Curr Pediatr Res2025; 29 (3): 2391-2395 *ISSN 0971-9032*
www.currentpediatrics.com

Analysis of Acute Heart Failure Etiology and Outcome in a Cohort Admitted to a Non-Surgical Pediatric Intensive Care Unit of a Developing Country

Ola Soliman, Radwa Iraqy, Hebat Allah Fadel Algebaly*, Fatma Mamdouh Hussein, ElShima Salah, Aya Osama Mohamed

Department of Pediatrics, Faculty of Medicine, Cairo University , Al Giza, Giza Governorate 12613, Egypt

Received: *28 May, 2025, Manuscript No. AAJCP-25-166153;* **Editor assigned:** *30 May, 2025, Pre QC No. AAJCP-25-166153 (PQ);* **Reviewed:** *13 June, 2025, QC No. AAJCP-25-166153;* **Revised:** *20 June, 2025, Manuscript No. AAJCP-25-166153 (R);* **Published:** *29 June, 2025, DOI:10.35841/0971-9032.29.03.2391-2395*

Abstract

Background: In infants, the most common cause of heart failure is congenital heart disease. In children with a structurally normal heart, myocarditis and primary cardiomyopathies come first. Infants diagnosed with CHD awaiting surgery (either correction or palliation may be at a high risk of poor outcome. Post-viral myocarditis, arrhythmia, or right ventricular dysfunction in idiopathic or acquired pulmonary hypertension are among the root causes of acquired cardiac disease admitted to the ICU. This study aimed to understand the etiology and outcomes of critically ill children presenting with cardiac problems in a tertiary care hospital.

Methods: A cohort study was conducted on 120 cardiac patients who received care in the Pediatric Intensive Care Unit (PICU) from August 2021 to November 2022 among 800 total admissions. Results: Total cardiac cases were 120. Heart failure and cardiogenic shock constituted 20% of the total admissions, and acute heart failure on top of Congenital Heart Disease (CHD) was the most prevalent admission diagnosis, accounting for (40%) of patients. Followed by cardiogenic shock due to myocarditis, dilated cardiomyopathy (30%), atrial arrhythmia (11%), and coronary dilation (4%), respectively. Non-survivors had a younger age, poor nutritional status, lower oxygen saturation, higher need for ventilation compared to survivors. The independent factors affecting mortality were younger age and required higher VIS, with p-values of 0.019 , and .004, respectively.

Conclusion: Acute heart failure on top of Congenital heart disease and cardiogenic shock in cardiomyopathy patients constitutes an important category in non-surgical PICU. The independent factors affecting mortality were age, nutritional status, and inotropic agents. Close Monitoring of cardiac patients and prevention of infection, early surgeries, and better nutrition may lower this incidence and decrease the rate of admission to the PICU.

Keywords: Cardiac patients; Etiology; Mortality; Pediatric intensive care unit

Accepted on 30th May; 2025

Introduction

In infants, the most common cause of heart failure is congenital heart disease. In children with a structurally normal heart, myocarditis and primary cardiomyopathies are the most common causes [1]. Patients with CHD awaiting surgery and who are admitted to the PICU with acute illness are at high risk for mortality. Stringent criteria to diagnose pneumonia or sepsis should be used in these patients [2,3]. Infants diagnosed with CHD awaiting surgery (either correction or palliation), due to either lack of resources or expertise for earlier repair, may be at a high risk of death. Myocarditis and the right-sided heart failure in idiopathic or acquired pulmonary hypertension increased the burden of patients with acquired cardiac disease admitted to the ICU. Differences in the availability of resources and infrastructure together with the differences in the nutritional status of the patients among the countries may contribute to an increase in the prevalence of mortality in developing countries [4]. The most frequent causes for ICU admission among congenital or acquired heart disease are cardiogenic shock, cardiovascular failure with a concurrent lower respiratory tract infection, and critical cyanotic cardiac disease with a cerebrovascular insult [5,6]. Arrhythmias constitute about 11% of patients admitted to the PICU [7]. Children with cardiovascular diseases frequently experience morbidity and mortality due to malnutrition, which particularly affects ventilation duration, postoperative outcomes, and length of hospital stay negatively [8]. In cardiogenic shock, certain medications as vasopressors and inotropes, are utilized to induce vasoconstriction or augment cardiac contractility [9].

Hence, drug therapy should be given with the lowest dose response and the least duration [10].

Our research aimed to understand the clinical status, characteristics, and outcomes of children admitted to the PICU with a cardiac problem in developing countries, and this plays a substantial role in planning policies and improving existing essential healthcare resources.

