

Aetiology and outcome of childhood heart failure in an emergency paediatric unit in North Central Nigeria

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Abstract

Background: Heart failure is a common consequence of both cardiac and non-cardiac disease contributing significantly to mortality amongst children.

Objective: The study aims to describe the burden of heart failure in an emergency paediatric unit (EPU), its causes and the outcome.

Methods: This is a retrospective review of admissions into the EPU over a 24-month period from May 2013 to April 2015. Children aged 1 month to 14 years who met the case definition for heart failure were recruited. Unit registers and hospital folders were reviewed, and data on age, sex, aetiology of heart failure, and outcome were extracted and recorded.

Results: Two hundred and ninety-one (12.5%, 95% confidence interval: 11.3–14.0) of the 2321 medical admissions over the study period had heart failure. Majority (75.6%) of the children were aged < 5 years and 164 (56.4%) were male. The common causes of heart failure were severe anaemia (66.7%), acute lower respiratory infections (21.3%), congenital disease (8.3%) and acquired heart disease (3.8%). The case fatality rate for heart failure was 5.8% (17 deaths) with majority (64.7%) of the deaths resulting from severe anaemia.

Conclusion: Heart failure is a common contributor to morbidity and mortality in this environment, and the causes are largely preventable. Aggressive management of these cases may result in an improved outcome.

Keywords: Children, emergency room, aetiology, heart failure, Nigeria

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INTRODUCTION

Congestive cardiac failure occurs when the heart cannot deliver adequate blood to meet the metabolic needs of the body.¹ This clinical syndrome is often accompanied by oedema, respiratory distress, growth failure and exercise intolerance, with attendant circulatory,

neurohormonal and molecular derangements.² It is a common complication of cardiac and non-cardiac disease resulting in significant morbidity and mortality amongst children.² Studies from Europe have documented that it is responsible for between 10 and 33% of admissions of children into emergency paediatric units (EPUs).²⁻⁴

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Studies from Nigeria have reported that it is responsible for between 2.7% and 15.5% of admissions into EPUs of tertiary hospitals.⁵⁻¹⁰

The aetiology varies widely between adults and children, and even amongst children, there are variations in the aetiology between developing and developed countries.^{2,8,11} Amongst children, infections/infestations predominate as causes of heart failure in developing countries as against primarily cardiac conditions such as cardiomyopathies and congenital heart diseases in developed countries.^{1,2,7,8,11} The most common causes of heart failure in Nigeria are non-cardiac conditions, such as severe anaemia, pneumonia, sepsis and asphyxia.⁶⁻⁸ Cardiac diseases such as congenital heart diseases, rheumatic heart disease and cardiomyopathies are less common as causes of heart failure in children.⁶⁻¹⁰ Lagunju and Omokhodion,⁸ Animasahun *et al.*⁷ and Otaigbe and Tabansi⁹ in three different studies documented pneumonia as the most common cause of childhood heart failure in Nigeria while Anah *et al.*,⁶ Adekanmbi *et al.*⁵ and Oyedeji *et al.*¹⁰ reported severe anaemia as the most common cause. Strategies to address the burden of heart failure would depend on the local patterns and aetiology of heart failure in different regions. Unlike in other zones of Nigeria, the aetiology of childhood heart failure in North Central Nigeria has not been described. Thus, this study aims to determine the burden of heart failure, its aetiology and outcome amongst children presenting at the EPU of a tertiary hospital in North Central Nigeria.

METHODS

The study was a retrospective study of children aged 1 month to 14 years admitted with heart failure. It was conducted at the EPU of the University of Ilorin Teaching Hospital located in North Central Nigeria. The hospital is a referral centre for paediatric cardiology services and receives referrals from the state and neighbouring states. The EPU is a 22-bedded unit manned by resident doctors and consultants who attend to all patients. It receives admissions of all emergencies in children aged 1 month to 14 years. We reviewed admission records of the EPU over a 2-year period from May 2013 to April 2015. Inclusion criteria were all children admitted with a diagnosis of heart failure. Children that presented more than once with heart failure over the study period had only the first visit recorded. All other visits were excluded from the study. Registers from the unit were examined to identify cases, and hospital records of identified patients with heart failure were retrieved to obtain other relevant information.

