A Cohort Study to Evaluate the Effect of Nutritional Intervention on Severe Acute Malnutrition Children Admitted to A Nutritional Rehabilitation Centre in A Tertiary Care Hospital in Central Gujarat, India

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DOI: 10.55489/njcm.150720243583

ABSTRACT

Background: Undernutrition is one of the most concerning health and development issues in India as well as in the world. Nutritional rehabilitation centres (NRC) were started by Government of India to control severe acute malnutrition. The aim is to assess the effect of nutrition interventional measures for severe acute malnutrition (SAM) children admitted at NRC through selected anthropometric indicators.

Methodology: A hospital-based prospective cohort study was conducted at NRC of SSG Hospital, Vadodara, Gujarat from April to September 2022, all children of 6-60 months of age admitted during this period were observed during their stay with three follow-ups after discharge at 15 days interval. The data was entered in Microsoft Excel and was analysed using Medcalc Software.

Results: A total of 76 children were analysed for anthropometric indicators. A statistically significant difference was obtained between the weight of children at admission, discharge and 3 follow-ups (ANOVA=141, p<0.001); difference of mid upper arm circumference (MUAC) (ANOVA=84.2, p<0.001) and difference of height (ANOVA=43.3. p<0.001) at admission, discharge and follow-up were also statistically significant.

Conclusions: NRCs have had a positive impact on the selected anthropometric indicators of severe malnourished children but lag behind proper follow-up visits.

Key-words: Severe acute malnutrition, Nutritional Rehabilitation Centre, Under five children, Anthropometric Indicators

ARTICLE INFO

Financial Support: None declared
Conflict of Interest: None declared
Received: 14-12-2023, Accepted: 24-05-2024, Published: 01-07-2024
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How to cite this article: Panchal F, Parmar R, Shringarpure K, Damor J. A Cohort Study to Evaluate the Effect of Nutritional Intervention on Severe Acute Malnutrition Children Admitted to A Nutritional Rehabilitation Centre in A Tertiary Care Hospital in Central Gujarat, India. Natl J Community Med 2024;15(7):546-552. DOI: 10.55489/njcm.150720243583

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www.njcmindia.com | pISSN: 0976-3325 | eISSN: 2229-6816 | Published by Medsci Publications
INTRODUCTION

Undernutrition among under-five children is a major public health problem in India as well as around the world. Nearly one-third to half of all under five children who die each year in the world due to undernutrition which is linked to high rates of morbidity and mortality.¹

According to NFHS-5, the prevalence of stunting, wasting, severe wasting and underweight in under five years children was found to be 33.5%, 19.3%, 7.7% and 32.1 respectively and children under five who are stunted were found to be approximately 39%, wasted 25.1%, severely wasted 10.6% and underweight is 39.7% in Gujarat.²

Severe Acute Malnutrition (SAM) is the most extreme and visible form of undernutrition. Severe acute malnutrition is defined as very low weight-for-height/length (Z-score below -3 SD of the median World Health Organization (WHO) child growth standards), or a mid-upper arm circumference <11.5 cm, or by the presence of nutritional oedema.¹ Three of the defined admission criteria and provided with medical and nutritional therapeutic care.¹ Once discharged from the NRC, the child remains enrolled in the Nutrition Rehabilitation program till he/she attains the defined discharge criteria.²

Follow-up of severe acute malnutrition (SAM) children is crucial because mortality rate of 10-30% has been documented after discharge from hospital.⁶ Hence, this study commits among children aged 6 to 60 months admitted at NRC and their follow-ups after discharge from NRC at an interval of 15 days for assessment of nutritional status and growth of the child through anthropometric measurements.

Based on this background, main objective of the present study is to evaluate the effect of nutritional intervention undertaken at NRC in improving the nutritional status of admitted SAM children through review of selected anthropometric indicators.

