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TURKISH SOCIETY OF PEDIATRIC EMERGENCY AND INTENSIVE CARE MEDICINE

EDITORIAL

Advancing Pediatric Emergency and Intensive Care in a Changing World

Pediatric emergency and intensive care face unrelenting challenges. Disasters, infections, and caregiver dynamics continue to test the resilience of health systems. This issue brings together insights that point not only to urgent problems but also to practical solutions.

Following the Kahramanmaraş earthquakes, Bosnak et al. show how early recognition of crush syndrome complications-especially fluid balance and renal dysfunction-shapes survival. Wibisono et al. confirm that early fluid overload remains a decisive predictor of mortality in critically ill children, underscoring the need for precise management.

Hospital-acquired infections remain formidable. Bobotyana et al. detail the burden of central-line infections in a South African pediatric intensive care unit, a reminder that infection control protocols are as vital as new drugs in the fight against antimicrobial resistance. Beyond pathogens, Butun et al. capture the anxieties of parents during emergency procedures, while Göger et al. highlight the importance of caregiver education in first aid. Çevik Özdemir et al. address tracheostomy home care, turning attention to pressure ulcer prevention.

Case reports extend clinical awareness-from an azygos lobe mimicking pathology (Köse et al.) to rare propofol-induced green urine (Özel et al.). The neurocritical care study group provides a timely review on pediatric stroke, mapping out evolving therapies and multidisciplinary approaches.

The letters in this issue, from airway management in Treacher Collins syndrome to frontline correspondence, remind us of the collaborative spirit that drives pediatric critical care forward.

Together, these contributions highlight a central message: preparedness, precision, and partnership are the pillars of progress. In uncertain times, we must translate knowledge into action-ensuring that every child receives not only care, but the best care.

We warmly thank all authors, reviewers, and readers whose dedication sustains the quality and spirit of our journal. We invite colleagues to share their research, perspectives, and innovations with us, contributing to the global dialogue in pediatric emergency and intensive care. Together, through collaboration and scholarship, we can continue building a more resilient future for child health.

Prof. Dr. Hayri Levent Yılmaz

Editor-in-Chief

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The Dawn of Phoenix: A New Era in the Definition of Pediatric Sepsis

Phoenix'in Doğuşu: Pediatrik Sepsis Tanımında Yeni Bir Dönem

Hayri Levent Yılmaz

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Editorial: The Dawn of Phoenix: A New Era in the Definition of Pediatric Sepsis?

Pediatric sepsis continues to be one of the most critical topics in child health, from both a clinical and an academic perspective. Recent advances in the definition of sepsis have introduced innovative approacheswith the potential to transform the diagnosis and treatment processes for patients. In this editorial, we examine how the phoenix sepsis score (PSS), introduced in 2024, represents a turning point in pediatric sepsis management and discuss the implications of this new paradigm for clinical practice, research, and ethical considerations. Our journal aims to present these significant developments in child health to our readers, thereby strengthening the role of data-driven medicine in clinical practice and promoting a patient-centered approach to care.

A Paradigm Shift in Pediatric Sepsis

The year 2024 heralded a fundamental transformation in the definition of pediatric sepsis with the introduction of the PSS. Developed from the data of 3.6 million pediatric patients across six continents, the PSS has entered the medical literature as the first data-driven global consensus criterion.[1,2] Unlike the 2005 IPSCC SIRS-based definition, the PSS redefines sepsis as "infection + life-threatening organ dysfunction", shifting the focus from inflammation to organ-specific risk stratification.[2] This transformation also marks a philosophical evolution-from intuitive classification toward measurable pathophysiology.

Phoenix Sepsis Score: Development and Validation

The PSS evaluates dysfunction in four major organ systems-respiratory, cardiovascular, coagulation, and neurological-using objective parameters, thereby excluding subjective or non-specific triggers present in previous definitions. Children with suspected infection and a PSS ≥2 are classified as septic, while those with a score ≥2 and at least one cardiovascular point are defined as having septic shock.[2] Validation data show that the PSS outperforms previous scoring systems such as PRISM III and PELOD-2 in predicting in-hospital mortality.[1,3]

However, while this statistical superiority is noteworthy, translating it into therapeutic decisions-especially in hemodynamic support-remains a challenge. This progress necessitates a reevaluation of treatment approaches used in pediatric sepsis.

Therapeutic Implications and the "Press On" Paradigm

Given the Phoenix criteria's emphasis on organ dysfunction, timely cardiovascular support has become central in the new management paradigm. This brings into focus the "press on" concept-advocating for early vasopressor therapy. A 2025 meta-analysis by Shi et al.[4] showed that early initiation of norepinephrine during the early phase of septic shock reduces 30-day mortality by 35%, lowers fluid requirements, and decreases the time to reach target mean arterial pressure by over an hour. MacLaren's[5] editorial interprets these findings as strong support for the indispensable role of early vasopressor administration in modern sepsis management.

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Additionally, a study by Eisenberg et al.[6] reported 0% mortality among children who received norepinephrine as first-line treatment, compared to 4.1% in those treated with epinephrine. Specifically, 6 out of 147 patients (4.1%) in the epinephrine group died within 30 days, while no deaths were observed among the 84 patients in the norepinephrine group. In a secondary analysis using propensity score matching-a method employed because the primary inverse probability of treatment weighting analysis was not feasible for 30-day mortality outcomes due to the absence of deaths in the norepinephrine group-epinephrine was associated with a statistically significant greater 30-day mortality compared to norepinephrine (3.7% vs. 0%), with a risk difference of 3.7% (95% confidence interval, 0.2-7.2%). The fact that this confidence interval does not include zero indicates a statistically significant difference favoring norepinephrine.[6]

Beyond a Binary Question: Quantifying Shock with Norepinephrine Equivalent (NEE) and Vasoactive-Inotropic Score (VIS)

In clinical practice, the mere question of "is a vasopressor being used?" or the number of agents used does not provide sufficient information about the true severity of shock. The NEE score was developed to address this gap by providing a quantitative measure of hemodynamic support, converting the doses of different vasoactive agents into a standardized norepinephrine dose. This score can be used to standardize heterogeneous vasoactive agent regimens and to measure the severity of shock in a comparable manner. Its formula was updated by Kotani et al.[7] in 2023 to include a variety of vasopressor agents, specifically for adult intensive care patients.

However, while the NEE score focuses solely on vasopressor effects and excludes inotropes, the VIS offers a more comprehensive metric that includes both vasoactive agents and inotropes, based on dopamine dosage. A recent retrospective cohort study in adult sepsis patients (Li et al.[8]) highlighted that in the second hour after sepsis onset, both NEE (>0.10 μg/kg/min) and VIS (>15.04) scores were independently associated with 28-day mortality; higher scores correlated with an increased risk of death.[8]

VIS has also been validated as an independent predictor of mortality in pediatric septic shock patients. In a study by Çeleğen and Çeleğen[9] on children with pediatric septic shock, a high VIS (with a cutoff value of ≥16.2) was shown to be associated with lower lactate clearance and a higher mortality rate. As noted in an editorial commentary by Dhochak and Lodha[10], a study by Kallekkattu et al.[11] reported cutoff values such as >42.5 for mean VIS to predict mortality in pediatric septic shock. Furthermore, a larger study by McIntosh et al.[12] also indicated that VIS was associated with mortality in critically ill children. Li et al.[8] noted that the threshold value identified for VIS in their study was lower than the prognostic threshold in pediatric patients (15.04 vs. 42.5), reflecting the significant heterogeneity between pediatric and adult patients.

The NEE has its limitations. The conversion ratios for each vasoactive agent can be arbitrary and may not always be based on high-quality evidence.[8] Furthermore, NEE only considers vasopressor effects and cannot measure the impact of other hemodynamic interventions, such as mechanical circulatory support. Despite these limitations, the future integration of quantitative hemodynamic indicators like NEE and VIS into subsequent versions of the Phoenix definition holds the potential to enhance both definitional sensitivity and prognostic prediction.

Implementation Challenges and Ethical Debates

The application of Phoenix criteria has sparked debate. Concerns include limited feasibility in resource-constrained settings, potential exclusion of high-risk patients, and paradoxes such as the decatecholaminization strategy that aims to reduce sympathoadrenal stress-potentially conflicting with Phoenix's use of vasopressor requirement as a diagnostic marker.[13,14] While the implementation of the PSS in emergency departments may face challenges in resource-limited settings due to its reliance on objective organ dysfunction parameters, proponents emphasize that it serves as a standardized classification tool to guide early recognition and management of pediatric sepsis, rather than a standalone clinical diagnostic instrument.[15,16]

Future Outlook: Data, Artifical Intelligence (AI), and the Limits of Precision

Phoenix's structural properties make it well-suited for integration into AI-based systems. Early research indicates that AI-supported decision systems can effectively predict deterioration in septic patients.[17] However, these models must be calibrated against standardized frameworks like Phoenix. Ethical questions also emerge: Will algorithms replace clinical intuition? Who bears legal responsibility for automated decisions?[18]

Conclusion: Bridging Data-driven Medicine and Compassionate Care

The PSS charts a modern and necessary course for pediatric intensive care. Yet, this technological orientation must not supplant clinical experience, empathy, or a patient-centered approach. True success will be measured not only by a reduction in mortality rates but also by an improvement in the quality of life for patients and their families. The future of pediatric sepsis care lies in a synthesis that harmonizes the data-driven power of Phoenix with the irreplaceable wisdom of clinical intuition.

Keywords: Phoenix sepsis score, sepsis, septic shock, pediatrics, organ dysfunction, vasoactive-inotropic score, vasopressors, critical care, mortality, consensus

Anahtar Kelimeler: Phoenix sepsis skoru, sepsis, septik şok, pediatri, organ disfonksiyonu, vazoaktif-inotropik skor, vazopressörler, kritik bakım, mortalite, konsensüs

Footnotes

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Research Article / Özgün Araştırma

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The Relationship Between Admission Characteristics and Prognosis of Patients Diagnosed with Crush Syndrome After Consecutive Kahramanmaraş Earthquakes

Ardışık Kahramanmaraş Depremleri Sonrası Crush Sendromu Tanısı Alan Hastaların Yatış Özellikleri ile Prognozları Arasındaki İlişki

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Abstract

Introduction: Crush syndrome (CS) is the systemic manifestation of rhabdomyolysis due to prolonged continuous pressure on muscle tissue. We aimed to discuss the clinical and laboratory characteristics of the children who were diagnosed with CS, after the consecutive Kahramanmaraş earthquakes.

Methods: Eleven cases followed in the pediatric intensive care unit with the diagnosis of CS were retrospectively evaluated. The patients' files were scanned in detail. Demographic, clinical, and laboratory data were recorded from the files.

Results: The mean age of the patients was 10.45±4.92 years. Seven of the patients were girls and four were boys. Patients were extricated from the rubble between 7 and 48 hours. The mean admission time was 29.9±39.2 hours. Acute kidney injury was present in 9 patients. Renal replacement therapy (RRT) was required in 7 patients. At admission, presence of dark urine, high prism score, high blood uric acid, and lactate levels was associated with the need for RRT. The mean age was significantly higher in the RRT group. Three patients died. The mean lactate and D-dimer levels at admission were found to be significantly higher in patients who died.

Conclusion: Our results show that survival is possible in CS cases with effective and timely treatment approaches. Many parameters at the time of admission are associated with the need for RRT and death. We also found that as the time spent under rubble increases, blood D-dimer and creatinine levels increase, and ionized calcium and albumin levels decrease.

Keywords: Children, crush syndrome, Kahramanmaraş earthquakes, pediatric, pediatric intensive care unit

Öz

Giriş: Crush sendromu (CS), kas dokusunda uzun süreli sürekli baskıya bağlı oluşan rabdomiyolizin sistemik bir sonucudur. Biz bu çalışmada, ardışık Kahramanmaraş depremlerinden sonra CS tanısı konulan çocukların klinik ve laboratuvar özelliklerini tartışmayı amaçladık.

Yöntemler: Çocuk yoğun bakım ünitesinde CS tanısıyla takip edilen 11 olgu geriye dönük olarak değerlendirildi. Hastaların dosyaları ayrıntılı olarak tarandı. Demografik, klinik ve laboratuvar verileri dosyalardan kaydedildi.

Bulgular: Hastaların yaş ortalaması 10,45±4,92 yıl idi. Hastaların 7'si kız, 4'ü erkekti. Hastalar enkaz altından 7 ile 48 saat arasında çıkarılmıştı. Ortalama yatış süresi 29,9±39,2 saatti. Dokuz hastada akut böbrek hasarı mevcuttu. Yedi hastaya renal replasman tedavisi (RRT) gerekti. Yatışta koyu renkli idrar, yüksek prism skoru, yüksek kan ürik asit ve laktat düzeyleri RRT gereksinimi ile ilişkiliydi. Ortalama yaş RRT grubunda anlamlı olarak daha yüksekti. Üç hasta öldü. Yatıştaki ortalama laktat ve D-dimer düzeylerinin ölen hastalarda anlamlı olarak daha yüksek olduğu bulundu.

Sonuç: Sonuçlarımız CS olgularında etkili ve zamanında tedavi yaklaşımlarıyla sağ kalımın mümkün olduğunu göstermektedir. Kabul anındaki birçok parametre RRT ihtiyacı ve ölümle ilişkilidir. Ayrıca enkaz altında geçirilen süre arttıkça kan D-dimer ve kreatinin düzeylerinin arttığını ve iyonize kalsiyum ve albümin düzeylerinin azaldığını bulduk.

Anahtar Kelimeler: Çocuklar, crush sendromu, Kahramanmaraş depremleri, pediatrik, çocuk yoğun bakım ünitesi

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Introduction

Crush syndrome (CS) is the systemic manifestation of rhabdomyolysis due to prolonged continuous pressure on muscle tissue. CS is characterized by clinical manifestations including acute kidney injury (AKI), hyperkalemia, hypovolemic shock, and muscle necrosis.[1-3] While during revascularisation, diffusion of calcium (Ca), sodium (Na), and water into the damaged muscle cells is seen, necrosis of the muscle causes potassium (K), phosphate, lactic acid, myoglobin, and creatinine kinase (CK) to be released from the cell.[4] Myoglobin induces renal injury by incompletely defined mechanisms. CS is typically encountered in sports, accidents, war zones, mining disasters, and natural disasters such as earthquakes.

On February 6, 2023, two consecutive catastrophic earthquakes struck near Kahramanmaraş, Türkiye. These earthquakes registered with magnitudes of 7.7 and 7.6 (Mw) on the Richter scale and were separated by just nine hours.[5] The follow-up and treatment of the majority of the patients extricated from the rubble within the borders of Gaziantep province were carried out in Gaziantep University Medical Faculty Hospital. Patients who developed CS, while in critical clinical condition, were monitored in the pediatric intensive care unit (PICU).

CS is often lethal unless promptly and vigorously treated. For treatment success, experiences with childhood CS need to be shared. The data about CS in children are limited compared to that of adults in literature.[4,6,7] We believe that considering the characteristics of a patient diagnosed with CS at the time of admission will contribute to obtaining more successful results. Thus, we wanted to reveal a possible relationship between the demographic, clinical, and laboratory characteristics of the patients at the time of admission and the subsequent need for renal replacement therapy (RRT) and occurrence of death in this study.

Materials and Methods

Study Design and Study Population

On February 6, 2023, two consecutive catastrophic earthquakes struck the near Kahramanmaraş, Türkiye. The earthquake caused destruction in 11 cities. Gaziantep province was used as a referral center because it is in the earthquake zone where the destruction was experienced while the city center is the least affected place. This study was designed as a retrospective chart review in a 16-bed tertiary PICU. Earthquake victims between the ages of 1 month and 18 years were included in the study.

Patients who did not require PICU did not develop CS were excluded from the study. In this context, 11 patients who were rescued from the rubble within the first week after the earthquake and diagnosed with CS were evaluated. The files of the patients were scanned in detail. Demographic, clinical and laboratory data were recorded from the files. The pediatric risk of mortality (PRISM) scores were calculated for all patients within the first 24 hours of intensive care admission.

Two patients were intubated at the scene; one patient was intubated in the hospital where they were initially admitted; three patients were intubated in our emergency department; and two patients were intubated in the PICU. AKI was detected in 9 patients. Hemodialysis was performed in 7 patients due to anuria and persistent hyperkalemia. In this study, fasciotomy was performed in 7 patients, and amputation 3 patients.

Definitions

CS was diagnosed in these children who had crushing injury to the skeletal muscle, myoglobinuria and/or hematuria, tense and swollen compressed limbs, and peak CK >1000 U/L.[6,8-11] CS diagnosis was made using clinical and laboratory features at the time of admission. Hypoxemia was defined as an arterial oxygen saturation of <90% recorded by a portable pulse oximeter or an arterial oxygen tension (PaO_2) <60 mmHg. AKI was defined with the KDIGO renal damage classification.[12] Initially, according to the CS treatment protocol of the unit, intravenous (IV) fluid infusion and alkaline therapy were started for all patients with suspected CS at the first admission. RRT was performed in hyperkalemic, hyperphosphatemic and/or anuric patients unresponsive to medical treatments. Intermittent hemodialysis (IHD) was performed on all patients as RRT. Since there was an issue with providing continuous RRT devices and equipment during the earthquake, IHD was performed on all patients. The patients were divided into two groups: those who were receiving RRT and those who were not. Also, patients were divided into two groups according to the anatomical sites of injury involving single or multiple extremities. The groups were compared in terms of demographic, clinical and laboratory characteristics.

Evaluated Parameters

Clinical and laboratory parameters were closely monitored. Clinically, systolic and diastolic blood pressure, heart rate, respiratory rate, pulse-oximetry monitoring, fluid input, urine output, and body temperature were continually monitored. Complete blood count, renal and liver function tests, CK, urea, creatinine (Cr), uric acid, magnesium (Mg), K, Na, Ca were measured. Disseminated intravascular coagulation (DIC) monitoring was performed with follow-ups prothrombin time, active partial thromboplastin time, D-dimer and fibrinogen. Urine, blood, and wound cultures were taken from children with fever. Whole body computed tomography and X-ray and Doppler ultrasonography of extremities performed for all patient.

Statistical Analysis

Descriptive and frequency statistical analyses were performed with the Statistical Package for the Social Sciences (SPSS) for Windows, version 17.0 (SPSS Inc.; Chicago, IL, USA). Chi-square test and Fisher's exact test were used to determine possible statistically significant differences between the categorical variables and are expressed as frequency (percentage). An Independent Student's t-test was used to compare continuous parametric variables, and the results were expressed as mean ± standard deviation. The Mann-Whitney U test was used to compare continuous non-parametric variables, and the results were expressed as median (minimum-maximum). Correlation coefficients and statistical significance were calculated using the Pearson test for normally distributed variables and the Spearman test for non-normally distributed variables. A statistically significant difference was defined as p-value <0.05.

Ethical Dimension of the Study

Ethical approval was obtained from Gaziantep University Clinic Research Ethics Committee (decision no: 2023/305, date: 04.10.2023).

Results

Eleven patients who were observed in the PICU and diagnosed with CS after the earthquake were included in the study. During this period, only CS patients were admitted to the PICU. Patients were transferred to other ICUs. The mean age of the patients was 10.45±4.92 years (range: 3-18 years). 7 of the patients were girls and 4 were boys. Patients were extracted from the rubble between 7 and 48 hours (median, 16 hours). The mean admission time was 29.9±39.2 (range: 1-120 hours). The mean PRISM score of the patients was 48.18±19.1 at admission. Four patients were in shock at the time of admission. Inotropic/vasopressor drugs were used in 5 patients. Dark urine was present in 8 (72.3%) patients upon admission. The mean CK, urea, Cr, and uric acid levels of the patients at admission were 84068±91297 (U/L), 91.4±42.1 (mg/dL), 1.68±0.92 (mg/dL), and 13.1±6.1 (mg/dL), respectively (Table 1).

There were lower extremity injuries in 10 patients, thoracic injuries in 2 patients, cranial injuries in 2 patients, and upper extremity injuries in 1 patient. Five patients had multiple areas of damage. Patients with single and multiple extremity injuries were compared for demographic, clinical and laboratory characteristics (Table 2). No significant differences were found for any parameters.

AKI was present in 9 patients. Two of these patients showed improvement with IV hydration. RRT was performed for seven patients. Three of these patients who underwent RRT died. These patients died due to CS and multiple trauma. The patients were examined in terms of the relationship between their findings at admission and the need for RRT (Table 3).

The need for RRT was significantly increased in patients with dark urine detected at admission (p=0.024). The mean age was significantly higher in the RRT group (p=0.003). RRT was performed in all male patients. The mean PRISM score was

Table 1. Demographic, clinical and laboratory findings of the patients at admission

Clinical and demografical features		
Categorical parameters	**n**	**%**
Sex (male)	4	36.5
Sex (female)	7	63.5
Dark urine	8	72.3
Shock*	4	36.5
Hypoxemia	5	45.5
Site of injury**		
Lower extremity	10	90.1
Thoracic injuries	2	18.2
Cranial injuries	2	18.2
Upper extremity	1	9.1
Continuous parameters	**Mean ± SD**	**Min-max**
Age (years)	10,45±4,92	3-18
PRISM score	48.18±19.1	6-64
Time for admission (hours)	29.9±39.2	1-120
Time spent under rubble (hours)	18.5±12.8	7-48
Laboratory findings	**Mean ± SD**	**Min-max**
Hct (%)	40.9±13.8	23.4-61.5
Leukocyte (/mm^3)	27678±11150	9480-44220
Platelet (/mm^3)	329090±170379	75000-599000
CK (U/L)	84068±91297	1651-234034
AST (U/L)	1477±1570	78-4691
ALT (U/L)	548±540	21-1480
LDH (U/L)	6129±5772	582-17640
Urea (mg/dL)	91.4±42.1	41-174
Cr (mg/dL)	1.68±0.92	0.43-3.11
Uric acid (mg/dL)	13.1±6.1	4.8-23.5
ICa (mg/dL)	1.1±0.2	0.6-1.5
Phosphorus (mg/dL)	9.1±4.6	3.9-19.5
Potassium (mEq/L)	6.1±1.7	3.6-9.5
Sodium (mEq/L)	136±11	125-164
Magnesium (mEq/L)	2.5±0.9	1.5-4.9
D-dimer (µg/L)	12.2±9.5	4.1-35.2
Lactate (mmol/L)	6.2±6.4	0.8-20
Albumin (gr/L)	27.6±10.2	8-41

*: Distributive shock, **: Some patients had injuries in more than one area, CK: Creatine kinase, AST: Aspartat aminotransferase, ICa: Ionized calcium, ALT: Alanine aminotransferase, LDH: Lactate dehydrogenase, Cr: Creatinine, SD: Standard deviation

significantly higher in the RRT group (p=0.042). The mean uric acid (p=0.026) and lactate levels (p=0.045) were found to be significantly higher for patient who had undergone RRT. Although the mean CK, LDH, and D-dimer levels were higher in the RRT group, this difference was statistically borderline (p=0.050, p=0.051, p=0.059 respectively). Although all other laboratory parameters were worse in the RRT group, no significant difference was found in the outcomes measured.

Table 2. Comparison of patients with single and multiple extremity injuries

Parameters	Single extremity injuries (n=6)	Multiple extremity injuries (n=5)	p
Age (year)	10±4 (4-16)	11±6 (3-19)	0.756
Sex (M/F)	3/3	1/4	0.545
Time to salvage (h)	17.40±9.55 (7-26)	19.60±16.68 (7-48)	0.804
Time before admission (h)	47.00±49.74 (12-120)	12.80±16.16 (1-41)	0.182
Dark urine	4	4	0.576
Shock*	2	2	0.652
Hypoxemia	3	2	0.608
Renal failure	5	4	0.545
Hct (%)	43.26±16.80	38.04±10.09	0.559
Leukocyte (/mm^3)	30345±13025	24478±8675	0.413
Platelet (/mm^3)	383333±138056	264000±197582	0.269
CK (U/L)	94057±90694	69085±103911	0.697
AST (U/L)	1703±1771	1205±1440	0.627
ALT (U/L)	612±556	469±573	0.685
LDH (U/L)	5459±4972	6930±7135	0.697
Urea (mg/dL)	94.50±43.16	87.60±45.53	0.802
Cr (mg/dL)	1.59±0.93	1.81±1.00	0.720
Uric acid (mg/dL)	14.28±5.56	11.52±7.03	0.484
ICa (mg/dL)	1.14±0.24	0.93±0.16	0.131
Phosphorus (mg/dL)	10.42±5.56	7.46±3.14	0.320
Potassium (mEq/L)	6.82±1.73	5.06±1.12	0.084
Sodium (mEq/L)	131.17±4.83	141.80±14.79	0.129
Magnesium (mEq/L)	2.73±1.24	2.18±0.55	0.382
D-dimer (µg/L)	10.41±5.99	14.86±13.95	0.500
Lactate (mmol/L)	5.92±7.37	6.54±5.77	0.881
Albumin (gr/L)	28.83±10.19	26.00±11.07	0.669
Hyperkalemia	5	3	0.545
Hyomagnesemia	6	4	0.455
Hyponatremia	5	2	0.242
Hypocalcemia	5	4	0.727
Fluid bolus	6	5	Null
O_2 suplementation	6	5	Null
Mechanicalventilation	4	4	0.576
Fasciotomy	5	2	0.242
Amputation	2	1	0.576
RRT	4	3	0.652
Inotrop-vasopressor	3	2	0.608
Nutrition (E/TPN)	0/6	0/5	Null
Length of stay in PICU	19.4±8.3 (6-27)	9.8±9.3 (2-23)	0.123
Outcome (Ex)	1	2	0.545

*Distributive shock, PICU: Pediatric intensive care unit, E/TPN: enteral/total paranteral nutrition, CK: Creatine kinase, AST: Aspartat aminotransferase, ICa: Ionized calcium, ALT: Alanine aminotransferase, LDH: Lactate dehydrogenase, Cr: Creatinine, RRT: Renal replacement therapy, Hct: Hematocrit

In patients who did not undergo RRT, the CK level decreased below 1000 U/L within an average of 9±5.19 days. In patients who underwent RRT and survived, CK levels decreased below 1000 U/L within an average of 13.96±1.4 days.

Despite all treatments administered in accordance with the CS treatment protocol, three patients died. The factors that may affect survival were examined in detail (Table 4). There was no significant association between demographic characteristics and survival. The mean lactate ($p<0.001$) and D-dimer ($p=0.039$) levels at admission were found to be significantly higher in patients who died. RRT was administered to all patients who died.

Correlation analysis was performed for parameters that may have been affected by the duration of stay under rubble and PICU admission duration (Table 5). We found that as the time spent under rubble increased, blood D-dimer and Cr levels increased, and iCa and albumin levels decreased. Also, a significant increase in hematocrit was detected as the time for admission to PICU increased. This may be related to hemoconcentration due to delayed fluid replacement.

