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ORIGINAL ARTICLE

Clinical profile and outcome of myocarditis in children.

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ABSTRACT… Objective: To determine the clinical profile and outcome of myocarditis in children. **Study Design:** Cross-sectional study. **Setting:** Department of Pediatrics, National Institute of Child Health, Karachi, Pakistan. **Period:** July 2024 to December 2024. **Methods:** A total of 73 children between 1 months up to 15 years of age, and admitted with myocarditis were analyzed. Demographic details, presenting complaints, and features were noted. Outcomes were noted in the form of survived and discharged successfully, or mortality. Data analysis was conducted by using IBM-SPSS Statistics, Version 26.0. **Results:** In a total of 73 children, 44 (60.3%) were females. The mean age was 2.0±0.9 years. At the time of presentation, fever (100%), loose motion (28.8%), and difficulty in breathing (21.9%) were the most frequent. Tachycardia, and respiratory distress noted among 71 (97.3%), and 71 (97.3%) children, respectively. During the treatment, ventilatory support, and inotropic support were given to 41 (56.2%), and 72 (98.6%) children, respectively. Mortality was documented among 27 (37.0%) children, whereas 46 (63.0%) children improved and discharged successfully. At the time of presentation, vomiting (0.047), hepatomegaly/splenomegaly ($p<0.001$), delayed capillary refill time ($p<0.001$), gallop ($p<0.001$), hypotension ($p<0.001$), and signs of shock ($p<0.001$). Place of admission as PICU ($p<0.001$), and need for ventilatory support ($p<0.001$) were also significantly associated with mortality. **Conclusion:** The high mortality rate in children with myocarditis underscores the need for early recognition of critical symptoms, standardized treatment protocols, and improved diagnostic and therapeutic infrastructure.

Key words: Fever, Gallop, Hypotension, Mortality, Myocarditis, Vomiting.

INTRODUCTION

Myocarditis is a serious and potentially fatal condition that most often impacts children and young adults.[1] Its diverse clinical manifestations and variable symptoms frequently make the diagnosis challenging. Post-motem data have shown the prevalence of myocarditis in the pediatric population as 3.5-5%, while the overall incidence is estimated to be between 0.1-0.6% among children.[2,3] Contemporary data reveals that myocarditis is expected to contribute to 4% of all sudden pediatric deaths.[4] Myocarditis mainly affects infants and teenageers, while around half of myocarditis cases belong to infants age group.[5]

Myocarditis refers to inflammation of the heart muscle, marked by the infiltration of white blood cells and resulting in fibrosis and tissue death.[6] In acute cases, myocardial injury is often driven more by immune-mediated processes than by direct viral invasion or replication. The condition is most commonly triggered by viral pathogens, including enteroviruses, adenoviruses, influenza viruses, human herpes viruses, parvovirus, and the novel coronavirus.[7,8] Children with myocarditis may present with vague and non-specific symptoms like nausea and vomiting, or breathlessness.[9] Diagnosis is established by histological , immunologic and immune histochemical criteria.[10]

A combination of invasive and non-invasive approaches is typically required for the diagnosis of myocarditis, guided primarily by the patient's clinical presentation and medical history.

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Traditionally, endomyocardial biopsy, assessed according to the Dallas Criteria, was regarded as the definitive method for diagnosing acute myocarditis.[11] Non-invasive investigations including laboratory markers such as cardiac troponins (TROP I, T) and creatine phosphokinase-MB (CK-MB), as well as imaging modalities like echocardiography and cardiac magnetic resonance imaging (CMR), can provide valuable diagnostic information, especially when a biopsy is not performed.[12] This study was planned to evaluate the clinical profile and outcome of myocarditis in children admitted in a tertiary care hospital, to help in improving the morbidity and mortality. The main objective of this study was to determine the clinical profile and outcome of myocarditis in children.

