

Prevalence and Factors Associated with Heart Failure in Children Admitted in a Tertiary Hospital in Northern Tanzania

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Abstract

Background: Heart failure is one of the emergency presentations among children admissions. Despite the high morbidity and mortality resulting from heart failure in children in our country from various causes, but still we have few information regarding on prevalence, etiology and factors associated with heart failure in pediatric population.

Methodology: A hospital based cross sectional study among children aged 0-12 years admitted to pediatric wards of Bugando medical centre from December 2015 to February 2016. Data regarding socio demographic, clinical, and laboratory information were collected by using structure questionnaire. Clinical diagnoses of heart failure were based on the presence of at least the first three signs which were cardinals. The signs include significant tachycardia more than standard per age, tachypnea above standards per specific age, tender hepatomegaly at least 3 cm below right costal margin, cardiomegaly with displaced apex beat above fifth intercostal space. Clinical staging of the heart failure was performed to all children with heart failure. Data analysis was done by using STATA version 13 and were considered statistically significant when the p-value was <0.05

Results: A total of 400 children were enrolled in the study. Median (IQR) age was 12 (4– 36) months. Male consisted of 61% of all participants. Heart failure prevalence was and a total of 29.8% (119/400). The most common etiology was congenital heart defect 51 (42.9%) followed by severe anemia, 42 (35.3%). Factors associated with heart failure includes difficulty breathing (OR 2.7; 95% CI; 1.04–6.98: p=0.041), hepatomegaly (OR 3.5; 95% CI 1.11– 11.3: p=0.036) and severe anemia (OR 5.6; 95% CI 2.56–12.0: p<0.001). Among children with heart failure we identified 7 (5.9%) children with heart failure clinical stage II by modified Ross classification. Children who presented with clinical stage III were 91 (76.5%) and stage IV were 21 (17.6%).

Conclusion: The high prevalence of heart failure among children observed in this study is worryingly high. Thorough clinical assessment and supported by routine echocardiogram screening for early detection of congenital heart defects and other cardiac related causes. Understanding the burden can reduce the magnitude of the problem owing to early diagnosis and prompt intervention.

Keywords: Heart failure in children; Clinical staging; Modified ross classification; Tanzania

Abbreviations: HF: Heart Failure; BMC: Bugando Medical Centre; CUHAS: Catholic University of Health and Allied Sciences; DCM: Dilated Cardiomyopathy; CHD: Congenital Heart Defects; DORV: Double Outlet Right Ventricle; PFO: Patent Foramen Ovale; VSD: Ventricular Septal Defect; AVSD: Atrioventricular Septal Defect; PDA: Patent Ductus Arteriosus; NICU: Neonatal Intensive Care Unit; RHD: Rheumatic Heart Disease; TAPVR: Total Anomalous Pulmonary Venous Return; TGA: Transposition of Great Arteries

Introduction

Heart failure in children is a major health problem which is associated with high morbidity and mortality worldwide [1,2]. The global epidemiology is still unclear with local variations scarcity of information from the low income countries [3,4]. The burdens of heart failure have been demonstrated from different studies with an estimated incidence of congestive heart failure in children to be 0.87 per 100,000 in United Kingdom. Children with heart failure have been demonstrated to comprise of about 10 to 33% of all admissions in pediatric intensive care units and congenital heart disease accounts for about 6 to 24% [5-8].

Heart failure occurs when the heart is unable to deliver enough cardiac output to meet body's metabolic demands as a results of ventricular dysfunction, volume or pressure overload which can be overlapping [9,10]. Structural heart defects is the leading cause of heart failure in children and contribute

significantly in morbidity and mortality in different settings [11]. Severe anemia due to infections such as malaria and sepsis greatly contribute to heart failure [12-14]. Various factors such as rheumatic heart disease, anemia from various causes and congenital structural heart defects influence heart failure in children mainly in Sub Saharan Africa. Congenital heart defects accounts for 15 to 25% of heart failure in children globally which without prompt management mortality can be as high as 50%.

