Original Article
DOI: https://doi.org/10.70749/ijbr.v3i9.2403

INDUS JOURNAL OF BIOSCIENCE RESEARCH
https://ijbr.com.pk
ISSN: 2960-2793/ 2960-2807

Disease Spectrum and Outcomes of Patients Admitted to the Pediatric Critical Care Unit of Tertiary Care Hospital of Karachi

Aasma Kayani[1], Murtaza Ali Gowa[1], Afshan Asif[1], Hira Nawaz[1], Uzma Siddique[1], Durfishan Dilshad[1]

[1]Department of Pediatrics, National Institute of Child Health, Karachi, Pakistan

ARTICLE INFO

Keywords: PICU, mortality rates, Mechanical ventilation, National Institute of Child Health (NICH).

Correspondence to: Aasma Kayani, Department of Pediatrics, National Institute of Child Health, Karachi, Pakistan. Email: dr.aasmakayani@gmail.com

Declaration

Authors' Contribution: All authors equally contributed to the study and approved the final manuscript.

Conflict of Interest: No conflict of interest.

Funding: No funding received by the authors.

Article History

Received: 11-08-2025 Revised: 26-08-2025
Accepted: 03-09-2025 Published: 10-09-2025

ABSTRACT

Background: Pediatric intensive care is a relatively new but rapidly developing field, driven by a growing public awareness of health issues and an increasing demand for specialised services. **Objective:** To determine the disease spectrum and outcomes of patients admitted to the pediatric intensive care unit (PICU) of a tertiary care referral hospital in Karachi. **Methodology:** This descriptive cross-sectional study was conducted over six months at the National Institute of Child Health (NICH), Karachi. Data on demographics, diagnoses, and outcomes were collected and analysed using chi-square and ANOVA tests. Outcomes were categorised as discharged, expired, or shifted. **Results:** A total of 151 children were included. Respiratory (33.8%) and neurological (26.5%) illnesses were the most common reasons for admission. Hematology/oncology (18%) and cardiac (15%) patients had the highest mortality rates. Mechanical ventilation was significantly associated with adverse outcomes. A considerable proportion of respiratory and neurological patients were shifted due to bed limitations. **Conclusion:** The disease spectrum in this PICU reflects both infectious and specialised conditions. Mortality was consistent with other local studies, underscoring the urgent need to expand pediatric critical care resources in Pakistan.

INTRODUCTION

Organ dysfunction and physiological instability are running issues for pediatric complex conditions such as respiratory distress, mitochondrial disease, or other complex medical technology, and require multidisciplinary teams to work together in complex conditions (1, 4). The pediatric intensive care unit (PICU) has become an essential part of tertiary pediatric care in high-income countries (HICs). In this setting, there is a technologically advanced environment with innovative life-support equipment such as mechanical ventilators, continuous renal replacement therapy, and invasive hemodynamic monitoring (2, 3). Coupled with the presence of a high percentage of specialisation of the nurses and physicians, this infrastructure can handle complex conditions successfully. In low- and middle-income countries, PICUs face persistent challenges due to inadequate infrastructure, shortages of critical care specialists, and limited access to essential medical resources (4, 5). This resource disparity contributes to persistently high child mortality, with an estimated five million under-five deaths reported globally in 2020 (6).

An excellent illustration of this problem is the situation in Pakistan, the world's fifth most populated country with a sizable youth population, where children and early adolescents, aged 5 to 14, make up 29% (7, 8). In 2023, Pakistan's child mortality rate declined from 60.5 deaths per 1,000 live births the year before to 58.5 deaths per 1,000 live births. This marks a 3.31% single-year decrease and contributes to a larger trend that has seen the rate drop by 27.24% since 2013 (9). Pakistan faces a heavy burden of infectious and respiratory diseases that often lead to critical illness in children, while pediatric intensive care remains a developing field driven by growing public awareness and demand for specialised services (10).

Although the need for pediatric critical care in Pakistan is clear, progress is hindered by a lack of recent, locally relevant data on patient profiles, disease patterns, and outcomes. While studies from other centers in Pakistan and neighboring regions point to infectious diseases like pneumonia (accounting for up to 37.3% of diagnoses), sepsis (14.6%), and meningitis (11.3%) as leading causes of admission (11, 7), the specific burden at a major national referral center like NICH remains unobserved. Similarly, research from other tertiary care units in the region has identified the respiratory and central nervous systems as the most commonly affected organ systems leading to hospitalisation and death (11, 12), but whether

this holds true for the specific patient demographic is unknown.

