Research Article

Association of severe acute malnutrition with infections in under-five children admitted to Nutritional Rehabilitation Center—study from central India

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Abstract

Background: Infectious disease is the foremost reason of illness and death in developing countries, especially in children with severe acute malnutrition (SAM). Protein energy malnutrition is the basic reason for the heightened vulnerability to infections that can lead to a vicious cycle.

Objective: To study the association of SAM with infection, cause of delay in admission, and action taken by health worker in under-five children admitted to Nutritional Rehabilitation Center (NRC).

Materials and Methods: This was a case–control study design conducted at Nutritional Rehabilitation Center of NSCB Medical College, Jabalpur, Madhya Pradesh, India, and neighbourhood control subjects were selected from affected community. The χ^2-test, Student's *t*-test, and qualitative analysis were done for data analysis using SPSS software, version 17.

Result: A total of 700 subjects were taken for the study, of which 350 were severely malnourished children and 350 well-nourished control subjects. Severe malnourished children on an average present most commonly with fever (2.8 episodes, 11 days in last 3 months), followed by diarrhea (2.7 episodes, 10 days illness in last 3 months) and acute respiratory infection (ARI) (1.6 episodes, 7 days illness in last 3 months). There is a significant difference in illness owing to fever, diarrhea, and ARI between the severe malnourished children and normal nourished children. The average time between identification of child as severe malnourished and their admission was 4.38 months. The most important cause of delay in admission to NRC was because no information regarding NRC was given by health worker in early stage of disease, care of other sibling, and work at home in severe malnourished children.

Conclusion: There is strong association of SAM and infections. SAM and infections should be treated urgently to decrease morbidity and mortality.

KEY WORDS: Severe acute malnutrition (SAM), childhood infections, Nutritional Rehabilitation Center (NRC)

Introduction

Protein energy malnutrition is a major public health problem in India. Malnutrition is one of the most important underlying causes of child mortality in developing countries, particularly during the first 5 years of life.[1] Severe acute malnutrition (SAM) is associated with increased severity of common infectious diseases. There are multiple mechanisms of action in the relationship between malnutrition and susceptibility to bacterial infections diseases such as SAM, which impairs normal immune system development.[2] Infection itself can lead to a deficit in crucial body supplies of protein, energy, minerals, and vitamins. In the course of immune response, energy spent rises at the same time that the infected host undergoes a reduction in food consumption.[3]

Malnourished children experience largely from bacterial, gastrointestinal, and respiratory infections.[4] The first line of

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defence against these types of infection is the innate immune response, particularly epithelial barriers and the mucosal immune response.[5] SAM importantly compromises mucosal epithelial barriers in the gastrointestinal, respiratory, and urogenital tracts resulting in susceptibility of infection. Fifty million Indians under the age of five are affected by malnutrition. The national average is 42 of 100 children. According to the 2010 report of the National Rural Health Mission, malnutrition among children is the most prevalent in MP. The Integrated Child Development Service (ICDS) is the main program of Government of India to tackle the severe malnutrition. Delay in identification of the problem and referral is a major challenge. This study was conducted to know the association of severe malnutrition with infection, time gap between identification of malnourished children and their admissions to Nutritional Rehabilitation Center (NRC), and services provided by health workers during this period in Jabalpur district of central India (Madhya Pradesh).

Materials and Methods

Study Design and Study Period

A case–control study was conducted at NRC of NSCB Medical College, Jabalpur, India, and affected community. The study was conducted for the duration of 1 year from Oct 1, 2010 to September 30, 2011.

Sample Size Calculation

Sample size was calculated for two-proportion hypothesis testing large proportion equal allocation using the proportion of severe malnutrition 33% as per NFHS in MP. Sample size to show a difference of 11% in one of the risk factors across cases and control subjects was found to be 306 in each group, with 80% power and 5% alpha level. Assuming 10% drop out, the calculation was 339 (rounded to 350).

Selection of Cases

The cases were selected according to admission criteria of severe malnourished children in NRC.[6]

Infant Less than 6 Months or Less than 3 kg Being Breastfed

The infant is too weak or feeble to suckle effectively independently of his/her weight for-length (if this is owing to acute illness, the acute illness should be treated first), the infant is not gaining weight at home (by serial measurement of weight during growth monitoring), or presence of bilateral edema.

