Can Sever Acute Malnourished children be effectively rehabilitated physically, biochemically and developmentally at nutritional rehabilitation centers: A follow up study from Ujjain

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ABSTRACT

Background: Under-nutrition has got serious and lasting impact on health, development, society and economy. It may result in poor growth, development of child and can cause increase mortality, morbidity, health care cost, low productivity and economic growth. Nutritional rehabilitation is one of key intervention to address the under nutrition. It is questionable that nutritional intervention has potential to improve multiple domains. **Methods:** Follow up study evaluated the multi-domain impact of nutritional interventions on 204 admitted Severe Acute Malnutrition (SAM) children. Data was analyzed with SPSS version 20. **Results:** Significant positive changes were observed in physical, biochemical, developmental domains. Macnemar, paired t- test, co relation, z test were applied for data analysis. **Conclusion:** Nutritional intervention was found to be effective in improving selected physical, biochemical and developmental parameters. After discharge rate of improvement in anthropometric parameters was less. Actual quantification of recovery especially in biochemical and developmental parameters due to nutritional intervention is difficult.

Keywords: Biochemical, developmental parameter, nutritional intervention impact, physical, SAM

Introduction

Synergism between nutrition and health is well established. Adequate nutrition is required for growth, development and normal body function.[1] Under-nutrition is prevalent in India. Faulty infant and young child feeding practices,

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increased physiological needs, high susceptibility to diseases and limited energy reserves makes children more vulnerable for under-nutrition.[2] It becomes more intense with severity i.e., (SAM).[3] Prevalence of SAM is 7.5% in India and 9.2% in MP.[4] Various direct and indirect nutritional programmes were launched for combating under-nutrition. One of them is through Nutritional Rehabilitation Centre. Aim was to find out impact of nutritional intervention on physical, biochemical & developmental profile.

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Methodology

Ethical approval was taken from institutional ethical committee in 13/12/15. Permission from Dean of R.D. Gardi Medical College, CMHO of Ujjain district hospital & NRC in charge was taken along with the informed written consent from parents of admitted SAM children in NRC. There are 10 NRCs in Ujjain block, by purposive sampling we selected Madhav Nagar NRC of Ujjain. It has got 5 projects, 1 for rural division and 4 for urban areas, as it has maximum number of beds (20) and is nearest one. It was institutional based study that's why sample size was depended on patient inflow at that NRC so for sample size calculation, time bound technique was used. All the SAM children who were admitted in NRC for duration of one year were recruited as study participants. Follow up study was found to be most suitable design to achieve the stated objectives. SAM cases admitted in selected NRC whose written informed consent was taken from parents of SAM children born full term were included in the study. SAM cases admitted in selected NRC with Congenital heart disease, Cleft lip, Cleft palate and Cerebral palsy were excluded from the study, as in above mentioned condition there will be feeding difficulties. All study participants were followed for duration of 90 days as per the NRC protocol. Data were collected at 6 point of time – at the time of admission, at discharge, 1st follow up, 2nd follow up, 3rd follow up and 4th follow up. Children admitted for 14–21 days as per the progress, after discharge follow up every 15 days later for 4 times. There were no suitable validated questionnaires available for the assessment of above stated objectives, so data were collected with the help of self-prepared, pre-tested semi structured questionnaires. It was prepared by relevant literature search and help was taken from of experienced persons in this domain. NRC records, care giver's interview, clinical examination and investigations were used for the data collection. Proforma consisted of the following information socio-demographic profile, feeding history, immunization, any significant past medical history, antenatal, natal history, clinical examination, anthropometric examination and developmental assessment and selected biochemical parameters analysis. Dependent variable of this study were the changes in anthropometric parameters, developmental parameters and biochemical parameters. Anthropometric parameters assessed in study were Height (cm), Weight in (kg), Mid upper arm circumference (cm), Head circumference (cm), Chest circumference in (cm), Calf circumference (cm), Z- score (SD). Gross motor development, Fine motor development, Language development, Personal social development and Developmental quotient (DQ) were assessed in Developmental parameters. Haemoglobin in g/dl, Complete blood counts, Random blood sugar mg/dl, Serum albumin g/dl, Serum urea mg/dl, Serum electrolyte (sodium, potassium) in m mol/l, Stool routine microscopy, Urine routine microscopy, Montux test, X- ray chest were assessed in Biochemical and other parameters.