The lack of localised data hampers evidence-based planning, leaving healthcare providers uncertain about the main causes of critical illness and unable to allocate resources or expertise effectively. This study focuses specifically on the PICU at the National Institute of Child Health (NICH) in Karachi. As a key public-sector referral center for Sindh and parts of Balochistan, its patient data is a crucial indicator of regional pediatric health. However, a systematic, published analysis of its PICU patient profile is conspicuously absent from the academic literature, meaning the unique challenges faced by one of the nation's busiest pediatric centers remain poorly understood. This research therefore aims to analyse and report all patient demographics, admission diagnoses and outcomes accurately, at the Pediatric Intensive Care Unit (PICU), National Institute of Child health, Karachi.

METHODOLOGY

A descriptive cross-sectional design was constructed which typically classifies the disease spectrum and outcomes among paediatric cases admitted at the PICU of the National Institute of Child Health (NICH), Karachi. This is known to be the most applicable design for such a description in terms of incidence and outcome variations of different conditions within a defined study period.

It was done in the highly resource-endowed and multidisciplinary Paediatric Intensive Care Unit (PICU) of the National Institute of Child Health (NICH), Karachi. Prospective data were obtained on all admitted children from 1 month through 12 years of age between September 2005 and March 2006, with an established diagnosis. This includes the important definition of the paediatric critical care age range, while excluding the neonates in the NICU and older adolescents. All the cases were included, as there was to be an overall spectrum of the diseases present in the unit. Besides, it was conducted for six months after approval by the Institutional Ethical Review Board (IERB) of NICH. During that period, all acutely ill children meeting the inclusion criteria were prospectively enrolled upon admission to the PICU.

The sample size was calculated using OpenEpi version 6, based on a previous study reporting an 11.3% outcome frequency among PICU admissions (Ashraf et al., 2024). With a 5% margin of error and 95% confidence level, a total of 151 patients were required to ensure statistical validity and generalisability. Data were collected using a structured proforma recording patients' age, gender, admission source, primary diagnosis, length of stay, admission and discharge or death dates, and need for mechanical ventilation as an indicator of disease severity and resource use.

The primary diagnoses were carefully classified into pre-defined systemic groups for the purpose of detailed analysis. These were subdivided into respiratory, CNS, CVS, blood, renal and an 'others' which encompassed rarer but important conditions such as IEM and immunodeficiency, and endocrinological disorders. The established diagnosis at the time of admission or during the PICU stay was used for each patient to be classified into one of these categories. The final outcome classification for patients was also rigidly determined, and included discharged PICU (discharged from PICU after successful stabilisation and recovery), expire (death in PICU), shiffted (transferred to a paediatric inpatient ward), DC/LAMA (transferred elsewhere to receive further treatment or left against medical advice). This detailed catergorisation of outcomes allowed a comprehensive understanding of patient trajectories within the critical care setting.

In compiling the data, great attention was given to protecting patient confidentiality. All patient identifiers were anonymised to maintain privacy of patients and protect the sensitive health information. The results were carefully entered in and analysed with the use of the Statistical Package of Social Sciences program (SPSS) (version 23). Frequencies and percentages were used to describe categorical variables such as age, gender, diagnosis, and outcomes. Associations between qualitative variables were tested using the chi-square test, and one-way ANOVA was applied for quantitative comparisons. Also, a p-value ≤ 0.05 was considered statistically significant.

RESULTS

In this study, 151 pediatric patients admitted to the Pediatric Intensive Care Unit (PICU) were analyzed. The age distribution showed that 37.1% (56) were aged 0 to 12 months, 41.7% (63) were 1 to 5 years, 15.2% (23) were 6 to 10 years, and 6.0% (9) were 11 to 16 years. Out of 151 patients, there were 53.3% (88) male and 41.7% (63) female children admitted (see Table 1).