Discussion

Support of airway, breathing, circulation should be provided in extrication and on scene management. Amputation in the

Table 3. Evaluation of the relationship between the findings at admission and the requirement for RRT

Parameters	**RRT (+)**	**RRT (-)**	**p**
Clinical and demografical features			
Categorical parameters	**n (%)**	**n (%)**	
Sex (male)	4 (100)	0 (0)	NS
Sex (female)	3 (42.9)	4 (57.1)	0.194
Dark urine	7 (87.5)	1 (12.5)	0.024
Shock*	4	0	NS
Hypoxemia	4	1	0.545
Continuous parameters	**Mean ± SD**	**Mean ± SD**	
Age (years)	13.285±3.450	5.5±2.380	**0.003**
PRISM score	61±3.464	40.857±20.594	**0.042**
Time spent under rubble (hours)	23.333±13.822	11.25±7.847	0.155
Time for admission (hours)	42.833±47.595	10.5±3.109	0.220
LOS in PICU (days)	19±11.619	11±6.377	0.604
Laboratory findings	**Mean ± SD**	**Mean ± SD**	
Hct (%)	44.5±14.8	34.5±10.2	0.267
Leukocyte (/mm^3)	25941±12365	30717±9448	0.523
Platelet (/mm^3)	325000±183800	336250±170562	0.923
CK (U/L)	127859±93939	18382±36645	**0.050**
AST (U/L)	2033±1742	504±407	0.125
ALT (U/L)	744±590	202±160	0.112
LDH (U/L)	8621±5808	1764±1919	**0.051**
Urea (mg/dL)	96.6±46.3	82.3±38.1	0.614
Cr (mg/dL)	2.10±0.93	1.14±0.67	0.143
Uric acid (mg/dL)	15.9±5.1	7.9±4.1	**0.026**
ICa (mg/dL)	1.1±0.27	1.1±0.11	0.515
Phosphorus (mg/dL)	10.9±4.5	5.8±3.3	0.084
Potassium (mEq/L)	6.7±1.6	4.86±1.05	0.083
Sodium (mEq/L)	136±12	137±9	0.879
Magnesium (mEq/L)	2.7±1.1	2.1±0.5	0.296
D-dimer (µg/L)	16.7±10.1	5.41±0.8	**0.059**
Lactate (mmol/L)	9.1±6.4	1.2±0.7	**0.045**
Albumin (gr/L)	25.9±12.3	30.5±4.5	0.495

*Distributive shock, CK: Creatine kinase, AST: Aspartat aminotransferase, ICa: Ionized calcium, ALT: Alanine aminotransferase, LDH: Lactate dehydrogenase, Cr: Creatinine, Hct: Hematocrit, RRT: Renal replacement therapy, LOS: Length of stay

field may be required for some patients. In these patients, adequate IV fluid infusion should be given as soon as possible. The study reported that fluid resuscitation during the initial two days is critical for preventing AKI.[13] Two patients were intubated at the scene, 1 patient was intubated in the hospital where they were firstly admitted, 3 patients were intubated in our emergency department and 2 patients were intubated in the PICU. Oxygen supplementation was given to all patients after they were removed from the rubble. The first fluid therapy was started in the emergency department for almost all of the patients.

Administration of IV fluid initiated in the field should be continued with close monitoring of urine output in hospital follow-up. Clinical examination and laboratory studies should be performed several times each day until stabilized. A urinary bladder catheter should be placed upon admission for close monitoring of urine output. Early recognition, evaluation, and treatment of compartment syndrome reduce the risk of CS and limb loss.[14] The need for amputations varies

Table 4. Evaluation of the factors that may have an impact on outcomes

Parameters	**Survivals**	**Non-survivals**	
Clinical and demografical features			
Categorical parameters	**n (%)**	**n (%)**	**p**
Sex (male)	3 (75)	1 (25)	0.98
Sex (female)	5 (71.4)	2 (28.6)	
Mechanical ventilation	5 (62.5)	3 (37.5)	0.491
Inotropic use	2 (40)	3 (60)	**0.061**
RRT	4 (62.5)	3 (37.5)	0.236
Fasciotomy	5 (62.5)	2 (37.5)	1.000
Amputation	3	0	NS
Wound infection	4	0	NS
Continuous parameters	**Mean ± SD**	**Mean ± SD**	**p**
Age (years)	8.8±4.2	14.6±4.5	**0.080**
PRISM score	45.37±21.82	55.66±4.93	0.453
Extracation time (hours)	16.3±8.7	23.7± 21.6	0.438
Time for admission (hours)	40,142±43,502	6±5.567	0.227
LOS in PICU (days)	18.5±9.38	9.66±12.42	0.503
Laboratory findings	**Mean ± SD**	**Mean ± SD**	**p**
Hct (%)	40.7±15.1	41.2±12.4	0.959
Leukocyte (/mm^3)	27487±10697	28186±14851	0.932
Platelet (/mm^3)	352250±158098	267333±223150	0.491
CK (U/L)	70953±83770	136527±137895	0.441
AST (U/L)	1511±1538	1384±2007	0.912
ALT (U/L)	542±485	560±796	0.965
LDH (U/L)	5399±4958	8071±8528	0.523
Urea (mg/dL)	94.3±42.3	83.3±49.7	0.720
Cr (mg/dL)	1.58±0.84	1.95±1.26	0.587
Uric acid (mg/dL)	11.2±5.1	17.8±7.1	0.110
ICa (mg/dL)	1.1±0.1	1.1±0.4	0.978
Phosphorus (mg/dL)	7.9±3.7	12.1±6.4	0.208
Potassium (mEq/L)	5.7±1.3	6.9± 2.5	0.325
Sodium (mEq/L)	135±7	139±21	0.580
Magnesium (mEq/L)	2.2±0.5	3.2±1.6	0.169
D-dimer (µg/L)	9.2±5.4	24.1±15.7	**0.039**
Lactate (mmol/L)	2.9±2.4	15.1±4.7	**<0.001**
Albumin (gr/L)	27.1±7.3	28.6±18.1	0.836

CK: Creatine kinase, AST: Aspartat aminotransferase, ICa: Ionized calcium, ALT: Alanine aminotransferase, LDH: Lactate dehydrogenase, Cr: Creatinine, RRT: Renal replacement therapy, PRISM: The pediatric risk of mortality, LOS: Length of stay, PICU: Pediatric intensive care unit, Hct: Hematocrit

Table 5. The time spent under rubble and the time for admission to PICU related correlation analysis

	Time spent under rubble		Time for admission	
Parameters	**r**	**p**	**r**	**p**
Hct[a]	0.118	0.745	**0.720**	**0.019***
Leukocyte[a]	-0.544	0.104	-0.062	0.866
Platelet[a]	-0.271	0.432	0.176	0.627
CK[a]	-0.090	0.818	0.035	0.928
AST[a]	0.093	0.798	0.457	0.184
ALT[a]	0.148	0.683	0.479	0.161
LDH[a]	-0.013	0.973	0.323	0.362
Urea[a]	0.602	0.065	0.095	0.795
Cr[a]	**0.702**	**0.024***	0.366	0.299
Uricasid[a]	0.099	0.786	0.224	0.534
iCalcium[a]	**-0.749**	**0.013***	-0.142	0.695
Phosphorus[a]	0.074	0.839	0.222	0.537
Potassium[a]	-0.155	0.668	0.098	0.788
Sodium[a]	0.509	0.133	-0.242	0.500
Magnesium[a]	-0.256	0.476	0.043	0.906
D-dimer[a]	**0.784**	**0.012***	-0.072	0.853
Lactate[a]	0.270	0.450	-0.168	0.643
Albumin[a]	**-0.698**	**0.025***	-0.089	0.808
Fasciotomy[b]	**0.647**	**0.043***	0.535	0.111
Amputation[b]	0.038	0.916	0.267	0.456
RRT[b]	0.534	0.108	0.178	0.622
Mortality[b]	0.038	0.916	-0.610	0.061

[a]: Pearson correlation test; [b]: Spearman correlation test, CK: Creatine kinase, AST: Aspartat aminotransferase, ICa: Ionized calcium, ALT: Alanine aminotransferase, LDH: Lactate dehydrogenase, Cr: Creatinine, RRT: Renal replacement therapy, Hct: Hematocrit

depending on delays in extrication, associated injuries, and local resources. Once AKI is established, aggressive IV fluid resuscitation is no longer appropriate. Hemodialysis is initiated for the usual indications of volume overload, hyperkalemia, severe acidemia, and uremia. IV fluids that had been started previously were continued in all patients, and clinical examination and laboratory studies were performed several times each day. In this study, fasciotomy was performed in 7 patients and amputation was performed in 3 patients. Five of the patients who underwent fasciotomy did not require amputation. Our data support that timely fasciotomy reduces the need for amputation. Also, clinical well-being was determined after amputation. AKI was detected in 9 patients, hemodialysis was performed in 7 patients due to anuria and persistent hyperkalemia.

In a limited number of pediatric CS studies, no association was found between the development of CS and age.[7] In addition, few of these studies examined the relationship between age and the need for RRT. Since only patients with CS were evaluated in our study, the relationship between age and CS development could not be examined. However, the relationship between age and RRT requirement was examined in our study. In this study, the mean age of patients who needed RRT was significantly higher. Also, a significant correlation was found between age and the need for RRT (r=0.839, p=0.001). This condition suggested that the injured muscle mass may have increased with increasing age.

Extrication time is strongly associated with earthquake-related mortality. A limited number of survivors may be extricated between 48 hours and 14 days after the event later.[15] It has been stated that widespread muscle injuries can be experienced also children who have been under the rubble only briefly.[9,16,17] Dönmez et al.[6] reported that the mean the time spent buried under rubble was 17.9±5.1 hours. They also reported that despite no significant correlation being observed between the time trapped under rubble and serum K, CK, AST, and LDH levels. Similarly, no significant correlation was found between the duration of being under rubble and F, CK, AST and LDH in our study. Iskit et al.[7] reported that the mean time spent under rubble was 35.44±13.34 and no correlation was found between the time spent under rubble and AKI. In this study, the time spent under rubble and the mean admission time were 18.5±12.8 and 29.9±39.2 hours, respectively. AKI was detected in 9 patients. The mean time

under rubble (21.3 h) and admission time to the ICU (34.5 h) were significantly higher in these patients. We think that the detection of AKI in almost all patients diagnosed with CS, who experienced very long stays under the rubble, may be affected by the correlation identified in their study. Although the mean time to stay under rubble in our study was very short compared to theirs, AKI was detected in most of our patients (82%) supports the importance of early rescue.

It is expected that some clinical and laboratory features in patients will be adversely affected as the duration of stay under the rubble is prolonged. In addition, the time for admission to PICU may also have an effect on these parameters. For these reasons, correlation analysis was performed between the duration of stay under the rubble, the time for admission to PICU, and various parameters (Table 5). There was a significant increase in Cr (r=0.702, p=0.024), D-dimer levels (r=0.784, p=0.012), and the need for fasciotomy (r=0.647, p=0.043), with prolonged time under the rubble. In addition, it was observed that there was a significant decrease in ionized calcium and albumin levels as the duration increased. In our study, similar to Dönmez et al.,[6] no significant correlation was found between biochemical indicators of muscle damage and the duration of stay under the rubble. This suggested that the muscle damage started early in patients and did not increase in correlation with the duration beyond a certain point. Previous studies support this as well.[16,17] In our study, the significant correlation of D-dimer, which is an indicator of DIC, and Cr, which is an indicator of AKI, with time under rubble revealed the importance of time under rubble. The most striking and overlooked finding was the relationship between ionized calcium and the time spent under rubble. Ionized calcium is a vital electrolyte that is not routinely checked. No correlation was found between the PICU admission time and any parameter. This may be related to the initiation of treatment prior to our involvement.

There are different reports in the literature regarding the relationship between the number of injured extremities and compartment syndrome complications. Oda et al.[9] reported that the peak serum CK level and incidence of AKI increased as the number of injured extremities increased. Dönmez et al.[6] reported that AKI was observed in only 14.3% of children with single extremity injury and 85.7% of children with multiple extremity injuries, and the peak serum CK level was higher in children with multiple extremity injuries, but this difference was not found significant. Iskit et al.[7] reported that there was no correlation between the number of extremities with crush injury (CI) and the incidence of AKI. They also reported that serum blood urea nitrogen, Cr, and potassium levels did not differ when CI involved more than one extremity. Although many parameters were poor in patients with multiple extremity injuries in our study, the differences were not significant (Table 2).

The most important and preventable prognostic complication in the CS is the development of AKI.[6,7,13,16,18] Efforts to prevent and treat AKI primarily focus on fluid replacements. RRT should be applied in unresponsive cases. We could not find literature information on clinical and laboratory features that would predict the need for RRT in pediatric patients with CS. For this reason, we examined the relationship between the clinical and laboratory characteristics of our patients at the time of admission and the need for RRT (Table 3). A significant relationship was found between the presence of dark urine, older age, high PRISM score, elevated blood uric acid and lactate levels, and RRT requirement. Although the mean CK, LDH, and D-dimer levels were higher in the RRT group, this difference was statistically borderline. Thus, it was concluded that patients with the characteristics listed at the time of admission may need RRT during follow-up. We think that this data make a significant contribution to the literature.

Study Limitations

There are some limitations of our study. The main limitation is that single center data has been presented, and the study includes a small number of cases. Since the number of patients is small, we think that the relationship between many laboratory parameters and the need for RRT remains statistically borderline. Since patients who did not develop CS were excluded from the study, no comment could be made on earthquake-related pediatric trauma. This is another limitation of this study.

Conclusion

Our results show that survival is possible in CS cases with effective and timely treatment approaches. We found that as the time spent under rubble increased, blood D-dimer and Cr levels increased, and iCa and albumin levels decreased. At admission, presence of dark urine, high prism score, high blood uric acid and lactate levels were associated with the need for RRT. Additionally, mortality was found to be higher in patients with high D-dimer and lactate levels at the time of admission. We think that our results should be confirmed with a larger number of patients.

Ethics

Ethics Committee Approval: Ethical approval was obtained from Gaziantep University Clinic Research Ethics Committee (decision no: 2023/305, date: 04.10.2023).

Informed Consent: Retrospective study.

Footnotes

Authorship Contributions

Surgical and Medical Practices: M.B., M.A.K., B.D.K., Concept: M.B., Ç.K., Design: M.B., Ç.K., M.A.K., B.D.K., Data Collection or Processing: E.K., M.D., Analysis or Interpretation: Ç.K., M.A.K., B.D.K., Literature Search: Ç.K., Writing: Ç.K.

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Association Between Early Fluid Overload and Mortality in Critically Ill Children

Kritik Hasta Çocuklarda Erken Sıvı Birikimi ile Ölüm Arasındaki İlişki

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Abstract

Introduction: Fluid therapy is essential during the resuscitation of critically ill children. However, aggressive resuscitation and additional fluids from medications and nutritional support often lead to fluid accumulation. Emerging evidence indicates that fluid buildup may negatively affect outcomes. This study aims to evaluate the relationship between early fluid accumulation and mortality in critically ill children.

Methods: This study enrolled 74 children in the pediatric intensive care unit (PICU) at Adam Malik, excluding those with prior renal impairment or a stay of less than 24 hours. Patients were categorized into survivors and non-survivors. Early fluid accumulation was calculated from the first 24 hours of fluid intake and output after admission.

Results: Out of 74 patients, 55.4% of whom were boys, with a median age of 31 months [interquartile range (IQR) 8-118 months]. The median first 24-hour fluid accumulation was 1.92% (IQR -48% to 20%). Fluid accumulation differed significantly between survivors and non-survivors (p=0.001), with non-survivors showing higher fluid accumulation (16%, IQR -10% to 27%) compared to survivors (-4%, IQR -20% to 4%). Bivariate analysis shows that fluid accumulation, vasoactive agent, mechanical ventilation, and pediatric logistic organ dysfunction-2 score have significant association with mortality (p<0.05). Multivariate analysis indicates that early fluid accumulation is linked to higher mortality [odds ratio (OR): 1.64; 95% confidence interval (CI): 1.22-2.19; p=0.001], while vasoactive agents are protective factors (OR: 0.28; 95% CI: 0.09-0.94).

Conclusion: Fluid accumulation is common in the PICU and significantly linked to mortality. These findings underscore the need to develop and evaluate strategies to mitigate the harmful effects of fluid accumulation.

Keywords: Critically ill children, early fluid accumulation, mortality

Öz

Giriş: Kritik derecede hasta çocukların resüsitasyonu sırasında sıvı tedavisi esastır. Ancak agresif resüsitasyon ve ilaçlardan ve beslenme desteğinden gelen ek sıvılar sıklıkla sıvı birikimine yol açar. Ortaya çıkan kanıtlar, sıvı birikiminin sonuçları olumsuz etkileyebileceğini göstermektedir. Bu çalışma, kritik derecede hasta çocuklarda erken sıvı birikimi ile mortalite arasındaki ilişkiyi değerlendirmeyi amaçlamaktadır.

Yöntemler: Bu çalışmaya Adam Malik'teki çocuk yoğun bakım ünitesinde (ÇYBÜ) böbrek yetmezliği olanlar veya 24 saatten az süre kalanlar hariç olmak üzere 74 çocuk dahil edildi. Hastalar sağ kalanlar ve sağ kalmayanlar olarak kategorize edildi. Erken sıvı birikimi, kabulden sonraki ilk 24 saatlik sıvı alımı ve çıkışından hesaplandı.

Bulgular: Yetmiş dört hastanın %55,4'ü erkekti ve ortanca yaşları 31 ay [çeyrekler arası aralık (ÇAA) 8-118 ay] idi. Ortanca ilk 24 saatlik sıvı birikimi %1,92 idi (ÇAA -%48-20). Sıvı birikimi sağ kalanlar ve sağ kalmayanlar arasında önemli ölçüde farklılık gösterdi (p=0,001), sağ kalmayanlar sağ kalanlara kıyasla daha yüksek sıvı birikimi gösterdi (%16, ÇAA -%10 ile %27) (-%4, ÇAA -%20-%4). İki değişkenli analiz, sıvı birikiminin, vazoaktif ajanın, mekanik ventilasyonun ve pediatrik lojistik organ disfonksiyon-2 skorunun mortalite ile önemli bir ilişkisi olduğunu göstermektedir (p<0,05). Çok değişkenli analiz, erken sıvı birikiminin daha yüksek mortalite ile bağlantılı olduğunu [olasılık oranı (OO): 1,64; %95 güven aralığı (GA): 1,22-2,19; p=0,001] ve vazoaktif ajanların koruyucu faktör olduğunu (OO: 0,28; %95 GA: 0,09-0,94) göstermektedir.

Sonuç: ÇYBÜ'de sıvı birikimi yaygındır ve ölümle önemli ölçüde bağlantılıdır. Bu bulgular, sıvı birikiminin zararlı etkilerini azaltmak için stratejiler geliştirme ve değerlendirme ihtiyacının altını çizmektedir.

Anahtar Kelimeler: Kritik derecede hasta çocuklar, erken sıvı birikimi, ölüm oranı

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Introduction

Fluid therapy is a crucial component in the resuscitation of critically ill children. Early aggressive fluid administration can adequately restore intravascular volume and is vital for saving lives. In addition to resuscitative fluid therapy, critically ill children are frequently administered other forms of "mandatory" fluids as part of their management, such as nutritional fluids, supportive medications, and maintenance fluids. This cumulative fluid administration frequently exceeds fluid losses, resulting in fluid overload (FO).[1,2]

Recent studies have shown that FO following initial resuscitation can substantially influence mortality in children.[3-5] Early FO has received considerable attention, as it appears to play a more critical role in predicting survival than late FO. This is because the peak severity of illness often manifests within the first few days of admission, after which the cumulative fluid balance curve flattens.[4,6] A threshold of 10% FO has been linked to increased mortality in some studies, with higher percentages correlating with even greater mortality rates.[5,7-10] At present, a clear definition of FO and a uniform threshold for predicting adverse outcomes, such as death or complications, in severely ill pediatric patients have yet to be established.

Materials and Methods

This study's data were collected from medical records until the required sample size was reached in both groups. The study population included all patients admitted to the pediatric intensive care unit (PICU) at Adam Malik Hospital, a major tertiary teaching hospital, between January and December 2022. Our PICU is a 10-bed, tertiary-level, university-affiliated PICU that combines medical and surgical (non-cardiac) and is staffed by board-certified pediatric intensivists, 24-hour residents, and one-to-one nursing care. Our PICU is equipped with ventilators, non-invasive ventilation such as continuous positive airway pressure and high flow nasal cannula, and continuous renal replacement therapy (CRRT). During the study period, our PICU did not adhere to a rigid protocol for net fluid balance; however, volume resuscitation was generally guided by the Surviving Sepsis Campaign guidelines.[1] In addition, local practice included the early administration of vasoactive drugs to ensure renal perfusion, as well as the early use of diuretics, hemodialysis, CRRT, and restricted fluid therapy to manage FO. Eligibility criteria included PICU admission for either medical or surgical reasons and an age range of 1 month to 18 years. Patients were excluded if they met any of the following criteria: 1) pre-existing acute or chronic kidney disease prior to PICU admission, 2) PICU stay of less than 24 hours, or 3) incomplete medical records. For patients with multiple PICU admissions during the study period, only the first admission was analyzed. Ethical approval for the study was granted by the University of Sumatra Utara Research Ethics Board (decision no: 457/KEPK/USU2023, date: 29.05.2023).

Data were collected from medical records using a consecutive sampling technique in both groups to achieve the required sample size. The sampling frame was derived from the mortality and admission registers of the PICU at Adam Malik Hospital. The independent variable in this study was early FO, while the dependent variable was mortality. Early FO was defined as FO within the first 24 hours of PICU admission.

FO was assessed based on the total fluid intake and output over a 24-hour period. Intake included all enteral and parenteral fluids, such as maintenance infusions, medications, nutritional products, and blood products. Output encompassed urine, blood loss, stool, nasogastric aspirates, and drainage. Urine output was measured either by weighing diapers or directly collecting urine via an indwelling urethral catheter. The percentage of FO was calculated using the following formula: [total fluid intake (L) - total fluid output (L)/body weight at PICU admission (kg)] × 100.[6,9,11]

To pinpoint independent predictors of mortality, we analyzed patient information gathered during the first 24 hours after PICU admission. This evaluation encompassed demographic data (including age, gender, body weight, and height), nutritional status, and clinical indicators, such as the pediatric organ logistic dysfunction (PELOD)-2 score and the presence of acute kidney injury (AKI). Additionally, data on PICU length of stay, use of diuretics and vasoactive medications, and net fluid balance were considered. The analysis also incorporated the earliest laboratory test results obtained during this period.

Statistical Analysis

Data analysis was conducted using SPSS software (version 25.0). For continuous variables, values were summarized as medians along with interquartile ranges (IQR), depending on the distribution pattern of the data. Group comparisons were made using the t-test for data with a normal distribution and the Mann-Whitney U test when the data were not normally distributed. Categorical variables were compared using the chi-square test or Fisher's exact test, as appropriate. Stepwise multivariate logistic regression analysis was conducted to identify factors potentially associated with mortality. To examine associations with PICU mortality, multivariate binary logistic regression was performed, yielding odds ratios (OR) along with 95% confidence intervals (CI). A two-tailed p-value of less than 0.05 was considered statistically significant.

Results

This study analyzed a total of 74 patients, evenly divided between the survival (n=37) and non-survival (n=37) groups. Respiratory conditions were the most frequent reason for PICU admission, accounting for 37.8% of cases. Other causes included postoperative status (20.3%), neurological disorders (18.9%), shock (10.8%), cardiac conditions (9.5%), and miscellaneous diagnoses (2.7%). Detailed sample characteristics are presented in Table 1. No statistically significant differences were found between the two groups in terms of age, gender, nutritional classification, diuretic usage, presence of AKI, or duration of PICU stay. In contrast, notable differences were observed in the administration of vasoactive medications, the use of mechanical ventilation, and early FO status, as shown in Table 2.

A bivariate analysis was first carried out to assess if early FO during the initial 24 hours of PICU admission independently correlates with increased mortality risk in critically ill pediatric patients, exploring associations between individual variables and mortality. Variables yielding a p-value below 0.25 in this initial analysis (see Table 2) were identified as potential confounders and were subsequently included in a multivariate binary logistic regression model, which used the backward elimination method.

In the multivariate logistic regression analysis, early FO (FO in the first 24 hours) was significantly associated with mortality (OR: 1.64; 95% CI: 1.22-2.19; p=0.001). The use of vasoactive agents was also significantly associated with mortality, acting as a protective factor (OR: 0.28; 95% CI: 0.09-0.94; p=0.039). However, no significant associations were found between sex (OR: 0.9; 95% CI: 0.26-3.12; p=0.877), use of mechanical ventilation (OR: 0.29; 95% CI: 0.05-1.54; p=0.147), or disease severity, as assessed by the PELOD-2 score (OR: 1.02; 95% CI: 0.99-1.05; p=0.075), and mortality in critically ill children (Table 3).

Table 1. Baseline characteristics of subjects

Variables	Total (n=74)
Age (months), median (IQR)	31 (8-118)
Gender (male), n (%)	41 (55.4)
24h fluid overload (%), median (IQR)	1.92 (-48-20)
Nutritional status, n (%)	
Severe wasted	20 (27)
Wasted	18 (24.3)
Normal	33 (44.6)
Overweight	2 (2.70)
Obese	1 (1.4)
Diuretic, n (%)	9 (12.2)
Vasoactive, n (%)	37 (50)
Mechanical ventilation, n (%)	49 (66.2)
PELOD-2 score, median (IQR)	4 (3-6)
AKI, n (%)	8 (10.8)
LOS (day), median (IQR)	6 (3-15)

IQR: Interquartile range, PELOD-2: Pediatric organ logistic dysfunction-2, AKI: Acute kidney injury, LOS: Length of stay

Table 2. Bivariate analysis between variables and mortality

Variables	Survivors (n=37)	Non-survivors (n=37)	p-value
Age (months), median (IQR)	48 (13-140)	17 (7-109)	0.394[a]
Gender (male), n (%)	23 (62.16)	18 (48.64)	0.242[b]
24h fluid overload (%), median (IQR)	-4 (-20-4)	16 (-10-27)	0.001[c]
Nutritional status, n (%)			0.670[b]
Severe wasted	9 (24.33)	11 (29.73)	
Wasted	11 (29.73)	7 (18.92)	
Normal	15 (40.54)	18 (48.65)	
Overweight	1 (2.7)	1 (2.7)	
Obese	1 (2.7)	0 (0)	
Diuretic, n (%)	6 (16.21)	3 (8.1)	0.286[b]
Vasoactive; n (%)	12 (32.43)	25 (67.56)	0.003[b]
Mechanical ventilation, n (%)	16 (43.24)	33 (89.18)	0.000[b]
PELOD-2 score, median (IQR)	3 (1-4)	6 (4-7)	0.000[a]
AKI; n (%)	3 (8.10)	5 (13.51)	0.454[b]
LOS (day), median (IQR)	6 (3-15)	6 (3-15)	0.665[a]

[a]: Independent t-test, [b]: Chi-square, [c]: Mann-Whitney U test, IQR: Interquartile range, PELOD-2: Pediatric organ logistic dysfunction-2, AKI: Acute kidney injury, LOS: Length of stay

Table 3. Multivariate analysis between variables and mortality

Variables	OR (95% CI)	p-value
Gender	0.9 (0.26-3.12)	0.877
24-h fluid overload	1.64 (1.22-2.19)	0.001
Vasoactive	0.28 (0.09-0.94)	0.039
Mechanical ventilation	0.29 (0.05-1.54)	0.147
PELOD-2 score	1.02 (0.99-1.05)	0.075

OR: Odds ratio, CI: Confidence interval, PELOD-2: Pediatric organ logistic dysfunction-2

Discussion

Children in critical condition are especially vulnerable to developing FO, notably within the initial 24 to 48 hours of care, due to the need for additional fluids for hemodynamic resuscitation, blood transfusion, medications, and capillary leak conditions.[12] Although no clinical trials have yet evaluated the impact of conservative fluid therapy or de-resuscitation strategies in children, recent recommendations for septic shock and acute respiratory distress syndrome (ARDS) suggest the use of a conservative fluid approach to prevent FO and associated complications.[13]

Findings from this study showed that the non-survival group had a higher FO compared to the survival group [median (IQR) FO in the first 24 hours for non-survivors and survivors: -4 (-20-4) and 16 (-10-27), respectively]. These findings suggest that a fluid restriction approach may have been applied more frequently in the survival group compared to the non-survival group. A study by Rameshkumar et al.[14] assessing cumulative FO over 7 days in the PICU, using a fluid restriction approach, found that a 3% FO did not significantly correlate with mortality or morbidity in critically ill children compared to a more aggressive resuscitation approach.