METHODOLOGY

A hospital-based prospective cohort study was conducted at Nutritional Rehabilitation Centre of a Tertiary Care Hospital (SSGH) (Sir Sayajirao General Hospital), Vadodara, Gujarat. The study group comprised of all Severe Acute Malnourished (SAM) children of 6-60 months of age, admitted in NRC from April 2022 to September 2022 and discharged from NRC as per Government guidelines (discharge after 15% weight gain of the admission weight with the absence of associated illness), were selected for the study after taking consent from their parents or caregivers.² The admission criteria for 6-60 months children are any of the following: (1) Mid Upper Arm Circumference (MUAC) <115mm with or without any grade of oedema (2) Weight-for-height < -3 SD with or without any grade of oedema (3) Bilateral pitting oedema +/+ (children with oedema +++ always need inpatient care).

Children who left without completing the treatment protocol and children who were referred to higher centre/NICU for treatment were excluded from the final analysis. According to record, every month average 15-18 SAM children were admitted at NRC of SSG Hospital. Hence, at the end of six months, approximate sample size came out 90. During the study period, total 82 children were registered. From them, three children were referred to higher centre for medical complications, two children had left NRC without completing treatment protocol and one child was died due to severe bronchopneumonia, hence ultimate sample size was 76.

A pre-tested, semi structured questionnaire was prepared and the data of baseline, socio-economic parameters and anthropometric details of admitted 6 to 60 months of age SAM children from April to September 2022 was collected at the time of admission, discharge and three follow-up visits after discharge with a gap of 15 days (at 15 days, 1 month and 1.5 month after discharge) from NRC to check the improvement in growth of child. The socio-economic scale was assessed by Modified B.G. Prasad socio-economic classification.

Upon admission to NRC, medical and nutritional therapeutic care was provided after assessment of severely malnourished child. Children were given supervised therapeutic feeding diet F-75 (75 kcal/100ml and 0.9 gm protein/100 ml), F-100 (100 kcal/100ml and 2.9 gm protein/100 ml) or special feeds according to complications/ symptoms by the NRC staff. Counselling sessions focusing health and nutrition aspects were conducted for the caregivers/mothers about the hygiene, feeding practices, child care and immunization. The growth was monitored using WHO reference charts.³ Follow-up data were obtained for each child from NRC who regularly showed up for the follow-up at appointed time and those who did not, collection of data was done through telephonic conversations with ‘field workers of the government health centre (ASHA or Anganwadi worker)’ of their residential area.

Among the anthropometric indicators, weight, height and mid-upper arm circumference (MUAC) were measured at the time of admission, discharge and 3 follow-up visits to assess nutritional status. The weight (kg) and height (cm) of each child were compared with the WHO growth reference data for the particular age and sex and Z score was calculated. Children below -3SD were considered as SAM.
MUAC (cm) was used to classify malnutrition in children. Children with MUAC 11.5-12.5 and less than 11.5 were considered as mildly malnourished and severely malnourished respectively. The anthropometric measurements of children enrolled in the study were recorded by trained and experienced health professional at NRC and by trained field workers (ASHA or Anganwadi worker) at time of follow-up.

**Measurement Tool**

**Weight:** Weight is measured using an electronic weighing machine to the nearest 0.1 kg. The beam should be properly balanced and the pointer should be on zero and should move freely when at rest. The scale should be set on a flat horizontal surface and keep the pan clean. The weight should be taken with minimum clothing and shoes should be removed. The result was read when the beam attains its balance point. If case of unavailability of electronic weighing scale, Salter’s scale was used for measuring the weight of children.

**Height/ Length:** For children below two years of age, an infant meter, a horizontal measure was used for measuring length after removing shoes and head covering. Beyond the age of two, a stadiometer, a vertical measure was used for measuring height to the nearest 0.1 cm. After removing the shoes, the subject was made to stand on a flat surface with feet along with heels, buttocks, shoulder and back of head touching the scale upright. A wooden scale was put on the head crushing hair and making contact with the top of the head.

**Mid upper arm circumference (MUAC):** MUAC was measured midway between the tip of the acromial process of the scapula and olecranon process of the ulna. To locate the correct point for measurement, the child’s elbow is flexed to 90°. The measuring tape is placed snugly around the arm at the midpoint mark. The tape should not be pulled too tight or too loose.

