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Burden and Correlation between Predisposing Factors of Malnutrition in Infants with Congenital Heart Disease on Follow-Up

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Abstract
Background: *Malnutrition is a common cause of morbidity and mortality in children with congenital heart disease (CHD). Children with congenital heart disease (CHD) are prone to malnutrition for several reasons including decreased energy intake, increased energy requirements, or both. Assessment of nutritional status among children with congenital heart disease (CHD) is a very important issue often neglected in paediatrics practice*
Materials and Methods: *Hospital based observational prospective study conducted in the year 2019-2020. Neonates with CHDs were followed up over a period of 6 months. Inclusion criteria: Neonates with CHD survived beyond 3months. Anthropometric measurements weight and length were documented using 2006 WHO growth chart (0- 24 months) and Z score for weight for length (WHZ) was calculated. Malnutrition was classified as moderately acute malnutrition (MAM), or severely acute malnutrition (SAM) based on Weight-for-length Z score* ≤ -2 *SD and* ≥ -3 *SD of the median, and* < -3 *SD of the median respectively, based on the WHO standard. Correlation between predisposing factors like low arterial oxygen saturation (spo2), congestive cardiac failure, and pulmonary artery hypertension (PAH), recurrent respiratory tract infection and feed intolerance were analysed.*
Statistical analysis was done on IBM SPSS STATISTICS VERSION 20.
Results: *In the present study, 30% of patients with recurrent RTI were APAH with MAM and 30% of recurrent RTI were CPAH with MAM. 53.9% of patients with recurrent RTI, 40% of patients with CCF and 50% of patients with feed intolerance were CPAH with SAM. 75% of the CPAH and 45.5% of the APAH were SAM respectively. 33.3% of the CPAH with SAM expired, whereas 30% of APAH with SAM expired.*
Conclusion*: Various predisposing factors like pulmonary artery hypertension (PAH), recurrent respiratory tract infection, congestive cardiac failure (CCF) and feed intolerance amplified the severity of malnutrition and increased the mortality, especially in CHDs with pulmonary artery hypertension.*
Key Word:*:congenital heart disease(CHD); severely acute malnutrition (SAM); moderately acute malnutrition (MAM)*

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I. Introduction

Malnutrition poses a burden not only on the health system, but the entire socio-cultural aspect of the country[1]. Malnutrition can be defined as a state of nutrition where the weight for age, height for age and weight for height/length indices are below -2 Z-score as per WHO recommendation[2].

Children with congenital heart disease (CHD) are prone to malnutrition for several reasons including decreased energy intake, increased energy requirements, or both[3]. Children with CHD in which there is congestive heart failure or an increase in after load (pulmonary hypertension) often present with increased energy expenditure[4, 5]. Chronic hypoxemia also affects growth as it causes inefficient processing of nutrients at the cellular level. Other factors that can cause malnutrition in children with congenital heart disease are pulmonary hypertension[6, 7].Assessment of nutritional status among children with congenital heart disease (CHD) is a very important issue often neglected in paediatrics practice.

This study therefore is aimed at determining the burden and correlation between various predisposing factors of malnutrition in infants with CHDs on follow-up. The results will help us to improve on early nutritional counselling and medical intervention to optimize the growth of children with CHD. Most of the

previous studies are based on paediatric age group .There have been few study on nutritional status of infants with CHDs.

II. Methods and methodology

This was a hospital based observational prospective study conducted in the Department of paediatrics at Sassoon General hospital, Pune from September 2019 to September 2020. Neonates diagnosed with CHDs were followed up over a period of 6 months.

Study Design: Prospective observational study.

Study Location: This was a tertiary care teaching hospital based study done in Department of paediatrics at Sassoon General hospital, Pune, Maharashtra.

Study Duration: September 2019 to September 2020.

Inclusion criteria: Neonates with CHD survived beyond 3months of age.

Sixty two neonates were detected with congenital heart disease in the year 2019-2020. But only 50 of them survived beyond 3 months of age. The 50 infants with CHD were followed up and were grouped based on association with pulmonary artery hypertension (PAH): group APAH (acyanotic patients with pulmonary artery hypertension); group AWTPAH (acyanotic patients without pulmonary artery hypertension); group CWTPAH (cyanotic patients without pulmonary artery hypertension); and group CPAH (cyanotic patients with pulmonary hypertension).

Anthropometric measurements of weight and length were documented and Z score for weight for length (WHZ) was plotted using 2006 WHO growth chart (0- 24 months). Malnutrition was classified as moderate, or severe based on Weight-for-length Z score ≤ -2 SD and ≥ -3 SD of the median, and < -3 SD of the median respectively, based on the WHO standard. Prevalence of malnutrition in infants with CHDs was analysed. Correlation between predisposing factors like low arterial oxygen saturation, congestive cardiac failure (CCF), pulmonary artery hypertension (PAH), recurrent respiratory tract infection and feed intolerance were analysed.

