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Prevalence and Biochemical Risk Factors of Severe Acute Malnutrition in Infants Under 6 Months Old in Single Tertiary Referral Hospital

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Abstract: Severe acute malnutrition remains to be a burden in developing countries, including Indonesia. Recent studies and researches started to highlight the importance of recognizing severe acute malnutrition in infants under 6 months old. This is a cross-sectional study aims to know the prevalence and biochemical risk factors of severe acute malnutrition in infants under 6 months old in our single tertiary referral hospital, Sanglah General Hospital, Denpasar, Bali, Indonesia. From January 2017 to December 2018, there were 138 children with severe acute malnutrition admitted to Sanglah General Hospital, Denpasar. From 138 subjects, 19 were below 6 months old of age (13,8%) and 119 were older than 6 months old (86,2%). Majority of our study samples were males with ratio of 1,5:1, had length of stay of more than 15 days (60,9%) and were marasmic (96,4%). Death occurred in 44,9% of study samples. Bivariate analysis including gender, length of stay, death, comorbidities, anemia, hypoalbuminemia, hypokalemia, hyponatremia and hypocalcemia. Of all the variables analyzed, only hypocalcemia yielded significant result with prevalence ratio between below and older than 6 months old age group was 0,432 (*p value* 0,045). The prevalence of hypocalcemia in infants under 6 months old with acute severe malnutrition is lower than children above 6 months old of age.

Keywords: Severe Acute Malnutrition, Age Under 6 Months Old, Prevalence, Biochemical Risk Factors

1. Introduction

Severe acute malnutrition remains to be a burden in developing countries, including Indonesia. Globally, 4,7 million infants under 6 months old suffer from severe acute malnutrition. Data in 2018 showed that prevalence of severe and moderate protein energy malnutrition in Indonesia is 10,2% with the highest prevalence in West Nusa Tenggara (14,4%) and the lowest prevalence in North Kalimantan (4,6%). In 2017, prevalence of severe acute malnutrition in Bali was 3,4% [1-3].

Severe acute malnutrition in children has short and long-term impact. This condition can increase morbidities, mortality and disability. According to the World Health Organization (WHO), up to 45% death in children were caused by severe acute malnutrition. In Indonesia, mortality rate of children under 5 years old in 2015 was 27 per 1000 livebirths [1, 3].

Burden of protein energy malnutrition in infant under 6 months of age is high but often overlooked. Mortality rate of infant under 6 months old with severe acute malnutrition is higher than in children older than 6 months old. Diagnosing severe malnutrition in infants under 6 months old of age present special challenges such as difficulties in performing anthropometric measurement and general assumption that severe acute malnutrition in this group of age is rare [4-6]. Previous guidelines focused on management of severe acute malnutrition in children aged older than 6 months old. Recent studies and researches started to highlight the importance of recognizing the severe acute malnutrition in infants under 6 months old. This study was done in order to know the prevalence and biochemical risk factors of severe acute

malnutrition in infants under 6 months old in a single tertiary referral hospital, Sanglah General Hospital Denpasar, Bali, Indonesia.

2. Methods

2.1. Study Design

This study was an observational study with cross sectional design. Children aged 28 days to 18 years old with severe acute malnutrition who were admitted to Sanglah General Hospital Denpasar, Bali, Indonesia from January 2017 to December 2018 was included in this study.

2.2. Variable Definition

Severe acute malnutrition is defined anthropometrically: weight/length under -3 SD z score in WHO growth chart or presence of bilateral pitting edema in infants under 6 months old, weight/length under -3 SD z score in WHO growth chart or presence of bilateral pitting edema or mid upper arm circumference < 11,5 cm in children aged 6-59 months and body mass index under -3 SD z score in WHO growth chart or presence of nutritional edema in children older than 5 years old [7]. Variables included in this study were gender, length of stay, comorbidities, severe acute malnutrition type, severe acute malnutrition condition, mortality, hypoglycemia, hypoalbuminemia, anemia, hyponatremia, hypokalemia and hypocalcemia. Length of stay were classified into < 15 days and 15 days or more. Comorbidities were further divided to infection and non-infection. Human immunodeficiency virus infection, tuberculosis, sepsis and pneumonia were classified into infection group whereas cancer, atresia and heart defects were classified into non-infection group. Hypoglycemia was defined as blood sugar < 54 mg/dL, hypoalbuminemia was defined as albumin < 3,5 g/dL, hyponatremia was defined as serum sodium < 135 mEq/L, hypokalemia was defined as serum potassium < 3,5 mEq/L and hypocalcemia was defined as serum calcium < 8,8 mEq/L. Anemia was further classified based on age as follows: < 11 g/dL in children age < 4 years old, < 11,5 g/dL in children 5 to 11 years old and < 12 g/dL in children > 11 years old [8-12].

