RESEARCH PAPER

Neurodevelopmental Status of Children aged 6-30 months with Severe Acute Malnutrition

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Objective*:* This cross sectional study was done to assess the developmental status in children (6-30 mo old) with severe acute malutrition (SAM). **Methods**: Study subjects were enrolled from children in SAM therapeutic unit, and controls were selected from well-baby clinic of the institute. Neurodevelopment of both groups was assessed using the Developmental assessment scale of Indian infants (DASII). Developmental quotient (DQ) ≤70 was considered delayed. **Results**: Mean (SE) motor DQ 59.04 (0.74) and mental DQ 62.1 (0.57) was lower in SAM as compared to controls (both *P*<0.0001). Clusters of early age were normal but clusters with items of later infancy were delayed. **Conclusions***:* Children with SAM show significant delay in development, and motor DQ is affected more than mental DQ.

Keywords: *Co-morbidity, Development, Nutrition, Outcome.*

Severe acute malnutrition (SAM) is known to be a major risk factor for impaired motor, cognitive, and socio-emotional development [1]. Survival has improved in SAM children with improved treatment in nutritional rehabilitation centers, which mainly focuses on nutrition supplementation [2]. These SAM children may also require comprehensive early intervention to limit neurodevelopmental sequelae. There is little information available on the neurodevelopmental status of Indian children with SAM. Thus, the present study was conducted to study the developmental status of children with SAM.

Methods

This cross-sectional study was carried out in Severe malnutrition therapeutic unit of a tertiary-care public hospital in central India from December 2014 to December 2015, after approval from the Institutional Ethical Committee.

Consecutive children aged between 6-30 months, admitted in the unit, as screened by the WHO criteria for identification of SAM were enrolled in the study. Children who were malnourished due to organic causes like congenital heart disease, cerebral palsy, malabsorption syndrome, genetic syndromes etc were excluded from the study. Further, those children who were clinically unstable to participate in the DASII test at the time of admission were also excluded from the study. Control group constituted children from well baby clinic of the institute in similar age group and of similar socioeconomic background. Parents were explained about the purpose of the study and a written informed consent was obtained.

Neurodevelopmental assessment was done by Developmental Assessment Scale for Indian Infants (DASII) by a single trained examiner at the time of admission before starting the intervention. DASII is an Indian modification of Bayley scale of infant development containing motor and mental scales with 67 and 163 items, respectively. After assessment of children, motor development quotient (DMoQ) and mental development quotient (DMeQ) was calculated as per manual of DASII scale. Developmental delay was defined as development quotient (DQ) ≤70 (≤2SD) in either the mental or motor scale. Samples from both groups were further classified as mild, moderate, and severe delay [3]. All the children were further assessed in all the clusters of both domains to evaluate for the specific areas of development affected by malnutrition [4,5]. All study children were provided standard management for SAM as per WHO guidelines.

Statistical analysis: Data were entered in Excel spreadsheets and analyzed using SPSS 20.0. Various clinical factors were compared by the Chi-square test. Mean DQ and cluster scores were compared by the Student's t test. A *P* value less than 0.05 was considered significant.

RESULTS

After exclusion of 98 children due to organic causes, refusal of consent or for being clinically unstable, we enrolled 102 children with severe acute malnutrition and 101 controls. Baseline characteristics were similar in both the cases and controls (***Table* I**).

The mean DQ was significantly lower in children with SAM as compared to controls ($P<0.0001$) in both domains (***Table* II**). No statistically significant differences were noted between the DQ of rural and urban children, or between MoDQ and MeDQ of SAM children. Other factors like gender, socioeconomic status and type of family also did not show any statistically significant differences (data not shown). Most of the SAM children had mild delay, and few had moderate delay. Mild delay (DQ 50-70) in motor domain was seen in 87.3% of study children and 10% of controls, whereas it was 94.1% and 12% in the mental domain. For moderate delay (DQ 35-50), these proportions were 12.7% and 1%, and 5.9% and 0% for motor and mental DQ, respectively. None of the SAM children had severe delay in any domain.

We also studied clusters in motor and mental domain and compared them with controls. It was seen that in motor domain there was no statistically significant difference in scores of neck control cluster but there was significant difference between the two groups in all other clusters, with lower scores in SAM children (***Web Table* I**). Similar finding were seen in mental clusters with no significant difference in cognizance (visual and auditory) between SAM children and controls but scores were significantly lower in all other mental clusters with SAM (***Web Table* I**).

TABLE I BASELINE CHARACTERISTICS OF THE SAMPLE STUDIED

Characteristics	*SAM (n=102) No. (%)*	*Controls (n=101) No. (%)*
Gender		
Male	64 (62.7)	59 (58.4)
Chronological age		
mo F: mean (SD)	13.1 (6.3)	12.5 (5.8)
Residence		
Rural	64 (62.7)	49 (48.5)
Urban	38 (37.3)	52 (51.5)
Type of family		
Joint	40 (39.2)	48 (47.5)
Nuclear	62 (60.8)	53 (52.5)
Socio economic status		
Class I	1 (1)	3 (3)
Class II	13 (12.7)	0
Class III	35 (34.3)	44 (43.6)
Class IV	34 (33.3)	25 (24.8)
Class V	19 (18.6)	29 (28.7)

DISCUSSION

In this hospital-based cross-sectional study of 102 children with SAM, assessed by DASII, all children with SAM had low Motor and Mental DQ. Most of the SAM children had mild delay in development. Those clusters which were acquired in early phase of life were not delayed, but those acquired in later infancy were delayed.