Fluid administration is a routine intervention in pediatric critical care, particularly during resuscitation. However, excessive fluid delivery can harm the vascular lining by disrupting the glycocalyx and damaging the endothelium. For this reason, intravenous fluids should be treated similarly to medications, each with its own clear indications, risks, and limitations. In 2014, Malbrain et al.[15] introduced a comprehensive framework for fluid stewardship, inspired by the principles used in antibiotic regulation. This framework includes the "4D" approach: considering the type of fluid, appropriate dosage, treatment duration, and timely reduction, as well as guidance on the initiation and cessation of both fluid therapy and fluid removal. The strategy also defines four clinical purposes for fluid use (resuscitation, maintenance, replacement, and nutrition) and categorizes therapy into four sequential stages, summarized by the ROSE acronym: resuscitation, optimization, stabilization, and evacuation.[16]

Recent literature suggests that FO is more related to fluid output than intake and that delaying fluid removal may worsen outcomes. In this study, diuretic use was higher in the survival group (16.21%) compared to the non-survival group (8.1%). This is likely associated with the early fluid deficit in the survival group, indicating fluid loss, compared to the non-survival group. These findings align with previous studies that suggest patients may benefit from fluid removal strategies such as diuretic use or hemofiltration.[4]

FO not only indicates that but also causes AKI. A meta-analysis of observational studies showed that the degree of FO correlates with mortality, with a 19% increased risk for every liter of fluid accumulated and a 6% increased risk for each percentage increase in FO. FO is also associated with a higher risk of AKI in critically ill children. A FO threshold >10% has been suggested as clinically significant for initiating RRT.[17] The renal angina index (RAI) is a tool used to assess the risk of AKI development in critically ill children, including FO in its analysis. Higher FO percentages lead to higher RAI scores. Studies have shown that an RAI value >8 can predict AKI on day 3 with a sensitivity of 43.7% and specificity of 79%.[18,19] This highlights that FO is an important factor in predicting AKI risk in critically ill children. In this study, the non-survival group had greater FO and a higher incidence of AKI (13.1%) compared to the survival group (8.1%), though the difference was not statistically significant (p=0.454). Further studies are needed to evaluate the direct relationship with FO.

In this study, no significant association was found among age, sex, and mortality in critically ill children. Research by Castañuela-Sánchez et al.[20] on post-cardiac surgery children showed that younger age was associated with FO, as younger children are more prone to hemodynamic instability, which increases their need for additional fluids to restore systemic perfusion.

Fluid resuscitation is the first step in early goal-directed therapy (EGDT) for managing children with sepsis or septic shock, which often requires intensive care. The administration of vasoactive and inotropic medications is the next step in cases where resuscitation does not respond to fluid therapy. EGDT has been shown to reduce mortality by up to one-third. The vasoactive-inotropic score (VIS) is a modality used to assess cardiovascular involvement that is associated with mortality in critically ill children, based on the maximum doses of vasoactive and inotropic drugs used. This study found a significant difference in vasoactive use between the non-survival and survival groups. Vasoactive agents were more frequently used in the non-survival group (67.56%) compared to the survival group (32.43%). These findings are consistent with research conducted at the Adam Malik Hospital PICU in 2021, which evaluated the relationship between VIS and

mortality. In this study, the VIS at 48 hours of PICU admission was higher in the non-survival group, compared to the survival group.[21] A VIS value >11 showed 78.87% sensitivity and 72.22% specificity in predicting mortality.[22] In this study, after multivariate analysis, vasoactive use was found to be a protective factor for mortality (OR: 0.28; p=0.039). This study did not analyze further the dosage, duration of vasoactive use, or VIS values, but it is hypothesized that vasoactive use as continuation therapy in cases unresponsive to fluid therapy may explain its protective role in mortality in this study. Furthermore, this study includes critically ill pediatric patients in general, without specifically targeting sepsis or septic shock cases. As a result, the use of inotropic agents in this study is not restricted to shock cases but may also apply to cardiovascular and other conditions. Further research is needed to assess the dose and duration of vasoactive drugs and their relationship to mortality and FO in critically ill children, considering that diagnosis classification may influence mortality outcomes.

Studies on ARDS and the latest consensus recommendations suggest that conservative fluid strategies with neutral or negative fluid balance can improve lung function and shorten PICU stay. In this study, the percentage of mechanical ventilation use was significantly higher in the non-survival group (89.19%) compared to the survival group (43.24%), (p=0.000). A meta-analysis indicated that FO >10% in the first 24 hours of PICU admission increases mortality, mechanical ventilation use, and length of PICU stay.[23] In this study, there was no significant difference in length of stay between survivors and non-survivors (p=0.665) - with a median stay of 6 days (IQR 3-15 days).

Based on bivariate analysis, a significant association was found between PELOD-2 scores and mortality in critically ill children (p<0.001); the median PELOD-2 score in the non-survivor group (median 6, IQR 4-7) was higher than in the survivor group (median 3, IQR 1-4). However, multivariate analysis revealed no significant association between PELOD-2 scores and mortality in critically ill children (p=0.075). Thus, it can be concluded that FO is an independent factor influencing mortality in this study. In line with previous studies, this research supports the hypothesis that early FO is associated with mortality in critically ill children and underscores the importance of monitoring and evaluating fluid therapy in this population. Fluid boluses for perfusion disorders in limited-resource settings have been associated with increased mortality within the first 24-48 hours.[24] This study shows that early FO within the first 24 hours increases mortality by 1.64 times after adjusting for disease severity. These results align with a meta-analysis of pediatric observational studies, which reported that each 1% rise in FO was linked to a 6% increase in mortality risk, even after accounting for initial illness severity.[5] Meanwhile, a study conducted in China in 2016 demonstrated significant findings, indicating that each 1% rise in FO was associated with a 36% higher risk of mortality.[9] Meanwhile, in patients undergoing dialysis, a twofold increase in mortality was observed in those with FO at dialysis initiation compared to those without it. Fluid removal through CRRT was found to reduce mortality. A study conducted by Kim et al.[25] in Korea showed that maintaining FO <10% during CRRT was associated with a reduction in mortality rates. A study conducted in Makassar in 2023 showed that a positive fluid balance ≥4.61% was associated with mortality in children, with 62.79% sensitivity and 58.95% specificity.[26] Preventing FO through a conservative fluid therapy approach and fluid evacuation can have a positive impact on outcomes in critically ill children.

Study Limitations

This study acknowledges several limitations that must be considered when interpreting the results.

Lack of pre-PICU admission fluid balance and PICU cumulative fluid balance data: The study was unable to assess the fluid balance prior to PICU admission, implying that initial fluid resuscitation, pressor administration, and diuretic therapy administered before admission were not recorded. Due to existing limitations, we did not assess cumulative PICU balance. This absence of baseline fluid balance data and PICU cumulative balances may have influenced the analysis of FO and its relationship with mortality.

Limited sample size and potential recording bias: The relatively small sample size and the risk of inaccurate recording of fluid input and output during PICU admission could introduce bias into the findings. Despite recalculating all collected fluid administration data from medical records to minimize potential inaccuracies, the limited sample size still raises concerns about the generalizability of the results.

Retrospective design: This was a retrospective, single-center study, which inherently limits the ability to infer causality and introduces potential bias associated with retrospective data collection. Additionally, the retrospective nature means that the findings are dependent on the quality of historical medical records and documentation.

These limitations underscore the need for further prospective, multicenter studies with larger sample sizes, detailed pre-admission baseline data, and PICU cumulative FO assessments to validate and expand the findings of this research.

Conclusion

In conclusion, FO is a prevalent issue in the PICU and is significantly associated with increased mortality. These findings highlight the critical need to develop and assess strategies aimed at mitigating the detrimental effects of FO in

critically ill children. Implementing targeted fluid management approaches has the potential to enhance clinical outcomes while minimizing the likelihood of complications associated with excessive fluid retention.

Ethics

Ethics Committee Approval: Ethical approval for the study was granted by the University of Sumatra Utara Research Ethics Board (decision no: 457/KEPK/USU2023, date: 29.05.2023).

Informed Consent: This study's data were collected from medical records until the required sample size was reached in both groups.

Footnotes

Authorship Contributions

Surgical and Medical Practices: M.A.W., R.A.C.S., A.P.P., S.M.L., H.W., J.H., Concept: M.A.W., R.A.C.S., A.P.P., Design: M.A.W., R.A.C.S., A.P.P., J.H., Data Collection or Processing: M.A.W., S.M.L., H.W., Analysis or Interpretation: M.A.W., R.A.C.S., A.P.P., J.H., Literature Search: M.A.W., S.M.L., H.W., Writing: M.A.W., R.A.C.S.

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Central-line-associated Blood Stream Infections in Children Admitted to a South African Paediatric Intensive Care Unit

Güney Afrika Çocuk Yoğun Bakım Ünitesine Yatırılan Çocuklarda Santral Venöz Kateterle İlişkili Kan Dolaşımı Enfeksiyonları

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Abstract

Introduction: Central line associated bloodstream infection (CLABSI) is a common complication of venous access. Rates of CLABSI are reportedly higher in middle-income countries compared with high-income countries. There is a paucity of data concerning CLABSI in South Africa. In this study we aimed to assess the prevalence of CLABSI and its associated factors at Dora Nginza Hospital.

Methods: We conducted a retrospective review of medical and laboratory records of all paediatric intensive care unit (PICU) patients who had central lines placed between January 2019 to December 2019. The CLABSI was defined according to Centers for Disease Control and Prevention guidelines. Eligible patients had to have had a central line for two days prior to CLABSI. Information concerning the type of the central line, associated factors, septic markers, and the organisms that were cultured was obtained from the records. Ethics approval was granted by the Institutional Review Board of Walter Sisulu University.

Results: In all, 289 patients were admitted in PICU during the period of the study, and 131 had central lines. The files of 107 children were used for the study with a total of 598 catheter days. Among 107 participants 19 CLABSI were identified yielding a CLABSI rate of 31.7 per 1000 catheter days. Patients with CLABSI had more central line days than those who did not develop CLABSI ($p<0.01$). Blood transfusion was also a risk factor for CLABSI in this study. Other known risk factors like antibiotics, catheter site, total parenteral nutrition, malnutrition were not found to be significantly associated in this study. Causes of CLABSI were Gram-negative (n=10, 52%) being predominant, followed by fungal at (26%, n=5) and Gram-positive (n=3, 15.8%).

Öz

Giriş: Santral venöz kateterle ilişkili kan dolaşımı enfeksiyonu (SVKİ-KDE), venöz erişimin yaygın bir komplikasyonudur. SVKİ-KDE oranlarının, yüksek gelirli ülkelere kıyasla orta gelirli ülkelerde daha yüksek olduğu bildirilmektedir. Güney Afrika'da SVKİ-KDE ile ilgili veriler yetersizdir. Bu çalışmada, Dora Nginza Hastanesi'nde SVKİ-KDE prevalansını ve bununla ilişkili faktörleri değerlendirmeyi amaçladık.

Yöntemler: Ocak 2019 ile Aralık 2019 tarihleri arasında merkezi venöz kateter takılan tüm çocuk yoğun bakım ünitesi (ÇYBÜ) hastalarının tıbbi ve laboratuvar kayıtlarını retrospektif olarak inceledik. SVKİ-KDE, hastalık kontrol ve önleme merkezleri kılavuzlarına göre tanımlandı. Çalışmaya dahil edilme kritelerine göre uygun hastalara, SVKİ-KDE gelişiminden iki gün önce merkezi venöz kateter takılmış olmalıydı. Merkezi kateterin türü, ilişkili faktörler, septik belirteçler ve kültürlenen organizmalarla ilgili bilgiler kayıtlardan elde edildi. Etik onay, Walter Sisulu Üniversitesi Kurumsal İnceleme Kurulu tarafından verildi.

Bulgular: Çalışma süresince ÇYBÜ'ye toplam 289 hasta yatırıldı ve 131'inde santral venöz kateter kullanıldı. Çalışmada 107 çocuğun dosyaları kullanıldı ve toplam 598 kateter günü kaydedildi. 107 katılımcı arasında 19 SVKİ-KDE olgusu tespit edildi ve bu da 1000 kateter günü başına 31,7 SVKİ-KDE oranı anlamına geliyordu. SVKİ-KDE olan hastalar, SVKİ-KDE gelişmeyen hastalara göre daha fazla santral kateter ile gün geçirdiler ($p<0,01$). Kan transfüzyonu da bu çalışmada SVKİ-KDE için bir risk faktörüydü. Antibiyotikler, kateter bölgesi, total parenteral beslenme, malnütrisyon gibi diğer bilinen risk faktörlerinin bu çalışmada anlamlı bir ilişkisi bulunmamıştır. SVKİ-KDE'nin nedenleri arasında Gram-negatif (n=10, %52) en yaygın olanıydı, bunu mantar (n=5, %26) ve Gram-pozitif (n=3, %15,8) izledi.

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Conclusion: The prevalence of CLABSI at Dora Nginza Hospital is high compared to rates reported in middle-income countries. Strict adherence to prevention bundles is required reduce CLABSI prevalence.

Keywords: Central-line-associated blood stream infections, children, South Africa

Sonuç: Dora Nginza Hastanesi'nde SVKİ-KDE prevalansı, orta gelirli ülkelerde bildirilen oranlara kıyasla yüksektir. SVKİ-KDE prevalansını azaltmak için önleme paketlerine sıkı sıkıya uyulması gerekmektedir.

Anahtar Kelimeler: Santral venöz kateterine bağlı kan dolaşımı enfeksiyonları, çocuklar, Güney Afrika

Introduction

Central line catheters are essential vascular access devices that are commonly used in critically ill patients. The use of central lines in intensive care is often necessary for patients requiring multiple infusions such as intravenous fluids, blood products, antibiotics, and total parenteral nutrition (TPN).[1,2] However, the use of central lines is not without risks, as they can lead to bloodstream infections.[1]

World-wide, central line associated bloodstream infections were the commonest cause of hospital acquired infections in 2001, with a reported mortality rate of 12-15%.[3] Central line associated bloodstream infection (CLABSI) can lead to high mortality, morbidity, increased length of stay and increased hospital costs in intensive care unit.[4]

The Centers for Disease Control and Prevention (CDC) defines CLABSI as "a laboratory confirmed bloodstream infection that occurs when an eligible bloodstream infection organism is identified and an eligible central line is present when the bloodstream is laboratory confirmed".[5] An eligible central line is defined as a central line that has been in place for more than two consecutive calendar days. An eligible pathogen is defined as any pathogen that can be used to meet laboratory confirmed bloodstream infection criteria. The infection cannot be related to any other infection the patient might have and must not have been present or incubating when the patient was admitted to the facility.[6]

With good aseptic techniques, most cases of central line-associated bloodstream infections can be minimised.[7] Introduction of CLABSI prevention guidelines reduced the incidence of CLABSI between 2001 and 2009 by 58%.[1] Care bundles are a group of interventions used for patients with intravascular central catheters, that when implemented together, result in better outcomes than when implemented individually. Central line bundle elements include hand hygiene, maximal barrier protection, chlorhexidine skin antisepsis, optimal catheter site selection, and daily review of need for the central line.[8]

Data on CLABSI from low- and middle-income countries are limited,[2] but it is reported that in low-income countries CLABSI rates are 3-5 times higher than in high-income settings.[9] In South Africa (an upper middle-income country), the CLABSI rate in a tertiary neonatal intensive care unit was 5.9 per 1000-line days,[2] and this was similar to that noted in some low- and middle-income countries, but higher than CLABSI rates in high-income settings. The rate of CLABSI noted in Iran (upper middle-income) was 10 per 1000 catheter days.[10] In the United States of America, CLABSI rate in intensive care units is estimated to be 0.8 per 1000 central line days.[11]

The risk factors of CLABSI may be classified as host-related and catheter-related. Host related risk factors include malnutrition,[12] leukopenia,[13] administration of blood products,[14] and TPN,[15] haematological malignancies,[12] prolonged use of broad-spectrum antibiotics,[16] stem-cell transplantation,[17] and male gender.[18]

Catheter related risk factors encompass types of catheters, including non-tunnelled, and multi-lumen catheters, as these carry a greater risk of CLABSI than tunnelled ones.[19] Femoral catheterisation is associated with a higher risk of infection than internal jugular and subclavian access.[20] The number of days since central line insertion is also a predictor for CLABSI.[21]

There is a paucity of data on CLABSI in critically ill children from low- and middle-income countries, particularly from Africa.[2] Knowledge of the CLABSI rate in poorly resourced settings and of common organisms causing CLABSI and their sensitivity patterns will help improve management of central lines and assist in choosing the appropriate antibiotics to treat CLABSI. This will likely assist in reducing morbidity and mortality associated with CLABSI in these settings. This study aimed to determine the prevalence, aetiology and outcomes of CLABSI in children admitted to a paediatric intensive care unit (PICU) in the Eastern Cape Province of the Republic of South Africa.

Materials and Methods

A descriptive study, cross-sectional and retrospective review of records of patients who had central lines in the PICU from January 2019 to December 2019 was conducted at Dora Nginza Hospital. The hospital is based in Gqeberha (formerly Port Elizabeth), in the Eastern Cape province (the poorest province in the Republic of South Africa). The hospital is the only public health facility offering regional and tertiary level paediatric services for children in the Western Region of the Eastern Cape, which has a population of approximately 2 million people. The PICU potentially has 16 beds, but only 6 beds are functional due to a nursing staff shortage. The nurse-to-patient ratio in the unit is typically 1:2. All children

with medical or surgical conditions that require intensive care are admitted to the unit. The ages of patients eligible for admission into the PICU range from one week to 12 years. There is one pediatric intensivist who supervises the medical officers and pediatric residents rotating in the PICU. Central lines are usually inserted by the medical officer/resident rotating in the unit. The indications for central line insertion include venous access for blood transfusion, administration of TPN, and inotropes.

All children with an eligible central line (two consecutive days) with a recovery of an eligible pathogen from blood culture by the time of infection or within 24 hours after the removal of the central line were enrolled. Children who did not meet the criteria of CLABSI, and those whose blood cultures were assessed as contaminants were excluded. Children who died or were discharged within 48 hours of PICU admission were also excluded.

The study was time-bound, but a priori sample size calculations indicated that at least 40 participants were required.

Paediatric intensive care files from January 2019 to December 2019 that met the inclusion criteria were evaluated by the principal researcher. The procedure included scrutiny of the PICU register to note the number of admissions for each month, the number of admissions who had central lines, and how many of them developed infections . The files were then retrieved from records storage, and demographic data (age and gender) and information on the indications of the central line, type of the central line, associated factors, septic markers, and the organisms that were cultured were reviewed by the researcher.

Known risk factors of CLABSI, underlying diagnoses, complications, antibiotics used, the duration of antibiotics, and the clinical outcome of each patient were identified. A data collection sheet was used for each patient.

The chi-square test was used to test for the association between organisms and complications, and for assessing association between demographic data, complications, antibiotics administered, and clinical outcomes. P-value of less than 0.5 was statistically significant.

Ethical clearance was obtained from the Institutional Review Board of Walter Sisulu University (certificate number: 009/2022, date: 30.03.2022).

Statistical Analysis

Data were analysed using the Statistical Package for the Social Sciences version 29.0 software. Data were assessed for normality by visual examination of histograms, followed by normality tests. Continuous data (including age and duration of central line) were described using frequencies and means with standard deviations if normally distributed, median with interquartile range was used for data that are not normally distributed. Frequencies were used to describe categorical data. Prevalence and common pathogens were described using frequencies.

Results

During the 12-month study period, 289 children were admitted to the PICU. One hundred and thirty-one patients had central lines, but 24 of them were excluded. Therefore, 107 patient files were fully analysed for the study, and 19 of them had central line-associated bloodstream infection. The assessment for eligibility and enrolment procedures is summarised in Figure 1.

Demographics, Human Immunodeficiency Virus (HIV), and Nutritional Status of the Patients

The gender distribution of the 107 children was 63 (58.9%) males; and the median age was 5.3 months. In terms of age distribution, more than half (52.3%) of the children were 6 months of age or younger and 18.7% were older than 5 years of age (60 months). Forty-two percent of children were between 1-6 months, 18% were above 60 months, and the remaining 40% were between 6 and 60 months.

The HIV status of all the children was known, and 8 (7.5%) were HIV positive with the remaining 99 (92.5%) being HIV negative. Seventeen percent of the children were malnourished, 13.1% (n=14) were moderately malnourished, 4.7% (n=5) were severely malnourished, and 82% (n=88) were well nourished. The demographic data is summarised in Table 1.

Prevalence of CLABSI

Out of the 107 children who had central lines, 19 (17.8%) developed central line associated bloodstream infections; the rest did not. There were 19 patients with CLABSI and 598 catheter days. The overall CLABSI rate was calculated to be 31.7 per 1000 catheter days.

Admission Diagnosis of Study Population and of Children with CLABSI

The commonest admission diagnoses among the 107 enrolled children were pneumonia (30 children), congenital heart diseases (13 children), acute gastroenteritis (12 children), sepsis (11 children) and surgical conditions (10 children). The remaining 31 children had other conditions. Among the 19 children who developed CLABSI, the most common diagnoses were pneumonia (6, 32% of children), congenital heart diseases (3, 16%) and surgical conditions (3, 16%).

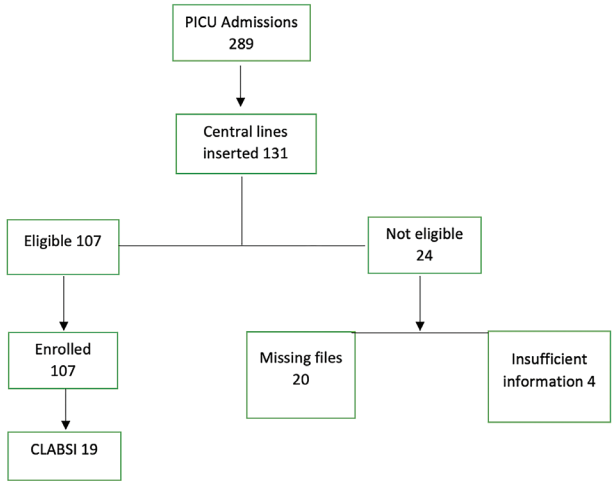

Figure 1. Consort diagram of the population
PICU: Paediatric intensive care unit, CLABSI: Central line associated bloodstream infection

Table 1. Demographics, HIV and nutritional status of the study population

Characteristics		Number	Percentage
Age in months	0-1	11	10.3%
	>1-6	45	42.0%
	>6-12	14	13.1%
	>12-24	9	8.4%
	>24-60	8	7.5%
	>60	20	18.7%
Sex	Male	63	58.9%
	Female	44	41.1%
Nutrition	Normal	88	82.2%

HIV: Human immunodeficiency virus

Risk Factors for CLABSI

Virtually all enrolled children (106/107) had non-tunneled central line catheters. All children who developed CLABSI had tunnelled central line catheters inserted in the femoral vein. There were 86 (97%) children who had femoral catheters, and 19 of these 86 children developed CLABSI (22%). With regard to duration of catheter days, 73 (83%) of the 88 children who did not have CLABSI had their central lines in situ for less than 7 days, while 9 (47%) of those who developed CLABSI had central lines in situ for less than 7 days. Findings related to catheter line days and other risk factors for CLABSI are summarised in Figure 2 and Table 2, respectively.

There were significantly more children with CLABSI who had central lines for more than 7 days (52.6%) compared to those children who did not develop CLABSI (16%), p<0.01. Eleven out of 19 patients who had CLABSI received a blood transfusion (57%), p<0.01.

All 19 patients who had CLABSI received antibiotics before the diagnosis of CLABSI, as opposed to 68 (77%) of those patients who received antibiotics on admission but did not develop CLABSI; however, this was not significant. There was also no difference in the prevalence of malnutrition and administration of TPN, between those who developed CLABSI and those who did not.

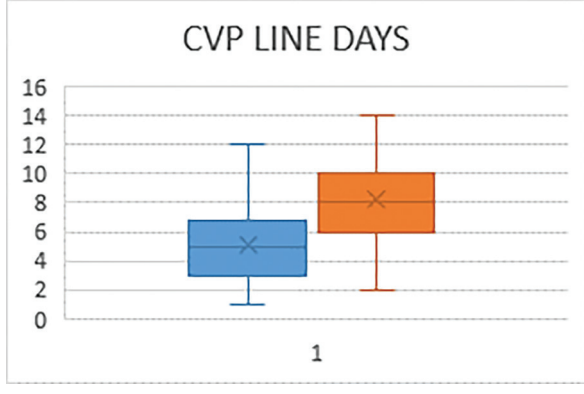

Figure 2. Association between catheter line days and development CLABSI
CLABSI: Central line associated bloodstream infection, Blue: No CLABSI, Orange: With CLABS

Laboratory Investigations on Non-CLABSI vs. CLABSI Patients

Most children with CLABSI (94.7%) had markedly or moderately elevated C-reactive proteins (CRPs). Only 5.3% had normal CRPs at the time of CLABSI diagnosis, and this was significantly different from children who did not have CLABSI. Fifty-two percent of all children with CLABSI had normal white cell counts. Of these, only 26.3% had low platelet counts, while 73.7% had normal or high platelet counts. This is shown in Table 2.

Organisms Causing CLABSI and Their Sensitivity

Out of the 19 children who developed CLABSI, 10 (52.6%) had Gram-negative bacilli responsible for the CLABSI. The Gram-negative bacilli were noted as follows: Five (26.3% of the CLABSI population) children had multidrug-resistant *Escherichia coli* (*E. coli*), which was sensitive to ertapenem and gentamicin; another two (10.5%) had *Klebsiella pneumoniae*, which was sensitive to meropenem, ertapenem, and gentamicin; and one (5%) who had *Chryseobacterium gleum* that was sensitive to ciprofloxacin.

The second most common organisms causing CLABSI were fungal infections, with 5 (26.3%) children having the following fungal infections: *Candida albicans* (two children), which was sensitive to fluconazole and amphotericin B; *Candida glabrata* (one child), which was only sensitive to amphotericin B; one child had *Candida parapsilosis*, which was sensitive to amphotericin B; and one child had *Candida tropicalis* (5% of CLABSI), sensitive to both fluconazole and amphotericin B.

The least common cause of CLABSI was Gram-positive organisms; 3 children (15.8% of CLABSI), and these were two children with *Staphylococcus epidermidis* (10%) and one with *Enterococcus faecium* (5%), both sensitive only to vancomycin (see Table 3).

Complications of CLABSI According to the Cultured Organisms

Out of 19 children who had CLABSI, 11 (59.9%) had septic shock as a complication. There was no evidence of other CLABSI complications. Fifty percent (n=5) of all the Gram-negative organisms had septic shock and needed inotropes, and the cultured organism was *Acinetobacter baumannii* in

Table 2. CLABSI risk factors

Catheter related		No CLABSI	CLABSI	p-value
Type of line*	Tunnelled	1	0	
	Non-tunnelled	87	19	
	Total	88	19	
Site*	Femoral	86	19	
	Subclavian	1	0	
	Other	1	0	
	Total	88	19	
Duration	1-7 days	73	9	p<0.01
	>7 days	15	10	
	Total	88	19	
Host related				
Antibiotics	No	20	0	p=0.21
	Yes	68	19	
	Total	88	19	
Blood transfusion	No	78	8	p<0.01
	Yes	10	11	
	Total	88	19	
TPN	No	85	16	p=0.62
	Yes	3	3	
	Total	88	19	
Nutrition	SAM	3	2	p=0.39
	MAM	12	2	
	Normal	73	15	
	Total	88	19	

TPN: Total parenteral nutrition, SAM: Severe acute malnutrition, MAM: Moderate acute malnutrition, *: P-value not calculated for type of line and site as some cells had zero as value, CLABSI: Central line associated bloodstream infection

Table 3. Organisms causing CLABSI and their sensitivity

Type	Organism	n (CLABSI%)	Sensitivity	
GNB	*Acinetobacter baumannii*	5 (26%)	Colistin only	
	Escherichia coli	2 (10.5%)	Ertapenem	Gentamicin
	Klebsiella pneumoniae	2 (10.5%)	Meropenem ertapenem	Gentamicin
	Chryseobacterium gleum	1 (5%)	Ciprofloxacin only	
GPC	*Staphylococcus epidermidis*	2 (10.5%)	Vancomycin only	
	Enterococcus faecium	1 (5%)	Vancomycin only	
Fungi	*Candida albicans*	2 (10.5%)	Fluconazole	Amphotericin B
	Candida glabrata	2 (10.5%)	Amphotericin B only	
	Candida parapsilosis	1 (5%)	Amphotericin B only	
	Candida tropicalis	1 (5%)	Fluconazole	Amphotericin B

GNB: Gram-negative bacilli, GPC: Gram-positive cocci, CLABSI: Central line associated bloodstream infection

80% of these cases. Thirty-three percent of the children in whom a Gram-positive organism was cultured developed septic shock, and the organism was *Staphylococcus epidermidis* in all cases. With respect to fungal infections, 5 (83%), children developed septic shock. Cerebrospinal fluid, hearing, eye, and bone assessments were not looked into in this study.