Materials & Methods

This cohort study was conducted in the PICUs at Cairo University Children's Hospital. The study enrolled cases from age 1 month to 12 years old with either congenital or acquired heart diseases from the end of 2021 till mid-2022 who were presented at PICUs. This study excluded newborns, patients with syndromes, and post-surgical cardiac children. The study protocol has been approved by the research ethical committee with the institutional review board number (N-223-2023). Baseline data of children with cardiac diseases were reviewed and gathered from the patient's files including the age, gender, cause of admission, diagnosis, vital signs (blood pressure, Heart rate, respiratory rate, temperature), whether the patient required mechanical ventilator or inotropic support, length of PICU stay, and status upon PICU discharge (alive or dead) were documented. All patients with cardiac defects were determined by using Echocardiography (ECHO).

Statistical analysis

SPSS statistical package version 26 was used for the data analysis. The Kolmogorov-Smirnov single-sample test was performed to test the data normality. Numerical data were outlined as means, medians, and ranges, while frequencies and percentages were used to describe qualitative data. The Chi-square test was used to find the relationship between qualitative data. The comparison between the two groups of numerical was done using the Mann-Whitney test. The significant factors affecting mortality in univariate analysis were entered in multivariate analysis using the stepwise logistic regression method-statistically significant data at P-values less than 0.05.

Results

One hundred and twenty cardiac patients were included in the study, presenting 20%, 73 (60.8%) participants were females and 48 (39.2%) were males. The median age of the participants was 24 months, and the cases who survived were significantly older than the deceased was (p-value<001). The median weight was 13.3 Kg, with a significant difference between the survivors and non-survivors (p-value 0.0001). Concerning non-operated CHD patients, the median z-score was -2 with a significant difference between survivors and non-survivors (p-value 0.001). 20.8% of patients died, as demonstrated in Table 1. There was a significant difference in the mortality rate regarding age.

Characteristics	Total (n=120)	Dead (n=25)	Discharged (n=95)	p-value
Age (months)	24 (1-168)	6 (1-144)	36 (1-168)	0.001
Median (range)				
Gender				
Female	73 (60.8%)	17 (68%)	56 (58.9%)	
Male	47 (39.2%)	8 (32%)	39 (41.1%)	0.409
Weight(kg)	13.3(3-33)	7(3-18)	14.4(3-33)	0.0001
Median (range)				
Weight Z score	-1.7 (-4 –2)	-2.15(-3.8 - 0.5)	-1.7 (-4 - 2)	0.05
Note: Z-score, the data were analyzed by X2 test (2 ≤ z score ≥ −2 for weight for age mean normal, z score <−2 for weight for age mean underweight.				

Table 1: Demographic characteristics of the participants.

Our study revealed that the commonest admission diagnosis was non-operated CHD in 27 (22.5%) patients, followed by CHD complicated by pneumonia in 22 (18.3%) patients and myocarditis in 20 (16.7%), with no statistically significant difference between survivors and non-survivors regarding diagnosis (p-value: 0.333). The most significant ECHO finding was non-operated CHD accounting for 45 (38.1%) patients, followed by DCM 43(36.4%), pulmonary hypertension, and severely dilated myopathic RV 9(7.6%), dilated coronaries 7(5.9%) and pericardial effusion 6(5.1%) with no significant difference between survivors and non-survivors in Echo findings as illustrated in Table 2.

Characteristics	Total (n=120)	Death(n=25)	Discharge (n=95)	p-value
Unrepaired CHD				0.333
N%	49 (40%)	11 (22%)	38 (77%)	
*VSD/ASD	18(15.3%)	4(16%)	14(15%)	
*CAVC	7(6%)	2(8%)	5(5.4%)	
*Valve disease	5(4.2%)	0	5(5.4%)	
*PAPVR	1(0.8%)	0	1(1.1%)	

*Double aortic arch	1(0.8%)	0	1(1.1%)	
*Fallot tetralogy	8(6.7%)	1(4%)	7(7.5%)	
*TGA	3(2.5%)	0	3(3.2%)	
*DORV	1(0.8%)	0	1(1.1%)	
*Single ventricle	1(0.8%)	0	1(1.1%)	
Cardiomyopathy N%	43 (36.4%)	11 (44%)	32 (34.4%)	0.18
*FS (%)	16.8(10-28)	14(10-28)	17.6(12-26)	
Idiopathic pulmonary hypertension and RV dysfunction	9 (7.6%)	2 (8%)	7 (7.5%)	
Coronary dilation with MOSF	7 (5.9%)	2 (8%)	5 (5.4%)	0.39
Cardiac tamponade	6 (5.1%)	2 (8%)	4 (4.3%)	
Others***	8 (6.8%)	1 (4%)	7 (7.5%)	

