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Original Research Article

Outcomes of pediatrics cardiac patients in the PICU: an analysis of clinical and echocardiographic risk factors

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ABSTRACT

Background: Cardiovascular diseases in pediatric patients present significant challenges in Pediatric Intensive Care Units (PICUs), with adverse outcomes influenced by factors such as ventricular dysfunction, sepsis and delayed intervention. Echocardiography plays a vital role in assessing cardiac function, identifying risk factors and guiding treatment. This study aims to analyze the clinical and echocardiographic profiles of pediatric cardiac patients admitted to the PICU and identify critical mortality risk factors to improve care and outcomes.
Methods: A prospective observational study was conducted over 18 months from November 2022 to April 2024 in a tertiary care hospital in Srinagar. The study included 103 pediatric patients aged 1 month to 18 years with congenital or acquired heart diseases. Data collected included demographics, clinical presentations, echocardiographic findings, laboratory results and outcomes. Statistical analysis was performed using SPSS 25, with $p<0.05$ considered significant.
Results: The cohort comprised 48 males (46.6%) and 55 females (53.4%), predominantly aged 1 month to 5 years. Ventricular Septal Defect (VSD) was the most common cardiac anomaly (18%), followed by Tetralogy of Fallot (4.8%). Respiratory distress (65.5%) and bronchopneumonia (30%) were prevalent comorbidities. Significant mortality risk factors included infant age, cyanosis (50% mortality), congestive heart failure (52.3%), deranged kidney function tests, altered pH and prolonged mechanical ventilation.
Conclusions: Early diagnosis and timely interventions targeting high-risk groups are critical to improving survival. Identifying key echocardiographic profiles and clinical risk factors provides insights for optimizing PICU care for pediatric cardiac patients.

Keywords: Echocardiographic findings, PICU mortality, Pediatrics cardiac disease, Risk factors

INTRODUCTION

Cardiovascular diseases in pediatric patients pose significant challenges in critical care settings, particularly within pediatric intensive care units (PICUs). The integration of clinical and echocardiographic profiles is essential for assessing the severity of these conditions and predicting outcomes.[1] Cardiac patients in PICUs face elevated risks of adverse outcomes due to factors like ventricular dysfunction, cardiac arrest, sepsis, multi-organ dysfunction syndrome (MODS) and delayed diagnosis or treatment. Echocardiography is vital in evaluating cardiac function, identifying risk factors and guiding treatment strategies.[2,3] Despite medical advancements, CHD continues to be a leading cause of infant and child mortality. This study assesses clinical and echocardiographic data to analyze critical risk factors and prognostic indicators. By focusing on clinical-echocardiographic profiling, this study aims to analyze the clinical-echocardiographic profiles and associated mortality risk factors in cardiac patients admitted to the PICU.

METHODS

Study type

This prospective observational study.

Study place

The study was conducted in the Pediatrics ICU, Department of Pediatrics at Government Medical College, a tertiary care center in Srinagar.

Study duration

The study was conducted over 18 months from November 2022 to April 2024.

Sample size

This study enrolled 103 pediatric patients with heart diseases who were admitted to the PICU during the study period.

Inclusion criteria

Patients eligible for inclusion were aged 1 month to 18 years and had either congenital or acquired cardiac abnormalities.

Exclusion criteria

All patients were enrolled after informed consent from their parents, while those under 1 month or without parental consent were excluded.

Data collection

Comprehensive data collection encompassed demographics, clinical details, Echocardiographic findings, laboratory results and outcomes.

Statistical analysis

Data were stored in Microsoft Excel and analyzed using SPSS 25, employing descriptive and inferential statistics. Tests included χ^2 for qualitative data, t tests and Mann-Whitney U-tests for quantitative data, with a significance level of $p<0.05$. Normality was assessed using the Kolmogorov-Smirnov test. The study aimed to identify critical associations between patient characteristics and outcomes to enhance care quality in PICU settings.

RESULTS

This prospective observational study, conducted over 18 months, included 103 patients with congenital or acquired heart disease admitted to the pediatric intensive care unit (PICU).

Baseline characteristics

As summarized in Table 1, The cohort comprised 48 males (46.6%) and 55 females (53.4%). The majority (88.3%) of patients were aged between 1 month and 5 years and 11.7% were more than 5 years of age. The mean age of the participants was 2.8±3.6 years, ranging from 5 days to 12 years. Of the patients, 18.9% were preterm, while 81.1% were term-born. Most patients (76%) were from rural areas.