Children between 6 Months and 60 Months of Age

W/H or W/L < –3 Z-score (WHO standards) and/or mid-upper arm circumference (MUAC) < 11.5 and/or presence of bilateral edema.

Selection of Control Subjects

The control subject shows normal weight for age as per the standard WHO Growth Chart and not showing signs and symptoms of severe malnutrition.[7] The control subjects were free from malnutrition and selected from the same area from where the maximum number of cases was reported to NRC (neighborhood reference population control).[8] The control subjects were selected from 35 different sites from community to prevent the selection bias.[9] A total number of 350 control subjects were selected for the study. A total number of 700 subjects were in the study. Matching was done for the age group and locality.

Ethics Approval and Consent

Research was initiated after acceptance of the study by the Ethical Review board of the NSCB Medical College, Jabalpur, India, for research. Informed written consent was taken from parents of participants. During processing of the data, strict confidentiality was maintained.

Measurement of Association of Severe Malnutrition and Infections

Information about the childhood problems such as respiratory problems, diarrhea, blood in stool, fever, and rashes was obtained in precisely the same manner both for cases and control subjects. Information regarding childhood problems was asked for previous 3 months duration. The information was collected by interviewing both the groups with the help of predesigned, pretested questionnaire.

Information regarding time gap was obtained from parents of the child only in cases of malnutrition. It was also cross-checked by the health worker with the help of growth charts. Open-ended questions were asked to parents of the child to know the cause of delay in admission and services provided by health worker during this period.

Result

A total number of 700 subjects were taken for the study, of which 350 were severely malnourished children and 350 well-nourished control subjects. Mean age of the cases was 21.46 ± 1.28 months and that of controls 25.93 ± 1.73 months. There were 152 (43.4%) male and 198 (56.6%) female children in the cases while 194 (55.4 %) male and 156 (44.6%) female children in normal studied subjects (control). The mean weight of SAM children was 6.69 ± 1.83 kg, while mean weight of control subjects was 10.14 ± 3.04 kg. The mean height/length of severe malnourished children was 72.89 ± 1.07 cm, while 80.14 ± 1.4 cm for that of control subjects. In most of the cases, 280 (80%) subjects were presenting MUAC < 11.5 cm, while most of the control subjects [249 (71.1%)] showed MUAC > 13.5 cm. A total of 323 (92.3%) of control subjects were with birth weight ≥ 2.5 kg, while only 213 (60.9%) of severe malnourished children were with birth weight of ≥ 2.5 kg. There was significant difference in mean weight, height/length, and MUAC of cases and control subjects [Table 1].

Severe malnourished children on an average present most commonly with fever (2.8 episodes with SD of 2.9 or

11 days with SD of 11.56 in last 3 months), followed by diarrhea (2.7 episodes with SD 3.4 or 10 days with SD of 13.0 illness in last 3 months) and ARI (1.6 episodes with SD 2.9 or 7 days with SD of 12.1 illness in last 3 months).

The control (normal) children on an average presented with fever (1.06 episodes with SD of 1.43 or 2.7 days with SD of 3.7 in last 3 months), followed by diarrhea (1.08 episodes with SD 1.7 or 3.6 days with SD of 6.7 illness in last 3 months) and ARI (0.06 episodes with SD 0.5 or 0.3 days with SD of 2.8 illness in last 3 months).

There was significant difference in illness owing to fever, diarrhea, and ARI between the severe malnourished children and normal nourished children ($p < 0.0001$) by independent sample *t*-test. There was no significant difference in illness of dysentery ($p = 0.08$) and measles ($p = 0.12$) in cases and control subjects of malnutrition [Table 2].

Average time gap between first identification of child as malnourished and their admission to NRC = 4.38 months; SD = 4.4; maximum time gap = 2 years; minimum time gap = 1 week.