Note: ** Other diagnoses include infantile nephrosis with pericardial effusion, lupus nephritis, atypical Hus, down $ with pericardial effusion, and HOCM; *** Other echo findings include normal, hypertrophic cardiomyopathy; # ASD: atrial septal defect; CAVC: common atrioventricular canal; CHD: Congenital heart disease; DCM: dilated cardiomyopathy; DORV: Double outlet right ventricle; FS: Fraction shortening; LV: Left ventricle; MISC: multi-inflammatory syndrome of childhood; PAPVR: Partial anomalous pulmonary venous return; RV: right ventricle

Table 2: Echocardiographic diagnosis of the involved cardiac patients.

There was a statistically significant evidence of fever, desaturation, and mechanical ventilation among the dead compared to surviving patients (p-value .046), (p-value .025)(p-value .001) respectively. The duration of stay in the PICU was significantly longer in the dead than in surviving patients (p-value .005). The median duration of mechanical ventilation was 5 days, ranging from (1-55 days). The percentage of inotrope use was much higher among dead patients than among survivors (91.3% *versus* 59.3%, p-value=.002). Higher VIS among dead patients than among survivors, with p-value=<.001 as shown in Table 3. The independent factors affecting mortality were younger age and higher VIS, with p-values (. 019, .004, respectively as shown in Table 4.

Characteristics	**Total (n=120)**	**Death (n=25)**	**Discharge (n=95)**	**p-value**
Median and range				
HR (beat /min)	140 (60-267)	140 (105-180)	140 (60-267)	0.711
RR (cycle/min)	40 (20-80)	40 (26-60)	40 (20-80)	0.968
BP (systolic)(mmHg)	90 (70-200)	90 (70-130)	90 (70-200)	0.252
BP (diastolic)(mmHg)	70 (40-130)	65 (46-90)	70 (40-130)	0.226
Temp (c)	37.6 (36.5-40)	38 (36.5-40)	37.5(36.8-40)	0.046
Oxygen saturation (%)	95% (50%-100%)	95% (53%-100%)	96% (50%-100%)	0.025
Length of stay in (days)	6 (1-90)	12 (2-90)	6 (1-74)	0.005
Mechanical ventilation (N %)	42 (35%)	25 (100%)	17 (17.9%)	<.001
Duration of mechanical ventilation (days)	5 (1-55)	6 (2-40)	5 (1-55)	0.931
Inotrope usage (N %)	75 (65.8%)	21 (91.3%)	54 (59.3%)	0.002
Type of Inotrope				
Milrinone	42 (56%)	5 (23.8%)	37 (68.5%)	<.001
Adrenaline	20 (26.7%)	12 (57.1%)	8 (14.8%)	<.001
Dobutamine	14 (18.7%)	5 (23.8%)	9 (16.7%)	0.476
Noradrenaline	12 (16%)	8 (38.1%)	4 (7.4%)	0.003
Levosimendan	1 (1.3%)	0 (0%)	1 (1.9%)	----

Table 3: Admission Clinical findings and management among the participants.

	p-value	**OR**	**95% CI for OR**	
			Lower	**Upper**
Age	0.019	0.847	0.738	0.973
VIS	0.004	9.6	2.1	44.9

Table 4: Multivariate analysis of factors associated with mortality.