CLABSI Outcomes

Out of 19 children with CLABSI, 4 (21.1%) died, and all of them had a fungal infection. The fungal organisms cultured were *Candida albicans* (two children), *Candida glabrata* (one child), and *Candida tropicalis* (one child). The catheters were removed from all patients suspected to have CLABSI before organism identification. There was no use of antibiotic lock therapy for any of the patients due to its unavailability in the institution.

All 10 patients who had Gram-negative organisms cultured survived. Additionally, 3 patients who had Gram-positive organisms survived and were discharged from the intensive care unit. However, only two of the six children (33%) who had fungal infections survived.

Discussion

We conducted a descriptive study to determine the prevalence (rate) of CLABSI, identify common pathogens and sensitivity patterns, identify complications of CLABSI, and evaluate factors associated with CLABSI.

Out of the 289 patients admitted in PICU over the duration of the current study, only 131 (45%) had central lines inserted. The rate of central line insertion is lower than that in other intensive care units. A study conducted in the United States of America (USA) revealed that 50-80% of critically ill patients require central lines at some point during their stay in the intensive care unit (ICU). The lower rate may be because there is no paediatric high care unit at Dora Nginza Hospital. Consequently, some high care level patients are admitted to the ICU and these patients only need non-invasive ventilation and may not require central line insertion.

The ages of patients admitted to PICU in this study ranged between 0.1 months and 5 years of age. Young age has been shown to be a risk for developing CLABSI.[23] This was also observed in a Swiss study, where children between the ages of 2 months and 5 years had high incidence rates of CLABSI.[24] In the current study, 84% of the patients who developed CLABSI were younger than 5 years of age; this was in keeping with the above studies.

In the current study, there were only eight patients who were HIV positive (7.5% of the study population), and this was unlike the findings noted in an American study where HIV positive patients had increased risk of developing CLABSI compared with HIV negative patients.[25] Children with malnutrition are reported to have an increased risk of developing CLABSI,[23] but this was not the case in the current study. Children who are severely malnourished are not eligible for admission into the Dora Nginza Hospital PICU, and this probably reduced the expected effect of malnutrition on the development of CLABSI.

The study found a CLABSI rate of 31.7 per 1000 catheter days in a PICU, where both medical and surgical patients are admitted. This rate is higher than most studies that were previously done in Mumbai, India. For example, the rate was 4.3/1000-line days.[26] In a study conducted in Cape Town, South Africa, the rate was 5.9/1000-line days,[2] and in one conducted in Bloemfontein, South Africa, the rate was 26.3/1000-line days.[27] These two studies were conducted in South African provinces that are better resourced than the Eastern Cape province. The rate noted in the current study is higher than what is reported in low- and middle-income countries, as CLABSI rates are reported to be 3-4 times higher than those in high-income countries.[28] In Egypt (a middle-income country), CLABSI rates are reported to range between

2.9 and 14.3 per 1000 catheter days, with an overall rate of 9 per 1000 catheter days,[29] while in India (a middle-income country), the overall CLABSI rate was 17 per 1000 catheter days, which is 16-fold higher than that in the USA.[17] The rate of CLABSI noted in another middle-income country Iran, was 10 per 1000 catheter days.[10]

The possible explanation for very high CLABSI rates in our institution might be attributed to poor adherence to CLABSI reduction care bundles. The non-adherence might be due to a shortage of staff in the PICU, but the reasons for non-adherence were not assessed in the current study.

Males had a higher percentage of CLABSI compared to females, and this was in keeping with other observed findings where there was male predominance in patients with CLABSI.[30] Age distribution for children with CLABSI was not different from those who did not develop CLABSI in the current study, and this was similar to studies conducted in Türkiye and India.[17,31] where there was no difference in age and sex between children who had CLABSI and those who did not develop it.

The common PICU diagnoses were acute respiratory conditions, congenital heart disease, sepsis, surgical patients post-operatively, trauma, and others in that order. This was in keeping with a study done in Australia where most indications of admission were respiratory; cardiac; surgical; trauma; sepsis, etc., but not necessarily in the same order.[32]

With regard to risk factors, the known risk factors associated withfor CLABSI in the current study were blood transfusion and long duration of the central line. Blood transfusion is known to be a risk factor for development of CLABSI.[14] TPN and malnutrition are known to be independent risk factors for development of CLABSI.[12,15] However, in the current study, they were not significantly associated with the development of CLABSI.

All children who developed CLABSI had received broad spectrum antibiotics prior to developing CLABSI. However, there was no significant association when compared to the children who had also received broad spectrum antibiotics but did not develop CLABSI. This was not in keeping with studies conducted in India,[17] America,[11] and Japan,[33] which reported that the use of broad spectrum antibiotics is a risk for developing CLABSI.

Risk factors related to the catheter site and the type of catheter inserted could not be compared for risk assessment because almost all (99%) study children had non-tunnelled central line catheters, Furthermore, out of all the non-tunnelled catheters, only one child had a subclavian central line; the rest, had femoral catheters. It is known that non-tunnelled catheters carry a greater risk of CLABSI than tunnelled,[19] Femoral catheterisation is associated with a higher risk of CLABSI than internal jugular and subclavian access.[20]

Central line days since insertion is also a predictor for CLABSI, and this was also true in the current study. There were significantly more patients who had the lines *in situ* for more than 7 days among children with CLABSI compared with those who did not develop CLABSI. This was in keeping with a systematic review and meta-analysis which showed that prolonged catheterisation is a major risk factor for developing CLABSI.[34]

Ninety-four percent of all the patients with CLABSI had markedly and moderately elevated CRP levels, and only 5% had normal CRP levels at the time of CLABSI diagnosis. Only 47% of the CLABSI had elevated white cell count, while 53% had normal white cell count. CRP is an inflammatory protein used in clinical practice to guide antibiotic therapy, and the discrepancy between its increase and normal WCC in the current study might be due to the prior use of antibiotics before the diagnosis of CLABSI. This was not in keeping with a study done in Japan where patients with CLABSI showed a low white cell count and CRP compared to bloodstream infections without central line catheter.[35]

The most common causes of CLABSI in the current study were Gram-negative organisms like multi-resistant *Acinetobacter baumannii*, *E. coli* and *Klebsiella pneumoniae.*. Fungal infections were the second most common cause, and these were *Candida albicans*, *Candida glabrata*, *Candida parapsilosis*, and *Candida tropicalis*. The least common cause was Gram-positive organisms such as *Staphylococcus epidermidis* and *Enterococcus faecium*.

These findings were not consistent with findings from the CDC, where Gram-positive organisms like *Coagulase negative staphylococci*, *Enterococci*, and *Staphylococcus aureus* were the common causes of CLABSI, followed by Gram-negative organisms like *Klebsiella*, *Enterobacter*, *Pseudomonas, E. coli*, and *Acinetobacter*, with *Candida* species being the least common. It was however, in keeping with South African studies where Gram-negative organisms were found to be a common cause of bloodstream infections and CLABSI rather than Gram-positive organisms.[2,27] Multi-resistant *Acinetobacter baumannii,* requires that there be an emphasis on infection prevention measures and on strengthening antibiotic stewardship.

Complications of CLABSI include port pocket infections, endovascular infections such as endocarditis and thrombophlebitis, and metastatic infections such as osteomyelitis and liver, spleen, and brain abscesses. The only complication of CLABSI recorded in the current study was septic shock, and there was no evidence of other complications during the clinical examination.

Catheter tip cultures were not done routinely in all the patients who had central lines; the positive tips did not help

in the diagnosis of CLABSI. Although 63% of the patients had positive catheter tips, with negative blood cultures. Peterson and Smith[36] did not find any clinical significance of central line catheter tip cultures in the diagnosis of CLABSI. Huang et al.[37] noted that central line catheter cultures had no impact on antimicrobial therapy for CLABSI.

The CLABSI mortality rate was 21% in the current study. The mortality rate for CLABSI is estimated to be 20-25% globally by the CDC, and 12-15% in Southern California.[38] The cause of death among all the CLABSI patients was fungal infection. Fifty percent of them were HIV positive and malnourished, adding more risk of mortality, and the other two had cardiac issues. The cause for fungal CLABSI mortality is due to late diagnosis as most patients who deteriorate in the ICU are empirically commenced on antibiotic treatment for Gram-negative and Gram-positive organisms.

Study Limitations

This was a retrospective record review study in a hospital with no electronic filing system for patients, and approximately one fifth of the hospital files were either missing or had insufficient information. The findings of the study may not be generalizable to hospitals in well-resourced settings and may be compared to similarly resourced settings. Dora Nginza PICU only admits children 12 years, but in the studies used for comparison, the ages of participants were up to 18 years, and this should be considered a limitation.

Conclusion

This study found a very high CLABSI incidence of 31/1000 line days at Dora Nginza PICU; blood transfusion and long catheter line days were significant risk factors. The multi-drug resistant *Acinetobacter baumannii* was the most common cause of CLABSI, and fungal infection was associated with high mortality. Further studies focusing on fungal causes of CLABSI are recommended.

Ethics

Ethics Committee Approval: Ethical clearance was obtained from the Institutional Review Board of Walter Sisulu University (certificate number: 009/2022, date: 30.03.2022).

Informed Consent: It was not included because it was a descriptive study with a cross-sectional retrospective review of the records of patients with central catheters.

Footnotes

Authorship Contributions

Concept: N.V.B., N.P.Z., S.M., Design: N.V.B., N.P.Z., S.M., Data Collection or Processing: N.V.B., Analysis or Interpretation: N.V.B., S.M., Literature Search: N.V.B., N.P.Z., S.M., Writing: N.V.B., N.P.Z., S.M.

Conflict of Interest: No conflict of interest was declared by the authors.

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Parents' State and Trait Anxiety Levels During Bloodletting Attempts in the Pediatric Emergency Department

Çocuk Acil Servisinde Kan Alma Girişimleri Sırasında Ebeveynlerin Durumluk ve Süreklilik Anksiyete Düzeyleri

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Abstract

Introduction: Parental stress and anxiety during pediatric bloodletting in the pediatric emergency department (PED) are influenced by a complex interplay of factors, including the child's medical condition, unfamiliarity with procedures, healthcare-provider interactions, and parental knowledge gaps. This study aimed to identify parents' state and trait anxiety levels during bloodletting procedures performed on their children in the PED and to explore factors influencing these anxiety levels.

Methods: This descriptive cross-sectional study was conducted in the PED of a tertiary hospital in the southeast of Türkiye. Data were collected from 180 parents using a questionnaire that included a socio-demographic information form, and the state-trait anxiety inventory. Data were collected between 6 January 2025 and 20 February 2025. The data were analysed using the IBM SPSS statistics for Windows version 22.0.

Results: Parents exhibited moderate levels of anxiety, with mean state anxiety scores of 41.494±10.322 and trait anxiety scores of 39.189±9.370. Mothers reported significantly higher trait anxiety levels compared to fathers (41.944±9.012 vs. 35.056±8.371, p<0.001). Lower maternal education levels, non-working status, and lower income were associated with higher trait anxiety. Parents who received education about their child's illness had significantly lower anxiety levels (p<0.05). Satisfaction with healthcare staff communication and information provision also correlated with reduced anxiety.

Conclusion: The study highlights the significant anxiety experienced by parents during pediatric bloodletting procedures, particularly among mothers and those with lower socio-economic status.

Öz

Giriş: Çocuk acil serviste (ÇAS) çocukların kan alma işlemleri sırasında ebeveynlerin yaşadığı stres ve kaygı, çocuğun tıbbi durumu, prosedürlere aşina olmama, sağlık çalışanlarıyla etkileşimler ve ebeveynlerin bilgi eksiklikleri gibi bir dizi faktörün karmaşık etkileşimiyle şekillenir. Bu çalışma, ÇAS'te çocuklarına kan alma işlemi yapılan ebeveynlerin durumluk ve sürekli kaygı düzeylerini belirlemeyi ve bu kaygı düzeylerini etkileyen faktörleri incelemeyi amaçlamaktadır.

Yöntemler: Tanımlayıcı kesitsel tipteki bu çalışma, Türkiye'nin güneydoğusunda bulunan üçüncü basamak bir hastanenin ÇAS'te gerçekleştirilmiştir. Veriler, sosyo-demografik bilgiler formu ve durumluk-sürekli kaygı envanterini içeren bir anket kullanılarak 180 ebeveynden toplanmıştır. Veriler 6 Ocak 2025 ile 20 Şubat 2025 tarihleri arasında toplanmıştır. Veriler, Windows için IBM SPSS istatistik, sürüm 22.0 kullanılarak analiz edilmiştir.

Bulgular: Ebeveynler orta düzeyde kaygı yaşamış olup, durumluk kaygı puanları ortalama 41,494±10,322 ve sürekli kaygı puanları ortalama 39,189±9,370 olarak bulunmuştur. Anneler, babalara kıyasla anlamlı derecede daha yüksek sürekli kaygı düzeyleri bildirmiştir (41,944±9,012'ye karşı 35,056±8,371, p<0,001). Daha düşük anne eğitim düzeyi, çalışmama durumu ve daha düşük gelir, daha yüksek sürekli kaygı ile ilişkilendirilmiştir. Çocuğunun hastalığı hakkında eğitim alan ebeveynlerin kaygı düzeyleri anlamlı derecede daha düşük bulunmuştur (p<0,05). Sağlık çalışanlarıyla iletişim ve bilgi sağlama konusundaki memnuniyet de azalmış kaygı ile ilişkilendirilmiştir.

Sonuç: Bu çalışma, özellikle anneler ve düşük sosyo-ekonomik statüye sahip olanlar arasında, pediatrik kan alma işlemleri sırasında

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Abstract

Providing educational support and improving communication between healthcare staff and parents can help to alleviate parental anxiety. These findings underscore the need for targeted interventions to support parents in PED settings.

Keywords: State anxiety, trait anxiety, parents, child, bloodletting, pediatric emergency department

Öz

ebeveynlerin yaşadığı önemli kaygıyı ortaya koymaktadır. Eğitim desteği sağlamak ve sağlık çalışanları ile ebeveynler arasındaki iletişimi iyileştirmek, ebeveynlerin kaygısını hafifletmeye yardımcı olabilir. Bu bulgular, ÇAS ortamlarında ebeveynleri desteklemek için gerekli müdahalelere duyulan ihtiyacı vurgulamaktadır.

Anahtar Kelimeler: Durumluk kaygı, sürekli kaygı, ebeveyn, çocuk, kan alma, çocuk acil servisi

Introduction

Hospitalization, especially unexpected visits to the pediatric emergency departments (PEDs), can be incredibly stressful for children and their families.[1] Parents play a crucial role in their children's health, providing not only direct care and access to healthcare services, but also shaping the attitudes and behaviours that influence children's well-being.[2] Parents frequently experience significant stress, including anxiety, depression, and insecurity, during a child's hospitalization.[1] Existing research often concentrates on specific pediatric populations, such as children with cancer,[3] particular hospital experiences like stays in the pediatric intensive care unit,[4] and those involving congenital heart disease and surgery.[5] However, the stress associated with hospitalization can affect any parent whose child requires medical care. It is essential to recognize the broader impact of this stress on families and consider support systems to help parents cope during these challenging times.

While hospitalization is undoubtedly stressful,[6] a visit to the PEDs can be particularly challenging, being a child's first experience with a hospital setting. This initial encounter can significantly influence future interactions with healthcare systems, affecting the likelihood of return visits and the utilization of other hospital services.[7] The unfamiliar environment, coupled with the urgency and potential seriousness of medical situations encountered in the PEDs, contributes to heightened stress levels in both children and their families.[7] Furthermore, the PED often acts as a gateway to further hospital care, shaping perceptions and anxieties surrounding future hospitalizations.

Various factors influence the stress and anxiety levels experienced by parents during PEDs visits and the PED treatment process. Common reasons for children presenting to emergency departments include health issues that require urgent intervention, such as poisoning, injuries, and infections, which can exacerbate parental anxiety.[8-10] According to s systematic review study, the perceived urgency of child's health condition was the most cited reason for PED visit.[11] Another systematic review found that parents worried about their child's health conditions, delayed recovery, complications of illness, and felt frustrated, fearful, and anxious.[12] Such situations often heighten parental concerns, thereby increasing their anxiety levels.[10,12-14] Additionally, a lack of sufficient information regarding their child's medical condition can further elevate anxiety levels among parents.[14] The information gap regarding their child's treatment process is another significant factor contributing to parental stress.[12,14]

Common initial procedures in the PEDs include establishing intravenous access and obtaining blood samples.[7] These procedures are often necessary for administering medications, fluids, and obtaining diagnostic information quickly. However, they can be stressful for children and their families. A supportive and empathetic approach from healthcare staff could help to alleviate parental anxiety.[15,16] The quality of communication between parents and healthcare staff directly impacts the stress levels experienced by parents. Providing information and actively listening to parental concerns can serve as an effective strategy to reduce anxiety levels.[16]

Parental stress and anxiety during pediatric bloodletting in the PED are influenced by a complex interplay of factors, including the child's medical condition, unfamiliarity with procedures, healthcare-provider interactions, and parental knowledge gaps. Anxiety levels in parents accompanying children during medical procedures significantly influence the overall experience in PEDs. The context of bloodletting attempts, in particular, raises unique challenges due to the invasive nature of the procedure, which often triggers heightened anxiety in both children and their caregivers.[17] Prior investigations into pediatric procedural experiences have demonstrated that parental anxiety can be a potent predictor of child distress, complicating the ability of healthcare staff to provide effective care and support during these critical moments.[18,19] As parents navigate their own fears regarding pain and potential complications associated with procedures such as medical interventions, their emotional responses play a crucial role not only in the parents' well-being but also in how successfully the child copes with the situation.[20] As parental emotional state can significantly impact both immediate coping in the PED, and subsequent treatment adherence and family care,[7] this study aimed to identify parents' state and trait anxiety levels during bloodletting from their child in the PED and to explore factors influencing these anxiety levels. By identifying

variations in anxiety levels and correlating these with the children's responses, this study aims to unravel the complex emotional interactions that occur in these high-stakes environments, ultimately guiding better practices and training for healthcare staff working with pediatric populations.

Materials and Methods

Study Design

This is a descriptive cross-sectional study.

Settings, Participants and Sampling

The setting of this study was PED at a tertiary hospital with a 700-bed capacity and located in the southeast of Türkiye. The population of this study consisted of parents of children who had undergone bloodletting during their PED visit. A prior G*Power 3.1.7 analysis was performed to determine the study's sample size. Due to the small effect size (0.1) and the small number of studies on parents the minimum sample size was calculated to be 158 with a margin of error of 5% and a confidence interval of 80% using the one group sign test.[21] The study sample consisted of 180 parents who agreed to participate and were selected using a convenience sampling method. Inclusion criteria were: (1) parents aged ≥18 years, (2) accompanying a child undergoing bloodletting, and (3) fluency in Turkish. Exclusion criteria included parents with cognitive impairments or acute distress (e.g., actively crying/agitated) that could interfere with questionnaire completion. Only one parent per child was eligible to participate in the study to ensure independence of observations and avoid data clustering.

Data Collection

Data were collected between 6 January 2025 and 20 February 2025. The data were collected by using a questionnaire technique, employing a data collection form consisting of 2 parts. The researchers explained the aim of the study to the parents. After parents were informed that their participation was voluntary and that they could leave without reason, the questionnaire was distributed as hard copies to be filled out during their free time. Parents completed the questionnaires in a designated quiet area adjacent to the PED treatment zone, separated by a privacy screen to minimize distractions. While the emergency department environment inherently involves some background activity, efforts were made to ensure confidentiality and reduce interruptions. Parents were allowed to remain with their children during data collection, as separation could exacerbate stress. However, if the child required immediate medical attention, parents were given the option to pause or resume the questionnaire later. Researchers monitored the process to address any disruptions promptly. The questionnaires were filled out by the parents and collected by the researchers. Filling out the questionnaire took about 10 minutes.

Data Collections Forms

Socio-demographic information form: The researchers (A.B., S.B., M.Ç.) developed a 24-item questionnaire to collect data on patient and parent demographics (gender, age, grade level, number of children in the family, parental education level) and aspects of their PED visit, including the time slot of PED visits, receipt of education about the child's illness, satisfaction with healthcare staff, communication, information provision, and care of the child received in the PED, adequacy of allocated time for care, and the likelihood of revisiting the PED in the future for the same health problem.

State-trait anxiety inventory (STAI): This tool was developed by Spielberg et al. [22] in 1971 and translated and validated in Turkish by Öner and Le Compte,[23] with permission to use the scale granted by them. It consists of two 20-item scales: one for state anxiety and one for trait anxiety. Each item is rated on a four-point Likert scale ranging from "not at all" to "completely." Total scores for each scale range from 20 (lower scores indicating lower anxiety levels) to 80 (higher scores indicating higher anxiety levels). A score of 36 and below indicates no anxiety. Thirty-seven-42 points indicate mild anxiety. A score of 43 and above indicates high anxiety. The Cronbach's alpha internal consistency coefficient for the STAI was between 0.94 and 0.96.[23] When the reliability analysis values of the scale were examined, Cronbach's alpha internal consistency coefficient was 0.876 for STAI-state anxiety and 0.892 for STAI-trait anxiety. The Cronbach's alpha values indicate that both scales have high internal consistency.

Statistical Analysis

The data were analysed using the IBM SPSS statistics for Windows, version 22.0 (SPSS INC., Chicago, IL, USA) statistical tool. The descriptive features of the parents who participated in the study were determined using frequency and percentage analyses, while the scale was analyzed using mean and standard deviation statistics. Kurtosis and skewness values were used to determine whether the study variables were normally distributed. In the relevant literature, the kurtosis values of the variables between +1.5 and -1.5[20] and the skewness between +2.0 and -2.0[21] are considered as indicators of normal distributions. It was established that the variables had a normal distribution. The data were analysed using parametric approaches. Categorical variables were represented as frequencies (%). Other variables were reported as mean ± standard deviation, median, and range. The variations in scale levels were investigated using an independent groups t-test, one-way ANOVA, and post-hoc

(Tukey, LSD) tests based on the parents' descriptive features. The results were assessed with a 95% confidence interval. Significance was determined at $p<0.05$.

Ethical Consideration

Ethical approval was obtained from the Mardin Artuklu University Non-invasive Clinical Research Ethics Committee (decision no: 2024/11-28; date: 05.11.2024). Institutional permission was granted by the Mardin Provincial Directorate of Health (date: 20.11.2024; reference number: E-68051626-770-260095201). Informed consent was obtained from all study participants. The study was conducted following the principles of the Declaration of Helsinki.

Results

The results regarding the parents' descriptive characteristics were presented in Table 1. When the descriptive characteristics of the parents were examined, it was seen that 60% of the participants were mothers and 40% were fathers. It was determined that the majority of mothers had primary school education (31.7%), and 35.6% of fathers had high school education. In the distribution of the participants according to their occupational status, it was determined that 45.0% were housewives, 11.7% were workers, 25.6% were civil servants, and 17.8% were self-employed. When evaluated in terms of where they lived, it was determined that 59.4% lived in the city centre. Considering the income status, the analysis revealed that 49.4% of the participants maintained an equal income-expenditure balance, and 10.6% had more income than expenses. In the distribution according to family structure, it was determined that 87.8% belonged to nuclear families and 12.2% belonged to extended families. The mean age of the children was 6.380±5.016 (min: 0; max: 18), mean maternal age was 32.270±6.785 (min: 19; max: 55), and mean paternal age was 35.940±7.442 (min: 21; max: 60). The mean number of children was 2.930±1.584 (min: 1; max: 9).

Table 1. Descriptive characteristics of participant

Variables	n	%
Child's gender		
Male	87	48.3
Female	93	51.7
Relation to the child		
Mother	108	60.0
Father	72	40.0
Mother's education level		
Primary school	57	31.7
Secondary school	44	24.4
High school	48	26.7
Bachelor's degree and higher	31	17.2
Father's education level		
Primary school	27	15.0
Secondary school	34	18.9
High school	64	35.6
Bachelor's degree and higher	55	30.6
Employment status of mother		
Working	23	12.8
Not working	157	87.2
Employment status of father		
Working	158	87.8
Not working	22	12.2
Occupation		
Housewife	81	45.0
Worker	21	11.7
Civil servant	46	25.6
Self-employment	32	17.8
Place of residence		
City centre	107	59.4
District	30	16.7
Village	43	23.9
Income status		
Income less than expenditure	72	40.0
Income equals expenditure	89	49.4
Income more than expenditure	19	10.6
Type of family		
Nuclear family	158	87.8
Extended family	22	12.2
	Mean	**SD**
Age of the child	6.380	5.016
Age of the mother	32.270	6.785
Age of the father	35.940	7.442
Number of children in the family	2.930	1.584

SD: Standard deviation

Parents' experiences with the PED are provided in Table 2. When the educational status of the patients with the disease was examined, it was determined that only 28.9% of them received education. In terms of satisfaction with the healthcare staff in the emergency department, the majority of the participants (83.9%) expressed satisfaction. The satisfaction rate with communication by healthcare staff was 80.0%, and for providing information, it was 78.9%. The percentage of patients satisfied with the care service provided in the PED was 82.8%, and the percentage who stated the time allocated for treatment and care was sufficient was 80.6%.

Table 3 shows the scores of state anxiety and trait anxiety. When the anxiety levels of the parents were examined, the mean state anxiety score was 41.494±10.322 (min: 20, max: 74) and the mean trait anxiety score was 39.189±9.370 (min: 21, max: 63). These findings suggest that parents experience moderate levels of anxiety overall. As a result of the reliability analysis for the state and trait anxiety scales used in this study, Cronbach's alpha values were determined to be 0.876 for the state anxiety scale and 0.892 for the trait anxiety scale. The scales used in the research are said to be very reliable, when Cronbach's alpha coefficient values are ≥0.80. Cronbach's alpha values in our study show that both scales have high internal consistency.

The differentiation of parents' state and trait anxiety scores according to demographic variables is presented in Table 4. When the differentiation of parents' state and trait anxiety scores according to demographic variables was examined, significant differences according to certain variables were found. When anxiety scores were evaluated, it was determined that the mean state anxiety score was similar in parents with male children (41.770±10.256) and parents with female children (41.237±10.432). In terms of trait anxiety scores, it was seen that 38.724±8.522 for parents with male children had scores of 38.724±8.522 and parents with female children had scores of 39.624±10.126. However, the difference was not statistically significant for either variable (p>0.05). When state anxiety scores were examined, there was no significant difference between groups of parents (p=0.168). However, there was a significant difference between mothers (41.944±9.012) and fathers (35.056±8.371) in terms of trait anxiety scores (p<0.001).

When the difference according to the mother's education level was examined, a significant difference was observed in trait anxiety scores (p<0.001). According to the post-hoc analysis, the trait anxiety scores of primary and high school graduate mothers were significantly higher when compared to secondary and undergraduate graduates (p<0.05). When grouped by the father's education level, there was no statistically significant difference in state and trait anxiety scores (p>0.05).