Even though the heart failure in children is higher in the list among the cause of hospital admission in emergency settings but still children with heart failure face many challenges in diagnosis and management. Less has been documented to explain the prevalence of heart failure and the associated factors in admitted children together with clinical staging.

We carried out this study in order to find out the magnitude of heart failure in children and learn the drivers of this problem in our setting. The modified ross classification for heart failure was adopted in classifying the severity of the problem among those who were found to have a problem among admitted children.

Materials and Methods

Study area and period

The study was held at Bugando medical center between December 2015 and February 2016. Bugando medical center is a consultant tertiary university teaching hospital for lake and western zone of the United Republic of Tanzania. The hospital is located along the shores of Lake Victoria in Mwanza city. The catchment population is more than 16 million people covering 9 regions of Geita, Mara, Mwanza, Kagera, Katavi, Kigoma, Simiyu, Shinyanga and Tabora. It provides both inpatients and outpatients services with a bed capacity of 1000 and more than 1000 employees. Pediatric ward is divided into neonatal unit, general wards and Pediatric Intensive Care Unit (PICU). The neonatal unit comprises of post natal ward, Neonatal Intensive Care Unit (NICU), premature unit and Kangaroo mother care. On average seven children are admitted on daily basis mostly being referral from the catchment area health facilities. The hospital is currently the sole center in the lake and Northwestern zone providing echocardiogram and other specialized services. Routine echocardiogram services are provided twice weekly and emergency echocardiogram provided on daily basis.

Study design and participants

A descriptive hospital based cross sectional study design was conducted. All children aged 0 to 12 years who were admitted at pediatric wards were included except for the abandoned children and premature babies with very low and extremely low birth weight.

Sample size

A minimum sample size of 400 was estimated based on Leslie Kish formula (1965) for cross sectional studies assuming 50%

had heart failure on admissions estimated from a Nigerian study by Oedeji, et al. among hospitalized children.

Study procedures

We included all admitted children who met the inclusion criteria whose caregivers consented to participate in the study. The children were enrolled on daily basis. Face to face interviews were conducted and a pre-tested questionnaire was used to obtain socio demographic information such as age, sex, place of residence, medical history, presenting illness and physical examination findings. Anthropometric measurements were taken for every participant and were used to determine the nutrition status using the z score for the children below 5 years. Body weight was measured by using a DETECTO scale from U.S.A which was adjusted to zero before each measurement. BMI (Body Mass Index) for age was used for children aged 5 years and above [15]. Blood Pressure (BP) was measured with age appropriate mercurial sphygmomanometer using standard techniques. Using pediatric task force guidelines on BP control in children with systolic and/or diastolic BP below the 5th percentile for age, gender and height was used [16].

Diagnostic of heart failure were made clinically based on the presence of at least the first three signs were cardinals. The signs include significant tachycardia more than standard per age, tachypnea above standards per specific age, tender hepatomegaly at least 3 cm below right costal margin, cardiomegaly with displaced apex beat with central trachea above fifth intercostal space. Heart failure staging was done by using modified ross classification to assess the presence and severity of heart failure Echocardiography was performed by experienced pediatric cardiologist to identify structural abnormalities and cardiac function of the heart.

Full blood picture were taken for assessment of anemia and blood smear to investigate for malaria parasite were taken in all patients and samples were sent to the laboratory to be processed and read by a well experienced technician. And intervention was done based on patient findings.

Operational definitions

We used the following operational definitions according to pediatrics heart association

Heart failure: Is a clinical syndrome whereby the heart is unable to provide adequate cardiac output to meet the metabolic demand of the body [17,18].

Clinical case definition of congestive heart failure: Is defined as the presence of the following cardinal features and the first three are compulsory. These are tachypnea and tachycardia above the upper limit for age, tender hepatomegaly of at least 3 cm below right costal margin and displaced apex beat when it is displaced laterally beyond midclavicular line or 4th intercostal space in <5 years old children and a lateral displacement below 5th intercostal space in children >5 years with central trachea.

