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Original Research

Changes in Nutritional Status of Children Under Five with Acyanotic Congenital Heart Disease Left to Right Shunt Type after Defect Closure by Catheterization

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ABSTRACT

Background: One of the impacts that occur in patients with congenital heart disease (CHD) is malnutrition. Malnutrition will affect the growth of the child. Closure therapy with catheterization can improve nutritional status after a few months. This study aims to determine the nutritional status of toddlers with simple left to right shunt-type acyanotic CHD before and after closure therapy with catheterization. **Material and Methods:** This study is an analytical observational study with a retrospective cohort method using medical record data involving pediatric patients less than 5 years old with simple left to right shunt-type acyanotic CHD who received closure by catheterization at Dr. Soetomo General Hospital from January 2020 to December 2020. **Results:** From 10 samples, the characteristics of the most samples were women (90%), age group 2-5 years (60%), and PDA abnormalities (50%). In addition, nutritional status after closure by catheterization improved. **Conclusion:** There was an improvement in nutritional status (W/H) after defect closure with catheterization in patients aged less than 5 years with simple left to right shunt type acyanotic CHD within several months.

Highlights:

1. The nutritional status of children with CVD after therapy is interesting to discuss to ensure whether surgery have influenced the children's antibody.
2. Changes in their nutrition intake after surgery would help for future treatments with related disease and same operation.

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Introduction

Congenital heart disease (CHD) is a morphological and physiological disorder of the cardiovascular system, a disorder resulting from the formation and development of the heart or blood vessels from intra uterine until birth [1–3]. The rate of occurrence of CHD throughout the world is around 1.2 million out of 134 million live births per year or around 6 – 10 out of 1,000 live births [2,4,5]. Meanwhile, the rate of occurrence of CHD in Indonesia is around 8 out of 1,000 live births [5,6]. The cause of CHD is still unclear, but it is most likely multifactorial (genetics, exposure to substances, etc.) [3,6]. The classification of CHD is generally divided into 2, namely acyanotic (not blue) and cyanotic (blue) [2,3,5,7,8]. One of the impacts that often occurs in CHD patients is under nutrition.[9–11]

According to other study, CHD patients had growth problems in almost half of the total research sample [9]. The acyanotic CHD group often experiences failure to thrive and wasting (very low body weight) so it is often associated with acute malnutrition [5,12,13]. Apart from that, malnutrition status in CHD is also influenced by internal factors (genetic disorders, type of CHD suffered, susceptibility to recurrent infections, complications that occur, increased metabolic needs, disruption of oxygen distribution, etc.) and external factors (low socio-economic status, low parental education status, low nutritional intake. low food, and others).[5,7,9,10,14–17]

Growth in children under five years (toddlers) is a very important period to pay attention to because there is very rapid and significant growth [18–21]. Factors that can influence growth during toddlerhood are divided into 2, namely internal factors (genetics, heredity, gender, age, hormones, etc.) and external factors (food intake, environment, drugs, etc.) [18,21,22]. If growth disorders occur during the toddler period, it will affect growth and development in the following period [5,18,21]. Monitoring growth in toddlers uses growth charts according to WHO standards. In this graph, there are several types of graphs used for toddlers, including weight for age (W/A), length for age (L/A), and weight for length (W/L) [18,23,24]. If there is a growth problem in a toddler with CHD, then one way to fix it is to close it with catheterization.

Intervention with catheterization is a non-surgical intervention so it is not invasive to correct CHD with appropriate indications [4,5,25–27]. Interventions with catheterization or corrective surgery can improve nutritional status in CHD patients [16,28,29]. Research in the Surakarta area found that the results of VSD closure with catheterization could improve nutritional status according to weight for height (W/H) after 3 - 6 months [29]. Meanwhile, research in the Medan area found that the results of PDA closure with catheterization could also increase the nutritional status in Weight for Height (W/H) after 1, 3, 6, and 12 months [30]. In line with this

information, research that discusses changes in nutritional status after closure with catheterization in patients with left to right shunt type acyanotic CHD such as VSD, PDA and ASD is still relatively small. This research needs to be carried out because it can provide information about changes in the nutritional status of toddlers with left to right shunt type acyanotic CHD after closure with catheterization at Dr. Soetomo General Hospital so that nutritional problems in CHD can be detected early and intervened appropriately.