METHODS

The cross-sectional study was conducted at the department of pediatrics, National Institute of Child Health, Karachi, Pakistan during July 2024 to December 2024. Approval from Institutional Ethical Review Board was obtained prior the commencement of this study (IERB-06/2022, dated: 1-4-2022). Parents/guardians were explained abou this study and written/informed consents were taken. A sample size of 73 was calculated using online EpiInfo Online sample size calculator considering the mortality rate of 6.7% among children with myocarditis,[13] with 95% confidence level, and 5% margin of error. Non –probability consecutive sampling. Inclusion criteria were children between 1 months up to 15 years of age, and admitted with myocarditis. Exclusion criteria were children with underlying malignancy or congenital malformation, chronic kidney disease, or rheumatic fever. Children who left against medical advice within 24 hours of admission were also excluded from this study. Myocarditis was diagnosed on the basis of clinical presentation with classic fulminant symptoms like fever, respiratory distress, tachycardia, hypotension, gallop rhythm, and cardiac murmur. Associated finding like rash or evidence of end organ involvement such as hepatitis or aseptic meningitis were also noticed. Chest x-ray showed globular heart, ECG evident of non-specific ST and T wave abnormalities, and echocardiographic examination showing left ventricular hypertrophy.

Demographic details of each child such as gender, age, weight, and height were noted. Presenting complaints such as fever, difficulty in breathing, diarrhea, or other nonspecific symptoms were documented. All children were treated as per standard institutional protocols. Administration of IVIG, inotropes, or ventilatory support was documented. Outcomes were noted in the form of survived and discharged successfully, or mortality. A special proforma was designed to record all relevant study data.

After collection of data, the analysis was conducted by using IBM-SPSS Statistics, Version 26.0. Mean and standard deviation were calculated for quantitative variable like age, height, weight, BMI, duration of symptom. Frequency and percentages were calculated for qualitative variables like gender, age groups, BMI classification, and signs and symptoms, administration of IVIG, inotropic support, ventilatory support, and outcome. Effect modifiers were controlled through stratification. Post-stratification, chi-square or fisher's exact test was applied to see the effect of study variables on outcome. $P<0.05$ was taken as statistically significant.

RESULTS

In a total of 73 children, 44 (60.3%) were females, and 29 (39.7%) males. The mean age, weight, and height were 2.0 ± 0.9 years, 10.7 ± 2.7 kg, and 75.5 ± 19.1 cm, respectively. At the time of presentation, fever (100%), loose motion (28.8%), and difficulty in breathing (21.9%) were the most frequent. Tachycardia, and respiratory distress noted among 71 (97.3%), and 71 (97.3%) children, respectively. Table-I is showing demographical and clinical characteristics of children.

During the treatment, ventilatory support, and inotropic support were given to 41 (56.2%), and 72 (98.6%) children, respectively. Figure-1 is showing treatment related aspects in children admitted with myocarditis.

		Frequency (%)
Gender	Male	29 (39.7%)
	Female	44 (6.3%)
Age (years)	≤1	23 (31.5%)
	>1 to 5	50 (68.5%)
Presenting symptoms/ complaints	Fever	73 (100%)
	Loose motion	21 (28.8%)
	Vomiting	11 (15.1%)
	Difficulty in breathing	16 (21.9%)
	Abdominal pain	8 (11.0%)
	Cough	12 (16.4%)
Presenting features	Hepatomegaly/ spleenomegaly	37 (50.7%)
	Tachycardia	71 (97.3%)
	Abnormal capillary fill time	37 (50.7%)
	Respiratory distress	71 (97.3%)
	Gallop	39 (53.4%)
	Hypotension	32 (43.8%)
	Signs of shock	35 (47.9%)
Place of admission	Ward	31 (42.5%)
	PICU	42 (57.5%)

Table-I. Characteristics of children (=73)

