



Epidemiology of Heart Failure in a children up to five years of age in the Pediatric Intensive Care Unit of Tertiary Care Hospital of North India

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Abstract

Background: *In contrast to the adult age group, epidemiologic studies on heart failure (HF) in the pediatric population are lacking. This prospective study aimed to analyze the epidemiology of HF during infancy and childhood.*

Patients and Methods: *This prospective study was conducted on all the consecutive patients up to 5 years of age admitted with the diagnosis of HF in Pediatric Intensive Care Unit of our Pediatric hospital between January 2016 and January 2018.*

Results: *Out of the 2000 children admitted to the Pediatric Intensive care unit 192 patients (9.6%) had HF. The subjects' age ranged from 1 month to 5 years. 112 were males and 80 females with M:F ratio 1.4:1. Out of 192 patients, 116 (60.4%) patients were less than one year of age. The common causes of HF were Congenital Heart Diseases (CHD) (60.4%), and Cardiomyopathies (15.1%). Other less common causes were sepsis (9.3%), severe anemia (6.7%), pulmonary hypertension and myocarditis each comprising (3.1%). Of the cardiac causes ventricular septal defect was the commonest 39.6%.*

Conclusion: *Heart failure is important cause of admission in pediatric intensive care unit. Structural heart disease is leading cause of HF in the children aged up to 5 years.*

Keywords: *Heart failure, Congenital heart diseases, Cardiomyopathies, Ventricular septal defect.*

Introduction

Heart failure occurs when the heart cannot deliver adequate cardiac output to meet the metabolic needs of the body. In the early stages of heart failure, various compensatory mechanisms are evoked to maintain normal metabolic function⁽¹⁾. The clinical syndrome of heart failure is a final common pathway of most forms of cardiovascular disease⁽²⁾. It is a common cause of morbidity and

mortality in Pediatric emergency⁽³⁾. Between 0.5% and 10% of pediatric emergency room admissions are cardiac, with Heart Failure [HF] being one of the most common cardiac emergencies⁽⁴⁾. HF is responsible for one-third of the referrals of children with Congenital Heart Diseases (CHD) to the cardiology clinic in infancy⁽⁵⁾. Several studies have reported the prevalence of HF to vary between 3% and 9%^(3,6-9). Thus, it is a pediatric

emergency that must be anticipated and excluded in every acutely ill child⁽⁸⁾.

The causes of heart failure in children differ significantly from those in adults^[10,11]. It varies between developed and developing countries and among the various age-groups that constitutes childhood. In developed countries, the leading causes of heart failure in children are congenital heart diseases (CHD) and cardiomyopathy^[12] whereas among the developing countries infectious diseases constitute the leading underlying causes^[6,8,13]. These infectious diseases like acute lower respiratory tract infection (ALRTI), severe anaemia and sepsis broadly belong to the non-cardiac causes of heart failure^[10].

HF is a cardiac emergency. Identifying the cause in children in an area with very few cardiac centres is an important first step in determining the outcome. To the best of the knowledge, no documented work has been done in Kashmir. Hence this study was designed to determine the clinical profile and aetiology of congestive heart failure among children admitted into the Paediatric Intensive care unit (PICU) of our Pediatric hospital.

Patients and Methods

All the patients aged 1 month to 5 years admitted to the PICU over two years (January 2016 – January 2018) were evaluated for heart failure and were consecutively recruited into the study. Heart failure was diagnosed by the simultaneous presence of at least 3 of the following criteria, with number 1 being inclusive:

1. Tender hepatomegaly, with the liver edge palpable at least 3 cm below the right costal margin along the midclavicular line⁽⁴⁾
2. Significant tachycardia: defined as a resting heart rate greater than the upper limit of normal for age; i.e., greater than 160 beats/minute in infancy, 140 beats/minute at 2 years, 120 beats/min at 5 years. In the patients with fever, an allowance of 10 beats/minute was made for every

degree centigrade rise in above-normal temperature⁽⁴⁾.

