groups (Table 1).

Impact of HIV infection on weight gain

As illustrated in Figure 2, no significant difference could be observed between the HIV-infected and uninfected children in terms of WHZ changes during recovery. Although one of the children with HIV/TB co-infection died and was excluded after two weeks, most of the other HIV-infected children achieved catch-up growth at similar rates to the uninfected children. All those who did not recover were HIV

infected, and secondary infections noted during the intervention period could have contributed to the poor weight gain. However, the sample size was too small for further inferential statistics.

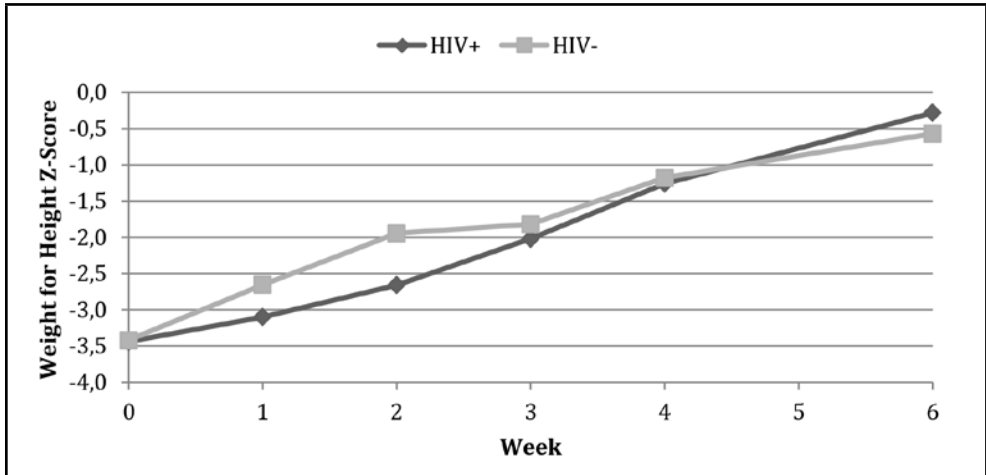


Figure 2: WHZ changes by HIV-status

DISCUSSION

SAM in children can be seen as an important treatable cause of infant mortality, with reduced case fatality rates if the WHO guidelines are adhered to (Puoane et al, 2004:37). In optimal conditions following the WHO Ten Steps, children should reach their target weight within 2–4 weeks, and attain growth velocity rates in excess of 10g/kg/day (WHO, 1999:22). In a study in India, children with SAM, monitored from the initial phase, attained average growth velocity rates of 9.3g/kg/day, with a mean duration of stay of 16 days (Shah & Javdekar, 2014:5). Even though it is marginally more than the mean growth velocity in this study group, the majority of patients also fell within the moderate weight gain group of between 5 and 10g/kg/day. No HIV-infected children participated in that particular study, which may have had an effect on the better average growth velocity rates and recovery times reported than in this study.

HIV/AIDS and diarrhoeal infections have been associated with an increased risk of mortality in children with SAM receiving treatment in in-patient units (Heikens et al, 2008:1306). Despite the high HIV prevalence in this study, only one death, due to HIV/TB co-infection and diarrhoea, was reported, most likely due to the fact that only clinically stable children participated. More interestingly, similar recovery rates could be observed between HIV-infected and uninfected children, supporting research by Fergusson et al (2009:515) indicating that it is not unreasonable to expect

fast nutritional recovery in HIV-infected children with SAM if optimally treated. It should, however, be noted that all the children in the sample who failed to recover were HIV-infected.

The duration of hospital stay for children with SAM in Bangladesh was reported to be less than 28 days for 83.6% of the cases, and only 4% stayed for 31–40 days (Hossain et al, 2009:77). Results from the study at Clairwood Hospital indicated that an acceptable moderate weight gain of more than 5g/kg/day was achieved by the majority of children in both supplementation groups, and that RUTF promotes weight gain that is at least as good as F-100 during the rehabilitation phase of the management of SAM. However, the sample in the RUTF group recovered significantly faster than the F-100 group. If these results can be replicated in larger samples, significant savings may be possible in terms of reduction in hospital stay.

In conclusion, RUTF and F-100 can both be used effectively in rehabilitation of children with SAM in a supervised facility/hospital setting. Significant potential savings resulting from faster recovery may be possible should children with SAM receive RUTF core nutrition supplement according to current WHO guidelines and should be further investigated. This study, although the numbers are limited, provides an important benchmark for weight velocity in clinically stable children with SAM, treated according to WHO guidelines. Weight gain of less than 5g/kg/day should be acknowledged as treatment failure, also in HIV-infected children being treated for SAM, and catch-up growth to -1 SD of the WHZ within 4 weeks of starting the rehabilitation phase should be the norm.

LIMITATIONS

The number of referrals from the surrounding hospitals to Clairwood Hospital for nutrition rehabilitation had an impact on the total number of participants. Initially it was estimated that a total of 60 children would be included in the trial. However, most referring hospitals in Ethekewini district started managing the SAM patients until discharge, which resulted in fewer referrals to Clairwood Hospital for rehabilitation. Children were not forced to eat either of the supplements; this further decreased the number of children participating in this study by 7. Despite the limited sample, significant differences were demonstrated in relation to rate to recovery.

Children were fed by nurses and mothers or caregivers, and the estimated amounts of RUTF and F100 taken by each child were recorded by the nurse. There was no full observation of intake or plate wasting done by the researcher to confirm the exact amounts of RUTF or F100 consumed by each child. However, all children received supplements in amounts calculated according to WHO guidelines together with a ward diet.

RECOMMENDATIONS

RUTF can be used in the rehabilitation of HIV-infected and uninfected children with SAM in South Africa, if acceptable to the children. Children will be able to achieve weight gain comparable to F-100, but results suggest that a faster recovery may be possible if RUTF can be used. Further research with larger samples may provide more guidance. Nurses should ensure that daily weights are taken in non-oedematous children to calculate growth velocity and monitor that at least moderate levels of catch-up growth (>5g/kg/day) are achieved. Although both nutrition supplement options as recommended by the WHO should ensure catch-up growth of more than 5g/kg/day, RUTF may result in faster recovery.

However, the provision of F-100 should be maintained for those children who do not like RUTF. Further research or monitoring of children recovering from SAM is urgently needed to determine catch-up growth and recovery rates of children in Southern Africa.

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