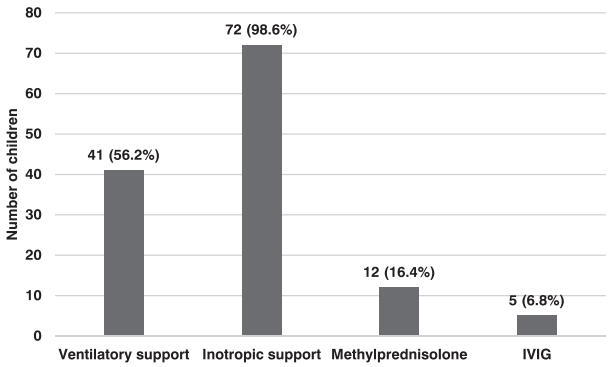

Figure-1. Management aspects of children with myocarditis (n=73)

Mortality was documented among 27 (37.0%) children, whereas 46 (63.0%) children improved and discharged successfully. At the time of presentation, vomiting (0.047), hepatomegaly/ splenomegaly (p<0.001), delayed capillary refill time (p<0.001), gallop (p<0.001), hypotension (p<0.001), and signs of shock (p<0.001). Place of admission as PICU (p<0.001), and need for ventilatory support (p<0.001) were also significantly associated with mortality. Table-II is showing association of demographical, clinical, and treatment related characteristics with final outcome.

DISCUSSION

Myocarditis in children remains a significant cause of morbidity and mortality, often presenting with nonspecific clinical manifestations that complicate timely diagnosis and management. This study adds to the growing body of literature highlighting the complex interplay of clinical features, diagnostic modalities, and therapeutic interventions in pediatric myocarditis. The mortality rate in this study as 37.0%, a figure considerably higher than the 17.5% reported by Jayashree et al.[14] This discrepancy may stem from differences in the availability of advanced care facilities, such as extracorporeal membrane oxygenation (ECMO), and the early initiation of intravenous immunoglobulin (IVIG) therapy. Lee et al.[15], from Taiwan shoed the mortality rate of 30.4% among children with myocarditis. In this study, 56.2% of children required ventilatory support, and nearly all (98.6%) received inotropic support, underscoring the severity of myocardial dysfunction at presentation. These findings mirror those reported by Phatigomet et al.[16], who observed that patients requiring higher inotropic support had significantly worse outcomes. Nurtriandari et al.[17], reported tachypnea (65%) and hepatomegaly (55%) as prominent physical findings, findings that align with the observations noted in this study, where respiratory distress (97.3%) and hepatomegaly/splenomegaly (p<0.001) were significantly associated with mortality.

One of the striking findings in this study was the association of hypotension (p<0.001), delayed capillary refill time (p<0.001), gallop rhythm (p<0.001), and clinical signs of shock (p<0.001) at presentation with mortality. Jayashree et al.[14], reported that hypotension and multiorgan dysfunction were independent predictors of poor outcomes.

Characteristics		Survived (n=46)	Mortality (n=27)	P-Value
Gender	Male	19 (41.3%)	10 (37.0%)	0.719
	Female	27 (58.7%)	17 (63.0%)	
Age (years)	≤1	17 (37.0%)	6 (40.7%)	0.903
	>1 to 5	29 (63.0%)	11 (59.3%)	
Presenting symptoms/ complaints	Fever	46 (100%)	27 (100%)	-
	Loose motion	12 (26.1%)	9 (33.3%)	0.509
	Vomiting	4 (8.7%)	7 (25.9%)	0.047
	Difficulty in breathing	8 (17.4%)	8 (29.6%)	0.222
	Abdominal pain	6 (13.0%)	2 (7.4%)	0.457
	Cough	6 (13.0%)	6 (22.2%)	0.307
Presenting features	Hepatomegaly/splenomegaly	11 (23.9%)	26 (96.3%)	<0.001
	Tachycardia	44 (95.7%)	27 (100%)	0.272
	Delayed capillary refill time	11 (23.9%)	26 (96.3%)	<0.001
	Respiratory distress	44 (95.7%)	27 (100%)	0.272
	Gallop	12 (26.1%)	27 (100%)	<0.001
	Hypotension	6 (13.0%)	26 (96.3%)	<0.001
	Signs of shock	8 (17.4%)	27 (100%)	<0.001
PICU admission		15 (32.6%)	27 (100%)	<0.001
Ventilatory support		14 (30.4%)	27 (100%)	<0.001
Inotropic support		45 (97.8%)	27 (100%)	0.440
Methylprednisolone		5 (10.9%)	7 (25.9%)	0.110
IVIG administration		2 (4.3%)	3 (11.1%)	0.269