According to the mothers' working status, it was determined that the trait anxiety scores of the non-working mothers were significantly higher than those of the working mothers (p=0.005). However, there was no significant difference in terms of state anxiety (p=0.925). A significant difference was found in trait anxiety scores according to the working status of the participants (p<0.001). According to the post-hoc analysis, the trait anxiety scores of mothers who were housewives were significantly higher than those who were civil servants and self-employed people (p<0.05).

A statistically significant difference was found in terms of trait anxiety scores of parents according to place of residence (p=0.009). According to the post-hoc analysis, trait anxiety scores of individuals living in the district were found to be significantly higher than those living in the city center (p<0.05). There was also a significant difference in trait anxiety scores according to income status (p=0.003). According to the post-hoc analysis, it was observed that the trait anxiety scores of individuals whose income was less than their expenses were significantly higher compared to other groups (p<0.05).

It was determined that both state (p=0.043) and trait anxiety (p=0.007) scores of parents who received education about their child's disease status were significantly lower than those who did not receive education. When the variables of satisfaction with PED were examined, significant differences

Table 2. Participants' experiences with the PED

Variables	n	%
Receiving education about child's illness		
Yes	52	28.9
No	128	71.1
Satisfaction with the healthcare staff in the PED		
Yes	151	83.9
No	29	16.1
Satisfaction with the communication of healthcare staff in the PED		
Yes	144	80.0
No	36	20.0
Satisfaction with providing information by healthcare staff in the PED		
Yes	142	78.9
No	38	21.1
Satisfaction with the care of the child received in the PED		
Yes	149	82.8
No	31	17.2
Adequacy of allocated time for care		
Yes	145	80.6
No	35	19.4
Status of revisit to the PED in the future for the same health problem		
Yes	171	95.0
No	9	5.0

PED: Pediatric emergency department

Table 3. State anxiety and trait anxiety scores

	n	Mean	SD	Min.	Max.	Cronbach's alpha
State anxiety	180	41.494	10.322	20.000	74.000	0.876
Trait anxiety	180	39.189	9.370	21.000	63.000	0.892

SD: Standard deviation

Table 4. Parents' state and trait anxiety scores according to demographic variables

Demographic characteristics	n	State anxiety	Trait anxiety
Child's gender		Mean ± SD	Mean ± SD
Male	87	41.770±10.256	38.724±8.522
Female	93	41.237±10.432	39.624±10.126
t		0.346	-0.643
p		0.730	0.521
Relation to the child		Mean ± SD	Mean ± SD
Mother	108	42.361±10.149	41.944±9.012
Father	72	40.194±10.513	35.056±8.371
t		1.383	5.168
p		0.168	**0.000**
Mother's education level		Mean ± SD	Mean ± SD
Primary school	57	42.175±9.638	42.456±10.608
Secondary school	44	39.386±10.976	36.727±6.886
High school	48	43.917±10.162	40.750±8.729
Bachelor's degree and higher	31	39.484±10.337	34.258±8.262
F		2.001	7.331
p		0.116	**0.000**
Post-hoc			1>2, 3>2, 1>4, 3>4 (p<0.05)
Father's education level		Mean ± SD	Mean ± SD
Primary school	27	43.185±11.094	41.037±8.026
Secondary school	34	39.059±9.695	37.853±9.248
High school	64	43.578±9.720	40.766±9.127
Bachelor's degree and higher	55	39.746±10.622	37.273±10.053
F		2.318	1.983
p		0.077	0.118
Employment status of mother		Mean ± SD	Mean ± SD
Working	23	41.304±12.459	34.044±8.819
Not working	157	41.522±10.018	39.943±9.236
t		-0.094	-2.877
p		0.925	**0.005**
Employment status of father		Mean ± SD	Mean ± SD
Working	158	41.380±10.183	38.823±9.536
Not working	22	42.318±11.495	41.818±7.762
t		-0.399	-1.409
p		0.691	0.161
Occupation		Mean ± SD	Mean ± SD
Housewife	81	41.815±10.096	42.198±8.721
Worker	21	42.286±11.328	38.381±10.317
Civil servant	46	40.348±11.162	35.348±9.122
Self-employment	32	41.813±9.261	37.625±8.526
F		0.263	6.208
p		0.852	**0.000**
Post-hoc			1>3, 1>4 (p<0.05)
Place of residence		Mean ± SD	Mean ± SD
City centre	107	41.486±9.872	37.701±9.344
District	30	42.900±10.959	43.467±10.358

Table 4. Continued

Demographic characteristics	n	State anxiety	Trait anxiety
Village	43	40.535±11.083	39.907±7.779
F		0.461	4.797
p		0.631	**0.009**
Post-hoc			2>1 (p<0.05)
Income status		Mean ± SD	Mean ± SD
Income less than expenditure	72	42.375±10.889	42.083±8.947
Income equals expenditure	89	40.202±9.579	37.270±9.143
Income more than expenditure	19	44.211±11.138	37.211±9.635
F		1.629	6.049
p		0.199	**0.003**
Post-hoc			1>2, 1>3 (p<0.05)
Type of family		Mean ± SD	Mean ± SD
Nuclear family	158	41.411±10.043	39.114±9.508
Extended family	22	42.091±12.394	39.727±8.498
t		-0.289	-0.287
p		0.773	0.775
Receiving education about child's illness		Mean ± SD	Mean ± SD
Yes	52	39.058±9.552	36.269±9.458
No	128	42.484±10.493	40.375±9.106
t		-2.036	-2.711
p		0.043	**0.007**
Needing more information/education about child's illness?			
Yes	96	41.979±9.615	38.417±9.392
No	84	40.941±11.108	40.071±9.323
t		0.673	-1.183
p		0.502	0.238
Satisfaction with the healthcare staff in the PED			
Yes	151	39.483±8.951	39.073±9.360
No	29	51.966±10.795	39.793±9.567
t		-6.645	-0.378
p		**0.000**	0.706
Satisfaction with the communication of healthcare staff in the PED			
Yes	144	39.188±9.102	38.278±9.149
No	36	50.722±9.846	42.833±9.482
t		-6.690	-2.653
p		**0.000**	**0.009**
Satisfaction with providing information by healthcare staff in the PED			
Yes	142	39.183±8.798	38.472±9.387
No	38	50.132±11.104	41.868±8.924
t		-6.429	-2.001
p		**0.000**	**0.047**
Satisfaction with the care of the child received in the PED			
Yes	149	39.839±9.336	38.920±9.217
No	31	49.452±11.254	40.484±10.132
t		-5.027	-0.845
p		**0.000**	0.399

Table 4. Continued

Demographic characteristics	n	State anxiety	Trait anxiety
Adequacy of allocated time for care			
Yes	145	39.593±9.529	39.021±9.518
No	35	49.371±9.852	39.886±8.828
t		-5.413	-0.489
p		**0.000**	0.625
		r/p	r/p
Age of the child		-0.113/0.130	0.032/0.674
Age of the mother		-0.135/0.071	-0.042/0.571
Age of the father		-0.116/0.120	-0.040/0.592
Number of children in the family		-0.023/0.760	0.017/0.824

F: One-way ANOVA test, t: Independent groups t-test, Post-hoc: Tukey, LSD: Pearson correlation analysis, SD: Standard deviation, PED: Pediatric emergency department

were found in satisfaction with PED healthcare staff the communication of healthcare staff, information provided by healthcare staff, care of the child , and adequacy of allocated time for care. It was determined that the state anxiety scores of individuals who were not satisfied with PED were significantly higher in all these variables ($p<0.001$). However, in terms of trait anxiety, there was a significant difference only in satisfaction with providing information by healthcare staff ($p=0.047$) and satisfaction with the communication of healthcare staff ($p=0.009$). In addition, when the correlation analyses were examined, there was no significant relationship between child age, mother's age, father's age, number of children in the family, and anxiety scores ($p>0.05$).

Discussion

Being in the hospital is a situation that creates stress and anxiety in parents. Being hospitalised is a stressful procedure for children as well as for members of the family. Many of the parents experience increased levels of anxiety during these procedures. During bloodletting in the PED, parents may experience anxiety about the procedures in general. Invasive procedures are procedures that cause anxiety and panic in families.[24] Parents are likely to feel incompetence, inadequacy, and insecurity about themselves during such times.[25] In addition, during such processes, fears and anxieties stemming from issues such as deficiencies in parental roles within families, understanding the disease, and anticipating its consequences are primary factors that heighten parental anxiety.[24]

The present study reveals that parents experience moderate levels of anxiety during bloodletting attempts in the PED. This result aligns with prior research suggesting that parental anxiety in similar contexts often reaches moderate levels, influenced by varying situational pressures and the overarching stress of managing a child's medical needs.[26,27] The anxiety experienced by parents may stem from their concerns regarding the pain their child may endure during procedures, as well as the potential for adverse outcomes, both of which can significantly exacerbate emotional distress.[27] When the anxiety levels of the parents were examined, it was found that they generally experienced moderate anxiety in both the state and trait anxiety categories. It is natural for parents to experience anxiety due to the health condition of their child. The results are consistent with the existing studies regarding parents admitted to the emergency departments.[28]

In analyzing the differences between mothers and fathers, a significant disparity was observed in trait anxiety scores, with mothers exhibiting a higher average score compared to fathers. This result is consistent with literature indicating that mothers typically report higher levels of anxiety, particularly in contexts involving their children's health.[29] In the literature, studies have found that mothers and fathers experience different levels of anxiety during hospitalization. Mothers feel anxiety at a higher rate than fathers when their children are hospitalized.[30] This can be explained by the fact that mothers may react more intensely to the health status of their children due to the pregnancy and birth process.[30] These results suggest that mothers are more sensitive to their children's health conditions, which may be due to mothers' traditional roles in childcare. Psychological, emotional, and social well-being of caregivers can directly affect the quality of care children receive.[31] Therefore, reducing parental anxiety could contribute to better experiences of both parents and children.

Different results regarding the anxiety level according to the education level have been reported. Some studies found that the level of education did not affect the level of anxiety, while others stated that anxiety increased as the level of education decreased.[32] In this study, there were no differences in the stress levels experienced by fathers across different education levels. However, it was observed that the trait anxiety scores of primary and high school graduate mothers were significantly higher than college and undergraduate

graduates. The influence of maternal education level on trait anxiety scores suggests that educational background plays a pivotal role in managing anxiety, with a significant difference noted. Post-hoc analysis revealed that mothers with only primary education or high school education had significantly higher anxiety scores compared to those with secondary or undergraduate qualifications. This result resonates with previous studies highlighting that lower educational attainment often correlates with increased anxiety levels, likely due to reduced access to health information and coping resources during stressful medical encounters.[27,33]

In addition, this study determined that the trait anxiety scores of mothers who were not working or who were housewives were higher than those of the other groups. Similar results were found in previous studies, which show that stress-inducing interventions in the hospital environment can lead to more anxiety in non-working mothers.[34] Moreover, this study revealed that trait anxiety scores of parents, whose income was less than their expenses, were found to be significantly higher than the others. The findings that economic factors increase anxiety seem to be consistent with other studies.[35]

Geographical and socio-economic factors also emerged as significant contributors to trait anxiety. Parents living in district areas reported significantly higher anxiety scores than those in city centres, and income status was similarly positively correlated with anxiety levels. These results are consistent with a body of literature that links environmental and economic stressors to elevated parental anxiety while highlighting that parents from lower socio-economic statuses often face additional emotional burdens due to financial insecurities and limited healthcare access.[27,36] Thus, community-based resources and support systems are paramount to addressing these disparities in parental anxiety levels.

The difference in both state and trait anxiety scores among parents who received education regarding their child's disease status underscores the impact of informational support. Educated parents reported significantly lower anxiety levels, likely due to their enhanced understanding of the medical process and expected outcomes, enabling them to feel more prepared and less apprehensive in the face of their child's treatment.[26] This finding aligns with existing research that supports the effectiveness of pre-procedural education as a tool to alleviate anxiety and build confidence among caregivers.[37] In addition, increased parental anxiety could negatively affect the process of children's coping with medical procedures. Providing information to parents could help to prevent their fears and relieve their anxieties. Therefore, informing families about the disease, creating a suitable environment for parents to express themselves, and answering the questions they have were important factors that could help to reduce parents' anxiety.[38] In line with these studies, this current study found that both state and trait anxiety scores of parents who received prior education about their child's disease lower than those who did not receive education. Therefore, informing parents about the health condition of their children could help to alleviate parental anxiety.

Parents' stress and anxiety levels may also differ individually. In hospitals, parents generally need someone to explain the current situation of their children to them and to provide emotional and spiritual support. If families do not communicate adequately with healthcare staff, their anxiety and stress could increase. At this point, nurses play an important and effective role in alleviating stress and anxiety of families.[39] Providing sufficient, descriptive, and accurate information about the procedure to be performed on the child in a timely manner could help to reduce the anxiety of parents. Within the scope of the family-centered care and caregiver role of nurses, enabling and supporting parents' participation in bloodletting procedures could contribute to reducing their anxiety and stress and increasing parental satisfaction.[40] In line with the existing literature, a significant difference was found in both state and trait anxiety scores in parents regarding communication and information satisfaction. The results show that parents' anxiety increases when they do not communicate adequately with nurses and do not receive enough information. It was emphasized that the role of nurses in informing and supporting parents is critical.

Study Limitations

A key strength of this study is its identification of modifiable factors such as maternal education level, healthcare staff communication, and pre-procedural parental education, that significantly reduce anxiety during pediatric bloodletting and offer actionable pathways for clinical interventions to support vulnerable families. However, the use of self-report questionnaires and the inability to measure physiological parameters (such as blood pressure, pulse, etc.) and biological stress parameters (such as epinephrine, norepinephrine, cortisol, etc.) were considered as limitations of the study. In addition, the data were collected at a single hospital, limiting the generalizability of the results. Future research involving multiple hospitals across diverse geographic locations and populations could confirm these results.

Conclusion

The current study revealed that the stress level of parents was high, and it found that their trait anxiety scores were generally higher as well. In light of these results, it is recommended to establish parent support programs in PED settings and to provide training to strengthen the communication of healthcare staff with parents in order to reduce parents'

anxiety. Educating parents about medical procedures and potential outcomes may serve as an effective intervention to mitigate anxiety levels, particularly among lower-educated groups. In addition, this study revealed the intricate dynamics among various factors influencing parental anxiety during pediatric bloodletting attempts. The elevated anxiety levels experienced by parents, particularly mothers, highlight the need for tailored psychological interventions, comprehensive education, and strong support systems to effectively mitigate stress during medical procedures in pediatric emergency settings. Future research should continue to investigate these relationships, possibly exploring the long-term effects of parental anxiety on child outcomes and the potential benefits of enriched support frameworks within emergency care settings.

Ethics

Ethics Committee Approval: The study was obtained from the Mardin Artuklu University Non-invasive Clinical Research Ethics Committee (decision no: 2024/11-28, date: 05.11.2024).

Informed Consent: Informed consent was obtained from all study participants.

Footnotes

Authorship Contributions

Surgical and Medical Practices: A.B., S.B., M.Ç., Concept: A.B., S.B., M.Ç., Design: A.B., M.Ç., Data Collecting or Processing: A.B., Analysis or Interpretation: A.B., S.B., M.Ç., Literature Search: A.B., S.B., Writing: A.B., S.B., M.Ç.

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First Aid Self-efficacy in Mothers of Children Aged 0-4 Years: The Gümüşhane Example

0-4 Yaş Arası Çocuğu Olan Annelerin Ev Kazalarına Yönelik Öz-yeterlilikleri: Gümüşhane Örneği

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Abstract

Introduction: The high relationship between the effective application of first aid after home accidents and survival determines the priorities in first aid. Childcare is mostly the responsibility of mothers, and their knowledge and practices regarding the management of home injuries are crucial in reducing morbidity and mortality associated with home accidents. This study aimed to examine the first aid self-efficacy of mothers with children aged 0-4 years to manage their children's home accidents.

Methods: This cross-sectional study, focusing on the first aid self-efficacy of mothers with children aged 0-4 for home accidents, was conducted with 266 mothers at a district government hospital affiliated with the Ministry of Health in the Eastern Black Sea Region between January 1, 2023, and August 1, 2023. Data were collected through a "demographic information form" and the "first aid self-efficacy scale for home accidents".

Results: The mean score of the first aid self-efficacy scale in home accidents was found to be 2.15±0.95 and significant differences were found according to the mother's level of education, number of children, income status, caregiver of the child and mothers' first aid status.

Conclusion: In conclusion, the findings of the study showed that first aid self-efficacy is not based solely on demographic factors, but instead may be shaped more by education, experience and the general approach of parents as parents, although mothers' knowledge of first aid was below average.

Keywords: Mother, child, home accidents, self-efficacy

Öz

Giriş: Ev içi kazalardan sonra ilk yardım uygulamalarının etkili bir şekilde harekete geçirilmesi ile yaşamda kalma arasındaki ilişkinin yüksek olması, ilk yardımdaki öncelikleri belirlemektedir. Çocuğun bakımı çoğunlukla annelerin sorumluluğundadır ve evdeki yaralanmaların yönetimi konusundaki bilgi ve uygulamaları ev kazalarıyla ilişkili morbidite ve mortaliteyi azaltmada önemlidir. Bu çalışma 0-4 yaş arası çocuğu olan annelerin çocuklarının ev kazalarını yönetmeye yönelik ilk yardım öz-yeterliliklerini incelemeyi amaçladı.

Yöntemler: 1 Ocak 2023-1 Ağustos 2023 tarihleri arasında Doğu Karadeniz Bölgesi'nde Sağlık Bakanlığı'na bağlı bir ilçe devlet hastanesinde 0-4 yaş arası çocuğu olan annelerin ev kazalarına yönelik ilk yardım öz-yeterliliklerine odaklanan bu kesitsel çalışma 266 anne ile yürütüldü. Veriler "bilgi formu" ve "ev kazalarında ilk yardım öz-yeterlik ölçeği" ile toplandı.

Bulgular: Annelerin ev kazalarında ilk yardım öz-yeterlik ölçeği puan ortalaması 2,15±0,95 saptanmış olup annenin eğitim düzeyi, çocuk sayısı, gelir durumu, çocuğa bakım veren kişi ve annelerin ilk yardım alma durumlarına göre anlamlı farklılıklar saptandı.

Sonuç: Sonuç olarak, araştırmanın bulguları, ilk yardım öz-yeterliliğinin sadece demografik faktörlere dayanmadığını, bunun yerine daha çok eğitim, deneyim ve anne-baba olarak ebeveynlerin genel yaklaşımına bağlı olarak şekillenebileceğini bununla birlikte annelerin ilk yardım konusundaki bilgilerinin ortalamanın altında olduğunu gösterdi.

Anahtar Kelimeler: Anne, çocuk, ev kazaları, öz-yeterlilik

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Introduction

Accidents in childhood are among the leading causes of death in young children; additionally, accidents that can lead to disability can have lifelong negative effects on children and their families.[1,2] The risk of home accidents in children under five is high, particularly due to their inherent curiosity, excessive activity, inability to assess pain, and low levels of awareness.[3] The most common home accidents include falls, burns, cuts, suffocation (due to aspiration), poisoning, and electrical shocks.[4]

Current statistics indicate that home accidents are the leading cause of death in children under five and the second leading cause of death in children aged 5 to 14 years.[5] Furthermore, injuries in children under the age of six mostly occur in the home environment, making this age group a high-risk category.[6] According to 2017 data from the World Health Organization, each year, 200,000 children under five die from unintentional injuries related to the environment, such as falls, poisoning, and suffocation.[7] According to the statistics on deaths and causes of death, poisoning accidents at home were reported as a significant cause of death among children aged 1-4 years in 2022 in Türkiye.[8] Childhood accidents are caused by genetic, behavioral, and environmental factors, as well as parental characteristics.[9] The primary caregivers for children aged 0-4 years are generally their mothers. The mother's education level is known to have a positive impact on her knowledge and practices regarding child health.[10] However, studies have shown that the knowledge of mothers is generally low and that there is a lack of local studies addressing this problem.[11-14] Studies informing injury prevention and evaluating the outcome of educational interventions have highlighted that parents have inadequate knowledge of paediatric first aid principles.[15-17] Childhood home accidents are a health problem that places a significant burden on families and has a major impact on a child's health, leading to long-term mental and functional impairment. Considering this information, the current study examines the self-efficacy of mothers with children aged 0-4 years in managing home accidents.

Materials and Methods

Type of the Study

The study has a descriptive and cross-sectional design.

Time and Place of the Research

The study was conducted between January 1, 2023, and August 1, 2023, at a district government hospital affiliated with the Ministry of Health in the Eastern Black Sea Region of Türkiye.

Study Sample

The study sample consisted of 266 parents whose children were hospitalized in the pediatric health and disease department of a state hospital. The inclusion criteria for the parents were as follows: (1) being a parent with a child aged 0-4 years, (2) being literate, and (3) being willing to participate in the study. Exclusion criteria are: (1) a neurological disorder in the mother and child; (2) the mother does not speak Turkish. The random sampling method was used in the study. The population of the study consisted of mothers of children aged 0-4 years who were hospitalised between 1 January 2023 and 1 August 2023 to receive health care services. The sample consisted of 266 mothers who met the inclusion criteria of the study.

Study Questions

1. What are the types of accidents frequently encountered by mothers with children aged 0-4 years in home accidents?

2. How do mothers' descriptive characteristics influence their first aid self-efficacy levels?

Data Collection Tools

Demographic information form for mothers and children: This form was developed by the authors of the current study. It included 11 questions regarding the mother's age, education level, number of children, the gender and age of the child 0-4 years, chronic health conditions of the child, history of previous home accidents, the person responsible for childcare, family income status, whether the parents have social security, as well as whether the mother has previously received any first aid training.

First aid self-efficacy scale for home accidents: This scale was developed by Wei et al.[2] for evaluating interventions that mothers can apply in home accidents. The Turkish version of the scale was validated for reliability by Altundağ et al.[18]. The scale consists of 12 items with a 5-point Likert type design, ranging from "strongly agree" to "strongly disagree", that are scored from 1 to 5. The original study reported a Cronbach's alpha value of 0.86, and the current study found a value of 0.89. Scores from 1 to 5 indicate higher levels of perception. Higher scores indicated better self-efficacy in first aid.

Data Collection Process

The data were collected by the researcher through face-to-face interviews with the mothers who were accompanying their hospitalized children. The mothers were first informed about the study and its aims, and their consent was obtained. The mother was then asked the research questions in the patient room where only the mother and child were present. The patient rooms in the pediatric ward are single; only the mother is present as a companion. The data collection process took approximately 15 minutes.

Statistical Analysis

The data were analyzed using SPSS-25 (Statistical Package for Social Sciences) software. Initially, the normality of the data was tested using skewness and kurtosis values. The distribution is considered to be normal if the skewness and kurtosis coefficients fall between -1.5 and +1.5.[19] The data collected in the current study showed a normal distribution. Accordingly, the "Independent samples t-test" was used for comparing two independent groups, and "one-way ANOVA" was used for comparing three or more independent groups. A significance level of $p<0.05$ was used to determine statistical differences. In cases of significant differences in group comparisons, Cohen's d was used to assess the effect size for pairwise comparisons. A Cohen's d of 0.2 or below represents a small effect, 0.5-0.8 represents a medium effect, and 0.8 or above represents a large effect. For comparisons involving three or more groups, eta-squared (η^2) was used. An eta-squared value of 0.01 indicates a small effect, 0.06 indicates a medium effect, and values above 0.14 indicate a large effect.[19] The current study also included percentage, frequency, mean, and standard deviation analyses.

Ethical Dimension of the Study

Ethical approval was obtained from Gümüşhane University Scientific Research and Publication Ethics Committee before the study started (decision no: E-95674917-108.99-137523, date: 26.10.2022). The participants were informed about the research, and their consent was obtained before they were included in the study. The research was conducted in accordance with the ethical principles outlined in the Helsinki Declaration.

Results

In the current study, 52.6% of the mothers were aged between 20 to 30 years, and 47.4% were between 31 to 47 years of age. Fifty-nine point four percent have a high school education or less. In terms of the number of children in the family, 42.5% had one child, 36.8% had two children, and 20.7% had three children. The gender distribution of the children under four years old indicated that 53.4% were male, with a mean age of 1.26±0.44 years. Among them, 73.3% were from 0 to 1 year of age, and 26.7% were from 2 to 3 years of age. 53.4% of the surveyed children are the first child of their families. 4.1% of the children had a chronic illness, while 38.7% had a prior experience of a home accident. Evaluation of the frequency of accidents indicated that 68.9% of the children had had at least one home accident. The top three among the various types of accidents that the children experienced were falls at 77.1%, burns at 8.3%, and aspiration at 6.3%.

Based on the data provided by the participants, 60.5% had incomes lower than their expenses, and 85% had access to social security. Additionally, 75.9% of the mothers took care of their children under the age of four by themselves, while 12% stated that their children were cared for by grandmothers and 12% by nannies. Additionally, 69.2% of the mothers reported that they had not received any education on home accidents (Table 1).

The mean score of the participants on the first aid self-efficacy scale for home accidents was found to be 2.15±0.95 (Table 2). The mean and standard deviation values for each item are presented in Table 2. Only four items had above-average scores, which were as follows: "I know how to call 112 in case of an accident"; "I can stop the bleeding when a child's nose is bleeding"; "If a child has a burn from a hot liquid, I can intervene with water, remove the clothes, submerge the area in water, cover the wound, and send the child to a hospital"; and "I can intervene in a child's injury when there is a wound". The items where mothers felt the least competent were, "I can perform cardiopulmonary resuscitation (CPR) if a child's heart stops", "I can intervene in the injured area when a child has a bone fracture", and "I can carry out artificial respiration if a child is not breathing".

A comparison of the results of the descriptive information of the mothers and their children, as well as the mean scores on the first aid self-efficacy scale for home accidents, is presented in Table 3. No statistically significant differences were found among the mother's age, child's gender, child's age, child's chronic illness status, child's previous home accident history, the family's social security status, as well as the mean scores on the first aid self-efficacy scale for home accidents ($p>0.05$).

The parameters that showed a significant difference with regard to the mean scores on the first aid self-efficacy scale for home accidents were the level of education of the mother ($F=7.054$; $p<0.001$; Cohen's $d=0.88$), the number of children that the mothers had ($F=7.398$; $p=0.001$; $\eta^2=0.05$), the family's income status ($F=4.479$; $p=0.012$; $\eta^2=0.03$), the person responsible for childcare ($F=22.709$; $p<0.001$; $\eta^2=0.14$), and whether the mother had received any first aid training previously ($t=12.939$; $p<0.001$; Cohen's $d=1.76$) (Table 3). A Bonferroni analysis of our data indicated that higher levels of education, higher income levels, childcare provided exclusively by the mother, mothers who had previously received first aid training, as opposed to their counterparts, were all associated with higher mean scores on the first aid self-efficacy scale for home accidents (Table 3). Additionally, the decrease in the mean self-efficacy score was identified as the number of children increased. A Bonferroni analysis indicated that mothers with three children had lower mean scores compared to mothers with two children or one child; moreover, mothers with two children had lower mean scores compared to mothers with one child.