The diagnosis of heart failure was based on the criteria of the presence of at least three (that must include tender hepatomegaly) of the four cardinal features of heart failure in childhood listed below:^{8,12} Tender hepatomegaly (liver is at least 3 cm below the right costal margin and tender); tachypnoea (respiratory rate >50 breaths/min in children younger than 1 year, >40 breaths/min in children aged 1–5 years and >30 breaths/min in children older than 5 years); tachycardia (heart rate >160 beats/min in infancy, >140 beats/min in children aged 1–2 years, >120 beats/min in children aged 3–4 years and >100 beats/min in children 5 years and above) and cardiomegaly.^{8,12} Cardiomegaly was defined based on a clinical determination of displacement of the apex beat (beyond the fourth intercostal space, midclavicular line in children aged 4 years and below, and beyond the fifth left intercostal space, midclavicular in the older child) in the absence of tracheal deviation and/or an increased cardiothoracic ratio on a chest radiograph (cardiothoracic ratio >0.6 in infants and 0.5 in the older child).^{13,14} The aetiology of heart failure was determined from the clinical evaluation and investigations, including echocardiography, where required.

Data obtained from each patient included age, sex, symptoms at presentation, duration of illness, cause of heart failure, packed cell volume and outcome. Data were extracted, coded and entered into an excel sheet designed by the authors. Data analysis was performed using IBM SPSS Statistics for Windows, version 20.0 (IBM Corp, Armonk, NY, USA) software. Median, range and interquartile ranges were used to describe quantitative data, such as age. Frequencies and proportions were used to describe relevant categorical data. Tables were used to depict a summary of several variables. Chi-square and Student's *t*-tests were used to identify significant differences for categorical and continuous variables, respectively. The 95% confidence intervals (95% CI) for selected variables were presented. $P < 0.05$ was considered as statistically significant.

RESULTS

A total number of 2321 children aged 29 days to 14 years were admitted as medical emergencies over the 24-month study period. Of these, 291 children had heart failure making up 12.5% (95% confidence interval 11.3–14.0) of all admissions over the period. There were 164 males (56.4%) with a male-to-female ratio of 1.3:1. Majority of the children were aged between 1 and 5 years [Table 1]. The median age of the children was 2.0 years with a range of 1 month to 14 years. The 25th and 75th quartiles were 0.8 and 4.1 years, respectively. The age and sex distribution of the children with heart failure is as shown in Table 1.

The causes of heart failure were severe anaemia, acute lower respiratory infections (ALRIs) and structural heart disease in 194 (66.7%), 62 (21.3%) and 35 (12.0%) patients, respectively. The causes of heart failure are summarised in Table 2.

Severe anaemia resulted from severe malaria in 111 patients (57.2%), from sepsis in 64 children (33.0%), from sickle cell anaemia in 14 cases (7.2%), 3 cases (1.5%) were due to glucose-6-phosphate dehydrogenase deficiency and 2 (1.0%) from acute lymphoblastic leukaemia. Ventricular septal defect was the most frequent structural heart disease causing heart failure in 15 (5.2%) children. Others are shown in Table 2.

The packed cell volume (PCV) of the children with heart failure (27 children had missing records of PCV at admission) ranged between 5% and 41% with a mean \pm standard deviation (SD) of 16.46% \pm 8.03%. The mean \pm SD PCV of children with severe anaemia was significantly lower at 11.49% \pm 2.81% compared to the other causes of heart failure (F test = 265.33; P = 0.000) [Table 3]. The box plot [Figure 1] shows that PCV was similar amongst the children with heart failure caused by pneumonia, congenital heart disease, rheumatic heart disease and dilated cardiomyopathy.

Table 1: Age and sex distribution of children with heart failure

Age groups	Male	Female	Total (%)
29 days to <12 months	55	38	93 (32.0)
1-4 years	72	55	127 (43.6)
5-9 years	26	25	51 (17.5)
10-14 years	11	9	20 (6.9)
Total (%)	164 (56.4)	127 (43.6)	291 (100.0)

Table 2: Causes of heart failure

Cause	Frequency (%)
Severe anaemia	194 (66.7)
ALRI (without structural heart disease)	62 (21.3)
Ventricular septal defect	15 (5.2)
Atrioventricular septal defect	6 (2.1)
Rheumatic heart disease	7 (2.4)
Dilated cardiomyopathy	4 (1.4)
Patent ductus arteriosus	3 (1.0)