The limitations of this study are its small sample size, and absence of follow-up to assess improvement with intervention. Other psychosocial factors like over-crowding, and lack of education in parents, were not assessed in this study, which may have an effect on development of the children.

There is a significant difference in motor and mental DQ of SAM children in this study as compared to controls, which shows impact of malnutrition on child development, as also shown by other studies in literature [6-8]. Literature suggests that if malnutrition occurs in the vulnerable period of brain development, it can result in neurodevelopmental sequelae [8-10]. Prevention and early treatment of malnutrition may protect these children from this calamity.

Further we studied various clusters of motor and mental scales and found that SAM children had normal scores in those clusters that had items of early part of infancy like neck holding and visual and auditory cognizance. However, there was significant failure in those clusters which had items of later part of childhood. This finding may show that these children had inherent potential for normal development as they developed normally in early infancy but as they were affected by severe malnutrition in later life they had development delay. This has been mentioned before also by various authors that malnutrition typically affects child around 6-18 months and can cause developmental problems and decreased work capacity as adults [11,12].

TABLE II SHOWING MENTAL AND MOTOR SCORE AND DQ* IN CASES AND CONTROLS

Variables	*SAM (n=102) Mean (SE)*	*Controls (n=101) Mean (SE)*	*P Value*
Mental age	8.2 (0.4)	10.4 (0.5)	< 0.001
Motor age	7.9 (0.4)	10.1 (0.5)	0.01
Mental DQ	62.1 (0.6)	83.5 (1.0)	<0.001
Motor DQ	59.0 (0.7)	80.0 (1.0)	<0.001

**Assessed using Development Assessment Scale for Indian Infants. DQ: Development quotient; SAM: severe acute malnutrition*

WHAT THIS STUDY ADDS?

- There is a high incidence of developmental delay in SAM children, with most children having mild delay.

Delayed development has lifelong implications but if identified early and intervened timely, many children can be saved from disabilities. Treatment programs designed for severe acute malnutrition should also have robust early intervention protocol for prevention of neuro-developmental disabilities in these children.

Contributors: NB, DD: conceived and planned the study, and supervised the conduct of the study and preparation of the manuscript; SS: enrolled subjects, did the neurodevelopmental assessment, analyzed data, and prepared the initial draft of the manuscript; DD: supervised the neurodevelopmental assessment and prepared the initial draft of manuscript. JS, HPS: assisted in the planning of the study and preparation of the manuscript. All authors approved the final manuscript for publication.

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WEB TABLE I MEAN SCORES IN MOTOR AND MENTAL CLUSTERS IN CASES AND CONTROLS*

Cluster No	*Motor Clusters (no. of items)*	*SAM (n=102) Mean (SE 95% CI)*	*Control (n=101) Mean (SE 95% CI)*	*P value*	*Cluster No.*	*Mental Clusters (no. of items)*	*SAM(n=102) Mean (SE 95% CI)*	*Control (n=101) Mean (SE 95% CI)*	*P value*
I	Neck Control (7)	6.98 (0.01)	7 (0.0)	0.159	I	Cognizance (Visual) (25)	23.1 (0.2)	23.4 (0.2)	0.225
II	Body Control (23)	16.14 (0.4)	18.45 (0.3)	< 0.001	II	Cognizance (Auditory) (7)	6.9 (0.0)	6.9 (0.0)	0.310
III	Locomotion -1 (10)	3.64 (0.3)	4.93 (0.3)	0.001	III	Reaching & Manipulation (36)	23.5 (0.8)	27.7 (0.5)	<0.001
IV	Locomotion -2 (13)	0.29 (0.1)	0.73 (0.2)	0.010	IV	Memory (11)	7.7 (0.2)	9.2 (0.2)	<0.001
V	Manipulation (14)	9.19 (0.4)	10.92 (0.3)	<0.001	V	Social interaction & imitative behaviour (22)	12.2 (0.4)	13.7 (0.5)	0.025
					VI	Language I (Vocalization, speech & communication) (11)	5.0 (0.2)	6.3 (0.2)	<0.001
					VII	Language 2 (Vocabulary & comprehension) (18)	2.5 (0.3)	4.4 (0.3)	<0.001
					VIII	Understanding relationship (18)	0.9 (0.5)	1.6 (0.3)	0.023
					IX	Differentiation by use, shape & movements (8)	2.1 (0.2)	3.2 (0.2)	<0.001
					X	Manual Dexterity (7)	0.1 (0.0)	0.3 (0.1)	0.044

DASII: Developmental Assessment Scales for Indian Infants.