Table 1

Characteristics of Pediatric Patients (N=151)

Characteristic		N	%
Age: 0–12 months		56	37.1
Age: 1–5 years		63	41.7
Age: 6–10 years		23	15.2
Age: 11–16 years		9	6.0
Gender	Male	88	58.3
	Female	63	41.7

The spectrum of diagnoses leading to PICU admission was predominantly respiratory diseases, accounting for 33.8% (51) of cases, followed by neurological diseases at 26.5% (40). Infectious and septic conditions comprised 9.9% (15), renal diseases 7.9% (12), cardiac diseases 7.3% (11), gastro-intestinal and hepatic diseases 4.6% (7), haematology/oncology 6.0% (9), endocrine/metabolic disorders 1.3% (2), and trauma/toxicology contributed 2.6% (4). Figure 1 displayed the frequency distribution of diagnosis categories.

The majority of patients (57%) were shifted to other facilities for further management, while 41.06% expired during treatment. A small proportion (2%) either left against medical advice or were discharged (LAMA/DC) (see Figure 2).

Figure 1

Graphical Representation of PICU Patients' Diagnoses

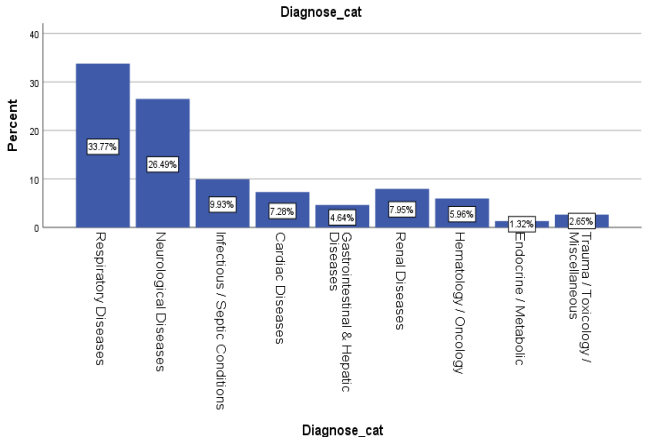
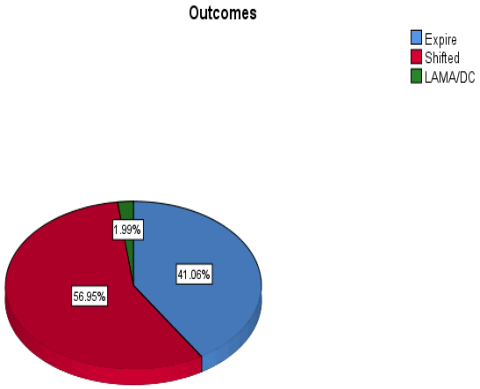


Figure 2

Percentage of Outcomes of PICU Patients (N=151)



A chi-square test of independence was performed to examine the relationship between patient outcomes and selected demographic variables (see Table 2). The results showed no significant association between age group and outcomes (p = .74). Mortality was highest among patients aged 1 to 5 years (44.4%) and 0 to 12 months (41.1%), while the shift rate was highest in the 6 to 10 years group (60.9%) and 1 to 5 years group (55.6%), although these differences were not statistically significant. Similarly, no significant association was observed between gender and outcomes (p = .58). A chi-square test further revealed a statistically significant association between diagnosis and patient outcomes (p = .012). Among expired patients, the highest proportions were observed in hematology/oncology diseases (77.8%) and cardiac diseases (72.7%), followed by infectious/septic (60.0%) and renal diseases (58.3%). In contrast, patients with respiratory (70.6%) and neurological (62.5%) conditions were more likely to be shifted. LAMA/discharge was most frequent in trauma/toxicology/miscellaneous cases (33.3%). Intubation status was also significantly associated with outcomes (p < .001). Of the 151 patients with reported outcomes, 59.6% of intubated patients expired compared to 14.5% of non-intubated patients, whereas the majority of non-intubated patients (83.9%) were shifted. Lastly, no statistically significant difference was observed in the mean length of ICU stay across outcome groups (p = .29). Patients who expired had the longest average ICU stay (M = 7.45, SD = 6.69), followed by those who were shifted (M = 5.64, SD = 7.88), and those who left against medical advice/discharged (M = 4.00, SD = 2.65).

