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Original Article

Incidence of Pediatric Mortality in the Emergency Department: A Retrospective Study in Iran

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Abstract

Background: Pediatric Emergency Departments (EDs) play a vital role in identifying and managing life-threatening conditions in children. Despite global reductions in under-five mortality, pediatric mortality remains a significant public health concern, particularly in Low- and Middle-Income Countries (LMICs). Localized studies on mortality patterns in pediatric EDs are essential for developing targeted interventions. This study aimed to investigate the incidence of pediatric mortality in the emergency department of the Children's Medical Center, a national referral hospital in Iran, from 2019 to 2022.

Methods: A retrospective study was conducted on children under 18 years of age who died in the ED during the study period. Data were collected from medical records, including demographic information, causes of death, and time of death. Descriptive statistics were used for analysis.

Results: Among 76187 pediatric admissions, 155 deaths occurred, yielding a mortality rate of 2.03 per 1000 admissions. The mean age of the deceased was 43.58±6.1 months, with a slight male predominance (52.9%). Infants had the highest mortality rate (32.3%), while neonates had the lowest (5.8%). Neurological disorders (36.1%) were the most common cause of death, followed by infectious diseases (29.0%), cardiological conditions (20%), and hematological disorders (12.3%). A significant proportion of deaths (40%) occurred within one *hr* before or two hours after shift changes.

Conclusion: The findings highlight the need to enhance neurocritical care and infection management in EDs. The high proportion of deaths near shift changes underscores the importance of effective handover protocols to improve patient safety.

Keywords: Child, Cause of death, Emergency service, Infant, Iran, Retrospective study

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Introduction

Pediatric Emergency Departments (EDs) play an essential role in modern healthcare systems as critical entry points for ill children. Emergency Departments (EDs) often serve as the frontline in identifying and managing life-threatening conditions. This underscores their critical role in addressing preventable deaths (1-3). These settings are pivotal in providing timely and life-saving interventions for pediatric populations (4,5). Ensuring the effective functioning of children, EDs is vital for reducing mortality rates and improving health outcomes in children (6,7).

Globally, pediatric mortality continues to be a significant public health concern (8). Since 2000, the global under-5 mortality rate has declined by over 50%, decreasing from 76 deaths per 1000 live births in 2000 to 37 per 1000 in 2022. The number of annual deaths in children under five has reached to 4.9 million in 2022, compared to 9.9 million in 2000, with significant progress observed across Low- and Middle-Income Countries (LMICs) (9). While advances in medical technology and healthcare delivery have led to substantial reductions in child mortality, disparities persist between and within countries (10-12). Variations in mortality rates across regions are influenced by access to healthcare, socioeconomic conditions, and the burden of disease, highlighting the importance of localized studies to address context-specific challenges (13-15).

Pediatric mortality in EDs reflects not only the burden of disease but also the capacity of healthcare systems to respond effectively (5,16-18). In High-Income Countries (HICs), mortality is frequently associated with complex or rare conditions such as congenital anomalies, severe trauma, or advanced-stage diseases (19,20). Conversely, in LMICs, infections and malnutrition, dominate mortality statistics (21,22). For example, a study conducted in sub-Saharan Africa have demonstrated the significant role of pneumonia, malaria, and diarrhoea in high mortality rates of pediatrics (23). In contrast, a study conducted in 51 European countries revealed that injuries and neoplasms are the leading causes of mortality among children aged 5-14 years (24). These differences highlight the need for localized research to better understand the causes of pediatric mortality in different regions.

A review of the existing literature on pediatric mortality indicates that most studies have not focused on emergency settings (8,25,26). Moreover, no studies have examined pediatric mortality in EDs in Iran. Addressing this gap is essential for developing effective, evidence-based strategies to reduce pediatric mortality in EDs and improve emergency care services and overall health outcomes. This study aimed to investigate the incidence of pediatric mortality in the ED of the Children's Medical Center Hospital from 2019 to 2022.

Materials and Methods

Study design

This retrospective study was conducted on pediatric patients under 18 years of age who died in the ED of the Children's Medical Center, affiliated with Tehran University of Medical Sciences, Iran, during the period from 2019 to 2022.

Setting

This study was conducted at the Children's Medical Center Hospital, a leading institution specializing in pediatric care and serving as a referral center for complex and diverse cases from all over Iran. The hospital's ED offeres a unique setting for investigating mortality patterns, providing valuable insights into the broader healthcare challenges faced by children across the country. As a national referral center, the findings from this study reflect the Iranian healthcare context, offering important perspectives on the specific needs and challenges of pediatric care in Iran.