Developmental parameters were derived by comparison with standard milestone chart[5] and developmental quotient (DQ)[6]

was derived with the help of DST (developmental screening test). Investigations were done with the help of lab support. Base line investigations Haemoglobin, Complete blood counts, Random blood sugar, Urine routine microscopy, Montux test, X-ray chest (as per the NRC guideline)[3] were done for all the SAM children at admission. Some additional relevant[7] investigations (Serum albumin, Serum urea, Serum electrolyte, Stool routine microscopy) were also done. All other parameters were taken 6 times but because of feasibility and financial constraint biochemical parameters were taken 2 times at admission and at 4th follow up. After explaining the purpose of study to the care givers (mother) written informed consent was obtained. Preliminary data (gender & address) of patient admitting at NRC was collected from SAM card; rest of the data was collected during regular NRC visits & during interview of caregiver of admitted patient to elicit information on study variables described above.

Observation and Results

Table 1 shows that age of children ranged from 0-60 months with the mean age of 25.72 months among children, maximum (38.7) belonged to age range 13-24 months. regarding gender of children, 51% were males. Maximum 51% participants belong to ST category and 57% participants were from urban areas. Most (58%) participants belong to joint family, 81% were from BPL family. Approximately 31% mothers and 28% fathers of study participants were uneducated.

Figure 1 showing changes in the anthropometric parameters of study participants over the period of time. Figure 2 showing changes in z score category of participants from admission to 4th follow up. Table 2 Statistically significant changes in desired direction were observed in height, weight, head circumference, MUAC and chest circumference from admission to 4th follow up, as the *P* value for all the variables were <0.05.

Table 3 Shows the linear correlation between different anthropometric parameters at 4th follow up height, weight, head circumference, MUAC, chest circumference, calf circumference. There was significant positive perfect co-relation between weight and height as r = 0.963 & *P* value (0.000) so height increases as the weight. Similarly there is positive moderate co-relation between weight at 4th follow-up and head circumference ($r = 0.756$ and $P = 0.000$), MUAC ($r = 0.781$, 0.000), chest circumference ($r = 0.647$, $P = 0.000$), calf circumference ($r = 0.652$, $P = 0.000$)

Table 4 is showing comparison in mean & SD between different biochemical parameter at 2 point of time at admission and at 4th follow-up. Significant improvement was found in Albumin, urea and sodium during the study period, as after applying t- test, *P* –value was (0.001), (0.002), (0.04), respectively. No significant changes were observed in Hb and potassium between admission and 4th follow up.

Table 1: Basic demographic profile of study participants		
Characteristics (*n*=204)	**Number**	**Percentage**
Age in months		
0-6 months	08	3.9
7-12 months	32	15.7
13-24 months	79	38.7
25-36 months	41	20.1
37-60 months	44	21.6
Gender		
Male	104	51
Female	100	49
Caste		
General	16	7.3
OBC	73	35.8
SC	104	51
ST	11	5.4
Residence		
Urban	116	56.9
Rural	88	43.1
Family type		
Nuclear	86	42.2
Joint	105	51.5
3rd generation	9	4.4
Others	4	2
Socio-economic status		
APL	39	19.1
BPL	165	80.9
Mother's education		
Uneducated	63	30.9
Primary	42	20.6
Middle	43	21.6
Higher secondary	51	25
Graduate or more	5	2.5
Father's education		
Uneducated	58	28.4
Primary	37	18.1
Middle	46	22.5
Higher secondary	56	27.5
Graduate or more	7	3.4