Table 2

Association of Outcomes with Demographical and Clinical Features (N=151)

Factors	Outcomes			
	Expired (n=62)	Shifted (n=86)	LAMA/DC (n=3)	p value
Age Group				0.74
0 to 12 months	23 (41.1%)	31 (55.4%)	2 (3.6%)	
1 to 5 years	28 (44.4%)	35 (55.6%)	0 (0.0%)	
6 to 10 years	8 (34.8%)	14 (60.9%)	1 (4.3%)	
11 to 16 years	3 (33.3%)	6 (66.7%)	0 (0.0%)	
Gender				0.58
Male	33 (37.5%)	53 (60.2%)	2 (2.3%)	
Female	29 (46.0%)	33 (52.4%)	1 (1.6%)	
Diagnosis				0.012
Respiratory Diseases	14 (27.5%)	36 (70.6%)	1 (2.0%)	
Neurological Diseases	14 (35.0%)	25 (62.5%)	1 (2.5%)	
Infectious/Septic	9 (60.0%)	6 (40.0%)	0 (0.0%)	
Cardiac Diseases	8 (72.7%)	3 (27.3%)	0 (0.0%)	
GI & Hepatic	2 (28.6%)	5 (27.3%)	0 (0.0%)	
Renal Diseases	7 (58.3%)	5 (41.7%)	0 (0.0%)	
Hematology/Oncology	7 (77.8%)	2 (22.2%)	0 (0.0%)	
Endocrine/Metabolic	1 (50.0%)	1 (50.0%)	0 (0.0%)	
Trauma/Toxicology/Misc	0 (0.0%)	3 (3.6%)	1 (33.3%)	
Intubation				<0.001
Yes	53 (59.6%)	34 (38.2%)	2 (2.2%)	
No	7 (14.5%)	51 (83.9%)	1 (1.6%)	
ICU Stay (days), Mean±SD	7.45 ± 6.69	5.64 ± 7.88	4.00 ± 2.65	0.29

DISCUSSION

The aim of this study was to describe the spectrum of diseases and outcomes among children admitted to the pediatric intensive care unit (PICU) of a tertiary referral hospital in Karachi. This study explored the disease spectrum and outcomes of children admitted to the PICU at a tertiary referral hospital in Karachi. The findings highlight critical gaps in pediatric intensive care delivery and provide insight into the clinical and systemic challenges shaping outcomes in Pakistan. The discussion below compares these findings with previously published national and international literature to highlight consistent patterns and notable differences.

In the present study, respiratory conditions and neurological illnesses emerged as the most frequent diagnoses. Comparable findings have been documented in several studies. In Multan, neurological illnesses constituted 23.5% and respiratory diseases 17.6% of admissions (10). Similarly, an Iranian cohort reported respiratory illnesses (36.5%) and neurological conditions (18.5%) as dominant causes (19). North Indian studies also described central nervous system and gastrointestinal disorders as frequent diagnoses, with respiratory diseases following closely, as seen in (11) and (20). These consistent results across different settings suggest that acute respiratory and neurological conditions remain the main drivers of pediatric critical care admissions in South Asia. The high proportion observed at NICH likely reflects its tertiary referral role, where children with severe disease are centralised. This pattern underscores the need for stronger preventive care, early diagnosis, and referral systems to reduce the burden of such cases in tertiary PICUs.

In the current study, hematology, oncology, and cardiac patients accounted for the majority of deaths, contributing

to an overall mortality rate of 41%. This finding contrasts with the Multan cohort, where oncology cases were much less frequent and mortality was 19% (10). Reports from Islamabad and Lahore documented mortality rates between 14% and 29% again lower than the present figure. International studies also recorded reduced case fatality, with mortality at 15.5% in Iran (1) and 13.4% in North India. The divergence is best explained by differences in case mix. As a national referral center, NICH admits a large proportion of oncology and cardiac patients, conditions consistently associated with poor prognosis in the literature (l3). The high mortality among oncology and cardiac patients reflects both disease severity and systemic gaps, such as delayed diagnosis, lack of specialised equipment, and limited multidisciplinary expertise. Addressing these areas through dedicated cardiac and oncology critical care units could significantly improve survival.

In this cohort, the requirement for mechanical ventilation was strongly linked with death. Similar associations have been described in other settings. In Multan, ventilated patients had significantly poorer survival (10), while Indian cohorts also demonstrated increased risk of death among ventilated children (23). Another Iranian study reported that 25% of children required ventilation, and mortality was higher in this group (1). Consequently, the strength in the association of mechanical ventilation with mortality therefore highlights some severity in the sick and the limitations in ventilatory support capacity when witnessing causative factors in patient mortality due to service constraints. Implementing a proper staff-training system would upgrade expertise in managing ventilation, and by ensuring maintenance of both ventilators and their accessories, it could reduce preventable death.