Modified ross classification: Is a score adopted to classify heart failure in all pediatric age groups.

Data analysis

Data were entered into Microsoft Excel were coded cleaned first after entry. Data were transferred to the software and analyzed by using STATA version.

Primary outcome of the study was prevalence of heart failure based on clinical assessment based on case definition of heart failure and clinical staging by modified ross classification of heart failure in all pediatrics age group during admission. Independent variable were age, gender, nutritional status, paleness, height, weight. Independent variable were outcome of the study

Dependent variables were presence of heart failure and independent variables were age of the patient, sex, caregiver's level of education, history of previous admissions, presenting symptoms and signs, nutritional status.

Results were summarized using proportions for categorical data and medians (IQR) for continuous variables. Categorical variables were compared using either *chi square* or Fisher's exact tests where appropriate. Continuous variables were summarized as proportional or percentages. The prevalence of heart failure was determined by the number of children with heart failure regardless of their clinical staging of heart failure over the number of the children enrolled during the study period.

Multivariate logistic regressions analysis was used to determine factors associated with heart failure. Odds ratios with respective 95% confidence interval were reported and p value of less than 0.05 was considered statistically significant.

Results

Participants age and sex

During the study period we recruited 400 children from November 2015 to February 2016.

Toughly history and physical examination were done to all 400 children together with some investigations including echocardiographic examination. Out of 400 children, 119 children were found to have heart failure equivalent to 29.8%.

Among the 400 participants 244 (61%) were male and those who had heart failure were 74 (18.5%) with male to female ratio 1.6:1. The most affected age group are infants below 12 month old account for 58 (28.4%) with heart failure followed by children under five years of age with 35 (26.1%) children. More of the children 62 (51.3%) were residing in rural areas of more than 20 kilometers away from Buganda Medical Centre and the majority were peasants 74 (62.2%) (Tables 1 and 2).

Table 1: Baseline socio demographic, clinical presentation and laboratory characteristic of participants.

Variable name	With HF N=119	Without HF N=281	Univariate OR (95% CI)	P-value	Multivariate OR (95%CI)	P-value
Age (in month)	13 (3-48)	12 (5-31)	1.01 (1.00-1.01)	0.032		
≤ 12	58 (28.4)	146 (71.6)	1			
13-60	35 (26.1)	99 (73.9)	0.9 (0.5 - 1.5)	0.642	2.8 (0.9 -9.2)	0.083
>60	26 (41.9)	36 (58.1)	1.8 (1.1 - 3.3)	0.047	1.9 (0.75-0.68)	0.52
Sex						
Male	71 (59.7)	108 (38.4)	0.2 (0.6-1.4)	0.7		
Female	48 (40.3)	173 (61.6)	1			
	3 (2-3)	3 (2-3)	0.9 (0.74-0.1)	0.33		
Occupation						
None	2 (1.7)	11 (3.91)	1			
Employed	15 (12.6)	60 (21.35)	1.3 (0.3-6.9)	0.7		
Small business	28 (23.5)	66 (23.5)	2.3 (0.5-11.20)	0.29		
Peasant	74 (62.18)	144 (51.3)	2.8 (0.6-13.1)	0.84		