Table-II. Association of study variables with final outcome (N=73)

The results of the present study showed that PICU admission (p<0.001), and ventilatory support (p<0.001) were significantly associated with mortality, corroborating findings from Khan et al.[18], who demonstrated that mechanical ventilation was required in 13.6% of cases, with a mortality rate of 20.3%. Differences in mortality rates across these studies may be attributable to variations in sample size, healthcare infrastructure, and adherence to standardized treatment protocols.

In this study, fever (100%) was the most common presenting complaint, followed by diarrhea (28.8%) and difficulty breathing (21.9%). These findings parallel those of Jayendra and Tushar[19], where tachycardia, breathlessness, and fatigue were the predominant symptoms. However, unlike their findings, this study observed a higher frequency of gallop rhythm (p<0.001), and hypotension at presentation. The variance in symptomatology might reflect differences in the stages of disease progression at the time of hospital presentation. The use of IVIG, although widely debated, remains a cornerstone in the treatment of myocarditis.[20,21] Jayashree et al.[14], demonstrated a significant reduction in mortality in the IVIG-treated group (12.1% vs. 28.9%, p=0.02). The widespread use of inotropes and ventilatory support emphasizes the severity of disease and the limited efficacy of conventional management strategies in fulminant myocarditis. Diagnostic modalities also played a crucial role in this study. Chest X-ray findings of a globular heart and echocardiographic evidence of left ventricular hypertrophy were consistent with findings from Nurtriandari et al.,[17] who reported elevated AST and CKMB levels and echocardiographic abnormalities in over 80% of cases. However, unlike Khan et al.[18], this study did not include cardiac MRI findings due to resource constraints. The lack of advanced diagnostic tools such as cardiac MRI may have limited the ability to stratify

risk and predict outcomes more accurately.

The clinical implications of this study are multifaceted. Early recognition of critical symptoms, such as tachycardia, hypotension, and gallop rhythm, should prompt aggressive hemodynamic support and PICU admission. The findings of this study emphasize the need for standardized treatment protocols, including timely administration of IVIG and judicious use of inotropes. Improving diagnostic capacity through the integration of advanced imaging tools like cardiac MRI may enhance risk stratification and treatment planning. This study also raises important questions regarding the role of adjunct therapies, including steroids and antiviral agents, in the management of pediatric myocarditis. Future randomized controlled trials are needed to establish the efficacy of adjunct therapies in pediatric myocarditis.

Despite its strengths, this study has certain limitations. The single-center design limits the generalizability of our findings. The relatively modest sample size restricts the power of subgroup analyses, particularly concerning the impact of IVIG and adjunct therapies on outcomes. The lack of cardiac MRI and limited availability of advanced life-support measures such as ECMO may have influenced the outcomes. Long-term outcomes, including cardiac function and quality of life, were not evaluated in this study.

CONCLUSION

The high mortality rate in children with myocarditis underscores the need for early recognition of critical symptoms, standardized treatment protocols, and improved diagnostic and therapeutic infrastructure. By addressing these gaps, we can move closer to reducing the morbidity and mortality associated with this challenging condition in children.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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AUTHORSHIP AND CONTRIBUTION DECLARATION	
1	**Huma Mehmood:** Data collection, data analysis, drafting, responsible for data's integrity, approved for publication.
2	**Murtaza Ali Gowa:** Conception design, proof reading, critical revisions, approved for publication.
3	**Hira Nawaz:** Data analysis, methodology, proof reading, critical revision, approved for publication.
4	**Ghazala Jamal:** Data collection, literature review, proof reading, approved for publication.
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