Table 2: Change in physical parameters from at the time of admission to the 4th follow up						
Parameters	***n***	**Point of time**	**Mean (SD)**	**Mean difference**	***t***	***P***
Height	204	At admission	78.32 (11.19)	Upper limit -1.65	-21.23	0.000
		At 4th follow up	79.83 (11.06)	Lower limit -1.36		
Weight	204	At admission	7.75 (1.98)	Upper limit -1.24	-35.93	0.000
		At 4th follow up	8.93 (2.11)	Lower limit -1.11		
Head circumference	204	At admission	44.59 (2.71)	Upper limit -0.33	-9.8	0.000
		At 4th follow up	44.86 (2.61)	Lower limit -0.22		
MUAC	197	At admission	12.24 (1.11)	Upper limit -0.61	-24.37	0.000
		At 4th follow up	12.81 (1.05)	Lower limit -0.52		
Chest circumference	204	At admission	43.80 (3.70)	Upper limit -0.95	-3.52	0.01
		At 4th follow up	44.42 (2.86)	Lower limit -0.26		
Calf circumference	204	At admission	21.95 (3.68)	Upper limit -0.59	-1.50	0.133
		At 4th follow up	22.21 (3.10)	Lower limit -0.79		

Other results of study

Sixty six (32%) mothers were married at less than 18 year of age. All children were newly admitted cases. Vomiting & nausea were the most commonly encountered form of feeding intolerance. Pallor was most common finding encountered followed by and cervical lymphadenopathy on general physical examination. Conducted sound was the most common finding during systemic examination. Ten percent children had urinary tract infection. All children have normal Random Blood sugar at admission. Mean duration of stay of study participants was 12.68 days.

Summary of main results

1. NRC interventions have potential to improve the SAM child physically, biochemically as well as developmentally.
2. Almost all the physical parameters showed statistically significant improvement; however, sustainability of improvement is not certain. Most rapid gain was noted during the stay in NRC
3. Serum Albumin, sodium and urea return back to normal at the end of the study but sequence and timing of recovery of biochemical parameters is unclear.
4. All four domains of Development showed improvement after giving nutritional intervention, but need more time to follow up.

Table 5 shows according to DQ there are 3 categories normal, mild to moderate delay and severe delay. This table is showing the proportionate change in the different DQ categories at admission and at 4th follow up. After applying z–test, it is concluded that there is significant proportion change in mild to moderate delay category and severe delay category having the *P* value (0.02) and (0.00), respectively. Total population is constant so there are 2 possibilities either participants shifted from severe delay category to mild to moderate category and the other possibility is that participants shifted from normal to mild to moderate delay category but the number of participants in normal category is not decreasing so it is showing improvement here the severe delay children were promoted in not to normal category but in the number of severe delay children decreased significantly.

Table 6 shows there is a statistical significant (0.000) difference in gross motor activity, fine motor, personal social, language skill between admission and at 4th follow up.

Table 3: Co-relation between various anthropometric parameters at 4th follow up							
Parameters	Value	Scores					
		Weigh at 4th follow up	Height at 4th follow up	Head circumference at 4th follow up	MUAC at 4th follow up	Chest circumference at 4th follow up	Calf circumference at 4th follow up
Weight 4th follow up	r	1	-	-	-	-	-
	P						
Height at 4th follow up	r	0.963	-	-	-		
	P	0.000	-	-	-	-	-
Head circumference at 4th follow up	r	0.756	0.751	-	-		
	P	0.000	0.000	-	-	-	-
MUAC 4th follow up	r	0.781	0.758	0.580	-		
	P	0.000	0.000	0.000	-	-	-
Chest circumference 4th follow up	r	0.647	0.650	0.720	0.440		
	P	0.000	0.000	0.000	0.000	-	-
Calf circumference at 4th follow up	r	0.652	0.665	0.624	0.510	0.510	
	P	0.000	0.000	0.000	0.000	0.000	