Inclusion and exclusion criteria

The target population included all children under 18 years of age who died in the ED of the Children's Medical Center during the specified period. The inclusion criteria were complete medical records with all variables required for the study. Exclusion criteria included incomplete medical records and cases of death prior to arrival at the ED.

Data collection

Data collection was carried out based on the patients' medical records. Demographic information, including

age and gender, was recorded. Details regarding the cause of death and time of death were extracted and documented based on the medical records. Causes of death were categorized into the following groups: neurologic, infectious, cardiologic, hematologic, gastrointestinal, metabolic, immunologic, renal, respiratory, and rheumatologic. Cases that did not fit into these predefined categories were classified under the "other" category.

Definitions

Neurologic refers to death caused by disorders of the nervous system. Examples include status epilepticus, cerebral palsy complications, acute encephalopathy, and traumatic brain injury. Infectious deaths are those caused by infections affecting various organs. Examples are sepsis, pneumonia, meningitis, and gastrointestinal infections such as diarrheal diseases. Cardiologic refers to deaths from heart-related conditions. Examples include congenital heart defects, cardiogenic shock, arrhythmias, and myocarditis. Hematologic deaths are due to blood disorders or abnormalities in blood cells. Examples include leukemia, hemophilia, aplastic anemia, and severe anemia.

Gastrointestinal deaths occur due to disorders of the digestive system. Examples include intestinal perforation, gastrointestinal bleeding, and acute liver failure. Metabolic refers to deaths resulting from metabolic disturbances affecting the body's ability to maintain homeostasis. Examples include diabetic ketoacidosis, hypoglycemia, and inborn errors of metabolism. Immunologic deaths are caused by immune system disorders. Examples include autoimmune diseases like systemic lupus erythematosus and immunodeficiency conditions such as HIV/AIDS. Renal deaths occur due to kidney dysfunction or failure. Key examples include acute kidney injury, chronic kidney disease, and nephrotic syndrome. Respiratory deaths are those caused by disorders of the respiratory system. Examples include respiratory failure, asthma, bronchiolitis, and pulmonary hemorrhage. Rheumatologic deaths are caused by disorders of the connective tissue and joints. Examples include rheumatoid arthritis complications, juvenile idiopathic arthritis, and systemic sclerosis. Others includes any causes of death that do not fall into the above categories, such as trauma, poisoning, and malignancies not classified under hematologic conditions.

Ethical approval

The Research Ethics Committee of Children's Medical Center, affiliated with Tehran University of Medical Sciences, approved the current study (Code no. IR.TUMS.CHMC.REC.1402.078). The authors adhered to the ethical declaration of Helsinki. The confidentiality of the data and information was maintained. Patient names were not collected, and identifiable information was not disclosed. Numerical codes were used instead of patient names.

Data analysis

The data were analyzed using SPSS software version 26. Descriptive statistics, including frequencies, percentages, means, and standard deviations, were used to summarize and report variables.

Results

The findings of the present study revealed an overall mortality incidence of 2.03 deaths per 1000 admissions during the study period. Out of 76187 patients admitted to the Children's Medical Center, 155 deaths occurred. The mean age of the patients was 43.58±6.1 months. Regarding gender, 82 of the deceased patients (52.9%) were male, and 73 (47.1%) were female. The patients were categorized into five age groups. The highest mortality rate was observed in infants with 50 deaths (32.3%). The lowest mortality rate was reported in neonates with 9 deaths (5.8%) (Table 1).

Neurological disorders were identified as the most common underlying condition, accounting for 56 cases (36.1%). This was followed by infectious diseases (45 cases, 29.0%), cardiological conditions (31 cases, 20%), and hematological disorders (19 cases, 12.3%) (Table 2).

The highest frequency of deaths occurred during the 7:00 AM–1:00 PM, accounting for 30.3%, followed by the 1:00 PM–7:00 PM at 27.7%, the 7:00 PM–1:00 AM at 22%, and the 1:00 AM–7:00 AM shift at 20%. A significant proportion of deaths (40%) occurred within one *hr* before to two *hr* after shift handover (near rotation time), while 60% occurred during the

Table 1. Characteristics of deceased pediatric patients in the emergency department

Variables	Mean±SD	n (%)
Mean age (months)	43.58±6.1	-
Gender		
Male	-	82(52.9%)
Female	-	73(47.1%)
Age group		
Neonates (<1 month)	-	9(5.8%)
Infants (1-12 months)	-	50(32.3%)
Toddlers (1-3 years)	-	41(26.5%)
Preschoolers (3-6 years)	-	12(7.7%)
School-age (6-12 years)	-	32(20.6%)
Adolescents (12-18 years)	-	11(7.1%)

Table 2. Distribution of mortality causes in pediatric emergency department patients

Cause of mortality	Frequency (percentage)
Neurologic	56(36.1%)
Infectious	45(29.0%)
Cardiologic	31(20.0%)
Hematologic	19(12.3%)
Gastrointestinal	13(8.4%)
Metabolic	13(8.4%)
Immunologic	6(3.9%)
Renal	6(3.9%)
Respiratory	5(3.2%)
Rheumatologic	3(1.9%)
Others	17(11.0%)

shifts (Table 3).