Distance to the referral center						
<20 kilometer	58 (48.7)	179 (63.70)	1			
>20 kilometer	61 (51.3)	102 (36.30)	1.8 (1.2-2.8)	0.006	1.5 (0.7 -3.3)	0.29
Presenting complains						
Difficulty breathing	90 (39.0)	141 (61.0)	3.08 (1.9)	<0.001	2.7 (1.04-6.98)	0.041
Cough	77 (33.8)	151(66.2)	1.5 (0.96-2.3)	0.072		
Failure to thrive	46 (37.4)	77 (62.6)	1.7 (1.0-2.6)	0.026		
Easy fatigability	26 (66.7)	13 (33.3)		<0.001		
Diaphoresis	19 (86.4)	3 (13.6)	17.6 (5.1-60.7)	<0.001	0.76 (0.46-1.2)	0.32
Presenting signs						
Systolic murmur	68 (57)	7 (2.5)	113 (46.6-274.8)	<0.001		
Hepatomegaly	38 (50.0)	38 (50.0)	3 (1.8-5)	<0.001	3.5 (1.1-11.3)	0.036
Gallop rhythm	28 (23.5)	6.0 (2.14)	54.4 (20.4-144.8)	<0.001		
Pallor	29 (25.21)	51 (17.8)	2.24 (1.4-3.6)	0.004	5.6 (2.56-12)	<0.001
Nutritional status						
Mild malnutrition	11 (9.2)	10 (3.60)	2.7 (1.1-6.7)	0.28		
Moderate malnutrition	10 (8.4)	10 (3.60)	2.4 (1.0-6.2)	0.05		
Severe malnutrition	21 (17.6)	70 (24.9)	0.7 (0.4-1.3)	0.3		
CHD	54 (45.3)	8 (2.85)		<0.001	97.4 (12.4-766)	<0.001
AHD	24 (20.2)	2 (07)	35.2 (8.2-15)	<0.001		
Pneumonia	63 (42.3)	56 (42.3)	2.4 (1.6-3.8)	<0.001	3.07(1.23-8.4)	0.028
Malaria	35 (29.4)	47 (16.7)	2.1(1.3-3.4)	0.005	4.9 (1.7-14.8)	0.003

Table 2: Distribution and relative frequency of congenital heart defects by echocardiography with heart failure.

Types of HD	Number (n)	Percent (%)
VSD	14	27.5
PDA	9	17.6
Avcanal	7	13.7
PDA and PFO	3	5.9

PDA and ASD	1	1.96
VSD and PDA	4	7.84
TGA	3	5.9
Truncus arteriosus	3	5.9
Tapvr	3	5.9
Hypoplastic left heart syndrome	1	1.96
Double outlet RV	1	1.96
Single ventricle	1	1.96
Coactationof aorta	1	1.96
Total	51	100

Prevalence of heart failure in children

Of the four hundred children, a total of 29.8% (119) children had heart failure based on our operational definition of heart failure in children where by the presence of the following cardinal features and the first three are compulsory. These are tachypnea and tachycardia above the upper limit for age, tender hepatomegaly of at least 3 cm below right costal margin and displaced apex beat when it is displaced laterally beyond midclavicular line or 4th intercostal space in below 5 years old children and a lateral displacement below 5th intercostal space in children above 5 years with central trachea. Mostly of the children were aged below one year 58 (28.4%).

Etiological factors associated with heart failure

Among those with heart failure, 77 (64.7%) children had structural heart defects both congenital and acquired. Out of all patients with cardiac abnormalities 51 (71.4%) had of Congenital Heart Defects (CHD). Those with rheumatic heart disease were 18 (23%) and dilated cardiomyopathy were 8 (10.4%) Anemia accounted for 42 (35.3%) cases.

The leading congenital heart defect were ventriculoseptal defects in 14 patients (18%) followed by Patent Ductus Arteriosus (PDA) in 9 patients (11.7%) however PDA and VSD overlapped with other lesions such as Patent Foramen Ovale (PFO) and Atrioseptal Defect (ASD) lesions. Acquire heart disease were found in 26 patients 18 were RHD and 8 were diagnosed to have dilated cardiomyopathy.

Clinical staging

Among children with heart failure we identified 7 (5.9%) children with heart failure clinical stage II by modified Ross classification. Children who presented with clinical stage III were 91 (76.5%) and stage IV were 21 (17.6%).