3. Tachypnea: defined as a resting respiratory rate above normal for age⁽⁴⁾.

4. Cardiomegaly: defined as a cardiothoracic ratio greater than 60% in the first five years of life⁽⁴⁾.

The clinical state was defined as New York Heart Association (NYHA) functional classes II-IV.^[14] Simple extrapolation of the NYHA scale to infants is not possible, so the 4-class scoring system of Ross et al.^[15] was used in that age-group.

In children between 1 month and 5 years of age admitted with a clinical diagnosis of CHF, detailed history, general, and systemic examination was done. X-ray chest, electrocardiogram (ECG), and echocardiogram (ECHO) were taken. And investigation to ascertain the other etiologies such as complete blood count, peripheral smear, haemoglobin (Hb) electrophoresis, bone marrow aspiration, and renal function tests were done.

Enzyme assays were performed in suspected metabolic causes causing cardiac failure.

Statistical analysis: Data were entered and analyzed using Excel for Windows software (Microsoft Corporation, Redmond, Wash., USA). Data were analyzed using simple descriptive statistics.

Results

A total number of children less than five year of age admitted in the Pediatric Intensive Care Unit during our study period were 2000. Among them, 192 were admitted with cardiac failure. It constituted 9.6% of the total admissions. Males admitted with CCF were 112 and females 80 making 58.4% and 41.6%, respectively. The male to female ratio is 1.4:1

In our study, the majority of the children admitted with cardiac failure were below 1 year of age (60.4%, n = 116). 17.7 % (n = 34) were between 1 and 2 years of age, 9.8% (n = 19) between 2 and 3 years of age, 8.3% (n = 16) between 3 and 4 years of age, 3.6% (n = 7) were 4 to 5 years old [Table 1]. Around 80.7% (n = 155) of the cardiac failure

cases were due to cardiac etiologies whereas non cardiac causes constituted the remaining 19.27% (n = 37).

CHDs contributed 60.4% (n = 116) of the heart failure cases due to cardiac aetiology. The next common cardiac causes were Cardiomyopathies making 15.33% (n = 29) .The proportion of cases due sepsis, anemia, pulmonary hypertension, myocarditis and miscellaneous causes were 9.3%, 6.77, 3.1%, 3.1% and 2.08% respectively [Table 2].

Among the various congenital cardiac diseases causing cardiac failure, acyanotic CHD comprised 74% (n=86) whereas cyanotic CHD comprised 26 % (n=30). Overall the ventricular septal defect (VSD) was the most common CHD making 39.65% (n = 46). Among the cyanotic CHD, the most common CHD was DORV with VSD 8.64% (n=10). Cardiomyopathies were the second commonest cause of CCF occurring in 29 children [15%]. Dilated cardiomyopathy was commonest occurring in 21 children [72.4%], Hypertrophic cardiomyopathy occurred in 5 [17.24%], Tachycardiomyopathy in 2 and Restrictive cardiomyopathy in 1 patient [Table3a,3b].

Table 1: Age distribution

| Age [yr] | N=192 | Percentage % |
|----------------|-------|--------------|
| 1 month-1 year | 116 | 60.4% |
| 1-2 | 34 | 17.7% |
| 2-3 | 19 | 9.8% |
| 3-4 | 16 | 8.3% |
| 4-5 | 7 | 3.6% |

Table 2: Etiology of cardiac failure

| Cause | N=192 | Percentage% |
|--------------------------|-------|-------------|
| Congenital heart disease | 116 | 60.4% |
| Cardiomyopathy | 29 | 15.1% |
| Sepsis | 18 | 9.3% |
| Anaemia | 13 | 6.77% |
| Pulmonary hypertension | 6 | 3.1% |
| Myocarditis | 6 | 3.1% |
| Miscellaneous | 4 | 2.08% |