Table 1. Distribution of the descriptive data of the mother and her children

Mother's age (years)	n	%
20-30	140	52.6
31-47	126	47.4
Mean	30.70±5.06	
Mother's education level		
High school and below (high school, middle school, primary school)	158	59.4
Above high school (associate degree, bachelor's degree, graduate degree)	108	40.6
Number of children		
One	113	42.5
Two	98	36.8
Three or more	55	20.7
Child's gender		
Female	124	46.6
Male	142	53.4
Child's age		
Under 1 year	195	73.3
Over 1 year	71	26.7
Child's average age	1.26±0.44	
Order of birth of the child		
First	142	53.4
Second	80	30.1
Third and more	44	16.5
Presence of a chronic illness in the child		
Present	13	4.9
Absent	253	95.1
History of the child having a home accident		
Yes	103	38.7
No	163	61.3
The frequency of accidents among children who have had an accident (n=103)		
Once	71	68.9
Twice	21	20.4
Three or more	11	10.7
Types of accidents that the children have experienced (multiple answers allowed) (n=96)		
Falls	74	77.1
Burn	8	8.3
Aspiration	6	6.3
Poisoning	5	5.2
Drowning	3	3.1
Family income status		
Income is higher than expenses	60	22.6
Income is equal to expenses	45	16.9
Income is lower than expenses	161	60.5
Social security status		
Present	226	85.0
Absent	40	15.0
Person who takes care of the child		
Mother	202	75.9
Grandmother	32	12.0
Nanny	32	12.0

Table 1. Continued

Mother's age (years)	n	%
Mother's first aid training status		
Yes	82	30.8
No	184	69.2
Total	**266**	**100**

Table 2. Distribution of the mean and standard deviation values related to the items of the mothers' first aid self-efficacy scale for home accidents

Items	Mean	SD
1. I know how to call 112 in case of an accident.	3.60	0.95
2. I can perform actions such as rinsing with water, removing clothes, immersing in water, covering the wound, and sending the child to the hospital in case of a burn accident with a hot liquid.	3.04	1.20
3. I can perform first aid if a child is choking (Heimlich maneuver).	1.90	1.65
4. I can perform artificial respiration if a child is not breathing.	1.43	1.60
5. I can perform chest compressions if a child's heart stops.	1.30	1.63
6. I can assist with the injured area in case of a bone fracture in a child.	1.34	1.48
7. I can treat wounds in case of an injury to a child.	2.79	1.18
8. I can stop the bleeding if a child has a nosebleed.	3.31	1.15
9. I can assist with the affected area in case of muscle cramps/spasms in a child.	1.77	1.42
10. I can administer first aid if a young child is choking.	1.54	1.48
11. I can apply the correct methods if a child accidentally swallows something.	1.76	1.56
12. I can assess the severity of a child's injury in case of an accident.	1.98	1.33
Total scale	2.15	0.95

*Mean: Average, SD: Standard deviation

Discussion

In the current study, the self-efficacy of mothers with children aged 0-4 years in managing home accidents using first aid was examined. We observed that 38.7% of the children of the participating mothers had previously experienced a home accident. Among the accidents that the children had experienced, the most common were falls, followed by burns, aspiration, poisoning, and suffocation. Falls are very commonly seen in this age group and rank among the most frequent accidents.[20-23] Other studies conducted in Türkiye also reported falls, burns, cuts, poisoning, suffocation, and foreign body aspiration as the most common home accidents.[24-26] The results of the current study are therefore consistent with the literature. Our findings clearly show that home accidents during childhood, especially among children aged 0-4 years, are a significant health issue. The fact that

Table 3. Comparison of the average scores of the mothers' first aid self-efficacy scale in home accidents and their descriptive characteristics

Variables	Scale Mean ± SD
Mother's age	
20-30 (n=140)	2.10±0.91
31-47 (n=126)	2.20±1.01
t;p	0.832;0.406
Mother's education level	
High school and below (n=158)	1.84±0.89
Above high school (n=108)	2.61+0.85
t;p	7.054;p<0.001
Cohen's d	0.88
Number of children	
a One (n=113)	2.34±0.95
b Two (n=98)	2.16±0.97
c Three or more (n=55)	1.75±0.82
F;p	7.398;0.001
η^2	0.05
Bonferroni result	a>b>c
Child's gender	
Girl (n=124)	2.09±0.97
Male (n=142)	2.20±0.94
t;p	0.985;0.326
Cohen's d	-
Child's age	
0-1 (n=195)	2.16±0.95
2-3 (n=71)	2.13±0.98
t;p	0.257;0.797
Cohen's d	-
Presence of chronic illness in the child	
Present (n=13)	2.30±1.07
Absent (n=253)	2.14±0.95
t;p	0.562;0.575
History of the child having a home accident	
Yes (n=103)	2.05±0.99
No (n=163)	2.21±0.93
t;p	1.359;0.175
Frequency of accidents among children who have had an accident (n=103)	
Once (n=71)	2.18±0.84
Twice (n=21)	1.16±0.31
Three or more (n=11)	1.75±0.24
F;p	3.451;0.239
Family income status	
[a]Income is higher than expenses (n=60)	2.29;0.87
[b]Income is equal to expenses (n=45)	1.99±1.10
[c]Income is lower than expenses (n=161)	1.88±0.95
F;p	4.479;0.012
η^2	0.03
Bonferroni result	a>b, a>c
Social security status	
Present (n=226)	2.18±0.95
Absent (n=40)	1.96±0.99
t;p	1.367;0.173
Person who takes care of the child	
a Mother	1.95±0.91
b Grandmother	2.89±0.77
c Nanny	2.71±0.81
F;p	22.709;<0.001
η2	0.14
Bonferroni result	a>b, a>c
Mother's first aid training status	
Yes (n=82)	3.04±0.69
No (n=184)	1.75±0.77
t;p	12.939;<0.001
Cohen's d	1.76
Total	

*Mean: Average, SD: Standard deviation, t: Test value, p: Significance value, η^2: Eta square,
F: Ratio of variances, a-b-c: Characterisation of diversity and sequence information

falls are the most common type of accident in this age group indicates the physical vulnerability of young children, as they are still in the developmental stages of their motor skills and are more sensitive to environmental risk factors. Other common types of accidents, such as burns, aspiration, poisoning, and suffocation, can largely be prevented with measures that can be taken in the home environment. This highlights a critical role of mothers' level of knowledge and self-efficacy in preventing home accidents.

The scores on the home accident first aid self-efficacy scale were found to be below average, with only four items scoring above the average. These items were as follows: "I know how to call 112 in the case of an accident"; "I can stop the bleeding when a child's nose is bleeding"; "If a child has a liquid burn, I can intervene by rinsing with water, removing their clothes, immersing the area in water, covering the wound, and sending them to the hospital"; and "I can intervene in wounds when a child is injured". In contrast, the items where mothers felt the least competent were: "If a child's heart stops, I can perform CPR", "If a child has a broken bone, I can intervene at the injured area", and "If a child is not breathing, I can perform artificial respiration". Our data corroborate similar studies that have reported that most parents are aware of an emergency number and how to call it

in case of an accident, but lack CPR and other critical first aid skills.[2,27] Wei et al.[2] reported that the mothers' CPR skills were the lowest compared to all other skills. Similarly, Asmar et al.[28] reported that mothers of children under five years of age had very low self-efficacy scores for carrying out CPR if the child was suffocating. Another study conducted with 2,125 parents of 3-12-month-old babies also reported insufficient self-confidence in providing CPR during suffocation.[29] The findings of the current study, as well as published studies, show that the self-efficacy of the mothers in intervening in home accidents is at a basic level, with significant gaps in critical skills such as CPR, artificial respiration, and bone fracture intervention. This suggests the need to expand the scope of first aid training, with a particular focus on practical training in critical skills, especially CPR such training programs could increase the self-confidence of mothers and help them manage the outcomes of home accidents more effectively.

The current study identified that the education level of the mother was an important factor in influencing first aid self-efficacy. Thus, mothers with education levels higher than high school had significantly higher self-efficacy scores compared to mothers with lower educational levels, indicating that as education levels increase, so do the individuals' knowledge and skills. Nonetheless, both groups of participants scored below average, suggesting that despite a higher level of education, there was a deficiency in knowledge and skills regarding first aid. This further underscores the need for widespread education on home accidents and first aid. Other studies have also reported that the education level of mothers has a significant impact on their skills in preventing home accidents and providing first aid. For example, Inbaraj et al.[30] noted that the education level of mothers significantly influenced their perception of risks and dangers related to home accidents. Thein et al.[31] identified the education level of mothers as playing a determining role in preventing injuries from home accidents and developing first aid skills. Moreover, Wei et al.[2] reported that an increase in the level of education of the mother was associated with an improvement in their first aid self-efficacy. These findings suggest that mothers with higher levels of education may have superior abilities to cope with emergencies and may therefore benefit more from first aid training programs for parents. The current study found that mothers with three children had lower first aid self-efficacy scores compared to those with two or one child. Mothers with two children also had lower self-efficacy scores than those with one child.[6] A study conducted during the recent COVID-19 pandemic indicated that mothers with fewer children had higher self-efficacy levels in performing first aid and preventing home accidents. These mothers were able to spend more time with each child individually and thus manage the risks more effectively.[32] Another study noted that as the number of children increased, the mothers felt less self-efficacious in first aid because their attention was more divided.[33] This love self-efficacy scores suggest that many mothers may lack the confidence or skills to provide effective first aid in emergency situations, potentially leading to delays in life-saving interventions.

The current study also found that individuals with an income level higher than their expenditures had higher self-efficacy scores compared to those whose income was equal to or less than their expenditures. This suggests that economic power is likely to influence parenting skills and self-efficacy. Income may have a direct effect on the ability of the parents to more effectively manage their behaviors and decisions related to child care. For instance, families with higher income levels may spend more quality time with their children and have easier access to educational and developmental opportunities, which can improve parenting skills. However, one study reported the lack of a significant relationship between family income and parental self-efficacy.[2] While other studies have suggested that socio-economic disadvantages may limit parental self-efficacy.[34] These conflicting findings indicate that the impact of socio-economic status on parenting is complex and multifaceted. Higher income is likely to provide more opportunities and resources while lower income levels can increase the stress levels of the parents, which may negatively affect their self-efficacy. Therefore, the relationship between income and self-efficacy may be shaped not only by economic factors but also by environmental and psychological factors. We found in the current study that the first aid self-efficacy of the participants varied significantly depending on who was taking care of the child. Specifically, mothers who cared for their own children had higher self-efficacy scores than childcare combinations such as mother-grandmother or mother-nanny. This suggests that the level of parental involvement in child care can affect how competent the parents feel about first aid. Supporting our findings, studies have shown that mothers who take an active role in child care develop better coping skills for emergencies and increase their self-efficacy. One study highlighted that mothers who provided direct care for their children managed the child's safety and their own first aid knowledge more effectively.[35] Other studies also suggest that the role of caregivers or extended family members in child care can influence the parents' preparedness for emergencies.[36] Therefore, it can be assumed that mothers who take care of their children themselves may have enhanced skills for quick and effective intervention in emergencies. Additionally, because they feel more responsible, they may be inclined to acquire more knowledge on the subject. Parental involvement thus directly influences self-efficacy, which can increase safety in child care. We observed a direct correlation between the first aid knowledge of the mother and self-efficacy, which is consistent with previous research. Hess et al.[37], Suzuki et al.[38], and Sevigny

and Loutzenhiser[39] also reported that mothers who received first aid training had higher self-efficacy scores than those who did not. This finding indicates that trained individuals are more prepared and confident in handling emergencies, which allows them to intervene more effectively in home accidents. The literature provides strong evidence that first aid training helps individuals feel more equipped to handle emergencies. This training goes beyond acquiring knowledge, as it enables individuals to feel more competent in applying this knowledge, thus playing a key role in creating a safe environment.

We observed no statistically significant relationship between the first aid self-efficacy scores and the mothers' age, child's gender, child's chronic illness status, previous accident history frequency of accidents in the children as well as the family's social security status, which suggests these factors do not influence mothers' first aid self-efficacy. However, previous studies have reported conflicting findings regarding the impact of such factors. Some studies suggest that demographic factors such as the mother's age and child's health status can influence the first aid knowledge and application skills of the parents. For example, it has been noted that as the parents age, their experience increases, but physical and psychological barriers may also emerge.[40] Some studies have reported no significant impact of factors such as social security and the history of a child's previous accidents on the first aid self-efficacy of the parents.[41] Factors such as a child's gender or the presence of chronic illnesses could also influence the mothers' attitude towards first aid. However, the impact of such demographic variables is quite complex, and each individual may respond differently to these factors.[42] The findings of the current study also indicate that first aid self-efficacy is not solely based on demographic factors, but rather is more likely shaped by education, experience, and the general approach of individuals towards parenting.

Study Limitations

The study used a cross-sectional design, with data collected at a single point in time from one center. This may limit the generalizability of the findings to all mothers of young children. Therefore, the results may not be applicable to mothers from different regions, cultural backgrounds, or socio-economic statuses. Longitudinal studies are needed to examine the changes in the factors influencing first aid self-efficacy and the observed outcomes over time, and to provide a better understanding of the cause-and-effect relationships.

Conclusion

As a result, it was found that education level, number of children, income status of the family, child caregiver, and mothers' first aid training status played an important role among the factors affecting first aid self-efficacy of mothers with insufficient first aid knowledge in the study. These findings suggest that more training and support for parents in first aid would increase their self-efficacy and lead to more effective results in terms of child safety. Although the training should include individual mothers, it should be provided not only theoretically but also practically. In this way, practical first aid training can be encouraged. Accordingly, it is recommended that training programmes be used as a powerful tool to increase parents' level of preparedness for emergencies.

Ethics

Ethics Committee Approval: Ethical approval was obtained from Gümüşhane University Scientific Research and Publication Ethics Committee before the study started (decision no: E-95674917-108.99-137523, date: 26.10.2022).

Informed Consent: The participants were informed about the research, and their consent was obtained before they were included in the study.

Footnotes

Authorship Contributions

Surgical and Medical Practices: B.G., İ.K., B.Ç., Concept: B.G., İ.K., B.Ç., Design: B.G., İ.K., B.Ç., Data Collection or Processing: B.G., B.Ç., Analysis or Interpretation: B.G., İ.K., B.Ç., Literature Search: B.G., B.Ç., Writing: B.G., B.Ç.

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The Effect of Practices by Caregiver Mothers of Children with Tracheostomies at Home on the Occurrence of Pressure Ulcers

Evde Trakeostomili Çocuğuna Bakım Veren Annelerin Uygulamalarının Basınç Yarası Oluşumuna Etkisi

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Abstract

Introduction: Children with tracheostomies who are bedridden at home are vulnerable to the risk of pressure ulcers. This study aimed to determine the practices made by mothers, who care for their children with tracheostomy at home, for pressure ulcers and identify the associated factors.

Methods: This cross-sectional descriptive study was designed with 190 mothers with a child with tracheostomy who met the inclusion criteria. A comprehensive, semi-structured questionnaire was used for data collection. Besides descriptive analyses, chi-square statistical test was used to test the relationship between variables.

Results: 60.5% of mothers with tracheostomy children lacked sufficient knowledge about how to prevent pressure ulcers. Pressure ulcers developed in tracheostomy children, mostly due to medical devices such as percutaneous endoscopic gastrostomies (36.8%) and tracheostomy tubes (33.2%). There was a significant correlation between caregiver mothers' knowledge about pressure ulcers, their practices (positioning the child, moisturising the skin, massaging, etc.), and the presence of pressure ulcers (p=0.000).

Conclusion: The risk of medical device-related pressure ulcers is high in children with tracheostomies who are dependent on medical technology at home. It is important for nurses and caregivers to identify risk factors for children with tracheostomies. Practical training programmes should be organised to improve caregivers' knowledge and practices to prevent pressure ulcers.

Keywords: Caregivers, medical devices, pediatric, pressure injuries, tracheostomy

Öz

Giriş: Evde yatağa bağımlı olan trakeostomili çocuklar basınç yaralanmaları riskine karşı savunmasızdır. Bu çalışma, evde trakeostomili çocuğuna bakım veren annelerin basınç yaralarına yönelik uygulamalarını belirlemeyi ve ilişkili faktörleri tespit etmeyi amaçladı.

Yöntemler: Bu kesitsel tanımlayıcı çalışma, dahil edilme kriterlerini karşılayan trakeostomili çocuğa sahip 190 anne ile gerçekleştirildi. Veri toplamak için kapsamlı, yarı yapılandırılmış bir anket kullanıldı. Tanımlayıcı analizlerin yanı sıra, değişkenler arasındaki ilişkiyi test etmek için ki-kare istatistiksel testi uygulandı.

Bulgular: Trakeostomili çocuğa sahip annelerin %60,5'i bası yaralarını önleme konusunda yeterli bilgiye sahip değildi. Trakeostomili çocuklarda bası yaraları çoğunlukla perkütan endoskopik gastrostomi (%36,8) ve trakeostomi tüpleri (%33,2) gibi tıbbi cihazlar nedeniyle gelişti. Bakım veren annelerin bası yaraları hakkındaki bilgileri, uygulamaları (çocuğun pozisyonlandırılması, cildin nemlendirilmesi, masaj yapılması vb.) ve bası yaralarının varlığı arasında anlamlı bir korelasyon bulundu (p=0,000).

Sonuç: Tıbbi teknolojiye bağımlı olarak evde bakım gören trakeostomili çocuklarda tıbbi cihazlara bağlı bası yarası riski yüksektir. Hemşireler ve bakım verenler için trakeostomili çocuklarda risk faktörlerini belirlemek büyük önem taşımaktadır. Bakım verenlerin bası yaralarını önlemeye yönelik bilgi ve uygulamalarını geliştirmek amacıyla eğitim programları düzenlenmelidir.

Anahtar Kelimeler: Bakım verici, tıbbi cihazlar, pediyatrik, basınç yarası, trakeostomi

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Introduction

Pressure ulcers have persisted as a major health concern when caring for children with medical complexities.[1,2] A pressure ulcer is defined as an injury localised to the skin or subcutaneous tissue caused by pressure, shear, and friction, usually over a bony prominence or associated with medical devices.[3,4] Pressure ulcers cause pain, prolonged recovery time, impaired quality of life, and raising the risk of infection and death.[5] It also leads to higher medical expenditures for patients and the healthcare system.[6]

Children who are critically ill and dependent on the use of medical technology represent a vulnerable group at high risk for pressure ulcers.[1,7] This group also includes children with tracheostomies who require ongoing home care and treatment. Due to advances in technology, mortality has significantly dropped with the use of medical devices in children with functional diversity, who are usually treated at home.[8,9] However, medical devices, such as tracheotomies, intravenous catheters, gastrostomies, colostomy bags, and urinary catheters, continue to be important sources of pressure for these children. Evidence suggests that medical devices are one of the leading causes of the development of pressure ulcers in the paediatric population.[10,11] Medical devices are an essential therapeutic component of life-sustaining treatment and an extremely important consideration, as they are associated with 50% of pressure ulcers in paediatric inpatients,[12] but are highly challenging to prevent.[11,13]

While the problem of pressure ulcers in adults continues to draw considerable attention, there are a limited number of studies on pressure ulcers in children. A retrospective study in the hospitalised paediatric population found that the prevalence of pressure ulcers was 2.25% in all patients and 6.04% in paediatric intensive care unit (PICU) patients; 21% of patients had pressure ulcers associated with medical devices.[14] In another study, medical device-related pressure ulcers (MDRPI) were observed at approximately 7% in the PICU.[15] In a similar study, pressure injuries caused by medical devices were detected in 26.5% of children in intensive care.[16] A meta-analysis study on the incidence and prevalence of MDRPI in paediatric patients revealed that these were moderate to high for hospital and medical device-associated pressure ulcers.[17] A review reported that skin lesions related to tracheostomy may develop in children with tracheostomy.[18] No study has been found to describe the incidence or prevalence of pressure ulcers in paediatric patients with medical complexity. Multicentred studies on paediatric patients in paediatric hospitals have reported a point prevalence of pressure ulcers ranging from 4% to 35%.[19,20] However, these studies do not allow us to estimate the point prevalence among paediatric patients with medical complexity.[1]

Children with tracheostomies continue to be cared for at home following their treatment in the hospital.[21,22] For optimal care of these children, it is essential to involve the family caregivers in maintaining care continuity and social support. This necessitates that nurses be more sensitive when training families. Parents who care for their children at home are trained on some issues, such as aspiration, follow-up, and care before discharge. However, it appears that parents are inadequately trained regarding pressure ulcers.[23-26] Family caregivers assume an important role in caring for children with tracheostomies and in preventing pressure ulcers. If caregivers know how to prevent pressure ulcers, they can help enhance the child's quality of life.[23,27]

Pressure ulcers in children with tracheostomies who are cared for at home have not been sufficiently studied and have been overlooked. However, it is highly important to understand the incidence, prevention, and control of pressure ulcers in these children for both patient safety and safe care interventions.[28] Therefore, caregivers should have adequate knowledge about the preventive practices for pressure ulcers.[29] Nurses should assess the knowledge and practices of caregivers about preventing pressure ulcers.[30] When the literature was reviewed, no similar studies were found that examined the practices of family caregivers of children with tracheostomies in Türkiye who are cared for at home to prevent pressure ulcers. This study was conducted to determine the practices employed by mothers who care for their children with tracheostomy at home, for pressure ulcers and identify the associated factors.

The research questions were determined as follows:

What are the most common sites of pressure ulcers in children with tracheostomies who are cared for at home?

What are the factors that affect the occurrence of pressure ulcers in children with tracheostomies who are cared for at home?

What are the practices of mothers, who care for their children with tracheostomies, to prevent and care for pressure ulcers?

Materials and Methods

Study Design

This descriptive and cross-sectional study was conducted between October 2023 and March 2024.

Sample

The population of the study consisted of mothers who cared for their children dependent on medical technology at home in Türkiye, and the purposive sampling method was utilised to select the mothers. Power analysis was carried out using G*Power (3.1.9.2) software to calculate the sample size in

the study.[31] Based on the percentage values of the methods, to be studied in the literature review, the total sample size was calculated as n=174 using the G*Power program at an effect size of 0.4, a power of 95%, and a margin of error of 0.05.[32] Given the challenges of time, cost, and missing data, the study was completed with 190 mothers. The inclusion criteria were determined as being a mother of a child with a tracheostomy who was dependent on medical technology, over 18 years of age, having cared for her child for at least six months, and voluntarily participating in the study. Mothers of children who were dependent on medical technology had secondary medical conditions like skin and dermatologic diseases, and had paid caregivers were excluded from the study.

Data Collection

The tool used to collect the data was a structured questionnaire developed by the researchers based on a comprehensive literature review.[25,33]

The questionnaire consisted of three parts. The first part included questions about the characteristics of children with tracheostomies, (age, gender, weight, height) and their mothers (age, educational background, place of residence, length of caregiving, status of receiving training on pressure ulcers). The second part included the type of medical device to which the child was attached, the type of feeding, and the sites of pressure ulcers. The last part included questions about practices to prevent pressure ulcers. The questionnaire was sent to six experts in the field and finalized based on their feedback.

The data were collected using a Google form on social media platforms (Instagram, WhatsApp) and via telephone. The researcher sent a research invitation for the study and informed mothers of children with tracheostomies about the study via the social media platform. The researcher sent an online questionnaire to mothers who had accepted the research invitation. It took approximately 15 minutes to complete the questionnaire. Mothers who refused to accept the research invitation, used no smartphones, and reported that they had no time, were excluded from the study.

Statistical Analysis

The SPSS 25.0 for Windows (Statistical Package for Social Sciences, IBM SPSS, Version 25.0., Armonk, NY: IBM Corp.) software was used to statistically analyse the data. In order to obtain statistical results, the Shao method was used to assess whether the data were normally distributed. The mean, standard deviation, and minimum and maximum values, were calculated in continuous data analysis. Numbers and percentages were calculated in categorical data analysis. The data were compared using chi-square.

Ethical Considerations

Before beginning the study, ethical approval was obtained from the Kilis 7 Aralık University's Ethics Committee, under the reference number 2023/18-10, date: 13.10.2023. The study was conducted in accordance with the principles of the Declaration of Helsinki. The researcher informed the mothers about the study, informing them that participation was voluntary. The mothers provided their consent to participate in the study.

Results

Table 1 shows that 55.3% of the children with tracheostomies were girl, and their mean age was 6.09±4.70 years. The children's mean body mass index was 18.08±5.08 kg/m^2. 56.8% of the children used a tracheostomy and mechanical ventilation, 21.6% used a tracheostomy and oxygen therapy, 15.3% used only tracheostomy, and 6.3% used a pulse oximetry probe.

The mean age of the mothers was 34.10±6.85 years; 45.3% of them graduated from secondary school. The majority of the mothers (66.8%) lived in the city centre. 50.5% of the mothers reported that their child with a tracheostomy had pressure ulcers (Table 1).

The mothers reported that their children with tracheostomy had pressure ulcers mostly on the sacrum (20.3%) and buttocks (15.6%), and least on the face (5.2%) and fingers (4.2%). Pressure ulcers were caused by a percutaneous endoscopic gastrostomy (PEG) in 36.8% of the children, by a tracheostomy in 33.2%, by a nasogastric catheter in 15.3%, and by a saturation probe in 18.4%. While 37.5% of the mothers applied Rif and creams, 20.8% applied herbal products, and 5.2% applied wound care products, in pressure ulcer dressings (Table 2).

Table 3 shows the distribution of care practices of the mothers of children with tracheostomies. It was found that 82.6% of the mothers did not receive training about pressure ulcers when they were discharged home from the hospital, 60.5% did not know how to prevent pressure ulcers, and 72.1% did not know how to care for pressure ulcers. 12.1% of the mothers were placing nylon or oilcloth under their children and 70.5% were not using air mattresses. The majority of the mothers (90%) ensured that the sheets under their children were smooth and their skin was neither damp nor wet. 88.4% of the mothers used a pillow while positioning their children, and the majority of them (87.4%) massaged their children. The mothers bathed their children every 7.95±6.49 days on average and positioned their children every 3.06±4.12 hours (Table 3).

Table 1. Socio-demographic characteristics of children with tracheostomy and their mothers (n=190)			
Variables		**n**	**%**
Child's gender	Girl	105	55.3
	Boy	85	44.7
		Mean ± SD	**Min-max**
Child's age		6.09±4.70	1.00-18.00
Child's body weight		20.790±13.338	5.00-75.00
Child's height		103.19±27.51	53.0-188.0
Child's BMI		18.08±5.08	5.23-38.78
		n	**%**
Technological equipment	Tracheostomy + mechanic ventilation	108	56.8
	Tracheostomy + oxygen therapy	41	21.6
	Only tracheostomy	29	15.3
	Pulse oximetry probe	12	6.3
Nutrition	PEG	110	57.9
	Enteral	60	31.6
	Oral	20	10.5
		Mean ± SD	**Min-max**
Mother's age		34.10±6.85	20.0-50.0
		n	%
Educational level	Primary school	40	21.1
	Secondary school	86	45.3
	High school	29	15.3
	Bachelor's degree	35	18.4
Living place	Province	127	66.8
	Town	48	25.3
	Village	15	7.9
Pressure ulcer	Yes	96	50.5
	No	94	49.5

SD: Standard deviation, PEG: Percutaneous endoscopic gastrostomy, BMI: Body mass index

Table 4 shows the comparisons between maternal care practices and the presence of pressure ulcers. A significant difference was found among the status of receiving training on pressure ulcers during discharge (X^2: 5.872, p=0.015), having knowledge about how to care for pressure ulcers (X^2: 10.010, p=0.002), and having knowledge about how to prevent pressure ulcers and the occurrence of pressure ulcers (X^2: 10.460, p=0.001).

A significant difference was found among laying nylon or oilcloth under the child (X^2: 13.893, p=0.001), using an air mattress (X^2: 6.014, p=0.014), massaging the child (X^2: 4.532, p=0.033), and moisturising the skin of the child (X^2: 6.362, p=0.012) and the occurrence of pressure ulcers (Table 4).

Besides the above findings in Table 4, no significant difference was found in the occurrence of pressure ulcer according to the mothers' attention to keeping the sheet under the child smooth, keeping the child's skin dry, and using a pillow while positioning the child (X^2: 0.655, 0.655, 0.256, p=0.721, 0.613).

According to Table 5, a statistically significant difference was found between the mean frequency of bathing their children and the occurrence of pressure ulcer, and between the mean frequency of positioning the child and the occurrence of pressure ulcer (t=2.096, 2.919; p=0.037, 0.004).