Discussion

Children's cardiovascular disease is regarded as a major cause of morbidity and mortality [11]. Children with heart disease living in low-income countries tend to present late and frequently suffer from poor nutrition, infections, and pulmonary hypertension, which present further challenges to their management in resource-limited settings. Resuscitation might be specifically challenging for cardiac patients, so considerable attention should be given to preventive steps [12]. The mortality rate reported of 30%-65% in the literature for pediatric cardiac patients [13]. We observed that mortality was higher in children and infants with underweight, fever, Lower oxygen saturation on presentation to the emergency room, a higher % of need for invasive ventilation, more frequent use of dobutamine, adrenaline, and noradrenaline. Meanwhile, better survival was observed with milrinone. The most prevalent diagnosis was complicated, unrepaired congenital heart disease, followed by cardiomyopathy and then pulmonary hypertension. The mortality rate for cardiac patients admitted to the PICU was 20.8%, and the survival rate for both genders was nearly similar, which is in concordance with Gundogdu, et al. study [14]. But Gilboa, et al. [15] observed that male patients had remarkably lower mortality. However, the surviving patient's median age was considerably higher than that of the deceased [16-21]. This is related to the fact that protein intake is essential for the proper functioning of cardiac muscles. such as arrhythmias and myocardial ischemia [22]. This study shows a higher rate of mortality among those on inotropes except milrinone. A statement from AHA that long-term treatment of adults with HF with phosphodiesterase-3 inhibitors is associated with increased morbidity and mortality, several clinical series have reported that long-term use of milrinone in children is safe and efficacious as a bridge to oral HF therapies or transplantation. This is in line with the study done by Gao and Zhang [23], reporting that the need for inotropic support had been associated with increased mortality [24,25]. Inotropes should be administered cautiously, at the lowest dose, for the shortest duration, while the patient is being closely monitored in cases of cardiogenic shock. The longer duration in the PICU will make the patients prone to develop metabolic, neuro-endocrine, immunological, and neuromuscular disorders; the cases will become dependent on the treatments used in the ICU and may need ongoing organ support and acquire sepsis, which in turn are all leading causes of mortality [26-28]. However, our study revealed that patients on mechanical ventilation had a significant mortality rate. This is consistent with a study done by Shorofsky, et al. [29] and Valavi, et al. [30] who found ventilation as risk factor for death in cardiac patients, A study on pulmonary hypertension children Patients who received both invasive mechanical ventilation and vasoactive infusions on either PCICU admission Day 1 or Day 2 were found to have a more than fivefold-increased risk of hospital mortality compared with those who received neither of these [31-34].

Therefore, encouraging prenatal follow-up for early diagnosis may help in early intervention. Close monitoring to detect early complications, proper nutritional support, and judicious use of inotropes may improve outcome.

Conclusion

Cardiovascular disease is one of the primary causes of morbidity and mortality in children. The independent factors affecting mortality were age, weight, and inotropic agents. Close monitoring of cardiac patients may lower this incidence and decrease the rate of admission to PICU. Encouragement of prenatal follow-up should be emphasized to allow early intervention and thus decrease the rate of mortality. Nutritional support during the management of critically ill children is crucial since nutritional status may worsen during PICU stay and thus negatively affect the prognosis.

References

1. Hsu DT, Pearson GD. Heart failure in children: Part I: History, etiology, and pathophysiology. Circ Heart Fail. 2009;2:63-70.
2. Mohsin SS, Haque A, Shaikh AS, et al. Unrepaired heart disease in infants. Congenit Heart Dis 2014;9:116-121.
3. Pfammatter JP, Stocker FP. Delayed recognition of hemodynamically relevant congenital heart disease. Eur J Pediatr 2001;160:231-234.
4. Rossano JW, Price JF, Nelson DP, et al. Treatment of heart failure in infants and children: Medical management. In: Nichols DG, editor. Rogers's Textbook of Pediatric Intensive Care. 4th ed. Philadelphia: Lippincott Williams & Wilkins; 2008: 1093-1108.
5. Yates MC, Rao PS. Pediatric cardiac emergencies. Emerg Med 2013;3:1-7.
6. Cassel-Choudhury GN, Aydin SI, Toedt-Pingel I, et al. Arrhythmias in the pediatric intensive care unit: A prospective study of the rates and predictors of arrhythmias in children without underlying cardiac disease. Cardiol Young 2015;7:1281-1289.
7. Ismail SR, Mehmood A, Rabiah N RM, et al. Impact of the nutritional status of children with congenital heart diseases on the early post-operative outcome. Egypt Pediatr Assoc Gazette 2021;69(28):1-6.
8. Van Diepen S, Katz JN, Albert NM, et al. Contemporary management of cardiogenic shock: A scientific statement from the American Heart Association. Circulation 2017;136:e232-e268.
9. Levy B, Buzon J, Kimmoun A, et al. Inotropes, and vasopressors use in cardiogenic shock: when, which and how much? Lippincott Williams & Wilkins; 2019: 384-390.
10. Vallabhajosyula S, Dunlay SM, Bell MR, et al. Epidemiological trends in the timing of in-hospital death in acute myocardial infarction-cardiogenic shock in the United States. J Clin Med 2020;9:E2094.
11. McShane P, Draper ES, McKinney PA, et al. Effects of out-of-hours and winter admissions and number of patients per

unit on mortality in pediatric intensive care. J Pediatr 2013;163:1039-1044.