Table 3a: Distribution of congenital heart disease (n=116)

| Acyanotic CHD | N=86 | Percentage% |
|---|------|-------------|
| Ventricular septal defect[VSD] | 46 | 39.65% |
| Atrioventricular septal defect[AVSD] | 14 | 7.75% |
| Patent ductus arteriosus[PDA] | 4 | 3.35% |
| Combined shunt lesions[VSD+ASD/VSD+PDA] | 10 | 8.6% |
| Severe left ventricular outflow obstruction[COA, severe AS] | 10 | 8.6% |
| Mitral and aortic regurgitation | 2 | 1.72% |
| Cyanotic CHD | N=30 | |
| DORV +VSD | 10 | 8.62% |
| Transposition of great arteries +VSD | 9 | 7.7% |
| Total anomalous pulmonary venous connection | 4 | 3.44% |
| Tricuspid atresia +VSD | 3 | 2.48% |
| Single ventricle with pulmonary arterial hypertension | 1 | 0.86% |
| Tetralogy of Fallot | 1 | 0.86% |
| Ebstein anomaly | 1 | 0.86% |

Table 3b: Distribution of Cardiomyopathies

| Cardiomyopathy | N=29 | percentage% |
|-----------------------------|------|-------------|
| Dilated Cardiomyopathy | 21 | 72.4% |
| Hypertrophic Cardiomyopathy | 5 | 17.24% |
| Tachycardiomyopathy | 2 | 6.89% |
| Restrictive cardiomyopathy | 1 | 3.44% |

Discussion

In our study, the incidence of heart failure in children up to five years of age was 9.6% of the total admission of children of the same age. Our result is comparable to the study by Massin et al.^[16] which was a prospective study of 1196 children over 10 years, reported heart failure in 124 children (10.4%) with congenital and acquired heart diseases. 5.8% of total pediatric admissions in Lagunju and Omokhodion's study of Ibadan study^[7] is due to HF. The prevalence rate of HF in Adekanmbi et al.'s^[6] study is 7.02%. In our study, among the total children admitted with cardiac failure the male to female ratio is 1.4:1. The prevalence was higher among males than females in Rashid et al.'s^[17] study. In the study by Lagunju and Omokhodion,^[7] the male to female ratio is 1.2:1.

The prevalence of HF is higher in children under 1 year of age in our study. 60.4% of the total admissions due to cardiac failure are between 1 month and 1 year of age. Keith et al^[18] reported that 90% of failure due to CHD occurred in the first year of life. Keith in 1956 pointed out that if a patient of CHD does not develop failure within the first year of life, he is not likely to develop so in the next 10 years unless complicated by anaemia, infection or infective endocarditis. In Krithiga et al^[19] 52.7% of the children with HF fall under 1 year of age. In Laguna et al.'s study,^[7] 54% of admissions due to HF is between 1 month and 1 year of age.

Cardiac causes constitute 80.7% of all admissions due to cardiac failure and noncardiac causes form 19.27%. Our result is in agreement with studies by Rashid et al.^[17] and Krithiga et al^[19] study in which cardiac causes were 84 %, 92.7% and noncardiac causes were 16% and 7.4% respectively. Our result is in contrary to various studies in underdeveloped countries of Africa^[6-9] were non-cardiac conditions like pneumonia and anaemia cause more heart failure than structural heart disease. Significant reduction of infectious disease, early diagnosis and treatment of common childhood infections at the primary health care unit could explain the absence of infectious etiologies as a cause of heart failure in our study. Furthermore, factors causing severe anaemia in early childhood like malaria, hemoglobinopathies are less prevalent in our geographical area.