Statistical Analysis:
Statistical analysis was done on IBM SPSS STATISTICS VERSION 20.
Categorical variables were taken in the form of frequencies and proportions and cross tabulations were done for the chosen parameters and column proportions were compared using Chi square test. Distribution was represented by pie charts or bar graphs. Column proportions was represented in % on bar or column charts.

III. Results

62 neonates were diagnosed with CHDs in the neonatal period, out of which 12 expired before 3 months of age and 50 survived**.** The 50 neonates were followed up from 3rd to 6th months and there nutritional status was analyzed.

In table .1 shows gender distribution of CHDs, among the 50 CHDs, 26(52%) were male and 24 (48%) were female, giving a male to female ratio of 1.1:1.

Sex(n=50)	**N (%)**
Male	26(52.0)
Female	24(48.0)

Table 1.Gender distribution of CHD

Table .2 shows the distribution of CHDs among acyanotic and cyanotic CHDs, 72% of the cases were acyanotic and 28% were cyanotic CHDs.

Type of CHDs(n=50)	**N (%)**
Acyanotic CHD	36(72.0)
Cyanotic CHD	14(28.0)

Table 2. Distribution of CHDs among acyanotic and cyanotic CHDs

Table .3 shows groups of CHDs based on pulmonary artery hypertension, 22(44%) cases were APAH and 8(16%) were AWPAH. Hence, overall 30(60%) cases were associated with pulmonary artery hypertension.

Groups based on pulmonary artery hypertension(n=50)	**N (%)**
Acyanotic patients with pulmonary hypertension(APAH)	22(44.0)
Acyanotic patients without pulmonary hypertension(AWPAH)	14(28.0)
Cyanotic patients with pulmonary hypertension(CPAH)	08(16.0)
Cyanotic patients without pulmonary hypertension(CWPAH)	06(12.0)

Table 3. Frequency of cardiac diseases based on association with pulmonary artery hypertension (PAH).

Fig.1.Groups of CHD based on pulmonary artery hypertension

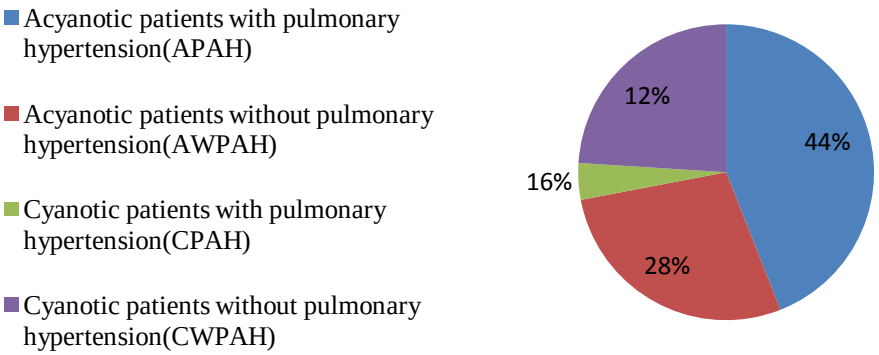

Table .4 shows predisposing factors of malnutrition in CHDs. In the current study, 60% of the cases were associated with PAH, whereas 48% were associated with feed intolerance and 46% with recurrent respiratory tract infection. Only 20% were associated with CCF.

Predisposing factors of malnutrition in CHD(n=50)	N (%)
Pulmonary artery hypertension(PAH)	30(60.0)
Recurrent respiratory tract infection	23(46.0)
Congestive cardiac failure(CCF)	10(20.0)
Feed intolerance	24(48.0)

Table 4. Predisposing factors of malnutrition in CHD

Table .5 shows the distribution of predisposing factors of MAM among various CHD groups. In the present study, 30% of patients with recurrent RTI were APAH with MAM and 30% of recurrent RTI were CPAH with MAM. Thus, indicating that CHDs with associated pulmonary artery hypertension had higher risk of recurrent RTI which in turn predisposes to MAM.

CHD group with MAM	**mean z core**	**mean spo2**	**recurrent RTI(n=10) N (%)**	**CCF**	**Feed intolerance(n=14) N (%)**
APAH	-2.48	90.3	03(30.0)	00	04(28.6)
AWPAH	-2.56	95.8	02(20.0)	00	02(14.3)
CPAH	0	0	03(30.0)	00	04(28.6)
CWPAH	-2.56	65.1	02(20.0)	00	04(28.6)

Table 5. Distribution of predisposing factors in CHD with MAM

Table .6 shows the distribution of predisposing factors of SAM among various CHD groups. In the present study, 53.9% of patients with recurrent RTI, 40% of patients with CCF and 50% of patients with feed intolerance were CPAH with SAM. Thus, indicating cyanotic CHDs with associated pulmonary artery hypertension (PAH) and other associated risk factors predisposes to higher risk of SAM.