After getting permission from The Institutional Ethics Committee for Human Research- PG Research (IECHR-PGR) (IEC approval letter number- IECBHR/093-2022 and Date of approval was 08/06/2022) to carry out this study, the data of SAM children admitted at NRC from April to September 2022 were collected after taking their informed written consent.

The data was entered in Microsoft Excel 2019 and was analysed using MedCalc/ JAMOVI Software. Key output analysis for quantitative variables like weight, height, mid upper arm circumference (MUAC), z-score etc. of children was summarized as Mean (standard deviation) or Median (Inter-quartile range) depending on the normality of data and qualitative variables like gender, socioeconomic status, vaccination status, feeding data etc. of children in proportions and percentages. A repeated measures ANOVA were used to determine the association of growth outcome at admission, after discharge and at their 3 follow-ups in NRC. Level of significance was considered at p<0.05.

**RESULTS**

A total of 76 children were included in the analysis amongst them 38 (50%) males and 38 (50%) females. Majority (42.2%) belonged to age group of 13-24 months and 40.8% were in age group of 6-12 months. The mean age of study population was 17.7 ± 11.0 months and for boys it was 17.6 ± 11.0 months while for girls 17.8 ± 11.2 months. More than half of the children (89.47%) were from lower socio-economic class (class IV & V) according to Modified B.G. Prasad socio-economic classification [10] [Table 1]

At time of admission and discharge in NRC, total 76 children were analysed for anthropometric data. From them, 62 children were reported for the first follow-up visit, 56 for the second follow-up visit and 45 for 3rd follow-up visit with drop-out rates of 18.42%, 26.31% and 40.78% respectively. There was gradual decline of SAM children during each follow up.

The average weight gain of children during their stay at NRC was 7.90 ± 5.65 g/kg/day. According to discharge criteria from facility-based care of SAM children, achieved weight gain should be ≥ 15% after admission at NRCs (Target weight). More than half of children (56.58%) had achieved their target weight after admission at NRC.

<table>
<thead>
<tr>
<th>Table 1: Socio-demographic profile of admitted SAM children</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Variable</strong></td>
</tr>
<tr>
<td>Age (months)</td>
</tr>
<tr>
<td>6-12</td>
</tr>
<tr>
<td>13-24</td>
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<tr>
<td>25-36</td>
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<tr>
<td>37-48</td>
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<tr>
<td>49-59</td>
</tr>
<tr>
<td>Gender</td>
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<tr>
<td>Male</td>
</tr>
<tr>
<td>Female</td>
</tr>
<tr>
<td>Religion</td>
</tr>
<tr>
<td>Hindu</td>
</tr>
<tr>
<td>Muslim</td>
</tr>
<tr>
<td>Socio-economic class</td>
</tr>
<tr>
<td>I (Upper class)</td>
</tr>
<tr>
<td>II (Upper middle class)</td>
</tr>
<tr>
<td>III (Middle class)</td>
</tr>
<tr>
<td>IV (Lower middle class)</td>
</tr>
<tr>
<td>V (Lower class)</td>
</tr>
<tr>
<td>Residential Status</td>
</tr>
<tr>
<td>Rural</td>
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<tr>
<td>Urban</td>
</tr>
<tr>
<td>Tribal</td>
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<tr>
<td>Type of Family</td>
</tr>
<tr>
<td>Nuclear</td>
</tr>
<tr>
<td>Joint</td>
</tr>
<tr>
<td>Broken</td>
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</table>
follow-up; gain in weight, height, and MUAC were insignificant between the first, second, and third follow-ups, but decreasing trend of follow-up visits and the improvement in child’s height and MUAC were significant (P<0.05) in a repeated measure ANOVA test.

To ascertain the association between socio-demographic factors and the improvement in child’s growth between admission and discharge, as well as between admission and the first, second, and third follow-up; gain in weight, height, and MUAC were analysed based on the socio-demographic profile. Within all socio-demographic variables, the weight gain difference between the age group of 6-12 months and 12-60 months SAM children showed statistically significant from admission into to discharge from NRC (t=2.577, p=0.01). Following a comparison of height gain by family type from admission to the second follow-up, it was also found that there was a statistically significant difference between nuclear and joint families (t=2.107, p=0.03), while rest of the all variables did not show any significant differences.