Material and Methods

This study was an analytical observational study with a retrospective cohort method using medical record data[1] involving pediatric patients less than 5 years old with left to right shunt type acyanotic CHD who received closure by catheterization at Dr. Soetomo General Hospital from January 2020 to December 2020. This study had received ethical clearance from the Ethical Committee of Dr. Soetomo General Hospital with ethical number 1049/LOE/301.4.2/IX/2022 on 29 September 2022.

Acyanotic CHD is a congenital heart disease with structural and functional disorders of the heart from birth that are not characterized by cyanosis/perfusion disorders. This type of acyanotic CHD has a left to right shunt type and an obstructive type. The most common abnormalities in acyanotic CHD are types of acyanotic CHD with shunts, for example VSD, ASD, and PDA.[3]

The study population was pediatric patients less than 5 years old with left-to-right shunt type acyanotic CHD who received closure by catheterization at Dr. Soetomo General Hospital in January 2020 to December 2020. The research sample was pediatric patients less than 5 years old with left to right shunt type acyanotic CHD who received closure by catheterization at Dr. Soetomo General Hospital from January 2020 to December 2020 who met the inclusion criteria, namely 1) Aged 0 – 5 years 2) acyanotic CHD type simple left to right shunt/1 defect 3) Regularly check nutritional status, both weight and height in the previous and following months 3, 6, and 12 after closing the defect with catheterization. Exclusion criteria are: (1) incomplete medical record data; (2) complex CHD/more than 1 defect; (3) Accompanied by genetic syndromes such as Down syndrome and others; (4) Accompanied by chronic diseases such as infections and others. The research sample size used total sampling.

Research data included age, gender, type of acyanotic CHD, left to right shunt type and body weight and height. Data on body weight and height are used to determine nutritional status (W/H). The z-score calculation of nutritional status (W/H) is done manually with the help of standard anthropometric tables listed in "Minister of Health Regulation Republic of Indonesia Number 2 of 2020". Nutritional status (W/H) is also grouped into

poor nutrition, undernutrition, normal nutrition, at risk of overnutrition, overnutrition and obesity.

Nutritional status was assessed before closure and 3, 6, and 12 months after closure. The z-score analysis of nutritional status of W/H was statistically analytical using the dependent t-test (if the data distribution was normal) and the Wilcoxon test (if the data distribution was abnormal) with the help of SPSS 21.0. These two tests were used to assess differences in nutritional status between before and after 3 months, between after 3 months and after 6 months, and between after 6 months and after 12 months.

Result

Characteristics of the research sample (n=10) include: Firstly, a patient with acyanotic CHD with simple left to right shunt type/ 1 abnormality at RSUD Dr. Soetomo from January 2020 to December 2020 was dominated by women, namely 9 people (90%); secondly, the largest age group is 2 – 5 years with 6 people (60%), followed by the 0 – 2 year age group with 4 people (40%); thirdly, the type of Acyanotic CHD disorder is simple left to right shunt type/ 1 of the most common abnormalities is PDA with 5 people (50%) followed by ASD with 3 people (30%) and VSD 2 people (20%).

The characteristics of nutritional status (W/H) before closure therapy with catheterization consist of poor nutrition 2 (20%); undernutrition 1 (10%); normal nutrition 4 (40%); at risk of overnutrition 1 (10%); overnutrition 1 (10%) and obesity 1 (10%).

The characteristics of nutritional status (W/H) after 3 months closure therapy with catheterization consist of poor nutrition 1 (10%); undernutrition 1 (10%); normal nutrition 5 (50%); at risk of overnutrition 1 (10%); overnutrition 1 (10%) and obesity 1 (10%).

The characteristics of nutritional status (W/H) after 6 months closure therapy with catheterization consist of poor nutrition 0 (0%); undernutrition 2 (20%); normal nutrition 5 (50%); at risk of overnutrition 0 (0%); overnutrition 1 (10%) and obesity 2 (20%).

The characteristics of nutritional status (W/H) after 12 months closure therapy with catheterization consist of poor nutrition 0 (0%); undernutrition 2 (20%); normal nutrition 4 (40%); at risk of overnutrition 1 (10%); overnutrition 0 (0%) and obesity 3 (30%).

Table 1. T-test Dependent Z score (W/H) between Before and 3 Months After Closure Therapy

	Mean (SD)	Difference (SD)	CI95%	P value
Z score (W/H) before closure therapy	-0,597 (2,97)	0,61 (0,7)	0,10 – 1,11	0,023
Z score (W/H) 3 months after closure therapy	0,013 (2,75)			
SD= Standard Deviation; CI= Confidence Interval				

(The p value < 0.05 means there is a significant difference between the nutritional status of children with acyanotic CHD with simple left to right shunt type, before and after 3 months of closure therapy with catheterization).