Table 3. Distribution of pediatric deaths by time periods

Time periods	n (%)
Time blocks	
7:00 AM–1:00 PM	47(30.3%)
1:00 PM–7:00 PM	43(27.7%)
7:00 PM–1:00 AM	34(22%)
1:00 AM–7:00 AM	31(20%)
Timing relative to handover	
Near rotation time (1 *hr* before to 2 *hr* after)	62(40%)
During shifts	93(60%)

Discussion

This study offers valuable insights into the causes and characteristics of pediatric mortality within the ED setting of a major referral hospital in Iran. The overall mortality incidence of 2.03 deaths per 1000 admissions reflects a considerable burden on pediatric healthcare systems. This finding highlights the need for continuous evaluation and improvement in emergency care services. The results of a retrospective study conducted in Ethiopia revealed a higher mortality rate of 8.2 deaths per 1000 patients per year (27). This discrepancy may be attributed to differences in healthcare accessibility, the availability of specialized pediatric care, and variations in socioeconomic conditions. A study in Iran examining surgical outcomes reported a mortality incidence of 3.89 deaths per 1000 surgeries between 2015 and 2018 (28). This higher rate can be attributed to the study's focus on surgical patients, who inherently face increased risks of complications and mortality due to the nature of surgical interventions.

The demographic findings, with a slight male predominance (52.9%), suggest that gender does not play a significant role in pediatric mortality in this setting, as the distribution between males and females is relatively balanced. A study conducted in Northeastern Iran revealed that 53.2% of pediatric mortalities occurred in boys, which is consistent with the results of present study (29). According to a systematic review, pediatric mortality is higher in boys than in girls of the same age globally. However, the review also found that in some countries, including Iran, females aged 0–4 years experience higher mortality (30).

Age-specific mortality patterns revealed the highest rates among infants and the lowest among neonates. The present study's findings are consistent with a study of 2.8 million children from 77 LMICs, which reported that 81.5% of under-5 deaths occurred within the first two years of life (31). The lower mortality observed in neonates is a promising finding, reflecting the significant emphasis placed on their care. Neonates, due to their heightened vulnerability,

are often transferred to advanced Neonatal Intensive Care Units (NICUs), where they receive specialized monitoring and treatment. The advanced NICU facilities at the Children's Medical Center Hospital, along with the rapid transfer of neonates, have significantly improved neonatal survival rates in the ED. Infants, despite receiving advanced care similar to neonates, continue to experience higher mortality rates. This variation may be due to the greater focus and resource allocation toward NICUs compared to Pediatric Intensive Care Units (PICUs), which may face challenges related to fewer resources and less specialized attention. The present study's findings suggest that enhancing PICU capabilities can be an effective strategy to reduce mortality in infants.

The primary causes of death—neurological disorders, infectious diseases, cardiological conditions, and hematological disorders—underscore the importance of addressing both communicable and non-communicable diseases in developing countries like Iran. Neurological disorders accounted for 36.1% of deaths in our study. The results of a study revealed that children with neurological disorders have a significantly higher mortality rate compared to the general population, emphasizing their increased vulnerability (32). This is consistent with the present study's findings, which highlight the importance of strengthening neurocritical care capabilities in EDs, including rapid diagnosis, timely imaging, and access to neurosurgical expertise.

The present study's results revealed that infectious diseases, particularly sepsis, remain a significant contributor to pediatric mortality (29.0%), despite advancements in vaccination and antimicrobial therapies. Similarly, global reports indicate that infectious diseases continue to account for a substantial proportion of pediatric deaths (33). High mortality due to infectious diseases can be attributed to the emergence of antibiotic-resistant pathogens which hinder the effectiveness of medical advancements. Additionally, early diagnosis and prompt management are essential in reducing mortality. Delays in treatment can lead to higher mortality rates.

Cardiological conditions accounted for 20% of pediatric deaths. This highlights the need for improved access to pediatric cardiology services, including echocardiography and intensive care facilities. These conditions require a high level of attention due to their vulnerability and the potential for rapid deterioration. Early diagnosis and timely intervention are crucial to prevent complications and reduce mortality.