Most of the cases were identified by anganwadi worker (AWW) [186 (53.1%)], followed by accredited social health activist (ASHA) in 134 (38.3%), family member in 23 (6.6%), and, in only seven (2%) cases, it was referred by the health worker. The mean time between first identification of child as severe malnourished and their admission to NRC was 4.38 months. The maximum time gap was 2 years with minimum of 1 week in the studied subjects [Table 3].

In this study, cause of delay was identified by interviewing the mother of affected children and health worker. Most important cause of delay was no information regarding NRC given by health worker earlier in 65 (18.6%) cases, followed by owing to care of other siblings or working mother in 50 (14.3%), work at home in 45 (12.9%), family problems in 36 (10.3%), family members not willing for admission in 35 (10%), child parent's think that child will recover automatically in 32 (9.1%), mother is in labor in 22 (6.3%), owing to visit to mother's house in 19 (5.4%), fear of the hospital in 14 (4%), bed not available in nine (2.6%), and health worker says that she cannot admit one child to NRC in six (1.7%) of the malnourished children [Table 4]. In this study, after identification, health worker, in 215 (61.4%) cases first dietary counseled and then referred the children, but in 30 (8.6%) cases gave no intervention [Table 5].

Discussion

This was a case–control study done at NRC and affected community of Jabalpur district of central India (MP) to find out the association of SAM with other childhood infections, time gap between identification of child as severe malnourished, and their admission to NRC and action taken by health worker during this period. Of the total 700 subjects, 350 were cases of SAM and 350 control (well-nourished) children. Mean age of the cases was 21.46 ± 1.28 months and that of controls 25.93 ± 1.73 months. The mean weight of severe acute malnourished children was 6.69 ± 1.83 kg, while mean weight of control was 10.14 ± 3.04 kg. The mean height/length of severe malnourished children was 72.89 ± 1.07 cm while 80.14 ± 1.4 cm of control subjects. In most of the cases, 280 (80%) showed MUAC < 11.5 cm, while most of the control subjects [249 (71.1%)] showed MUAC > 13.5 cm. There was a significant difference in mean weight, height/length, and MUAC of cases and control subjects.

Information about the childhood problems such as respiratory problems, diarrhea, blood in stool, fever, and rashes was obtained in precisely the same manner both for cases and control subjects for the duration of last 3 months. Children with SAM are classified as "complicated" if they exhibit clinical features of infection or metabolic disturbance, severe edema, or poor appetite. Children with "uncomplicated" SAM were clinically well, alert, and had retained their appetite.

Severe malnourished children on an average present most commonly with fever of 2.8 episodes or 11 days in last 3 months while the normal children on average present with fever of one episode or 2.7 days in last 3 months. There was a significant difference in number of episodes/days of illness between cases and control subjects. "Sepsis" is defined as presence of the systemic inflammatory response syndrome (SIRS) with suspected or proven infection.[10] In the case of sepsis to be a syndromic diagnosis, the clinical criteria will be the same regardless of the presence of SAM, with the only provision that SAM is such an important risk factor for bacteremia that invasive bacterial disease can almost always be reasonably suspected as per guidelines.[11]

Severe malnourished children on an average experience 2.7 episodes or 10 days of diarrhea in last 3 months when compared with one episode or 3.6 days illness in control subjects. There was a significantly high number of illnesses of diarrhea in SAM children when compared with control subjects. Watery diarrhea is extremely common in children with SAM at presentation[12] and often accompanied by some degree of dehydration.[13,14] Determining which children with diarrhea are malnourished is important because the initial management is different. In a Colombian study, 68.4% of malnourished children revealed diarrhea, and 9% showed sepsis at the time of admission.[15] Two African studies also showed high incidence of diarrhea in SAM children of 49% and 67%.[16,17] However, previous reports have described malnutrition as an important risk factor for pneumonia than for diarrhea.[18] Diarrhea was the major comorbid condition found in our study.

In SAM, children experience 1.6 episodes or 7 days of acute respiratory tract illness in last 3 months, while normal nourished subjects experienced only 0.06 episode or 0.3 day of illness in last 3 months. There was a significant difference in cases and control subjects. A study from Africa[19] also reported a comparable incidence of respiratory illness and tuberculosis (18% each) in admitted SAM children. There was no significant difference in illness of dysentery ($p = 0.08$) and measles ($p = 0.12$) in cases and control subjects of malnutrition in our study.