Among the cardiac causes, the structural heart diseases were present in the majority of children 60.4% n=116 followed by cardiomyopathies. In a study by Webster G. et al^[20] congenital heart disease accounted for 61% of cases, and 82% of cases of heart failure in infants. Among the structural heart defect, ventricular septal defect constitutes the major cause for CCF [39.65%]. Rashid et al.^[17] and Krithiga et al^[19] reported that 44% and 33.5% of the CHD cases causing CCF in their study were due to VSD. Among the cyanotic CHD, the most common cause of heart failure was DORV with VSD occurring in 8.62% (n=10)

followed by Transposition of great vessels with large VSD in 7.75% (n=9). In a study by Krithiga et al^[19] the most common cyanotic CHD was TGA with VSD. In Laganju et al.^[7] study, among the 25 CHDs as the cause of CCF, there was 4 Transposition of great vessels forming 16%. Tetralogy of Fallot being commonest cyanotic CHD, it is less often complicated by heart failure. In our study only one patient with TOF had failure. Patient was 3 year old child and presented with severe iron deficiency anemia. Valvular regurgitation was seen in two patients. Both of them were case of mucopolysaccharidosis and presented with pneumonia and severe mitral regurgitation.

The second most common cause of CCF in children was cardiomyopathy comprising 15.1%. Dilated cardiomyopathy was commonest seen in 21 patients [72.4%]. Hypertrophic cardiomyopathy occurred in 5 patients [17.24%]. Arrhythmia induced heart failure in 2 [6.89%]. Both of the patients were less than one year. One had refractory atrial ectopic tachycardia and other child had short RP interval paroxysmal supraventricular tachycardia Restrictive cardiomyopathy was seen in only 1 patient. Primary Cardiomyopathies are the principal cause of heart failure signs and symptoms in children with a structurally normal heart^[21,22]. Dilated cardiomyopathy caused heart failure in 90% whereas Hypertrophic cardiomyopathy only in 7.5%^[22].

Sepsis leading to myocardial dysfunction and heart failure occurred in 9.3% (n=18). Sepsis-induced myocardial dysfunction occurs in 53% of patients with sepsis in paediatric intensive care unit^[23]. Furthermore, the incidence of sepsis in sick children is 23%^[24]. Significant number of children are prone to sepsis induced heart failure. Fluid management is very critical in these children as fluid overload often leads to heart failure in compromised myocardium.

All 13 anaemia cases had haemoglobin of less than 6 g/dl and all had cardiomegaly. Commonest cause was microcytic hypochromic anaemia.

Anaemia constitutes 6.77% of total admissions due to CCF in our study. In Adekanmbi et al.'s study,^[6] anaemia is the most common cause of CCF, anaemia alone constituting 46%. Lagunju and Omokhodion^[7] report 28% of CCF is due to anaemia in their study. Lower incidence of anaemia is due to less prevalence of malaria, haemoglobinopathies which cause severe anaemia in this age group.

Pulmonary arterial hypertension with right heart failure occurred in 6 patients. Majority of them had thiamine-responsive pulmonary hypertension. Study by Javaid et al^[25] had documented Shoshin beriberi in breastfed infants in Kashmir.

Six cases of myocarditis got admitted with CCF in this study. It forms 3.1% of the cardiac causes of CCF in this study. Myocarditis constituted 1% of CCF cases in the study by Adekanmbi et al.^[6] Acute viral myocarditis formed the overall common aetiology of CCF in Rashid et al.^[17] constituting 53% of cases between 1 and 5 years age group.

The miscellaneous cause was seen in 4 patients of the 2 renal failure. Chronic renal failure is the cause of 1% and 3% of CCF cases in Adekanmbi et al.^[6] and Lagunju and Omokhodion,^[7] respectively.

Conclusions

In this study, we identified the aetiology of heart failure in children up to the age of five years. Structural heart disease was most common followed by Cardiomyopathies. Our result is in contrary to results from other developing countries where infectious causes are more common. Our findings call for robust community-based studies to document the true burden of CHD and heart failure. It stresses the need for dedicated paediatric cardiac surgical setup in our community. The significant number of children had Cardiomyopathy. This can be due to the high rate of consanguineous marriage in our area and hence increased incidence of metabolic and genetic disorders. It is important to mention that rheumatic heart disease constituted an important

cause of heart failure in many studies however none of any patient in our study had a rheumatic valvular lesion. There are early diagnosis and extensive antibiotic use for sore throat in our area.

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