Discussion

Children with tracheostomies who are dependent on medical technology have a higher risk of developing pressure ulcers due to their reduced mobility. Pressure ulcers are an important health concern that affects morbidity and mortality in the paediatric population, increases the burden of caregivers, and leads to physical and psychological problems.[34]

Table 2. Some characteristics of pressure ulcers in children with pressure ulcers (n=190)

Features			n	%
Pressure ulcer area	Sacrum		20	20.3
	Buttock		14	15.6
	Back of head		12	12.5
	Back		10	10.3
	Ear		10	10.3
	Heel		8	8.1
	Neck		7	7.2
	Hand		6	6.3
	Face		5	5.2
	Fingers		4	4.2
Pressure ulcer associated with medical device	Nasogastric tube	Yes	29	15.3
		No	161	84.7
	PEG	Yes	70	36.8
		No	120	63.2
	Tracheostomy tube	Yes	63	33.2
		No	127	66.8
	Pulse oximetry probe	Yes	35	18.4
		No	155	81.6
Materials used in pressure sores	Rif and cream		36	37.5
	Herbal products		20	20.8
	Sterile water/physiological saline		13	13.6
	St. John's wort oil		12	12.5
	Batikon/alcohol		10	10.4
	Wound care product		5	5.2

PEG: Percutaneous endoscopic gastrostomy

Table 3. Mothers' practices regarding the care of children with tracheostomy

Practices		n	%
Receiving training on pressure ulcers during discharge from the hospital	Yes	33	17.4
	No	157	82.6
Knowledge on how to prevent pressure ulcers	Yes	75	39.5
	No	115	60.5
Knowledge on how to care for pressure ulcers	Yes	53	27.9
	No	137	72.1
Laying plastic/oilcloth under the child	Yes	23	12.1
	No	167	87.9
Use of an air mattress in the child's bed	Yes	56	29.5
	No	134	70.5
Paying attention to keep the sheet under the child's smooth	Yes	171	90.0
	No	19	10.0
Paying attention to keep the child's skin neither moist nor wet	Yes	171	90.0
	No	19	10.0
Using a pillow while positioning the child	Yes	168	88.4
	No	22	11.6
Massaging the child	Yes	166	87.4
	No	24	12.6
Moisturising the child's skin	Yes	147	77.4
	No	43	22.6
	Mean ± SD	**Min**	**Max**
Frequency of bathing the child (days)	7.95±6.49	1.00	45.00
Frequency of positioning the child (hours)	3.06±4.12	1.00	24.00

Table 4. Comparison of mothers' practices in the care of children with tracheostomy and pressure ulcers

Practices		Pressure ulcers				Test value
		Yes		No		
		n	%	n	%	X^2/p
Receiving training on pressure ulcers during discharge from the hospital	Yes	23	69.7	10	30.3	**X^2: 5.872**
	No	73	46.5	84	53.5	p=0.015
Knowledge on how to prevent pressure ulcers	Yes	27	36.0	48	64.0	X^2:10.460
	No	69	60.0	46	40.0	p=0.001
Knowledge on how to care for pressure ulcers	Yes	17	32.1	36	67.9	X^2: 10.010
	No	79	57.7	58	42.3	**p=0.002**
Laying plastic/oilcloth under the child	Yes	20	87.0	3	13.0	X^2: 13.893
	No	76	45.5	91	54.5	**p=0.001**
Use of an air mattress in the child's bed	Yes	36	64.3	20	35.7	X^2: 6.014
	No	60	44.8	74	55.2	**p=0.014**
Paying attention to keep the sheet under the child's smooth	Yes	88	51.5	83	48.5	X^2: 0.655
	No	8	42.1	11	57.9	p=0.721
Paying attention to keep the child's skin neither moist nor wet	Yes	88	51.5	83	48.5	X^2: 0.655
	No	8	42.1	11	57.9	p=0.721
Using a pillow while positioning the child	Yes	86	51.2	82	48.8	X^2: 0.256
	No	10	50.5	12	49.5	p=0.613
Massaging the child	Yes	79	47.6	87	52.4	X^2: 4.532
	No	17	70.8	7	29.2	**p=0.033**
Moisturising the child's skin	Yes	67	45.6	80	54.4	X^2: 6.362
	No	29	67.4	14	32.6	**p=0.012**

Table 5. Comparison of mothers' practices in the care of children with tracheostomy and pressure ulcers

Practices	Pressure ulcers		Test value
	Yes	No	
	Mean ± SD	Mean ± SD	t/p
Frequency of bathing the child (days)	8.92±7.32	6.96±5.39	t=2.096/p=0.037
Frequency of positioning the child (hours)	3.91±5.51	2.19±1.41	t=2.919/p=0.004

SD: Standard deviation

This study evaluated the practices related to pressure ulcer prevention of mothers of children with tracheostomies at home and the related factors.

In the study, the mean age of children with tracheostomies was 6 years (1-18 years), and more than half of them were connected to a mechanical ventilator. The children were also dependent on assistive medical devices such as nasogastric catheters and PEG. These results are compatible with studies that examined the prevalence of pressure ulcers in children in the PICU.[14,15] More than three-quarters of the children in the present study were fed enterally. Similar studies revealed that bedridden children were usually fed enterally.[15,35,36] Malnutrition and being connected to more than two medical devices have been reported as factors leading to pressure ulcers.[37,38]

Although pressure ulcers most commonly develop on the sacrum and buttocks in bedridden adult patients, the occiput and ears in children under 3 years of age, and the sacral region and heels in children over 3 years of age are the sites most affected by pressure. At 6-10 years of age, the sites of pressure ulcers are similar to those in adults due to their body proportions.[39,40] The results of this study, showed that the sacrum (20.3%), buttocks (15.6%), and occiput (12.5%) were the sites most commonly affected by pressure ulcers in children with tracheostomy. The findings of this study are compatible with the literature indicating that the head is the anatomical region most frequently affected by pressure ulcers.[17,41] In the present study, the vulnerability of the sacrum and buttock regions to pressure ulcers in children may be due to a combination of factors related to the anatomy or

physiology of the region, as well as the needs and conditions of paediatric patients and the practices of caregivers. As children are attached to medical devices such as mechanical ventilators, mothers may be concerned about positioning their children differently in bed and therefore often prefer the supine position. The most important factor that affects the site of the pressure ulcer is the patient's lying position. Staying continuously in the same position in patients with mobility problems disrupts capillary circulation in that region and causes tissue hypoxia.[37] Therefore, it is necessary to change the position of immobilised patients under treatment with mechanical ventilation every two hours, at most, and to position them laterally in a fowler or semi-fowler position.[42] One of the important findings of the present study was that pressure ulcers were frequently caused by medical devices such as nasogastric catheters, PEG, tracheostomy tubes, and pulse oximetry probes. Başbakkal et al.,[15] who examined pressure ulcers associated with medical devices in the PICU, reported that the most common pressure ulcers resulted from nasogastric tubes. Systematic and meta-analyses reviews showed that respiratory devices, tracheostomy tubes, ostomies, neck collars, and supportive/safety devices were the most common sources of pressure ulcers in critically ill patients.[17,43] The most problematic devices were found to be pulse oximeters, endotracheal tubes, neckties, and face masks,[11,28] and children connected to multiple medical devices were found to be more likely to develop MDRPI.[44] To prevent pressure ulcers associated with medical devices in children who are cared for at home, homecare providers should carefully assess the patient's risks of pressure ulcers, and family caregivers should be taught to practice preventive measures for the placement and repositioning of devices.[17]

The findings of the present study showed that more than three-quarters of the mothers did not have knowledge about how to prevent and care for pressure ulcers. Also, a great majority of the mothers (82.6%) indicated that they were not trained on pressure ulcers when they were discharged from the hospital. A study that investigated the practices of caregivers caring for chronic pressure ulcers at home showed that caregivers had insufficient knowledge on how to care for pressure ulcers.[33] Studies with caregivers of children with tracheostomies suggested that mothers felt inadequate when caring for and treating their children.[45-47] Results of the present study are compatible with the literature. The lack of sufficient knowledge about pressure ulcers in mothers may be attributed to several factors. First, the mothers had a low educational level and were not fully informed on how to prevent pressure ulcers. Furthermore, the lack of training on pressure ulcers by the formal caregivers during the hospitalisation period may have led to the mothers feeling inadequate in providing care.

The present study showed that the mothers of children with tracheostomies generally applied rifampicin and cream, herbal products (centaury oil), and sterile water or physiological saline solution to care for pressure ulcers. A study showed that a great majority of caregivers applied normal saline and herbal products such as centaury oil for pressure ulcers.[33] Results of the present study are compatible with the literature. Reports have indicated that the barrier creams and products used alone may not prevent pressure or shearing, but they can be used to protect the skin and avoid ulcers caused by pressure and moisture.[40]

Results of the current study revealed that mothers, on average, positioned their children every three hours to prevent pressure ulcers, and the majority used pillows while positioning. However, more than half of the children who were cared for at home had no air mattress. In their study, Arslan et al.,[35] found that 39.5% of the formal caregivers positioned patients under treatment in the PICU every 2 hours, and 35.5% positioned them every 3 hours. Although the frequency of positioning varies depending on the patient's condition, fewer pressure ulcers have been reported to develop with position changes every 2-4 hours.[35,48] Despite the low use of air mattresses in the present study, the use of static and alternative air mattresses has been reported to be effective in preventing pressure ulcers in the scientific literature.[49]

More than half of the mothers massaged their children, moisturised their skin, and bathed them once a week. Results of the present study showed a significant difference between the frequency of bathing or positioning children with tracheostomies and the occurrence of pressure ulcers. Bed baths keep bedridden patients clean and fresh. Traditional bed baths with soap and water alter skin acidity, resulting in skin damage.[50] Reportedly, dry skin may lead to infections and pressure ulcers.[51] Today, traditional bed baths have been replaced by disposable wet wipe bed baths. This technique has been reported to lower the risk of skin damage and pressure ulcers.[52]

The present study reported a significant difference in maternal educational level regarding pressure ulcer care. Previous studies have shown that training on how to prevent pressure ulcers is effective in raising the knowledge level of caregivers.[53,54] Results of the study are consistent with the literature. If planned training on pressure ulcers for caregivers is implemented, the risks of pressure ulcers in children with tracheostomies who are cared for at home can be lowered.

Study Limitations

The findings of the study were limited to mothers who were caring for their children with tracheostomies. In the evaluation of pressure ulcers in children with tracheostomies, the reports

by the mothers were taken into consideration. No scale was used to identify the pressure ulcers, and thus pressure ulcers could not be graded. However, the mothers who reported pressure ulcers in their children were interviewed by video call, and the site of the pressure ulcer was confirmed. For future research, multidisciplinary studies can be planned in larger sample groups, using pressure-sensitive scales. Future research can be planned as multidisciplinary studies using pressure sore scales in larger sample groups.

Contribution to Clinical Practice

Children with tracheostomies who are immobilized for long periods of time and dependent on multiple medical devices are more likely to experience MDRPI. This study showed the current occurrence of pressure ulcers in children with tracheostomies who were cared for at home within the Turkish population. This may increase the awareness of nurses and caregivers regarding pressure ulcers in children with tracheostomies. Knowing the risk factors for MDRPI in bedridden children with tracheostomies can help both nurses and caregivers recognise pressure ulcers earlier and take measures to protect patients from developing MDRPI.

Therefore, it is necessary to optimise the health and well-being of children and lessen the burden on caregivers through the collaboration of a multidisciplinary team that includes a comprehensive health service. Health professionals who provide home care services should follow up on children with tracheostomies to prevent pressure ulcers at home, and wound care nurses and paediatric nurses should plan and implement caregiver training. Consequently, parents who care for their children with tracheostomies should be empowered in their caregiving and guided based on the available evidence, including the best recognition and prevention strategies for pressure ulcers. Future studies are required to improve the skills of family caregivers accordingly.

Conclusion

Children who are bedridden at home are vulnerable pressure ulcers. This study suggested that children with tracheostomies who are cared for at home are at risk for pressure ulcers. Pressure ulcers developed most commonly in the sacral, hip, and head regions in children with tracheostomies. Children were connected to several devices that caused MDRPI. Mothers who were primary caregivers at home lacked sufficient knowledge and proficiency in how to prevent and manage pressure ulcers. Nurses should identify the risk factors for MDRPI and respond early to prevent pressure ulcers in children with tracheostomies.

Ethics

Ethics Committee Approval: Before beginning the study, ethical approval was obtained from the Kilis 7 Aralık University's Ethics Committee, under the reference number 2023/18-10, date: 13.10.2023. The study was conducted in accordance with the principles of the Declaration of Helsinki.

Informed Consent: The researcher informed the mothers about the study, informing them that participation was voluntary. The mothers provided their consent to participate in the study.

Footnotes

Authorship Contributions

Concept: H.N.Ç.Ö., E.E., Design: E.E., Data Collection or Processing: H.N.Ç.Ö., E.E., Analysis or Interpretation: H.N.Ç.Ö., E.E., Literature Search: H.N.Ç.Ö., E.E., Writing: H.N.Ç.Ö., E.E.

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Case Report / Olgu Sunumu

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Is the Opacity on the Chest X-ray Pathological? "Azygos Lobe"

Akciğer Grafisindeki Opasite Patolojik mi? "Azygos Lobu"

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Abstract

Chest radiography (chest X-ray) is one of the most frequently used radiological examinations in the pediatric emergency departments (PEDs). It is helpful in the diagnosis of infections, including malignancy, foreign bodies, and bone structure deformities. Chest X-rays should be interpreted in a particular order, and all anatomical structures should be evaluated. Here, three cases in which the opacity detected in the chest X-ray was evaluated as the azygos lobe are presented, and this rare condition is discussed. Three patients were admitted to the Gazi University Pediatric Emergency Department's PED and incidentally diagnosed with azygos lobe. Case 1, a 16-year-old male patient, presented with chest pain on the left side of the sternum. Case 2, a 9-year-old male patient, presented with dyspnea. Case 3, a 16-year-old female patient, presented with fever and abdominal pain. The tear-shaped opacity detected on the chest X-ray of all three cases was evaluated to be an azygos lobe. Although many cases of the azygos lobe are described, knowledge of it among clinicians is still insufficient. We presented these three cases to raise awareness of the azygos lobe, and remind physicians that its typical appearance on chest X-ray can be easily recognized.

Keywords: Azygos lobe, child, chest radiography, anatomical variant

Öz

Akciğer grafisi çocuk acil servislerinde en sık kullanılan radyolojik tetkiklerden biridir. Enfeksiyon tanısının yanı sıra malignensi, yabancı cisim ve yapısal deformitelerin tanısında da faydalıdır. Akciğer grafilerindeki tüm anatomik yapılar sırasıyla değerlendirilmelidir. Burada, akciğer grafisinde opasite saptanan ve azigos lobu tanısı alan 3 hasta ve bu varyasyon tartışılmaktadır. Üç hasta Gazi Üniversitesi Çocuk Acil servisine başvuran ve insidental olarak azigos lobu saptanmıştır. Birinci olgumuzda 16 yaş erkek hasta sternum sol yanında göğüs ağrısı ile, 2. olgumuzda 9 yaş erkek hasta dispne ile, 3. olgumuz ise 16 yaş kız hasta ateş ve karın ağrısı şikayeti ile başvurmuş. Üç hastanın da akciğer grafisinde damla şeklinde opasite saptanmış olup azigos lobu olarak değerlendirilmiştir. Azigos lobu hakkında çok fazla olgu tanımlanmış olsa da, klinisyenler arasında bilgi henüz yetersizdir. Biz bu 3 olguyu azigos lobu hakkında farkındalık yaratmak ve doktorlara akciğer grafisindeki görünümü tanıtarak bu lobun tanınmasını kolaylaştırmaktır.

Anahtar Kelimeler: Azigos lobu, çocuk, akciğer grafisi, anatomik varyasyon

Introduction

The azygos lobe is a rare congenital anatomical lung variation. It was first described was first described as an anatomical feature of the right upper lobe by the German anatomist Heinrich Wrisberg in 1778.[1] During embryogenesis, the azygos vein forms by penetrating the lung's upper lobe and advancing along the parietal and visceral pleura. The two pleural layers migrate across the right upper lobe, forming a fissure called the azygos fissure. It is not a true accessory lobe, as it has no bronchus or specific bronchopulmonary segment.[2] The incidence in the population is reported to be approximately 0.2-1.2%.[3] It is often detected incidentally on chest radiography (chest X-ray) and computed tomography (CT) of the thorax. A typical finding of the azygos lobe on the chest X-ray is a convex line and associated teardrop appearance. The azygos lobe is usually detected incidentally by a chest X-ray or CT during examination for another reason.[2] A chest X-ray usually has a typical appearance as a convex line due to the azygos fissure, extra pleural tissue on the fissure, and

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a trigonal area connected to the azygos vein at the bottom; this image is described as a teardrop.[4] The azygos lobe can be misdiagnosed as a neoplasm, lung abscess, or bulla.[5] This case report presents three cases admitted to the pediatric emergency department (PED) with various symptoms, who were incidentally found to have an azygos lobe. All patients have given consent to be included in this case report.

Case Report

Case-1

A sixteen-year-old male patient was admitted to the PED with a complaint of chest pain. It was revealed that he had intermittent stinging chest pain on the left side of the sternum for three days. His vital signs were stable, and the physical examination revealed no abnormalities. The laboratory findings showed that hemoglobin was 14.2 g/dL, leukocyte count was 4600/mm^3, platelet count was 200,000/mm^3, creatine kinase myocardial band (CK-MB) was 2.09 ng/mL (normal range: <4.87), and hs-Troponin T was <5 ng/L (normal range: 0-14). Liver and kidney function tests, and electrocardiogram were normal. Chest X-ray showed a vertical line and increased tear-shaped opacity in the right upper lobe (Figure 1).

The department of pediatric radiology was consulted because the opacity in the X-ray could not be identified. It was interpreted as an azygos lobe and an azygos fissure. When the patient's medical records were checked, the thorax CT taken due to previous trauma was observed, and it was identified that the azygos lobe was present in those images (Figure 2). The patient's chest pain resolved without any intervention, and his pain was evaluated as non-specific.

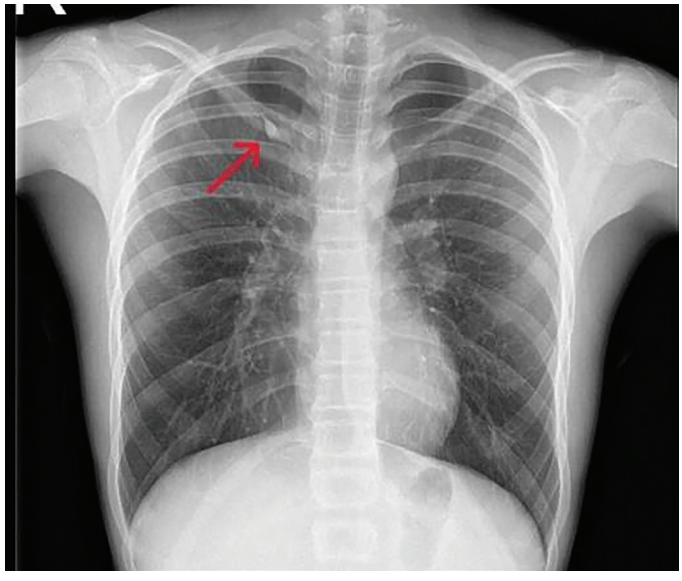

Figure 1. Azygos lobe view on chest radiography of Case 1

Case-2

A nine-year-old male patient was admitted with dyspnea. His complaints started approximately one hour before admission and were accompanied by a congested nose. The physical examination showed no abnormalities. His vital signs were stable, with a 97% oxygen saturation and a respiratory rate of 28/min. His complete blood count revealed the following: hemoglobin 13.3 g/dL, mean corpuscular volume (MCV) 78.6 fL, platelets 375,000/mm^3, and neutrophils 4100/mm^3. His venous blood gas analysis showed a pH of 7.39, CO_2 of 38.1 mmHg, pO_2 of 30.6 mmHg, lactate 0.7 mmol/L, base excess of -1.3, and HCO_3 of 22.6 mmol/L, which was non-specific. The chest X-ray showed no indication of a pulmonary pathology, except for a tear-shaped opacity near the upper sternum and a curved line extending from the opacity to the clavicle (Figure 3). Regarding our experience from the previous case, the observation was interpreted as the azygos lobe and the accompanying fissure. The patient's complaint of dyspnea, which was associated with an upper respiratory infection, was resolved in the follow-up.

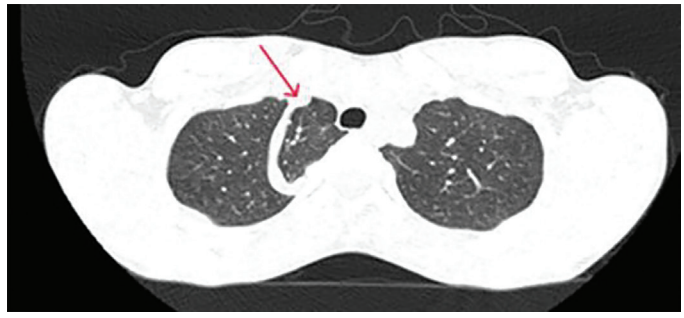

Figure 2. Azygos lobe view on chest tomography of Case 1

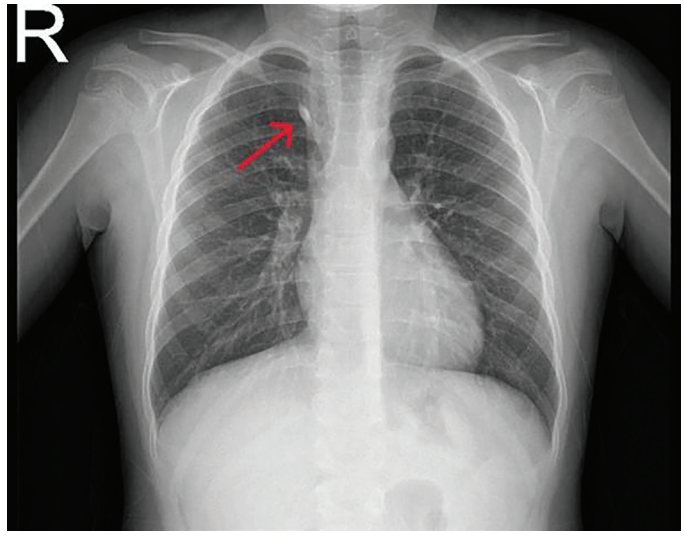

Figure 3. Azygos lobe view on chest radiography of Case 2

Case-3

A sixteen-year-old female patient presented to the PED with fever and abdominal pain. The physical examination showed no abnormalities. Her physical examination was normal, except for a heart rate of 141/min and a temperature of 37.4 °C. The laboratory findings were Hb: 12.9 g/dL, MCV: 81.2, platelets: 230,000/mm^3, neutrophils: 20,800/mm^3. Abdominal ultrasonography and chest X-ray were planned to rule out appendicitis and lobar pneumonia due to fever, leukocytosis, and abdominal pain. Abdominal ultrasonography was evaluated as normal. While no consolidation was detected on the chest X-ray, an azygos fissure was detected, along with an image compatible with the azygos lobe in the right upper lobe (Figure 4). During follow-up, the patient started to have diarrhea and she was diagnosed with acute gastroenteritis.

Discussion

The incidence of azygos lobe in the general population is low.[1] The azygos lobe, which is more commonly found in men than in women, is usually located in the right lung.[6,7] In all three cases we presented, the azygos lobe was in the right lung, and in two cases out of three, they were male. While the average age of children with azygos lobe detected, was two years, the youngest case reported in the literature was a newborn with azygos lobe detected incidentally on CT recorded during an evaluation for dyspnea and aspiration pneumonia, published by De Carolis et al.[8] Our patients' ages were higher than those reported in the literature.

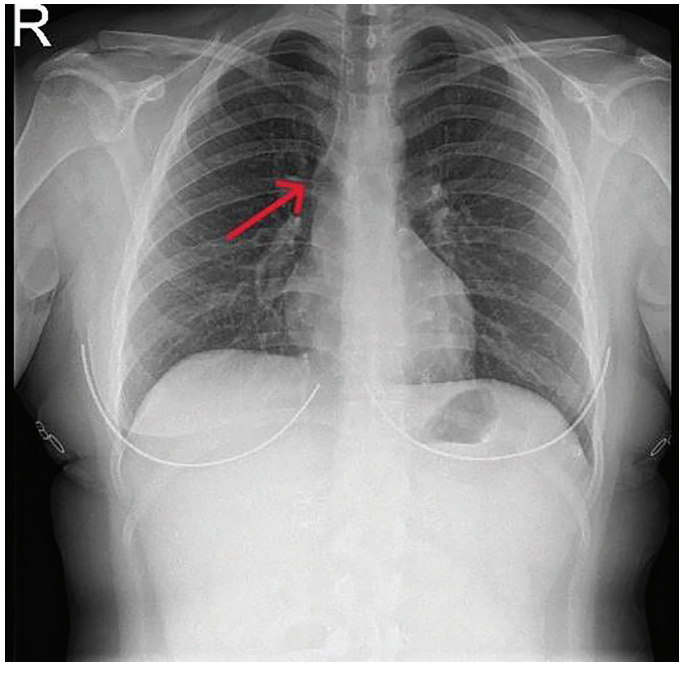

Figure 4. Azygos lobe view on chest radiography of Case 3

In the literature, the detection rate of the azygos lobe by chest X-ray was 2.6%, while the detection rate with CT was 6.7%.[9] Since CT is less frequently requested in pediatric patients due to radiation concerns, while the diagnosis of the azygos lobe can be made more easily with CT, most cases are diagnosed in adulthood.[10] In the study by Wang et al.,[11] which included 50 children with azygos lobe, it was reported that 80% of the cases were diagnosed by CT, 18% were diagnosed by chest X-ray, and 2% were diagnosed by both chest X-ray and CT. In our cases, the diagnosis was made through chest X-ray, and no additional CT imaging was done. In the first case, CT images due to trauma were obtained from hospital records, and were more evident in the imaging, revealing the azygos lobe.

Most cases of azygos lobe are asymptomatic. In the study conducted by Wang et al.,[11] 28% of the cases were detected incidentally, and 72% had accompanying symptoms, such as coughing and dyspnea, unrelated to the azygos lobe, as in our cases. Although the azygos lobe is not thought to cause any pathology due to its nature, it may be associated with some pathologies. In the literature, there are cases associated with the azygos lobe, such as malignancy, pneumothorax, hemothorax, extrapulmonary sequestration, vascular malformations, atelectasis, bronchiectasis, hemoptysis, and consolidation.[12] Additionally, reports indicate that the incidence of the azygos lobe increases in anomalies, such as sternal and tracheal anomalies, cystic adenomatoid malformation, congenital heart disease, and Down syndrome.[11] Since most cases do not have any symptoms at the time of diagnosis, it is appropriate to consider the azygos lobe as a benign lung variation but also to closely monitor it for complications that may develop in the long term or accompanying anomalies. It is essential to know the existence of the azygos lobe since it may pose a risk, especially during thoracic surgery.[13] No additional pathology was detected in any of our cases, but their parents were informed about the need for follow-up regarding the azygos lobe.

The azygos lobe is often detected incidentally during imaging while investigating other pathologies. However, it often cannot be diagnosed due to the omission of the azygos lobe in most textbooks and radiology atlases, as well as physicians' lack of knowledge. It is reported in the literature that the azygos lobe mimics the appearance of the bulla, the abscess, localized pneumothorax, pulmonary nodule, and neoplasm, causing patients to receive incorrect diagnoses and be exposed to unnecessary interventions.[14] In the study by Wang et al.,[11] which is the largest series of children 40% of cases with azygos lobes were not diagnosed by the first imaging examination. Another study by Al-Mnayyis et al.,[15] which included 227 graduate intern physicians and radiology assistants, and surgery assistants, showed that none of the

intern physicians or surgery assistants could recognize the azygos lobe image. Only 57% of the radiology assistants could identify it correctly. The diagnosis of azygos lobe can only be made by radiological imaging, so clinicians need to know its characteristic radiological features.