Clinical presentations associated with heart failure in bivariate and multivariate analysis

Among the admitted children, presence of difficulty in breathing, easy fatigability, heart murmur and hepatomegaly was found to be significantly associated with heart failure in both univariate and multivariable analysis (OR=24.8, 95% CI 4.5-137, p<0.001), (OR=24.8, 95% CI 4.5-137, p<0.001), (OR=271 95% CI 25.6-2867 p<0.001) and (OR=3.5 95% CI 1.1-11.30, p 0.036) respectively.

Age above 60 months and distance to the referral hospital above 20 kilometer was associated with heart failure on univariate analysis but not in multivariable analysis (OR=1.8, 95% CI 1 1.01-3.28, p=0.047 and OR=1.8, 95% CI 1.2-2.8, p=0.006) respectively (Table 2).

Discussion

This cross sectional hospital based study was carried out in order to determine the prevalence and factors associated with heart failure among children admitted at Bugando medical center. Our study involved clinical assessment and clinical staging of heart failure and echocardiographic imaging for evaluation of heart failure to all children at the time of admission.

In this study, the prevalence of heart failure among admitted children was found to be 29.7% this is nearly 1/3 of all admissions and late hospital presentation. This prevalence is significantly higher than the prevalence reported in compare to other studies done in western part of African countries with prevalence of 12 to 17%. As a Zone hospital in the Northern zone of Tanzania, the hospital receive large number of patients attending at our hospital both from rural and urban to seek for advanced care where echoradiogram examination is only available and a key tool guide in diagnosis of cardiac conditions. Ventriculoseptal defect was the leading cause of congenital heart defects followed by patent ductus arteriosus and atrioventricular canal defect in relation to heart failure with

almost similar findings to the study done with other studies [19]. Our results of congenital heart disease has minor disparity from other study done in Tanzania on pattern of congenital heart disease in the lake zone where the ventriculoseptal was leading in the list (spectrum of heart disease in Mwanza, Tanzania by Antke Zuechner. Heart failure in Belgium was reported to be 10.4% and the incidence was more pronounced during the infancy in which 58% had heart failure as a primary diagnosis. The higher prevalence in our study may be attributed by the late detection and late referral to the hospital as most of the children presented with heart failure class III and IV. The difference may also be accredited by high prevalence of anemia in the lake zone around Mwanza Tanzania of about 28%. The late presentation of heart failure could be attributed by inadequacy of infrastructures and teaching programs at the lower facility levels where most of heart failure has been termed as recurrent pneumonia. Even in the settings with adequate means of diagnosis but still surgical intervention are not taking place where we need to refer again patients for operation in another setting where operations are done. The median age of children found to have heart failure was 13 months compared to 12 months in the study done in Kenya [20]. The male to female ratio in this study was 1.6:1 this finding is almost has similar to that of 1.4:1 which were reported by study done in Nigeria (pediatric heart failure among emergency room admissions in a Tertiary Health in Southern Nigeria 2020) our study findings correlate with the study done in India a study done 2009 showed more than 90% of heart failure occurred in infancy period and mainly were due to congenital heart defects. 48.7% with almost similar results in the study done in a single hospital in Nigeria where 52.3% of children with HF were aged 1 to 5 years and was 58.1% in Belgium 2008, this could be due to difference in study population as they excluded children below six weeks of age who are also at risk of getting heart failure. Also the advancement in technology in western world where fetal echocardiography can be done and treatment can be provided as soon as possible reduces the risks and comorbidities.

Clinical signs and symptoms which were associated with heart failure included difficulty in breathing, easy fatigability, tachycardia, tachypnea, hepatomegaly, presence of heart murmur or gallop rhythm similar to the previous results.

The incidence of 37% by Omokhodion, et al. and the trend is decreasing where by in 2010, rheumatic heart disease was around 3% possibly because of advancement in primary prevention and a solution to prevent complications and mortality from heart failure In this study among children with heart failure, 77 (64.7%) patients presented with structural heart defects and 42.8% children had congenital heart defects due to shunting of blood resulting into over flow within the lungs. Findings from recent study done in Nigerian reported that 83.3 % of children with CHD had congestive heart failure. Furthermore another study done in New Delhi India in 2009 showed of more than 90% of heart failure occurred in infants before the end of their first year of life and mainly due to congenital heart defects [21,22].