After analysing post hoc comparison using Tukey’s test, it found that difference in weight was statistically significant between all pairs except weight at discharge and 1st follow-up; difference in MUAC was statistically significant between all pairs except MUAC at discharge and 1st follow-up and difference in height was not statistically significant between all pairs. [Table 3]

**DISCUSSION**

Total 82 severely acute malnourished children aged 6 months to 59 months admitted at NRC during April to September 2022. From them, six were excluded as per exclusion criteria, so the socio-demographic details and anthropometric data were taken for 76 admitted SAM children.

Maximum number (82.89%) of SAM children were within the age group of 6-24 months. Similar findings were found in the study conducted by Patel D et al., Panda et al and Joshi P et al.11,12,13 In our study, there was almost an equal distribution of male and female children similar to the studies conducted by Taneja et al., Bhanat MJ et al. and Bhujade et al.14,15,16 The children admitted to NRC were from rural and tribal (67%) areas compared to urban areas. This is similar to the results of study by VS Anjan et al.17

In the enrolled children, most of them (89.47%) belonged to lower socio-economic status (Modified BG Prasad class IV and V) and it was found in our study that the majority of the mothers (59.2%) were illiterate or educated up to primary school which was similar to the findings of study conducted by Bhanat and Mall et al. and Kumar et al.15,16 A large family size (Joint family) was associated with increased risk of SAM in our study (67.10%) which was similar to study by Sen et al.17 With regards to objective, study indicates that the overall mean weight of admission was 5.88 ± 1.48 kg and the mean weight at discharge was 6.66 ± 1.59 kg.

**Table 2: Anthropometric measures of SAM children on admission, on discharge, and on 3 follow-up visits at NRC**

<table>
<thead>
<tr>
<th>Admitted children</th>
<th>On admission (n=76)</th>
<th>On Discharge (n=76)</th>
<th>On 1st F-up (n=62)</th>
<th>On 2nd F-up (n=56)</th>
<th>On 3rd F-up (n=45)</th>
<th>ANOVA P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean ± SD weight (kg)</td>
<td>5.82±1.54</td>
<td>6.66±1.59</td>
<td>6.77±1.55</td>
<td>6.88±1.50</td>
<td>7.05±1.58</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Mean ± SD height (cm)</td>
<td>70.2±7.84</td>
<td>70.2±7.82</td>
<td>70.7±7.30</td>
<td>70.3±7.16</td>
<td>70.1±7.46</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Mean ± SD MUAC (cm)</td>
<td>10.8±1.03</td>
<td>11.2±0.926</td>
<td>11.4±0.80</td>
<td>11.5±0.83</td>
<td>11.6±0.82</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

Median length of stay at the centres was 17 days with IQR (14-23). A total 65 (85.53%) of the children in the study population had stayed at the NRCs for at least 14 days and rest 11 (14.47%) children had been discharged before 14 days because of achievement of target weight (15% weight gain after admission) as per discharge criteria of NRC.

According to z-score, 34 (44.74%) children were severely malnourished (z score ≤3 SD) from admitted SAM children, which was found to be statistically significant (P<0.05) in a repeated measure ANOVA test.

Within all socio-demographic variables, the weight gain difference between the age group of 6-12 months and 12-60 months SAM children showed statistically significant from admission into to discharge from NRC (t=2.577, p=0.01). Following a comparison of height gain by family type from admission to the second follow-up, it was also found that there was a statistically significant difference between nuclear and joint families (t=2.107, p=0.03), while rest of the all variables did not show any significant differences.