Table 1: Baseline characteristics of cases and control subjects

Characteristics	Cases	Control subjects	Significance
Age (months)	21.46 ± 1.28	25.93 ± 1.73	<0.0001
Sex, *n* (%)			
Male	152 (43.4)	194 (55.4)	0.002
Female	198 (56.6)	156 (44.6)	
Weight (kg)	6.69 ± 1.83	10.14 ± 3.04	<0.0001
Height/length (cm)	72.89 ± 1.07	80.14 ± 1.4	<0.0001
MUAC (cm), *n* (%)			
<11.5	280 (80)	0 (0)	<0.0001
11.5–12.5	64 (18.3)	14 (4)	
12.5–13.5	5 (1.4)	87 (24.9)	
>13.5	1 (0.3)	249 (71.1)	
Birth weight (kg), *n* (%)			
<2.5	137 (39.1)	27 (7.7)	<0.0001
≥2.5	213 (60.9)	323 (92.3)	

Table 2: Association of malnutrition with other childhood illness (in past 3 months)

Childhood illness	Case		Control		Independent sample *t*-test
	Mean	SD	Mean	SD	
ARI (episodes)	1.65	2.94	0.063	0.52	<0.0001
ARI (days)	6.98	12.16	0.291	2.81	<0.0001
Diarrhea (episodes)	2.69	3.43	1.088	1.75	<0.0001
Diarrhea (days)	10.13	13.09	3.68	6.78	<0.0001
Fever (episodes)	2.82	2.91	1.06	1.43	<0.0001
Fever (days)	10.91	11.56	2.74	3.77	<0.0001
Dysentery (episodes)	0.27	2.80	0.108	1.21	0.312
Dysentery (days)	0.34	3.19	0.457	0.603	0.082
Measles (episodes)	0.10	1.13	0.057	0.075	0.123

Table 3: People by whom the child was identified as malnourished

Identified	No. of children	Percentage
AWW	186	53.1
ASHA	134	38.3
Family member	23	6.6
Doctor	7	2
Total	350	100

Average time gap between first identification of child as severe malnourished and their admission to NRC is 4.38 months. The maximum time period from identification to admission was 2 years while minimum 1 week. Most of the cases were identified by AWW, followed by ASHA worker in the community. In this study, cause of delay was no information regarding NRC given by health worker earlier, followed by owing to care of other siblings or working mother, work at home, family problems, family members not willing for admission, child parent's think that child will recover automatically, mother is in labor, owing to visit to mother's house, fear of the hospital and, others. A study done by Nandan et al.[20] at Agra-social Audit for Community Action found that, in the children of age group 1–11 months and 1–5 years, delay in the recognition of seriousness of problem is the social cause of death in 67.8% and 55.9% of the cases, respectively. A world bank report on India's undernourished children: a call for reform and action by Gragnolati et al. states that ICDS Program got failure to effectively reach under-three children of poorer household and lower caste. In addition, ICDS faces substantial operational challenges and suffers from a lack of high level of commitment.[21]

Table 4: Causes of delay in admission to NRC

Cause of delay in admission	No. of children	Percentage
No information regarding NRC given by health worker earlier	65	18.6
Owing to care of other siblings or working mother	50	14.3
Work at home	45	12.9
Family problems	36	10.3
Family members not willing for admission	35	10
Child parent's think that child will recover automatically	32	9.1
Mother is in labor	22	6.3
Owing to visit to mother's house	19	5.4
Fear of the hospital	14	4
Bed not available	9	2.6
Health worker says that she cannot admit one child to NRC	6	1.7
Others	17	4.8
Total	350	100

Table 5: The services provided by the health worker after identification of child as malnourished

Services provided by the health worker after identification	No. of children	Percentage
Only referral to NRC	97	27.7
Dietary intervention at local level and then referral	8	2.3
Dietary counseling and referral	215	61.4
No intervention	30	8.6
Total	350	100

Conclusion

There is a strong association of SAM with fever, diarrhea, and acute respiratory tract infection. Delay in admission is a major challenge.

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