Table 2. T-test Dependent Z score (W/H) between 3 Months After and 6 Months After Closure Therapy

	Mean (SD)	Difference (SD)	CI95%	P value
Z score (W/H) 3 months after closure therapy	0,013 (2,75)	0,22 (0,29)	0,005 – 10,43	0,045
Z score (W/H) 6 months after closure therapy	0,231 (2,71)			
SD= Standard Deviation; CI= Confidence Interval				

(The p value < 0.05 means there is a significant difference between the nutritional status of children with acyanotic CHD with simple left to right shunt type between after 3 months and after 6 months of closure therapy with catheterization).

Table 3. Wilcoxon Z score test (W/H) between 6 months after and 12 months After Closure Therapy

	Median (Minimum – Maximum)	Difference (SD)
Z score (W/H) 3 months after closure therapy	0,013 (2,75)	0,22 (0,29)
Z score (W/H) 6 months after closure therapy	0,231 (2,71)	
Wilcoxon test, 1 sample with a decreasing Z score and 9 samples with an increasing Z score		

(The p value > 0.05 means there is not significant difference between the nutritional status of children with acyanotic CHD with simple left to right shunt type between after 6 months and after 12 months of closure therapy with catheterization).

Discussion

General Characteristics of the Research Sample

Toddlers with acyanotic CHD, simple left to right shunt type, are mostly found to be girls (90%), age category 2 – 5 years (60%) and PDA disorders (50%). The possibility of women experiencing acyanotic CHD disorder is higher than men [3]. This may be because the diameter of the arteries in women is smaller than in men, so they are more at risk of developing pulmonary hypertension [3]. Apart from that, other studies explain that PDA disorder is also often found in the acyanotic CHD population in women [16,30]. Apart from that, the age category with the most acyanotic CHD toddlers in one of the other studies is the age category 2 - 5 years, around 60% [5]. However, there are also differences in the age categories in other studies, namely the age category with the largest number being the under age 1 year more than half [31]. There are differences in sample characteristics in each study depending on the research location, research time, sample size, and the age at which the child was diagnosed with acyanotic CHD.[3,32]

Nutritional Status (W/H) between Before and 3 Months After Closure Therapy

Based on result, the nutritional status based on W/H in acyanotic CHD toddlers with simple left to right shunt type before catheterization was the most common, namely normal nutrition, 4 children (40%). The other study also found that the highest nutritional status based on W/H in acyanotic CHD was normal nutrition in 23 children out of 49 (46.9%)[16]. Meanwhile, the percentage of nutritional status below normal according to W/H was found to be 3 children (30%). This number is relatively low compared to research conducted at Dr. Soetomo General Hospital previously [3,5]. Nutritional status before catheterization varies greatly in previous studies because there are many factors that can influence it, such as food intake, socioeconomics, susceptibility to infection, type of CHD suffered, complications, location and time of research, and others [9,10,16]

Based on result, nutritional status based on W/H in acyanotic CHD toddlers with simple left to right shunt type at 3 months after catheterization has experienced an improvement in nutritional status. This is characterized by 1 child who was initially under-nourished becoming under-nourished and 1 child who was initially under-nourished becoming normal nutrition. This happens because defect closure therapy with catheterization can normalize blood circulation in the next few months [16,29]. Normal blood circulation can transport nutrients throughout the body adequately. Apart from that, the symptoms that usually occur in CHD such as shortness of breath, pulmonary hypertension and so on are starting to decrease which can have an impact on normal total energy expenditure.[3,16,28]

Table 1 shows that there is a statistically significant difference between the nutritional status of acyanotic CHD toddlers with simple left to right shunt type before and after 3 months of closure therapy with catheterization ($p<0.05$). In this regard, there has been no previous research that specifically examined the differences in nutritional status of children with acyanotic CHD from left to right shunt type. However, there are several studies that are in line, namely research by Irfan *et al*. [30] which explains that there is a statistically significant difference between the nutritional status (W/H) of PDA patients before and after several months of closure with catheterization. Apart from that, this is also in line with research by Oyarzún et al. [28] which explained that there was a significant difference in nutritional status in VSD patients between before and after 3 months of closure therapy.