Clinico echocardiographic findings

The most prevalent cardiac abnormality identified through echocardiography was Ventricular Septal Defect (VSD), which was observed in 18% of cases, followed by combined defects such as ASD+VSD (7.7%) and Tetralogy of Fallot (4.8%). In addition, acquired cardiac disorders like dilated cardiomyopathy and acute viral myocarditis were observed in (7.77% and 4.85%) cases respectively (Table 2).

The most common presenting symptoms were respiratory distress (65.5%), failure to thrive (53.4%) and feeding difficulties (46.6%). Cyanosis was reported in 41.4%, while 36.2% exhibited lethargy and 27.6% presented with shock. Other symptoms included fever (25.9%), seizures (10.3%) and peripheral edema (8.6%).

In this study bronchopneumonia emerged as the most common comorbidity, affecting approximately 30% of patients, followed by shock at 15.5% and severe malnutrition (10.3%). Additionally, 8.6% of patients had neurological complications and 6.9% had endocrine disorders such as hypothyroidism or adrenal insufficiency (Table 3).

Hemodynamic profiles showed that 58.6% had pulmonary hypertension, with severe cases constituting 18.9%. Left ventricular dysfunction was identified in 34.5% of patients, of which 12.1% had severe dysfunction. Additionally, 27.6% exhibited signs of heart failure.

Mortality risk factors

The study revealed significant associations between patient outcomes and various factors in the PICU. Mortality was highest in infants (1 month to 1 year), comprising 79.5% of deaths ($p<0.05$). Cyanosis was also associated with higher mortality, with 50% of patients with cyanosis dying ($p<0.01$). Patients with Congestive Heart Failure (CHF) had a mortality rate of 52.3% ($p<0.02$), while all patients with deranged Kidney Function Tests (KFT) died ($p<0.001$).

Deranged pH levels were linked to a higher mortality rate of 56.8% ($p<0.001$). Mechanical ventilation duration was associated with poor outcomes, especially those receiving less than 24 hours of ventilation ($p<0.001$). The duration

of PICU stay also impacted survival, with 76.3% survival in the 1–7 days group (p<0.001). Advancing age and shorter PICU stays were correlated with improved survival rates.

Table 1: Demographic details of study population.

	Frequency	%
Gender		
Male	48	46.6
Female	55	53.4
Age group		
1 month to year	68	66.0
1 year to 5 years	23	22.3
More than 5 years	12	11.7
Gestation		
Term	47	81.1
Preterm	11	18.9
Residence		
Rural	44	76
Urban	14	24

Table 2: Echo-cardiographic findings.

Structural heart disease	N	%
Ventricular septal defect	19	18
ASD+VSD	8	7.7
VSD+PDA	7	6.7
Atrioventricular canal defect	6	5.8
ASD	6	5.8
PDA	6	5.8
Tetralogy of fallot	5	4.8
Acquired heart disease		
Dilated cardiomyopathy	8	7.77
Acute viral myocarditis	5	4.85
Kawasaki disease with coronary ectasia	4	3.88
Restrictive cardiomyopathy	1	0.94
Rheumatic heart disease with Mitral regurgitation	1	0.94

Table 3: Associated co-morbidities.

Associated comorbidities	N	%
Bronchopneumonia	30	29.1
Shock	16	15.5
Severe malnutrition	6	10.3
Septic enteritis	2	1.9
Bronchopneumonia with AKI	4	3.8

Table 4: Risk factors associated with mortality.

Parameters	Expired N (%)	Survived N (%)	P value
Gender			
Male	20 (45.5)	28 (47.50)	0.84
Female	24 (54.50)	31 (52.50)	
Age group			
1 month-1 year	35 (79.5)	33 (55.2)	<0.05
1 year-5 years	6 (13.6)	17 (28.6)	
>5 years	3 (6.8)	9 (15.2)	

Continued.