Table 4: Change in biochemical parameter over the period of time						
Parameter		n	Mean	SD	t-test	P
Hb	Admission	204	9.63	1.53	1.34	0.193
	4th follow-up		9.80	1.13		
Albumin	Admission	204	3.24	0.75	3.94	0.001
	4th follow-up		3.60	0.72		
Urea	admission	204	20.65	4.70	3.50	0.002
	4th follow-up		22.65	4.90		
Sodium	admission	204	138.15	2.60	2.17	0.042
	4th follow-up		139.60	1.93		
Potassium	admission	204	3.60	0.49	1.468	0.159
	4th follow-up		3.74	0.40		

Table 5: Proportion change in Developmental Quotient (DQ) category			
DQ	At admission	At 4th follow up	P
>=85 Normal	35	36	0.8965
71-84 Mild to moderate delay	112	134	0.025
<=70 Severe delay	57	34	0.006

Discussion

According to the first objective of the present study, the impact of nutritional intervention on the anthropometric parameters: a significant desirable change was found in the anthropometric parameters, positive correlation ($r = 0.963$ for height, $r = 0.756$ for head circumference, $r = 0.781$ for MUAC, $r = 0.647$ for chest circumference, r = 0.652 for calf circumference with reference to weight) was also found between all anthropometric parameters included in this study. The rate of improvement was more during admission as compare to follow up. This may be because of un-adherence to the advised diet may be in terms of quality, quantity and frequency. May be it was not feasible for the family because of lake of time, financial and many other reasons. Child's

attitude, medical condition of child is also important factor for non-adherence. It is not fair to compare the results of therapeutic feed intervention with our routine diet at home. There were many studies found on the impact of the nutritional intervention on the weight, height and MUAC but on some other parameters which were included in present study like head circumference, chest circumference, calf circumference studies could not be found. Results of one study[8] (Khanna P. *et al.* 2020) showed that the intervention was effective in community-based management of severe malnutrition among children in rural northern India. Another study (Das J.K. *et al.* 2020)[9] concluded facility-based screening and management of uncomplicated SAM has no effect on recovery and mortality,

Elizabeth KE *et al.* (1997)[10] evaluated the role of developmental stimulation and nutritional supplementation in rehabilitation of SAM children in hospital and community setting. They followed SAM children for 2 years and concluded that interventions produced a significant positive impact on development but more if combined with developmental stimulation. Present study also concluded that nutritional intervention affect the development positively. Marko Kerac *et al.* (2000)[11] conducted a study to evaluate the long term outcomes following programme discharge. They concluded that weight improved but height remained low. While according to results of present study there was improvement in the height of the participant's also. R. S. Mamidi, 2010 *et al.*[12] revealed in their study that the diet based on local energy dense foods was found to be suitable for the nutrition rehabilitation of SAM. Teferi E, et al (2010)[13] conducted a study and concluded that the recovery rate was as 64.9% at 95% CI (61, 68). Death rate, default rate, weight gain, and length of stay were 1.2%, 2.2%, 4.2 g/kg/day, and 6.8 weeks, respectively. The recovery rate and weight gain were lower than sphere standard. Behailu Derseh, (2018) *et al.*[14] concluded that around 56% SAM children recovered. Mean weight gain for recovered children was 15.61 g/kg/day severely malnourished children though the rate of weight gain was moderate. P. Ferrinho, (1992) *et al.*[15] also conducted a study with the same objective as current study. D.Y. Gebremichael[16] concluded that nutritional recovery rate

Table 6: Change in developmental milestones of gross motor, fine motor, personal social and language domain at admission & 4th follow