ALRI: Acute lower respiratory infection

Table 3: Packed cell volume distribution across the various causes of heart failure

Cause	Number recruited (%)	Number analysed (%)	PCV, mean \pm SD
Severe anaemia	194 (66.7)	180 (67.4)	11.49 \pm 2.81
ALRI (without structural heart disease)	62 (21.3)	56 (21.0)	26.07 \pm 4.95
Congenital heart disease	24 (8.2)	21 (7.9)	27.24 \pm 4.07
Rheumatic heart disease	7 (2.4)	6 (2.2)	29.83 \pm 7.41
Dilated cardiomyopathy	4 (1.4)	4 (1.5)	29.00 \pm 3.16
Total	291 (100.0)	267 (100.0)	
F -test			265.33
P			<0.001

ALRI: Acute lower respiratory infection, SD: Standard deviation, PCV: Packed cell volume

Over the study period, there were 223 (9.6%) deaths amongst the 2321 medical admissions into the EPU, while amongst the 291 children with heart failure, there were 17 deaths with a case fatality rate of 5.8%. Thus, mortality amongst children with heart failure contributed 7.6% of total medical mortality recorded in the unit. The causes of heart failure amongst the children who died were severe anaemia in 11 cases (64.7%) and ALRI in 6 cases (35.3%). The mean \pm SD age of the children who died was 2.51 \pm 2.42 years compared to 3.14 \pm 3.23 years amongst the children who survived; however, this difference was not statistically significant (P = 0.427) [Table 4]. There was no significant difference in the gender distribution, aetiology of heart failure and mean \pm SD PCV between the children who died and those who survived (all P > 0.05).

DISCUSSION

Heart failure is a common complication of childhood illness in this environment being present in approximately 13 of every 100 medical admissions into the EPU. This is similar to the findings by Oyediji *et al.*,¹⁰ who reported

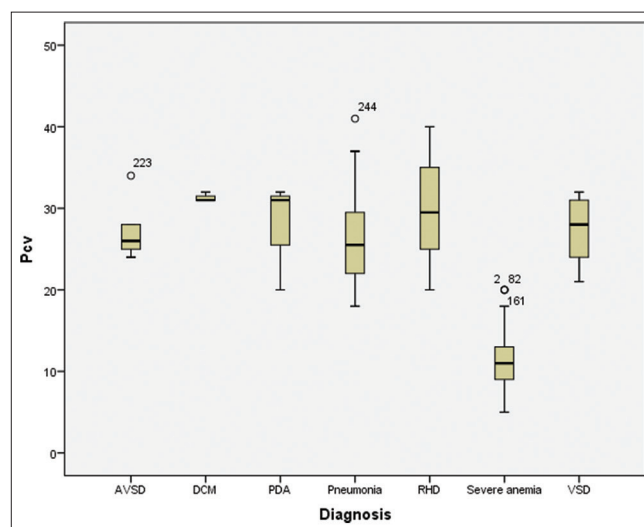


Figure 1: Box plot showing packed cell volume distribution across the various causes of heart failure. PCV: Packed cell volume, AVSD: Atrioventricular septal defect, DCM: Dilated cardiomyopathy, PDA: Patent ductus arteriosus, RHD: Rheumatic heart disease, VSD: Ventricular septal defect

Table 4: Sociodemographic and clinical characteristics of participants against mortality/survival

Characteristics	Total	Dead (n=17)	Alive (n=274)	t-test	P
Age (years), mean±SD	291	2.51±2.42	3.14±3.23	0.795	0.427
Gender					
Male	164	11	153	0.512	0.474
Female	127	6	121		
Cause of heart failure					
Severe anaemia	194	11	183	2.060	0.357
Pneumonia	62	6	56		
Structural heart disease	35	0	35		
PCV* (%), mean±SD	267	14.63±6.51	16.58±8.12	0.943	0.347