A sizeable percentage of patients were transferred to other hospitals, particularly patients suffering from respiratory and neurological illnesses. Studies conducted in Multan and Iran show that these patients had longer lengths of stay with fewer transfers, which means far better in-house continuity of care (10, 1). The higher transfer rate at NICH is probably due to bed shortages and the absence of step-down or subspeciality services (6). While transfers might help in alleviating pressure from a high patient volume, they also risk interrupting treatment, delaying attention, and increasing adverse outcomes. Evidence from this study supports the expansion of intermediate-care facilities and the fostering of inter-institutional coherence for a better continuum and outcome in paediatric critical care.

In the same manner, infants made up a large proportion of admissions, a trend also reported in Multan (42%) (10), Iran (49.7%) (1), and India, where children under one year made up nearly half of cases. Moreover, male predominance was another consistent finding across regional studies which reflects both biological vulnerability and sociocultural patterns in health-seeking behavior (3). Seasonal variations in admissions, such as clustering of respiratory cases in winter and spring observed in Iran could not be evaluated in the present study due to its shorter duration, though similar patterns are likely in Karachi. Overall, the demographic profile aligns with published evidence and supports the view that infants remain the most vulnerable subgroup in pediatric critical care.

In summary, the present study demonstrates that while the disease spectrum in Karachi PICU resembles national and regional trends, its outcomes are shaped by unique contextual factors. Respiratory and neurological diseases remain the dominant admission categories, consistent with prior literature. However, the high mortality observed among oncology and cardiac patients reflects the specialised referral role of NICH, while the strong association between ventilation and death mirrors previously reported challenges in resource-limited care. The distinctive pattern of frequent transfers highlights systemic constraints not commonly described in other centers. Together, these findings emphasise the urgent need to expand PICU capacity, adopt standardised prognostic tools such as PRISM and PIM2, and invest in specialised training for pediatric intensivists. Preventive strategies, particularly strengthening immunisation coverage and improving nutritional status, will further reduce the burden of critical illness. By situating local results within the broader body of evidence, this study underscores both shared challenges and specific priorities for improving pediatric critical care in Pakistan.

This study has important strengths, including a large sample size and the analysis of outcomes by disease category, providing a realistic picture of the case mix in a major referral center. Nevertheless, limitations must be acknowledged. Being a single-center study conducted over six months, its findings may not be generalisable to all PICUs in the country. The absence of standardised severity scores, lack of systematic nutritional assessment, and the exclusion of outcomes beyond PICU discharge further restrict the scope of the conclusions.

Future research should aim at multicenter collaborations to establish a more representative understanding of pediatric critical illness in Pakistan. The introduction of validated prognostic scores and routine nutritional assessments would enhance the ability to identify children at greatest risk. Given the disproportionate mortality among oncology and cardiac patients, dedicated services or subspecialty critical care pathways should be considered. Preventive measures such as strengthening vaccination programs, addressing malnutrition, and improving early detection of congenital heart disease remain essential to reducing the burden on PICUs. In the long term, expansion of pediatric critical care training programs is imperative to address the shortage of intensivists and improve the quality of care nationwide. Broader, multicenter studies integrating standardised data collection would allow national benchmarking and evidence-based policy formulation for pediatric critical care in Pakistan.

CONCLUSION

This study demonstrates valuable insight into the disease spectrum and outcomes of children admitted to the pediatric intensive care unit of a major tertiary care referral hospital in Karachi. Respiratory and neurological illnesses were the most frequent causes of admission, while hematology, oncology, and cardiac patients carried the highest risk of mortality. The overall outcome profile

was influenced not only by disease severity but also by systemic factors, such as limited critical care capacity and the need to transfer patients due to high caseloads. Compared with national and international data, the findings align in showing infant and male predominance but reveal a distinct burden of specialised conditions at this center. Mortality rates were similar to local studies yet higher than international reports, reflecting resource and case-mix differences. Strengthening pediatric critical care in Pakistan through expanded capacity, disease-specific protocols, prognostic scoring, and improved nutrition, vaccination, and training is essential to enhance survival outcomes.

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