2.3. Data Analysis

All data were secondary data taken from register and subjects with incomplete data were excluded. Minimum samples were determined by descriptive formula with α 5% and d 5% resulted in 50 samples the least. Data analysis was done with SPSS 25 on Windows 10. Difference between variables of two age group (below and above 6 months of age) were tested with chi square for bivariate analysis.

3. Results

From January 2017 to December 2018, there were 138 children with severe acute malnutrition admitted to Sanglah General Hospital, Denpasar. From 138 subjects, 19 were below 6 months old of age (13,8%) and 119 were older than 6 months old (86,2%). Characteristics of the subjects were shown in Table 1.

Table 1. *Characteristics of children with severe acute malnutrition admitted to Sanglah General Hospital, Denpasar.*

Variables		n (%)
Age group	< 6 months	19 (13,8)
	≥ 6 months	119 (86,2)
Gender	Male	83 (60,1)
	Female	55 (39,9)
Length of Stay	< 15 days	54 (39,1)
	≥ 15 days	84 (60,9)
Type	Marasmus	133 (96,4)
	Kwashiorkor	5 (3,6)
Condition	I	10 (7,2)
	II	0 (0)
	III	26 (18,8)
	IV	3 (2,2)
	V	99 (71,7)
Comorbidities	Infection	43 (45,6)
	Non-infection	36 (54,4)
Death	Yes	62 (44,9)
	No	76 (55,1)
Hypoglycemia	Present	16 (11,6)
	None	122 (88,4)
Hypoalbuminemia	Present	64 (46,4)
	None	74 (53,6)
Anemia	Present	89 (64,5)
	None	49 (35,5)
Hyponatremia	Present	87 (63)
	None	51 (37)
Hypokalemia	Present	51 (37)
	None	87 (63)
Hypocalcemia	Present	62 (44,9)
	None	76 (55,1)

The bivariate analysis between below 6 months old versus above 6 months old were further analyzed and shown in Table 2. Variables analyzed were gender, length of stay, death, comorbidities, hypoglycemia, hyponatremia, hypokalemia, hypocalcemia, hypoalbuminemia and anemia.

Table 2. Bivariate analysis between below 6 months old versus above 6 months old age group.

| Variables | Age group | | PR (CI 95%) | *P* value |
	< 6 months	≥ 6 months		
Gender				
Male	10 (52,6%)	73 (61,3%)	0,858 (0,547-1,345)	0,640
Female	9 (47,4%)	46 (38,7%)		
Length of stay				
< 15 days	7 (36,8%)	47 (39,5%)	0,933 (0,497-1,750)	1,00
≥ 15 days	12 (63,2%)	72 (60,5%)		
Death				
Yes	5 (26,3%)	57 (47,9%)	1,414 (1,028-1,946)	0,132
No	14 (73,4%)	62 (52,1%)		
Comorbidities				
Infection	9 (47,4%)	65 (54,6%)	0,867 (0,525-1,432)	0,733
Non-infection	10 (52,6%)	54 (45,4%)		
Hypoglycemia				
Present	3 (15,8%)	13 (10,9%)	1,445 (0,454-4,602)	0,819
None	16 (84,2%)	106 (89,1%)		
Hypoalbuminemia				
Present	5 (26,3%)	59 (49,6%)	0,531 (0,245-1,151)	0,101
None	14 (73,7%)	60 (50,4%)		
Anemia				
Present	8 (42,1%)	81 (68,1%)	0,619 (0,360-1,063)	0,053
None	11 (57,9%)	38 (31,9%)		
Hyponatremia				
Present	11 (57,9%)	76 (63,9%)	0,907 (0,604-1,361)	0,807
None	8 (42,1%)	43 (36,1%)		
Hypokalemia				
Present	6 (31,6%)	45 (37,8%)	0,835 (0,414-1,683)	0,789
None	13 (68,4%)	74 (62,2%)		
Hypocalcemia				
Present	4 (21,1%)	58 (48,7%)	0,432 (0,177-1,502)	0,045
None	15 (78,9%)	61 (51,3%)		

Table 2 showed that only hypocalcemia yielded statistically significant prevalence ratio. The prevalence of infants under 6 months old with hypocalcemia was 0,432 times (CI 95% 0,177-1,502; *p* value <0,05) of children aged above 6 months old.

4. Discussion

Diagnosing severe acute malnutrition in infants under 6 months of age is challenging. In this age group, anthropometric measurement is more difficult to perform and presence of false general assumption that severe acute malnutrition in this age group is non-existent. Rapid growth happens in this age group therefore making them susceptible to nutritional disturbances. Infant younger than 6 months of age need different nutrient requirements and have less mature physiological processes than those of older infants [13, 14].