Domain of development	Achieved	Gross motor at 4th follow up achieved		Total	McNemar *P*
		Yes	No		
Gross motor skills at admission	Yes	3	0	3	0.000
	No	129	70	199	
Total		132	70	202	
		Fine motor at 4th follow up achieved			
		Yes	No		
Fine motor skills at admission	Yes	24	3	27	0.000
	No	95	82	177	
Total		119	85	204	
		Personal social at 4th follow up achieved			
		Yes	No		
Personal social skills at admission	Yes	71	17	88	0.000
	No	56	60	116	
Total		127	77	204	
		Language at 4th follow up achieved			
		Yes	No		
Language skills at discharge	Yes	51	18	69	0.000
	No	78	57	125	
Total		129	75	204	
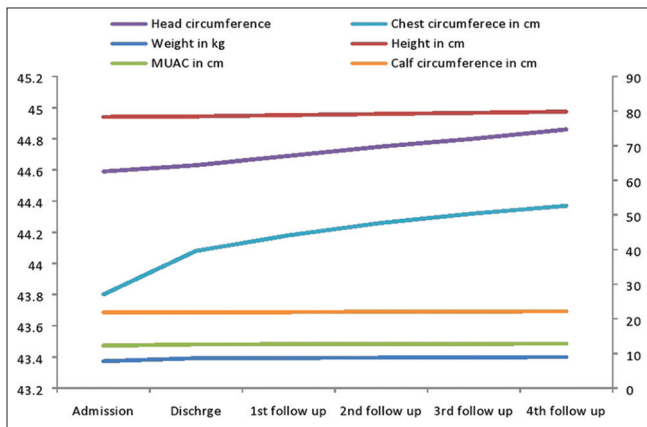
Figure 1: Line diagram of trends of various anthropometric parameters

Figure 2: Composite bar diagram of Z score category at admission and at 4th follow up

was 3.61 per 100 person day observations. Median nutritional recovery time was 22 and 29 days for oedematous malnourished and severely wasted children respectively. R. Sriswan, *et al.* (2010)[12] conducted a study to examine the composition of weight gain in 80 SAM children who underwent nutritional intervention in a hospital from India and they found that there was rapid weight gain with recovery of lost tissue in SAM children. In present study also significant weight gain was noted. G. Taneja, *et al.* (2012)[17] conducted a study to evaluate the effect of nutritional intervention on selected anthropometric indicators in 100 admitted children in NRC at Indore and Ujjain. They come with the conclusion that there was statistically significant difference between weight and MUAC, but they observed weight loss within 15 days of discharge from NRC. So they concluded that NRC was effective in improving the condition of admitted children but the effect was not sustained following
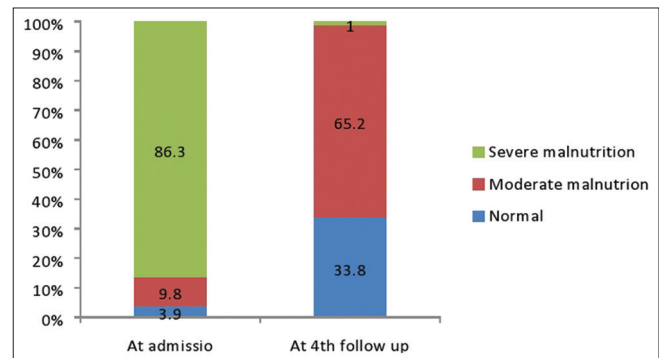
discharge. We also observed the same finding that there was significant improvement in weight, MUAC during stay in NRC but this improvement was not at similar rate after discharge in further follow up. But there was no weight loss observed after discharge. Colecraft EK, (2004) *et al.*[18] concluded that there were significant increases in children's weight-for-age ($P = 0.048$) and weight-for-height ($P = 0.002$) Z-scores between enrolment and discharge, most children discontinued programme participation before adequate recuperation like the present study. Educational approaches to enhance their responsiveness to caregivers' needs and effectiveness for the continued recuperation of malnourished children at home. J.F.R. *et al.* (2014)[19] conducted a study and the main results of the study were the nutritional intervention showed an increase in HAZ of children with moderate (0.51 ± 0.4, $P = 0.001$) and severe (0.91 ± 0.7, $P = 0.001$) stunting during the monitoring. They also included some biochemical parameters but were not included in current study. Lazzerini M, *et al* (2013)[20]

conducted a study to evaluate the effectiveness of special food in treating moderate acute malnutrition concluded that lipid based nutrient supplements & specific types of blended foods improved weight gain, weight for height and MUAC. K Singh, (2014) *et al*[21] assess the effectiveness of facility based care for children with SAM (1229) in NRC. They concluded weight gain was there but the desirable weight (target weight >15% of admission weight) was achieved by 46.85% SAM children.