Nutritional Status (W/H) between 3 Months After and 6 Months After Closure Therapy

Based on result, nutritional status based on W/H in acyanotic CHD toddlers with simple left to right shunt type at 6 months after catheterization also experienced an improvement in nutritional status. This is characterized by the absence of poor nutrition. This is in line with research by Sukandar and Lilijanti[29] which explains that closing the defect with catheterization still has an impact on improving nutrition 3 to 6 months after closure therapy. Apart from that, the existence of a catch-up growth event to catch up with growth delays, both in weight and height, 3 to 6 months after closure therapy will also have an impact on improving nutrition.[16,29]

Table 2 shows that there is a statistically significant difference between the nutritional status of acyanotic CHD toddlers with simple left to right shunt type between after 3 months and after 6 months of closure therapy with catheterization ($p<0.05$). This is also in line with research by Irfan *et al*. [30]. which found that there was a statistically significant increase in nutritional status (W/H) in PDA patients at 1, 3, 6 and 12 months after closure. Apart from that, this is also in line with research by Oyarzún et al.[28] and Sukandar and Lilijanti[29] who also found that there was a statistically significant difference in nutritional status (W/H) in VSD patients at 3 - 6 months after closure therapy.

Nutritional Status (W/H) between 6 Months After and 12 Months After Closure Therapy

Based on result, nutritional status based on W/H in acyanotic CHD toddlers with simple left to right shunt type at 6 months and 12 months after catheterization was found to have a tendency towards obesity. This could occur because there was an improvement in body weight but no improvement in height was found after 6 months of closure therapy [28]. Apart from that, there are still many factors that can influence nutritional status.

Table 3 shows that there is no statistically significant difference between the nutritional status of acyanotic CHD toddlers with simple left to right shunt type between after 6 months and after 12 months of closure therapy with catheterization (p>0.05). This is also in line with research by Oyarzún et al. [28] which explained that there was no statistically significant difference in nutritional status (W/A) in CHD patients in general after 6 months of closure therapy. This can happen due to factors that can influence nutritional status, one of which is inadequate nutritional intake.[28]

The strength of this study was discussing things that had not been discussed in previous studies, namely differences in nutritional status in patients with simple left to right shunt type acyanotic CHD between before and after 3 months of closure, between after 3 months and after 6 months, and between after 6 months and 12 months.

The limitation of this study were that the number of research samples is too small. The researchers' reasons for the small research sample are:

1. Dr. Soetomo General Hospital is a referral hospital where most patients are diagnosed with left to right shunt type acyanotic CHD with more than 1/complex defect. Meanwhile, the inclusion criteria used were medical records of acyanotic CHD patients with left to right shunt type with only 1 abnormality. The reason this criterion is used is to minimize factors that can influence nutritional status in acyanotic CHD patients with left to right shunt type.
2. The inclusion criteria used are patients aged 0 – 5 years. The reason this criterion is used is to minimize factors that can influence the patient's nutritional status. The age range 0 – 5 years is the fastest growth phase. Apart from that, in this range it is predominantly influenced by nutritional intake and growth hormones still do not play a role.
3. In 2020, patients who came to Dr. Soetomo General Hospital experienced a decline due to the COVID-19 outbreak. In addition, the medical record data for acyanotic CHD patients with left to right shunt type with 1 abnormality/simple are incomplete, especially data regarding body weight and height before and after 3, 6, 12 months of catheterization.

The existence of these three factors makes this research sample small. However, the existence of these inclusion criteria is also important to minimize the presence of other factors that can influence nutritional status in patients with acyanotic CHD, left to right shunt type with 1 abnormality/simple. Therefore, researchers cannot eliminate one element of the inclusion criteria.

Conclusion

There was an improvement in the nutritional status (W/H) of acyanotic CHD toddler with simple left to right shunt type/1 abnormality after closure with catheterization. However, there was a trend towards obesity after 6 months of closure. Statistically, there was a significant difference in nutritional status (W/H) between before and after 3 months of closure therapy; between after 3 months and after 6 months of closure therapy. However, there was no significant difference in nutritional status (W/H) between after 6 months and after 12 months of closure therapy.

The research uses a small research sample due to several reasons which have been mentioned in the limitations in the discussion section so that there are suggestions for future research include using a larger research sample and needing further studies regarding: nutritional status in other types of CHD, especially after closure with catheterization. Advice for the public is to pay more attention to children's nutritional status and try to maintain normal nutritional status by taking various actions such as: regularly checking their weight and height, consulting with a doctor and others.

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