12. Marino BS, Tabbutt S, MacLaren G, et al. Cardiopulmonary resuscitation in infants and children with cardiac disease: A scientific statement from the American Heart Association. Circulation 2018;137(22):e691-e782.
13. Yates AR, Sutton RM, Reeder RW, et al. Survival and cardiopulmonary resuscitation hemodynamics following cardiac arrest in children with surgical compared to medical heart disease. Pediatr Crit Care Med 2019;20(12):1126-1136.
14. Gundogdu Z, Babaoglu K, Deveci M, et al. A study of mortality in cardiac patients in a pediatric intensive care unit. Cureus 2019;11(11):e6052.
15. Gilboa SM, Salemi JL, Nembhard WN, et al. Mortality resulting from congenital heart disease among children and adults in the United States. Circulation 2010;122(22):2254-2263.
16. Sperotto F, Daverio M, Amigoni A, et al. Trends in in-hospital cardiac arrest and mortality among children with cardiac disease in the intensive care unit: A systematic review and meta-analysis. JAMA Netw Open 2023;6(2):e2256178.
17. Shin J. Risk factors for in-hospital mortality in premature infants with critical congenital heart disease. Clin Exp Pediatr 2020;63(10):391-392.
18. Bechard LJ, Duggan C, Touger-Decker R, et al. Nutritional status based on body mass index is associated with morbidity and mortality in mechanically ventilated critically ill children in the PICU. Crit Care Med 2016;44(8):1530-1537.
19. Costa CAD, Garcia PCR, Cabral DD, et al. Reducing malnutrition in critically ill pediatric patients. Rev Bras Ter Intensiva 2018;30(2):160-165.
20. Nangalu R, Pooni PA, Bhargav S, et al. Impact of malnutrition on pediatric risk of mortality score and outcome in pediatric intensive care unit. Indian J Crit Care Med 2016;20(7):385-390.
21. Nematifard E, Ardehali SH, Shahbazi S, et al. Combination of APACHE scoring systems with adductor pollicis muscle thickness for the prediction of mortality in patients who spend more than one day in the intensive care unit. Crit Care Res Pract 2018;2018:5490346.
22. Appiah LT, Sarfo FS, Agyemang C, et al. Current trends in admissions and outcomes of cardiac diseases in Ghana. Ghana Med J 2017;40(10):783-788.
23. Gao E, Zhang Y, et al. Inotrope use and intensive care unit mortality in patients with cardiogenic shock: an analysis of a large electronic intensive care unit database. Front Cardiovasc Med 2021;8:696138.
24. Haftu H, Hailu T, Medhaniye A, et al. Assessment of pattern and treatment outcome of patients admitted to pediatric intensive care unit, Ayder referral hospital, Tigray, Ethiopia, 2015. BMC Res Notes 2018;11(1):116.
25. Seifu A, Eshetu O, Tafesse D, et al. Admission pattern, treatment outcomes, and associated factors for children admitted to pediatric intensive care unit of Tikur Anbessa specialized hospital, 2021: a retrospective cross-sectional study. BMC Anesthesiol 2022;22:13.
26. Yotsna J, Kumar R, Sharan S, et al. The various scoring systems in pediatric intensive care units: a prospective observational study. Cureus 2023;15(5):e39679.
27. Botan E, Gün E, Şden EK, et al. Characteristics and timing of mortality in children dying in pediatric intensive care: A 5-year experience. Acute Crit Care 2022;37(4):644-653.
28. Kuhn BT, Bradley LA, Dempsey TM, et al. Management of mechanical ventilation in decompensated heart failure. J Cardiovasc Dev Dis 2016;3(4):33.
29. Shorofsky M, Jayaraman D, Lellouche F, et al. Mechanical ventilation with high tidal volume and associated mortality in the cardiac intensive care unit. Acute Card Care 2014;16(1):9-14.
30. Valavi E, Aminzadeh M, Shirvani E, et al. The main causes of mortality in pediatric intensive care unit in southwest of Iran. Zahedan J Res Med Sci 2018;20(2):1-5.
31. Nandiwada S, Islam S, Jentzer JC, et al. The association between cardiac intensive care unit mechanical ventilation volumes and in-hospital mortality. Eur Heart J Acute Cardiovasc Care 2021;10(7):797-805.
32. Saxena A. Status of pediatric cardiac care in developing countries. Children (Basel) 2019;6(2):34.
33. Bogle C, Colan SD, Miyamoto SD, et al. Treatment strategies for cardiomyopathy in children: A scientific statement from the American Heart Association. Circulation 2023;148(2):174-195.
34. Song JH, Yoon SY, Park TY, et al. The clinical impact of drug-induced hepatotoxicity on anti-tuberculosis therapy: A case-control study. Respir Res 2019;20(1):283.

Corresponding Author:

Hebat Allah Fadel Algebaly

Department of Pediatrics, Faculty of Medicine, Cairo University

Al Giza, Giza Governorate 12613, Egypt

Email: Hebatallah.gebaly@kasralainy.edu.eg