Hematological disorders (such as sickle cell crises, anemia, coagulopathies, and malignancies like leukemia and lymphoma), which contributed to 12.3% of pediatric deaths, are frequently underdiagnosed or undertreated in resource-limited settings, leading to preventable deaths. Early diagnosis is important in hematological conditions, as prompt treatment can significantly reduce the risk of mortality.

The present study revealed that the highest frequency of deaths occurred during the 7:00 AM–1:00 PM shift (30.3%), followed by the 1:00 PM–7:00 PM (27.7%). Similarly, a study reported a significantly higher occurrence of Cardiopulmonary Resuscitations (CPR) during the 2:00–4:00 PM and 6:00–8:00 PM and noted a higher rate of post-CPR death during these time blocks (34). These findings suggest that critical events, such as deaths and CPR, may exhibit time-related patterns. Certain periods may align with increased patient activity, medical interventions, or changes in staffing dynamics, potentially influencing patient outcomes. Further research is needed to identify the underlying factors contributing to these variations.

Approximately 40% of deaths occurred within one hour before or two hours after shift changes, suggesting that lapses in communication, delays in initiating care, or variations in team dynamics during handovers could significantly impact patient outcomes. This finding is crucial for healthcare delivery and patient safety. In line with previous research, multiple healthcare organizations have identified handoffs as a source of clinical errors. Appropriate shift changes are crucial in healthcare, particularly in critical care settings, to ensure the transfer of patient information, maintaining continuity of care and minimizing errors. Effective handovers allow healthcare providers to address immediate concerns, anticipate complications, and make informed decisions based on the latest patient data. Conversely, poor shift changes can lead to miscommunication, delayed interventions, and medication errors, contributing to adverse outcomes such as prolonged stays, preventable complications, and increased mortality (35,36). The shift change

duration should be shortened to initiate care more promptly, and efforts must be made to ensure the accurate transfer of information. Standardized handover protocols, such as the SBAR (Situation, Background, Assessment, Recommendation) tool, can reduce errors and improve patient safety (37).

The study's findings have significant implications for clinical practice and healthcare policy. Addressing the leading causes of death requires a comprehensive approach, including enhanced training for ED staff, the establishment of multidisciplinary teams, and the integration of evidence-based protocols for managing common pediatric emergencies. For example, strengthening the capabilities of ED staff in neurocritical care, improving access to pediatric cardiology services, and ensuring early diagnosis and timely interventions for infectious and hematological conditions can all help reduce mortality. Furthermore, the substantial number of deaths occurring near shift handovers highlights the need for systemic improvements. Ensuring continuous care during transitions demands a culture of accountability, effective communication tools, and the adoption of standardized protocols for shift changes. Finally, focusing on the vulnerabilities of different age groups is crucial to reducing mortality. The high mortality among toddlers highlights the need for targeted interventions that address the specific health risks faced by this age group, such as injury prevention.

Strengths and limitations

The study has several strengths that enhance its credibility and relevance. Conducted at a leading pediatric referral center, it provides valuable insights into mortality patterns among complex cases from across the country. The use of complete medical records ensures data accuracy and reliability. Additionally, the focus on ED-specific mortality addresses a gap in the existing literature, offering important perspectives for improving emergency care services. However, the study also has limitations that warrant consideration. It is subject to documentation bias due to its retrospective design. The exclusion of cases with incomplete records may introduce selection bias, potentially underestimating the true burden of mortality. Furthermore, the single-center setting limits the generalizability of the findings to other regions or healthcare systems in Iran. Future studies should adopt prospective designs to reduce the risk of bias associated with documentation. Multicenter studies are essential to examine regional variations and identify context-specific challenges in pediatric emergency care. Furthermore, qualitative research should explore the causes of pediatric mortality from the perspectives of nurses, doctors, and other healthcare providers, helping to identify systemic barriers and facilitators. Additionally, examining the role of social determinants of health, such as socioeconomic status, parental education, and access to healthcare, will provide a more comprehensive understanding of pediatric mortality.

Conclusion

This study underscores the significant burden of pediatric mortality in ED settings, with neurological and infectious conditions emerging as the primary contributors. By advancing our understanding of pediatric mortality patterns, this study provides a foundation for developing evidence-based strategies to improve outcomes in EDs. Future research should build on these findings to explore innovative solutions, enhance healthcare access, and ultimately reduce preventable deaths among the most vulnerable pediatric populations.

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Conflict of Interest

There was no conflict of interest in this manuscript.

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