*Excluded 24 patients with missing records of PCV on admission.
SD: Standard deviation, PCV: Packed cell volume

heart failure in 9.0% of admissions into the EPU. The team of Anah *et al.*,⁶ in an older study in Calabar, reported a slightly higher proportion of 15.5% amongst children emergencies while Lagunju and Omokhodion⁸ in Ibadan reported a prevalence of 5.8% in 2003. Thus, there is not much variation in the burden of heart failure across various children emergencies in Nigeria. The much lower report of 5.8% by Lagunju and Omokhodion may be explained by the additional recruitment of patients from the neonatal units and non-emergency paediatric admissions, thus increasing the denominator.⁸

The most common causes of cardiac failure in developing countries, such as Nigeria, are non-cardiac.⁶⁻⁹ The findings of this study support that assertion. Severe anaemia (usually from malaria) and ALRI were responsible for 88% of heart failure in this study. Lagunju and Omokhodion,⁸ Anah *et al.*,⁶ Oyedeji *et al.*¹⁰ and Duru *et al.*¹⁵ reported similar findings with the combination of severe anaemia and ALRIs being responsible for 64.0%, 90.6%, 94.3% and 80.6% of cases of paediatric heart failure, respectively. In this study, severe anaemia (66.7%) was more common as a cause of heart failure compared to ALRIs (21.3%) similar to reports from several centres in Nigeria.^{5,6,10} On the other hand, Lagunju and Omokhodion in Ibadan and Otaigbe and Tabansi in Port Harcourt reported ALRIs as more common than severe anaemia in the aetiology of heart failure.^{8,9} This may reflect differing epidemiology of severe malaria which was the most common cause of severe anaemia in all the Nigerian studies on childhood heart failure. While recent data show declining incidence of severe malaria globally, acute respiratory infections have assumed the leading position as the most common cause of under-five mortality beyond the neonatal period.¹⁶ Heart failure is the most common non-respiratory complication of ALRI and often results from a combination of pulmonary hypertension, hypoxia, myocardial dysfunction and myocarditis.^{17,18} When present in a child with ALRI, heart failure has been shown to worsen prognosis.¹⁹

The most common congenital heart disease causing cardiac failure was ventricular septal defect present in 15 cases (5.2%). Most authors in Nigeria have reported similar findings with ventricular septal defects, in isolation or combination with other defects, being the most frequent form of congenital heart disease associated with heart failure.^{5,7-9} Rheumatic heart disease was the most common acquired heart disease causing heart failure. It is a disease of poverty, overcrowding and infection predominant in developing countries where the predisposing factors abound.²⁰ Most studies on childhood heart failure in Nigeria report rheumatic heart disease as the most common acquired heart disease causing heart failure.^{8,15} These findings contrast with studies from the developed world where the cardiomyopathies are a more frequent acquired cause of heart failure, largely because rheumatic heart disease is unusual in those settings.^{2,3,11}

The case fatality rate amongst children with heart failure was 5.8% with children presenting with heart failure accounting for 7.6% of the overall medical mortality of the unit. The recorded case fatality rate is slightly lower than 8.6% recorded by Oyedeji *et al.* in Osogbo,¹⁰ 11.1% reported by Anah *et al.* in Calabar⁶ and 21.5% found by Duru *et al.* in Bayelsa.¹⁵ Death was most commonly associated with severe malaria and ALRI in this study. Severe anaemia complicating malaria often has a better prognosis than complications such as cerebral malaria.²¹ Urgent transfusion of red cells to increase oxygen carrying capacity of blood is a time-critical intervention for such children that reduces mortality rates drastically.²¹ PCV, age and gender were similar between the children who died and those who survived. One of the factors that has been implicated in heart failure associated death is severity, which was not examined for in this study.¹⁵ A previous study from the study site reported a case fatality rate of 8.5% amongst children with pneumonia, and in that study, hypoxaemia, which is contributory to heart failure, was associated with a several-fold increase in the risk of death.²² Presumably, appropriate and early antibiotic therapy, judicious use of oxygen, management of heart failure and respiratory support will reduce pneumonia-related mortality.²³ Thus, aggressive management of these conditions in the emergency unit may reduce the relatively high mortality rate associated with heart failure in paediatric practice in the tropics.

CONCLUSION

Heart failure in childhood is a major cause of morbidity and mortality, present in 11.3% of paediatric admissions. The causes in this environment are largely preventable.

Aggressive measures to address the burden of infections/infestations, such as ALRI, malaria and sepsis should result in dramatic reduction in burden and deaths from heart failure.

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Conflicts of interest

There are no conflicts of interest

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