CHD groups with SAM	**mean z score**	**mean spo2**	**recurrent RTI(n=13) N (%)**	**CCF(n=10) N (%)**	**Feed intolerance(n=10) N (%)**
APAH	-3.24	88.6	03(23.1)	03(30)	03(30)
AWPAH	-3.35	95.4	02(15.4)	02(20)	01(10)
CPAH	-3.33	61.5	07(53.9)	04(40)	05(50)
CWPAH	-3.35	66.2	01(07.7)	01(10)	01(10)

Table 6.Distribution of predisposing factors in CHD with SAM

Table.7 shows nutritional status among acyanotic and cyanotic heard diseases. In the present study, 40(80%) out of 50 cases were malnourished. 57.1% of the cyanotic CHDs and 41.7% of the acyanotic CHD were SAM. This finding showed that the severity of malnutrition were greater among cyanotic CHDs.

NUTRITIONAL STATUS	**ACYANOTIC(n=36) N (%)**	**CYANOTIC(n=14) N (%)**	**Total(n=50) N (%)**
Normal	08(22.2)	02(14.3)	10(20)
MAM	13(36.1)	04(28.6)	17(34)
SAM	15(41.7)	08(57.1)	23(46)

Table 7.Nutritional status among acyanotic and cyanotic heard diseases

Table .8 shows the status of nutrition among various CHD groups. In the current study, 75% of the CPAH and 45.5% of the APAH were SAM respectively, whereas 36.4% of the APAH were MAM. This findings showed that the severity of malnutrition were greater among CHDs with associated PAH.

Nutrition status	**APAH (n=22) N (%)**	**AWTPAH (n=14) N (%)**	**CPAH (n=08) N (%)**	**CWTPAH (n=06) N (%)**	**Total (n=50) N (%)**
Normal	04(18.2)	04(28.6)	00	02(33.3)	10(20)
MAM	08(36.4)	05(35.7)	02(25.0)	02(33.3)	17(34)
SAM	10(45.5)	05(35.7)	06(75.0)	02(33.3)	23(46)

Table 8. Status of nutrition among various CHD groups.

Table.9 shows mortality among CHDs associated with malnutrition. In the present study, 33.3% of the CPAH with SAM expired, whereas 30% of APAH with SAM expired. This findings showed that the mortality was higher among CHDs with associated PAH with severely acute malnutrition (SAM).

Mortality among CHDs with associated malnutrition	N (%)
Cyanotic with pulmonary artery hypertension (CPAH) with SAM(n=06)	02(33.3)
Acyanotic with pulmonary artery hypertension(APAH) with SAM(n=10)	03(30.0)

Table 9. Mortality among CHDs with associated malnutrition Discussion

IV. Discussion

The study was conducted at a tertiary care hospital to determine the burden and correlation between various predisposing factors of malnutrition in infants with CHDs on follow-up.

In our study, out of the 50 CHDs which were followed up, 52% were male and 48% were female, hence male to female ratio was 1.1:1. This finding was similar to study by Shah et al. in Nepal, wherein the male to female ratio was 1.5:1[8].

In our study, APAH was the most frequent CHD (44.0%), followed by AWPAH (28%), CPAH (16.0%), and CWPAH (12.0%).However, in a study by villasis-Keever et al., APAH was the most frequent CHD (62.7%), followed by CWPAH (15.6%), AWPAH (11.5%), and CPAH (10.2%)[9].

In the present study, 30% of patients with recurrent RTI were APAH with MAM and 30% of recurrent RTI were CPAH with MAM. Thus, indicating that CHDs with associated pulmonary artery hypertension had higher risk of recurrent RTI which in turn predisposes to MAM. 53.9% of patients with recurrent RTI, 40% of patients with CCF and 50% of patients with feed intolerance were CPAH with SAM. 75% of the CPAH and 45.5% of the APAH were SAM respectively, whereas 36.4% of the APAH were MAM. Infants with congenital heart disease with pulmonary artery hypertension had the lowest z-score .This findings showed that severity of malnutrition was higher among CHDs with associated PAH. This finding was similar to study by Pitmann et al., who reported the impact of pulmonary hypertension on growth and nutrition in cyanotic and acyanotic CHDs, and found that cyanotic patients with pulmonary hypertension were more affected than acyanotic children with hypertension. The preferred reason for this pulmonary hypertension induced malnutrition among children with cyanotic heart disease could be compensated metabolic acidosis caused by hypoxia[10].

In the present study, 33.3% of the CPAH with SAM expired, whereas 30% of APAH with SAM expired. This findings showed that the mortality was higher among CHDs with associated PAH with severely acute malnutrition (SAM).

In our study, out of 50 cases followed up, 40(80%) of them were malnourished. This was similar to study by Okoroma et al., in Lagos and Cameroon et al., where a prevalence of 90.4% and 97% were obtained respectively[11, 12].

V. Conclusion

In our study, APAH was the most frequent CHD (44.0%), followed by AWPAH (28%). 75% of the CPAH and 45.5% of the APAH were SAM respectively, whereas 36.4% of the APAH were MAM. The study concluded that various predisposing factors like pulmonary artery hypertension (PAH), recurrent respiratory tract infection, congestive cardiac failure (CCF) and feed intolerance amplified the severity of malnutrition and increased the mortality, especially in CHDs with pulmonary artery hypertension. Pulmonary hypertension was the most important predisposing factor of malnutrition in infants with CHDs.

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