According to 2nd objective effect of intervention on developmental parameters -In spite of statistically significant improvement in DQ at 4th follow up there were children in the sever delay category the reason behind this may be the development is multi-factorial and may be more time duration of follow up is needed for appreciate improvement. Grantham-McGregor SM (2014) *et al*.[22] conducted a systemic review to examine the effect of intervention on child development component and showed that nutritional interventions sometimes benefited child development but stimulation consistently benefited child development. There was little evidence of synergistic interaction between nutrition & stimulation on child development.

According to 3rd objective Study concluded there was statistically significant change in albumin, urea and sodium but not in the haemoglobin concentration and potassium. After completion of rehabilitation programme some biochemical parameter were not normalised, may be because of short duration of follow up. Studies similar to present study on the impact of nutritional intervention on biochemical parameters (which were included in the present study) can't be found. Although there are studies which show impact of nutritional intervention on other parameters which were not included in this study.

How the study can be considerate in strengthening primary health

Recent concept in management of SAM is 'continuum of care' it means the SAM children will be identified at primary level of care and referred to NRC (facility based management) after treatment the SAM children will be sent back to primary level of care. When after treatment SAM children will be coming back to primary level of care, results of current study can be utilized as guide for achieving the continuum of care. Primary health physician can check adherence to the advice given & sustainability of the improvement cause un-adherence & lake of sustainability are identified drawback by many studies which can push child back in to Malnutrition. Developmental and biochemical parameters requires long follow up as compared to existing duration of follow up (90 days) in NRC protocol, so primary health care physician can follow the children for longer duration and act complementarily with the facility based management by fulfilling the lacunae created by NRC and can contribute in treating the SAM children completely (physically, biochemically and developmentally), effectively and on sustainable basis.

Limitation of study

This study evaluated single urban NRC'S performance. It was an urban NRC which is at district level. For more strong evidences, study of other NRC of rural or PHC/CHC level was needed, so that outcome of intervention at different level would have been compared and its role in outcome would have been concluded. No control was used in present study. The outcome of treatment would have been compared with the outcome of SAM children who have treated at home or SAM children treated on day care basis, or in paediatric ward of hospital or with other type of interventions, in spite of treated at residential NRCs like this study than the effect on anthropometric, biochemical & developmental parameter would have been analysed. Biochemical parameter was taken on two point of time that is at admission & at 4th follow up. Like other parameters it would have been taken at 6 point of time for better conclusion of sequence of biochemical parameter recovery. Study duration is less to follow the parameters especially developmental & biochemical parameter. Other relevant biochemical parameter like serum cholesterol, serum retinol binding protein, serum Iron, and many other parameters like skin fold thickness which was not taken due to unavailability of herpenden's calliper, would have been included in study.

What this study Aids and recommends

1. Current study concluded that nutritional interventions given in NRC for treatment of SAM found to be effective in correction of selected deranged biochemical and delayed developmental parameters along with the physical parameters.
2. Study recommends
   - Need of continuum of care for effective management of SAM
   - Biochemical and developmental parameters should also be checked in follow up along with the physical parameters.

Conclusion

In present study improvement was noted in multiple domains, was ascribed to nutritional intervention that also partially addresses the underlying social and economic causes. Undoubtedly prominent changes were illustrated in physical parameters, but significant changes were also reported in few biochemical and developmental parameters. More robust research is needed to comment on effectiveness of nutritional interventions on biochemical and developmental domain. There is need of Nutritional intervention which can be effective on sustainable basis.

Acknowledgement

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have

given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Conflicts of interest

There are no conflicts of interest.

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