Parameters	Expired N (%)	Survived N (%)	P value
Cyanosis			
Present	22 (50)	15 (25.4)	0.01
Absent	22 (50)	44 (74.6)	
Congestive-cardiac failure			
Yes	23 (52)	17 (28.8)	0.02
No	21 (47)	42 (71.18)	
Mechanical ventilator			
No	8 (12)	55 (88)	0.001
<24hrs	12 (63)	7 (37)	
>24hrs	17 (80)	4 (20)	
PICU stay			
<24 hrs	22 (50)	1 (1.70)	
1-7 days	15 (34.10)	45 (76.30)	0.001
7-14 days	5 (11.4)	11 (18.60)	
>14 days	2 (4.5)	2 (3.40)	

DISCUSSION

Our study evaluated echocardiography (ECHO) profiles of the pediatric patients admitted to PICU and the risk factors associated with mortality in cardiac patients admitted to PICU. The study cohort comprised 103 patients, spanning from 1 month to 18 years old, presenting with congenital or acquired cardiac anomalies. Our study population was predominantly female (53.4%), with most patients aged between 1 month and 5 years, which aligns with studies conducted by Amro et al and Khan et al.[4,5]

Our study highlights Ventricular Septal Defect (VSD) as the most common cardiac anomaly (18%), consistent with findings from Thomford et al and Seifu et al.[6,7] who also identified VSD as one of the most prevalent congenital heart defects (CHD). Interestingly, Tetralogy of Fallot (TOF) was identified as the most common complex congenital defect in other studies, such as those by Thomford et al.[6] and Gundogdu et al.[8] However, our study found a lower prevalence of TOF, which could be attributed to regional differences or a sample size focused primarily on less complex congenital heart diseases.

Bronchopneumonia and respiratory distress were the most common comorbidities in our cohort, as was the case in Seifu et al and Dey et al.[7,9] where infections like pneumonia were found to be the leading causes of admission and mortality. Respiratory complications in our study occurred in 65.5% of patients, emphasizing the significant burden of respiratory issues in critically ill cardiac patients. These symptoms align with those typically seen in patients with left-to-right shunt defects or increased pulmonary blood flow, conditions that frequently lead to cardiac failure. In such cases, respiratory distress and fast breathing are often the initial presenting complaints. This pattern of symptomatology was also corroborated by studies conducted by Lee et al.[10] which reported similar clinical presentations.

Additionally, neurological complications (8.6%) were observed in our study, which aligns with findings from López-Herce et al, who identified neurological causes as risk factors for poor outcomes in pediatric cardiac patients.[11]

Risk factors for mortality in our study align with those identified in another research. Mortality was highest among infants (79.5% of deaths), a finding consistent with studies by Jana JK et al and Gundogdu et al.[8,12] where infants were also found to have the highest mortality rates in the PICU. Cyanosis was associated with a 50% mortality rate in our cohort. This finding mirrors the conclusions of Koth et al, who identified cyanosis as a significant predictor of poor outcomes.[13] Additionally, the presence of Congestive Heart Failure (CHF) was linked to a mortality rate of 52.3%, a trend observed in multiple studies, including Seifu A. et al, where the need for inotropic support was found to be a major predictor of mortality.[7]

Furthermore, deranged Kidney Function Tests (KFT) and altered pH levels were associated with higher mortality in our cohort, which is consistent with findings from López-Herce, J et al, who highlighted the importance of organ failure as a critical factor in predicting survival.[11] Finally, the duration of mechanical ventilation was a key risk factor, with longer durations correlating with poorer outcomes, a finding also emphasized by Seifu et al and Gundogdu et al, where mechanical ventilation was identified as an independent predictor of mortality.[7,8]

Our findings underline the importance of early intervention and timely use of the golden hour in improving outcomes for critically ill children. Pertinently, the potential influence of confounding variables, such as the severity of patients' conditions and comorbidities on the observed relationship between PICU stay duration and mortality needs to be taken into consideration for determining outcomes as highlighted by our study.

Our study has several limitations. The relatively small sample size limiting the generalizability of the findings. Additionally, the study was conducted in a single institution, which may not reflect broader regional or global trends. The study also did not comprehensively address all potential confounding variables, such as the precise timing of interventions or the impact of long-term follow-up on patient outcomes.

CONCLUSION

Our study highlights key echocardiographic profiles and comorbidities in pediatric cardiac patients, with ventricular septal defect (VSD) as the most common anomaly and respiratory complications as a significant comorbidity. Mortality risk factors include infant age, cyanosis, CHF, kidney dysfunction, altered pH levels and prolonged mechanical ventilation. Early diagnosis and intervention, particularly in high-risk groups, are crucial for improving outcomes.

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