This study aimed to define prevalence and biochemical risk factors of severe acute malnutrition in infants younger than 6 months of age in single tertiary referral hospital. From January 2017 to December 2018, there were 138 children with severe acute malnutrition admitted to Sanglah General Hospital, Denpasar. From 138 subjects, 19 were below 6 months old of age (13,8%) and 119 were older than 6 months

old (86,2%). Kanan and Swar in Sudan found in their study that from 593 children under 5 year of age with severe acute malnutrition that were admitted to Omdurman Children Hospital in 2014, mean age was 22,3 months with the highest number of cases in 12-24 months of age group (42,15%) [15]. Ahmed et al also found that from 388 children with severe acute malnutrition, 91,5% were younger than 3 years old with mean age 15,1 ± 10,9 months [16]. This study result also in accordance with study by Grijalva-Eternod et al which found that prevalence of severe acute malnutrition in infants younger than 6 months of age was 12% [17].

From all of the variables, only one variable yielded significant difference prevalence ratio. In our study, the prevalence of infants under 6 months old with hypocalcemia was 0,432 times (CI 95% 0,177-1,502; *p* value <0,05) of children aged above 6 months old. A study by Mishra, Bastola and Jha stated that there is a strong relationship between hypocalcemia and protein energy malnutrition in children. In this study, infants younger than 6 months of age are less likely to develop hypocalcemia [18]. This can be linked with no kwashiorkor cases in this age group. Calcium level can decrease in kwashiorkor case with hypoalbuminemia because calcium is bound to albumin [19]. Chisti et al added that children with severe acute malnutrition

who developed hypocalcemia significantly increase the risk of systemic manifestation such as severe sepsis, abdominal distention and vomiting [20]. The result of this study is different from study by Smilie et al who found that hypocalcemia in infant younger than 6 months with severe acute malnutrition is comparable to children aged 6 to 59 months. This could happen because the proportion of infants younger than 6 months old in our study is smaller than above 6 months of age group. Study result by Smilie et al also pointed out that hypocalcemia is higher in severe acute malnutrition children with sepsis [21]. In our study, only one subject under 6 months of age had sepsis.

The number of anemia in our study (42,1% in the first age group and 68,1% in the second age group) is higher than previous study by Ahmed et al. (26,9%) [16]. This result could be linked to high incidence of iron deficiency anemia cases in Indonesia. Data from Indonesian Pediatrician College stated that as much as 48,1% children under 5 and 47,3% school aged children in Indonesia suffer from iron-deficiency anemia [22, 23]. Female gender above 10 years old of age have higher risk of suffering from iron deficiency anemia due to menstruation but in our study, the higher proportion in above 5 years old age group is in pre-menstrual age. The higher comorbidities of infection in children above 6 months of age group can be a factor contributing to anemia compared to non-infection comorbidities in infants under 6 months old age group.

Study by Ahmed et al in Sudan stated that from 78 children younger than 15 years old with severe acute malnutrition, 49 children (62,8%) is male and 29 (37,2%) is female with ratio 1,7:1 [16]. Study by Kanan and Swar also found that prevalence of boys to develop severe acute malnutrition is higher than girls (ratio 1:0,9) [15]. Our study result is in accordance with previous studies that there are more boys with severe acute malnutrition than girls (ratio 1,5:1). There is no significant gender difference between the two age groups.

Our study found no significant length of stay difference between the two age groups. Most cases stay $\geq$ 15 days for hospitalization. Previous study by Tesfay et al also found that the median length of stay of 564 children aged 0-59 months with severe acute malnutrition is 15 days [24].

Death rate in infants younger than 6 months of age in our study is 26,3% (5/19) compared to 47,9% (47/119) in children above 6 months of age group but the difference is not statistically significant. Study by Grijalva-Eternod et al included 24.405 children with severe acute malnutrition found out that infants younger than 6 months of age stand for 12% of the cohort (2939 children) and stated that this age of group are in higher risk to pass away during hospitalization (4,6%) [17]. This number is lower than in our study and may be caused by difference in sample size.

Our study also does not find any significant difference of hypokalemia, hyponatremia, hypoalbuminemia and hypoglycemia between the two age groups. Another interesting result in our study is that in the younger than 6 months of age group, non-infection comorbidities is higher (52,6%) while in above 6 months age of group is vice versa. Non-infection comorbidities seen in infants younger than 6

months of age group in our study is mostly congenital heart disease. The immunity of this age group can also be aided by maternal antibodies that usually decrease at the age of 6-12 months old [25].

5. Conclusion

Prevalence of infants under 6 months of age with severe acute malnutrition admitted to Sanglah General Hospital from 2017-2018 is 13,8%. As reported cases were increasing, severe acute malnutrition in infants under 6 months old should be highlighted because of different nutrient requirements and management.

Conflict of Interest

All the authors do not have any possible conflict of interest.

Authors' Contributions

All authors are equally contributing to the study from the conceptual framework, data gathering, data analysis until presenting the results through publication.

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