After analysing post hoc comparison using Tukey’s test, it found that difference in weight was statistically significant between all pairs except weight at discharge and 1st follow-up; difference in MUAC was statistically significant between all pairs except MUAC at discharge and 1st follow-up and difference in height was not statistically significant between all pairs. [Table 3]

**Table 3: Post hoc comparisons of weight, height and MUAC at admission. Discharge & during three follow-ups**

<table>
<thead>
<tr>
<th>Anthropometric measures</th>
<th>n value</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Comparison of Weight</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weight 0 vs Weight 1,2,3,4</td>
<td>&lt;0.001</td>
<td></td>
</tr>
<tr>
<td>Weight 1 vs Weight 3,4</td>
<td>&lt;0.001</td>
<td></td>
</tr>
<tr>
<td>Weight 2 vs Weight 3,4</td>
<td>&lt;0.001</td>
<td></td>
</tr>
<tr>
<td>Weight 3 vs Weight 4</td>
<td>&lt;0.001</td>
<td></td>
</tr>
<tr>
<td>Weight 1 vs Weight 2</td>
<td>0.891</td>
<td></td>
</tr>
<tr>
<td><strong>Comparison of MUAC</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MUAC 0 vs MUAC 1,2,3,4</td>
<td>&lt;0.001</td>
<td></td>
</tr>
<tr>
<td>MUAC 1 vs MUAC 3,4</td>
<td>&lt;0.001</td>
<td></td>
</tr>
<tr>
<td>MUAC 2 vs MUAC 3,4</td>
<td>&lt;0.001</td>
<td></td>
</tr>
<tr>
<td>MUAC 3 vs MUAC 4</td>
<td>&lt;0.001</td>
<td></td>
</tr>
<tr>
<td>MUAC 1 vs MUAC 2</td>
<td>0.076</td>
<td></td>
</tr>
<tr>
<td><strong>Comparison of Height</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Height 0 vs Height 2,3,4</td>
<td>&lt;0.001</td>
<td></td>
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<td>Height 1 vs Height 3,4</td>
<td>&lt;0.001</td>
<td></td>
</tr>
<tr>
<td>Height 2 vs Height 4</td>
<td>&lt;0.001</td>
<td></td>
</tr>
<tr>
<td>Height 3 vs Height 4</td>
<td>&lt;0.001</td>
<td></td>
</tr>
<tr>
<td>Height 0 vs Height 1</td>
<td>0.444</td>
<td></td>
</tr>
<tr>
<td>Height 1 vs Height 2</td>
<td>0.002</td>
<td></td>
</tr>
<tr>
<td>Height 2 vs Height 3</td>
<td>0.004</td>
<td></td>
</tr>
</tbody>
</table>

(0= At Admission, 1= At Discharge, 2= At 1st follow-up, 3= At 2nd follow-up, 4= At 3rd follow-up)
A statistically significant difference was observed between the mean weight at discharge and admission (t=15.6, P<0.001, df=75). The mean height of admission was 70.2 ± 7.84 cm and at discharge was 70.2 ± 7.82 cm. But no difference was observed between mean height between admission and discharge (t=1.86, P<0.067, df=75). The mean MUAC at admission and discharge were 10.8 ± 1.03 cm and 11.2 ± 0.926 cm respectively. There was also a difference found between the mean MUAC at discharge and at admission (t=11.6, P<0.001, df=75).

According to a study conducted by Siddharam G et al., in 2019 in Madhya Pradesh, the mean weight at admission was 6.27±2.15 Kg and mean weight at discharge was 6.78 ± 2.28 Kg and this difference was found to be statistically significant. The mean mid upper arm circumference (MUAC) at admission was 11.07± 1.22 cm and at the time of discharge it was 11.30±1.21 cm. The total MUAC increase was 0.23 cm and this difference was found to be statistically significant. Similar results were obtained from a study done by Taneja et al. and Sen et al.7,14

An average weight gain of at least 8 g/kg/day is considered to be adequate for child during stay as per NRC guidelines. In our study, 43.42% SAM children had achieved ≥8 g/kg/day weight gain till discharge. The average weight gain of children during their stay at NRC was 7.90 ± 5.65 g/kg/day which is lower than results observed by Taneja et al.14 (Average weight gain was 9.25 ± 5.89 g/kg/day) and by Rastogi et al.20 (Average weight gain was 9.915 ± 5.43 g/kg/day). In contrast to this findings, average weight gain for entire study group was 3.2 ± 2.3 g/kg/day found in a study conducted by Rawat et al.21