Severe anemia is the second most frequent underlying cause of heart failure affecting 35.3% of cases which is comparable to the findings in Nigeria 28%-48% [23,24].

The lower proportion in our study can be explained by the fact that our study population included all children 12 years and below. Nigerian study which was conducted in children above one month up to 16 years this may bring such discrepancy on the burden which is higher than the previous studies.

All children diagnosed to have Rheumatic heart disease were also found to have heart failure which is the common cause of heart failure in older children and it attributed to 4.5% of heart failure in this study. Other studies done in Kenya reported of about 14.6% prevalence of RHD as a common cause of heart failure in children apart from congenital heart diseases. In Nigeria, rheumatic heart disease had. The difference in results could be explained by the fact that other studies used retrospective study design with smaller sample size compare to ours study.

Our study demonstrated that, 2% of all children with heart failure were contributed by Dilated Cardiomyopathy (DCM). Our findings is significantly low compared with the results in Cameroon by Tantchou, et al. 2011 which reported that dilated cardiomyopathy contributed to about 25% of congestive heart failure in children.

In this study we found that, most of the children presented with heart failure clinical stages III and stage IV. Clinical stage IV was presented by 17.6% which is almost twice as compare to 9% which was found in Nigeria. Another study in Belgium reported 40% and 12% stage III and IV respectively. In Kenya also the study findings demonstrated that most of the children had advanced stage IV of heart failure by 97% though they were assessed by using New York heart association in 2011 by Oyungu, et al. and in Cameroon reported on late presentation to the hospital with advancement of the disease and they documented on 44% of the patients had clinical stage III and 7% where in stage IV in 2011 by New York heart association. These late presentation to the hospital are almost similar findings in many developing countries as a results of great chance of complications and poor prognosis outcome.

Most of the children presented to our hospital with advanced stages have congenital heart defects. Advancement of the disease is an emergency which need urgent intervention as most of these conditions has specific time for intervention either is medical or surgical delay to that can increases chances for serious morbidity and mortality. Additionally most of the children admitted at hospital were referred from lower health facilities. It is therefore important to perform thoroughly physical examination to ensure that those who are suspected to have risks of heart failure be referred to higher facilities for early diagnosis and treatment.

Conclusion

Heart failure was present in nearly 1/3 of all children admitted at BMC. Congenital heart defects were the leading cause of heart failure followed by severe anemia, rheumatic heart

disease and dilated cardiomyopathy. Common clinical presentations associated with heart failure in this study were difficulty in breathing, easy fatigability, presence of severe anemia, hepatomegaly and heart murmurs. Most of our children with heart failure presented with clinical stages III and IV.

Recommendations

From the results findings with high magnitude of heart failure in children due to congenital heart defects and other highlighted etiologies, we recommend a large community based study to be done in order to find the etiological magnitude of heart failure in children. Capacity building to the primary health care facilities for early recognition of signs and symptoms of heart failure for timely referrals and timely interventions. Neonatal echocardiogram screening is a corner stone to all neonates for early detection and management.

Limitation

All confounders of heart failure could not be investigated in children such as confounders of congestive heart failure such as severe anemia, metabolic causes, endocrine causes and infectious causes. This study was hospital based, done in a single hospital and therefore the results cannot be generalized.

Ethical approval and consent to participate

The study was approved by CUHAS/BMC research and publications committee. Permission to conduct a study was obtained from the Institution Review Board of the Catholic University of Health and Allied Sciences and Bugando medical center research ethical committee in Mwanza Tanzania with research clearance certificate: (CREC/101/2015). Permission to conduct a study was obtained from Bugando medical center. Furthermore, written informed consent was requested from parent/guardian/caregiver of the study participants.

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