According to discharge criteria from facility-based care of SAM children, achieved target weight should be ≥ 15% after admission at NRCs. Our study reveals that 43% had achieved target weight after admission. This finding was comparable to a study conducted by Aguayo et al. in Jharkhand, found that only 39.4% of admitted children gained 15% or more of their initial weight.22

According to NRC guidelines, minimum duration of stay should be 14 days. In this study, it was found that the median duration of stay at NRCs was 17 days with IQR (14-23). Most of the children (85.53%) in the study population had stayed at the NRCs for at least 14 days. However, in a study by Rinki Shah et al., the duration of stay was 16 days while in a study by G Taneja et al., the duration of stay was 14 days.14,23

At analysis after discharge, the follow-up of SAM children was gradually declining with drop-out rates 18.4% at 1st follow-up (n=62), 26.3% at 2nd follow-up (n=56) and 40.8% at 3rd follow-up (n=45). A similar study conducted by PC Panda et al. (2019) reveals that dropout rates increased with each successive follow up visit. Dropout rates of 9.89%, 23.07%, and 61.76% were obtained for the three follow-up visits conducted 15 days, 1 month and 2 months from the day of discharge.13

In the present study, the weight gain difference between age group of 6-12 months and 12-60 months SAM children were found statistically significant from admission into to discharge from NRC (t=2.577, p=0.01). Saxena DM et al. proved similar findings that the weight gain difference between different age group children was found statistically significant (F=8.17, p<0.001).26 The comparison of height gain by family type from admission to the second follow-up, it was also found statistically significant difference between nuclear and joint families (t=−2.107, p=0.03). This result is supported by the study of AS Bhadoria et al. (2017), where the SAM children outcome was significantly associated with family size.27

The nutritional intervention at NRC elicited statistically significant changes through repeated measure ANOVA in weight from admission to 3rd follow-up, (F = 141, p <0.001). Post hoc analysis revealed that difference in weight was statistically significant between all pairs except weight at discharge and 1st follow-up. A statistically significant changes in MUAC also observed, (F = 84.2, p <0.001). Post hoc analysis revealed that difference in MUAC was statistically significant between all pairs except MUAC at discharge and 1st follow-up. There was a statistically significant changes also in height (F = 43.3, p <0.001). Post hoc analysis revealed that difference in height was not statistically significant between all pairs. Saxena DM et al., in their study revealed a statistically significant difference between the mean weight at follow up, at discharge and at admission for the entire study group (F=106.26, p<0.001).26

**STRENGTH & LIMITATIONS**

Since this was prospective cohort study, the main strength of this study is that participants were followed up over the period of time after they have left an NRC to determine the long-term impact of the nutritional intervention on the growth of the admitted SAM child at nutritional rehabilitation centre through obtaining regular anthropometric measurements.

As this study was limited to one NRC of Vadodara district of Gujarat and it was conducted in a limited...
group of subjects, hence, the findings cannot be generalized for the entire population. Lost to follow-up of SAM children were more on successive follow-ups.

CONCLUSION

NRCs have had a positive impact on the selected anthropometric indicators of severe malnourished children but lag behind proper follow-up visits. The study reveals that the average weight gain amongst the children was lower as compared to NRC guidelines and a proportion of 56.58% SAM children amongst the study group recovered (cured) with achieved target weight. As evident by the findings, the differences of weight, MUAC, height of the SAM children at the time of admission, discharge and three follow ups were statistically significant. There was observed a gradual decline in successive follow-up of SAM children after discharge with increasing drop-out rates for 1st, 2nd and 3rd follow-up visits respectively. In other words, effective management of SAM must be based on the basic principle of “Continuum of Care”-from the home and community, to the health centre/health facility and back again.

RECOMMENDATIONS

There is a need to have strong reference linkages of NRCs with community-based core model of management of severe acute malnutrition for better follow-up on long-term basis to provide a continuum of nutritional care and to reduce the drop-out rate.

ACKNOWLEDGEMENT

The authors are thankful to the staff of Nutritional Rehabilitation Centre for their help in Data Collection and for better understanding the intricacies of day-to-day work practices of NRC, SSG Hospital. We are also thankful to all study participants who have honestly participated with their full co-operation and provided their valuable time for the study.

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