Conclusion

Although azygos lobe cases have been described, there is still a lack of knowledge among clinicians on this subject. We present these three cases to increase awareness of the azygos lobe. We would like to remind physicians that the azygos lobe can be easily recognized by its typical appearance on chest X-ray, thus preventing misdiagnosis and unnecessary interventions.

Ethics

Informed Consent: All patients have given consent to be included in this case report.

Footnotes

Authorship Contributions

Concept: A.A.Ç., M.Y., O.D.G., Design: A.A.Ç., Data Collection or Processing: E.N.K., Y.D., M.Y., Analysis or Interpretation: A.A.Ç., O.D.G., Literature Search: E.N.K., Y.D., Writing: E.N.K., Y.D., A.A.Ç., M.Y., O.D.G.

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Case Report / Olgu Sunumu

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Green Urine: A Rare Adverse Effect of Propofol in Critically Ill Children

Yeşil İdrar: Kritik Hastalığı Olan Çocukta Propofolün Nadir Bir Yan Etkisi

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Abstract

Propofol is an intravenous agent commonly used for anesthesia induction, procedural interventions, and sedation in intensive care units due to its rapid onset and relatively safe profile. In this report, we present the case of a 12-year-old male patient with traumatic brain injury who developed green urine following propofol infusion for sedation. After excluding other potential causes of urine discoloration, the propofol infusion was discontinued at the 50th hour, and the urine color returned to normal within 5 hours. We aimed to highlight that green urine, which may be alarming for clinicians, is a benign side effect of propofol and does not impact renal function.

Keywords: Craniocerebral trauma, critical care, hypertonic solutions, phenols

Öz

Propofol, hızlı başlangıç ve nispeten güvenli profili nedeniyle anestezi indüksiyonu, prosedürel müdahaleler ve yoğun bakım ünitelerinde sedasyon için intravenöz olarak kullanılan bir ajandır. Bu yazıda, sedasyon için propofol infüzyonunu takiben yeşil idrar gelişen travmatik beyin hasarı olan 12 yaşında bir erkek hasta sunuldu. İdrar rengindeki değişimi yapabilecek diğer nedenler dışlandıktan sonra, propofol infüzyonu 50. saatinde propofol infuzyonu kesildi ve 5 saat sonra idrar rengi normale döndü. Klinisyenler için endişe verici olabilecek yeşil renkli idrarın aslında propofolün iyi huylu bir yan etkisi olduğunu ve böbrek fonksiyonlarını etkilemediğini vurgulamak istedik.

Anahtar Kelimeler: Kraniyoserebral travma, kritik bakım, hipertonik solüsyonlar, fenoller

Introduction

Propofol (2,6-diisopropylphenol) is an oil at room temperature with minimal solubility in water.[1] It is an intravenous agent widely used for induction of anesthesia, procedural sedation, and sedation in intensive care units (ICUs) due to its rapid onset and relatively safe profile.[2] The pharmacodynamics of propofol are characterized by its ability to enhance the inhibitory effects of the neurotransmitter gamma-aminobutyric acid (GABA) through GABA-A receptors.[3]

In adult ICUs, propofol infusions are favored for their ability to reduce cerebral blood flow, cerebral metabolism, and intracranial pressure.[4] Given its frequent use for sedation in adults, a rare side effect has been observed: green discoloration of urine.[5] The primary site of propofol metabolism is the liver, where a portion undergoes glucuronidation, rendering it water-soluble and allowing renal excretion. The remainder is metabolized via hepatic cytochrome P450 enzymes through oxidation, followed by sulfation, making it water-soluble.[6] The green discoloration of urine is thought to result from phenolic

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metabolites of propofol and is considered benign, with no adverse effects on renal function.[7] A meta-analysis identified 53 cases of propofol-induced green urine in the literature, of which only seven cases occurred in pediatric patients.[2]

With this case report, we aim to raise awareness of this rare and benign side effect of propofol infusion.

Case Report

A 12-year-old male patient was admitted to our pediatric ICU (PICU) with a diagnosis of traumatic brain injury following a motor vehicle accident as a pedestrian. Computed tomography revealed a subdural effusion and cerebral edema in the right frontal region. As the patient did not meet surgical drainage criteria, we decided to proceed with medical management. No intra-abdominal solid organ injuries or extremity fractures were identified.

On physical examination, the patient's general condition was poor. Prior to endotracheal intubation, his Glasgow Coma scale (GCS) score was evaluated as 8, and his pupils were bilaterally reactive to light. Due to his response to painful stimuli only, irregular breathing, and a GCS score of 8, we administered intravenous remifentanil (1 mg/kg) and ketamine (1 mg/kg) for intubation. Skin examination revealed ecchymosis and abrasions consistent with friction injuries, while other system examinations were unremarkable.

For sedation and analgesia, continuous infusions of propofol (1 mg/kg/hour) and fentanyl (1 mcg/kg/hour) were initiated. The propofol infusion was later increased to 2 mg/kg/hour for ongoing management. Hyperosmolar therapy with 3% NaCl was started to manage cerebral edema. Body temperature was maintained between 35 and 37 °C, and prophylactic levetiracetam was initiated. At the 16th hour of the propofol infusion, the patient's urine turned dark green. Comprehensive evaluations, including complete blood count, liver function tests, urine microscopy, and culture, were performed, but no findings explained the urine discoloration. The only notable laboratory result was alkaline urine with a pH of 8 (Table 1, Figure 1).

As there were no signs of systemic inflammation during the PICU stay, antibiotic therapy was not initiated. Blood culture samples were collected within the first 24 hours of admission. Early enteral nutrition was deferred, and intravenous isotonic sodium-containing dextrose solutions were administered.

Given that no other cause for the urine discoloration was identified, the propofol infusion was discontinued at the 50th hour, and ketamine was initiated at 1 mg/kg/hour. Within 5 hours of stopping the propofol infusion, the urine color returned to normal (Figure 2).

On the fourth day of monitoring, sedation infusions were gradually tapered off, and the patient was extubated and transitioned to oxygen therapy via nasal cannula. The patient's urine color remained normal throughout the remainder of the PICU stay, and blood and urine cultures showed no growth. Informed consent was obtained from the patient's parents.

Discussion

Green urine is a rare yet concerning finding associated with propofol administration.[8] In the literature, the exact incidence of propofol-induced green urine has not been clearly defined.[9] Other causes of green urine include urinary tract infections caused by *Pseudomonas* species, Hartnup disease, methylene

Table 1. Laboratory findings at PICU admission, at the time of green urine discoloration, and prior to discharge

Parameter	At PICU admission	At the time of green urine discoloration	Prior to discharge
Urea (mg/dL)	22.3	12.2	21
Creatinine (mg/dL)	0.46	0.72	0.4
Alanine aminotransferase (U/L)	20	17	38
Aspartate aminotransferase (U/L)	47	39	45
Alkaline phosphatase (U/L)	220	205	133
Gamma-glutamyl transferase (U/L)	32	37	32
Creatine kinase (U/L)	300	500	425
Glucose (mg/dL)	80	116	92
Sodium (mmol/L)	136	148	138
Potassium (mmol/L)	4	3.8	3.6
Chloride (mmol/L)	102	113	108
Calcium (mg/dL)	9.8	9.2	10.4
Phosphorus (mg/dL)	5	5.3	4.6
Magnesium (mg/dL)	2.4	2.32	2.15
Total bilirubin (mg/dL)	0.31	0.3	0.33
Direct bilirubin (mg/dL)	0.21	0.2	0.1

Table 1. Continued

Parameter	At PICU admission	At the time of green urine discoloration	Prior to discharge
Uric acid (mg/dL)	3.9	2.2	2.4
Albumin (g/dL)	4.2	3.3	3.2
Venous blood gas			
pH	7.48	7.41	7.45
CO_2 (mmHg)	35	37.6	32
HCO_3 (mmol/L)	24	24.1	23
Lactate (mmol/L)	0.3	1	1.5
Hemoglobin (g/dL)	13.1	10.1	10
Urinalysis (microscopy and biochemistry)			
pH	–	8	–
Density	–	1.019	–
Leukocyte and erythrocyte (strip)	–	Negative	–
Bilirubin, urobilinogen	–	Absent	–
Ketone, protein, nitrite	–	Absent	–
Bacteria and yeast cells	–	Absent	–
Pathological casts and crystals	–	Absent	–

PICU: Pediatric intensive care units

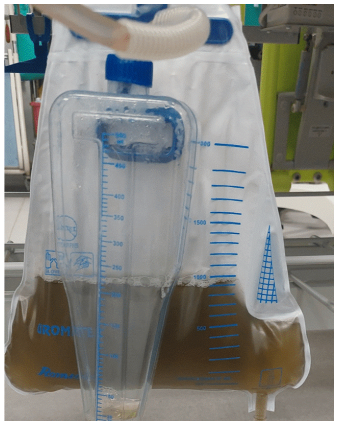

Figure 1. Dark green urine observed after propofol infusion

Figure 2. Normal urine color restored 5 hours after discontinuation of the propofol infusion

blue

administration, and the use of medications such as amitriptyline, cimetidine, metoclopramide, and promethazine.[10-12]

Propofol is primarily metabolized in the liver, and its metabolites are subsequently excreted via the kidneys. Water-soluble quinol derivatives of propofol metabolites are thought to be the main cause of urine discoloration.[8] Although propofol-induced green urine may raise suspicion for serious conditions such as propofol-related infusion syndrome (PRIS), it is generally considered a benign side effect.[13] PRIS, associated with prolonged propofol infusions, is a rare but potentially fatal condition characterized by multiorgan failure. Its primary manifestations include cardiovascular dysfunction, metabolic acidosis, lactic acidosis, rhabdomyolysis, hyperkalemia, hyperlipidemia, hepatomegaly, and acute kidney injury.[14] In our case, the appearance of green urine was not accompanied by clinical deterioration or abnormalities in hematological and biochemical parameters. After ruling out other potential causes, we discontinued the propofol infusion, and the urine color returned to normal within a few hours.

According to a meta-analysis summarizing cases of urine discoloration associated with propofol infusion, only seven pediatric cases have been reported.[2] This is the first reported case of green urine discoloration linked to propofol infusion in a pediatric patient with traumatic brain injury. However, we identified a single similar case in the adult population. That case involved a 77-year-old patient who developed green urine during a propofol infusion while receiving hypothermia and hyperosmolar therapy in the ICU due to intracerebral hemorrhage. The authors of that report speculated that the observed condition might be associated with tubulopathy, a

potential consequence of hypothermia treatment. However, they stated that no such association could be established in their patient.[15] Furthermore, it was emphasized that hypothermia treatment might increase the risk of tubular dysfunction and electrolyte imbalances, which could potentially combine with the effects of osmotic therapy to exacerbate renal side effects. However, in the reported case, the patient's renal function remained normal, with stable levels of creatinine, urea, and arterial blood gas parameters. Similarly, in our case, renal function was within normal limits for the patient's age, and no evidence of tubulopathy was observed. The absence of renal dysfunction in both our case and the previously reported case challenges the explanation for this side effect of propofol.

The mechanism of propofol-induced urine discoloration described in the literature is thought to involve extrahepatic propofol glucuronidation because impaired hepatic enzyme function or decreased gastrointestinal motility leads to reduced hepatic glucuronidation.[6,12,16] However, in our case, there were no signs of decreased gastrointestinal motility (e.g., ileus, constipation, vomiting), and the patient's liver enzyme and bilirubin levels remained within normal ranges from admission to discharge.

There is currently no biomarker to predict which patients might develop green urine during propofol infusion. However, it has been suggested that the excretion of phenolic metabolites is enhanced in alkaline urine.[8,17] In our case, the absence of other findings to explain this side effect supports the hypothesis that alkaline urine facilitated the excretion of these metabolites, resulting in green urine.

Conclusion

We believe that propofol metabolites are responsible for the development of green urine and that alkaline urine, which can influence propofol metabolism, facilitate the emergence of this side effect. We aimed to emphasize that green urine, which may initially be alarming for clinicians, is actually a benign side effect of propofol and does not adversely affect renal function.

Ethics

Informed Consent: Informed consent was obtained from the patient's parents.

Footnotes

Authorship Contributions

Surgical and Medical Practices: A.Ö., N.O.K., Concept: A.Ö., N.O.K., Ö.B., Design: A.Ö., N.O.K., Data Collection or Processing: A.Ö., Ö.B., S.M.I., M.E., Analysis or Interpretation: A.Ö., Ö.B., S.M.I., Literature Search: A.Ö., N.O.K., S.Y., M.E., Writing: A.Ö., N.O.K., S.Y.

Conflict of Interest: No conflict of interest was declared by the authors.

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Review / Derleme

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Turkish Society of Pediatric Emergency and Intensive Care Medicine Neurocritical Care Study Group Stroke in Critically Ill Children

Türk Çocuk Acil Tıp ve Yoğun Bakım Derneği Nörokritik Bakım Çalışma Grubu Kritik Çocuk Hastada İnme

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Abstract

Stroke is a disease whose differential diagnosis is not easy because its symptoms and signs can be seen in many neurologic diseases. When neurological examination, clinical findings and radiological imaging are evaluated together, neurological complications can be minimized with early diagnosis and treatment. Our aim is to increase stroke awareness by emphasizing the importance of time in pediatric acute stroke management and to remind the role of stroke team formation and multidisciplinary approach in early diagnosis and treatment.

Keywords: Child, stroke, pediatric intensive care

Öz

İnme; semptom ve bulgularının birçok nörolojik hastalıkta görülebilmesi nedeniyle ayırıcı tanısı kolay olmayan bir hastalıktır. Nörolojik muayene, klinik bulgular ve radyolojik görüntüleme birlikte değerlendirildiğinde erken tanı ve tedavi ile mortalite ve morbidite en aza indirilebilir. Amacımız, pediyatrik akut inme yönetiminde zamanın önemini vurgulayarak inme farkındalığını artırmak, inme ekibi oluşturulmasının ve multidisipliner yaklaşımın erken tanı ve tedavideki rolünü hatırlatmaktır.

Anahtar Kelimeler: Çocuk, inme, çocuk yoğun bakım

Introduction

Pediatric stroke is a sudden decrease or interruption in blood flow to the brain. Ischemic stroke occurs due to impaired blood flow to the brain as a result of blockage in the arteries, while hemorrhagic stroke occurs as a result of bleeding. Although there are some differences in approach, the supply of oxygen to the brain is disrupted in both cases; therefore, stroke is an emergency situation that requires rapid diagnosis and intervention. The fact that acute neurological changes can

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be seen in many clinical presentations delays early diagnosis and initiation of treatment, which increases morbidity and mortality.[1] Our aim is to raise awareness of the critical importance of time in this situation, to establish a pediatric stroke team, and to emphasize the stages and importance of a multidisciplinary approach.

Stroke Epidemiology

Stroke is difficult to diagnose due to the variability of its symptoms and findings. The incidence of childhood stroke varies widely in the literature, but is estimated to range from 2.5 to 13 per 100.000 each year.[2,3] Male children and the black people are known to be at higher risk.[4] Ischemic stroke is more common than hemorrhagic stroke. The mortality rate in children is approximately 10-25%, but hemorrhagic stroke has a significantly higher mortality rate than ischemic stroke.[1,5]

The Etiology of Stroke and Risk Factors

Common risk factors associated with pediatric stroke include vascular disorders, infections, cardiac causes, and coagulopathies.[6] Other risk factors include hematological disorders, renal disorders, child abuse, autoimmune disorders, metabolic disorders, and head trauma.[7] These risk factors increase the likelihood of cardiac-related embolic events, which are responsible for most ischemic strokes in children.[6] Congenital heart disease, bacterial and other thrombotic endocarditis, cardiomyopathies, rheumatic heart disease, and valvular disease are other cardiac-related risk factors.

Sickle-cell anemia is a hematological disease in which stroke occurs due to the obstruction of blood flow by cells that take on a sickle shape as a result of abnormal hemoglobin.[8] Antiphospholipid antibodies associated with venous thrombosis, protein C deficiency, factor V Leiden mutations, *MTHFR* gene mutations, and antithrombin III deficiency are some congenital or acquired prothrombotic conditions that are other important causes of stroke. These conditions can lead to ischemic or hemorrhagic strokes. Obtaining a detailed family history and reviewing the medications used by the patient can be helpful in determining the underlying etiology. Valproic acid, an antiepileptic drug, has been associated with acquired protein C deficiency.[9]

Hemorrhagic strokes can often be caused by congenital conditions such as arteriovenous malformations. Dissections usually occur as a result of tearing of the artery wall due to trauma. In conditions such as Marfan syndrome, pseudoxanthoma elasticum, moyamoya disease, and fibromuscular dysplasia, they may occur due to coughing, sneezing, or arteriosclerosis. Dissections can lead to strokes through obstruction of the vascular lumen due to the development of intramural hematomas or through thromboembolism. The onset of symptoms can range from one day to one week. Intracranial dissections are a more common cause of stroke in children than in adults.[10]

Cerebral venous thrombosis (CVT) may occur in adolescents with cancer, inflammatory or hematological diseases, and in those using oral contraceptives.[10] Craniofacial infections such as otitis, sinusitis, periorbital infections, meningitis, and encephalitis can lead to CVT.[9] Direct invasion, the presence of a prothrombotic state, and increased platelet aggregation are contributing factors. In the presence of prothrombotic risk factors, dehydration can act as a facilitating factor in triggering a stroke. Viruses such as varicella-zoster virus, human immunodeficiency virus, herpes virus, human parvovirus B19, enterovirus, and influenza A and other bacterial, fungal and parasitic agents such as *Mycobacterium tuberculosis*, *Treponema pallidum*, *Chlamydia pneumoniae*, aspergillus, and *Trypanosoma* cruzi are inflammatory causes that can lead to this condition.[11,12]

Oncological strokes can occur as a result of the cancer itself or the treatments used to treat it. The group at highest risk is leukemia patients and those undergoing radiation therapy.[12,13] Most cases occur during the first 5 months of treatment.[14] It is known that radiation exposure in these patients increases the risk of stroke in a dose-dependent manner.[15] Cytarabine and L-arginase are two important agents known to cause this effect.[16]

Genetic disorders are important risk factors for strokes in the pediatric population. Family history and a detailed physical examination are important in identifying the underlying genetic disorder. Neurofibromatosis type 1, hereditary hemorrhagic telangiectasia, homocysteinemia, cyanocobalamin, pyridoxine, and folate deficiencies can lead to stroke by causing early atherosclerosis and vascular wall damage.[17-19]

Moyamoya disease is a non-inflammatory vasculopathy associated with stenosis of intracranial arteries, particularly the distal internal carotid artery and its branches. These patients are at high risk of stroke due to occlusion or narrowing of the vessels. Collateral vessels formed at the base of the brain may delay the onset of symptoms. Symptoms may be related to ischemia or intracranial hemorrhages that arise as a complication of the collateral blood vessel network. Although hemorrhagic stroke is more common in adults, most children present with ischemia. It is associated with both genetic and environmental factors. It can be confirmed by radiographic studies.[20]

Clinical Findings in Stroke

Although the brain anatomy of children is similar to that of adults, there are many physiological differences. This situation leads to the emergence of different clinical pictures. The

brain of children is more metabolically active. The amount of glucose used by the brain of a five-year-old child is up to 200% higher than that of an adult brain.

The increased cerebral blood flow requirement in children makes them more susceptible to focal neurological damage during hypoglycemic attacks.[5] Different clinical symptoms may be observed depending on the affected brain regions. While seizures are the most common symptom in young children with stroke, focal impairments such as hemiparesis are more common in older children.[4] Other neurological findings include changes in consciousness, decreased muscle strength, numbness, tingling, difficulty speaking, and brief loss of vision in one or both eyes. Non-spesific clinical symptoms and findings such as headache, nausea, vomiting, and fever may also be present.

Diagnosis and Monitorization of Stroke

Pediatric Stroke Team

A multidisciplinary team approach involving professionals from different fields of expertise is invaluable in the diagnosis, treatment, rehabilitation, and long-term follow-up of stroke patients. This team should include specialists from different fields, such as pediatric neurology, pediatric intensive care, and radiology, as well as physical therapists, speech and language therapists, psychologists, nurses, and social workers.

The Importance and Stages of a Multidisciplinary Approach

In the follow-up of children with stroke, it is critical that the pediatric stroke team works in coordination to ensure rapid and accurate diagnosis of the stroke, prevention of complications, and provision of the best possible support for the child's physical and psychosocial recovery. The stages detailed below may not progress at the same pace for every patient. Factors such as the patient's age, the cause of the stroke, and the extent of neurological damage can result in the process varying from patient to patient.

Emergency Intervention and Diagnosis Period

Intervention during this period is important in terms of eliminating the risk of death and limiting potential damage. Diagnosis is confirmed through symptom recognition, neuroimaging, and laboratory evaluation, and a decision is made regarding the treatment to be administered and when to begin.

Acute Treatment and Follow-up Period

It covers what needs to be done to limit the damage caused. During this period, monitoring in a clinic or pediatric intensive care unit is recommended depending on the patient's clinical condition. At this stage, monitoring of vital signs and neurological findings, evaluation of response to treatment, careful attention to possible complications, and family information are included.

Rehabilitation and Neuropsychiatric Support Period

The aim is to facilitate the child's transition to school and social life by providing physical therapy, speech and language therapy, and psychological support.

Long-term Follow-up

Periodic checkups during this period are performed, including stages for preventing the risk of recurrence, monitoring patients who require long-term anticoagulant use, providing counseling to the family, and planning education.

Family History and Laboratory Tests

Once the patient has been stabilized, family history and laboratory tests are evaluated to identify any underlying bleeding disorders. In cases of acute ischemic stroke, evaluation of underlying thrombophilic abnormalities provides information about the likelihood of recurrence or other at-risk individuals in the family. Protein C, antithrombin, factor V Leiden, lipoprotein a, antiphospholipid antibodies, and homocysteine abnormalities may be associated with venous thrombosis. Antiphospholipid antibodies may also be elevated after viral infection, so it is recommended that the test be repeated 12 weeks after the first positive result. Measurement of protein and homocysteine levels may not be accurate during the acute phase of stroke, and repeat testing after the acute event is recommended.[21]

Pediatric National Institutes of Health Stroke Scale (PedNIHSS)

Clinical symptoms and findings of stroke, especially in young children, can vary widely, including changes in mental status, changes in consciousness, and apnea. The National Institutes of Health has developed scoring systems that motivate young children by asking them questions in a playful manner, thereby enabling accurate assessments. These scoring systems provide convenience for clinicians in terms of screening and follow-up. Adult stroke scales have limited applicability in the pediatric population due to their low sensitivity. The PedNIHSS is one of the most widely used scoring systems for this purpose. It measures the severity of stroke using a child-specific version of the adult NIHSS. The scale, which was introduced in 2011, is used in children aged 2-18 years to measure the severity of pediatric stroke, monitor progress, assess recovery, and predict morbidity and mortality. It consists of 11 categories and 15 headings. It enables a rapid and reliable neurological assessment. A score below 6 is considered mild, while a score above 25 is considered severe neurological deficit. The details of the test are outlined in Table 1.

Radiological Imaging Methods

Early and accurate diagnosis of stroke and stroke type is important for emergency stabilization and resuscitation. Magnetic resonance imaging (MRI) is the first imaging method of choice due to its high sensitivity in detecting early ischemia. Techniques such as diffusion, perfusion, susceptibility weighted imaging, and flair examination are helpful in diagnosis. However, its application may be challenging due to factors such as limited availability and the need for sedation to obtain adequate images. For evaluating arteries, magnetic resonance angiography is the most appropriate technique, while MRI and magnetic resonance venography are the most suitable techniques for diagnosing venous sinus thrombosis. Computed tomography (CT) remains the imaging method of choice in cases of acute focal neurological deficits due to its ease of access and application. CT may be preferred in emergency cases involving unconscious, unstable patients. It has been observed that only 50% of non-contrast CT scans show findings consistent with ischemic changes.[22,23] Brain CT may be normal in ischemic stroke cases within the first 24 hours. It can be helpful in the differential diagnosis of acute hemorrhage and in the evaluation of early ischemic infarction, gray-white matter distinction, and edema.[24] While CT is an important parameter in scoring systems and decision-making for mechanical thrombectomy in adults, it may be considered a diagnostic tool in children due to its high radiation dose and the varying hemodynamics of patients under 8 years of age.[25] If there is suspicion of large vessel occlusion, CT angiography may be indicative.

Pediatric Stroke Algorithm

In the recognition and assessment of pediatric stroke, it is important to have practical guidelines and manuals that are easy to use and guide physicians in rapid diagnosis and treatment. The algorithm shown in Figure 1 has been prepared for ease of use in cases of suspected stroke.

Stroke Treatment

Acute and Protective Treatment

There are very few clinicians with extensive experience in mechanical thrombectomy and intra-arterial treatment in pediatric acute ischemic stroke. When large vessel occlusion is detected, it should be evaluated on a case-by-case basis, and if deemed necessary, the patient should be referred to a center with a neuroendovascular specialist who is an expert in endovascular techniques. In cases of hemorrhagic stroke, it is important to correct coagulopathy, if present, and to manage blood pressure by setting age-appropriate blood pressure targets.

The main goals of stroke treatment are to control the size of the infarct, prevent complications, and minimize the risk of permanent damage. Supportive treatment is administered during the acute phase. It is important to ensure airway patency, respiration, and circulation. Patients are evaluated for the need for oxygen therapy and non-invasive or invasive mechanical ventilation. Blood pressure, blood sugar, electrolytes, and body temperature should be maintained at normal levels. Adequate hydration is important. The first choice of fluid may be 0.9% saline solution or Ringer's lactate solution. Hypoosmolar solutions such as 5-10% dextrose should not be used as they may increase cerebral edema.

If the patient has increased intracranial pressure (ICP) or is suspected of having it, the patient is monitored and treated according to traumatic brain injury (TBI) protocol recommendations. Intravenous hypertonic saline is used to control ICP elevation in children with severe TBI. The recommended bolus dose to maintain ICP below 20 mmHg is 2-5 mL/kg administered as an intravenous infusion over 10-20 minutes. A continuous infusion dose of 0.1-1 mL/kg/hour is recommended. Another treatment that can be administered for this purpose is mannitol. The initial dose of 0.25-1.0 g/kg can be titrated as needed to maintain plasma osmolality ≤310 mOsm/L. In recent guidelines, 3% hypertonic saline has become an increasingly important and recommended treatment for cerebral edema.[26]

Seizures, if present, should be controlled. The use of prophylactic anticonvulsants is controversial in cases where seizures are not observed. Since young children have lower seizure thresholds and are at high risk for seizures, anticonvulsant treatment is recommended in the early stages (within the first 7 days) for children with intracranial hemorrhage. Levetiracetam or phenytoin may be selected for this purpose in children.[27] Continuous electroencephalographic monitoring is recommended for the diagnosis of non-convulsive status epilepticus.

Anticoagulant Therapy

After ruling out hemorrhagic stroke, if the patient has arterial dissection, prothrombotic disorders, dural sinus thrombosis, and risk of embolism due to heart disease, anticoagulation therapy with unfractionated heparin or antiplatelet therapy with aspirin should be used in the acute phase.[28,29] Other important contraindications for anticoagulation include moyamoya disease, thrombocytopenia, surgery within the past 24 hours, active bleeding, platelet count below 50.000/mm^3, and a history of heparin-induced thrombocytopenia. Unlike in adults, studies on the use of anticoagulants in children with stroke are limited.

Table 1. PedNIHSS application and scoring

1A. Level of consciousness (0-3)
0: Alert, highly responsive.
1: Not alert but obeys, responds, or reacts to minor stimuli.
2: Not alert, requires repeated stimuli, indifferent to environmental stimuli, has slowed psychomotor responses, drowsy state, requires strong or painful stimuli to move.
3: Responds only with reflex motor or autonomic effects or totally unresponsive, flaccid, areflexic.

1B. Assessment of age and family members (0-2)
a) Ask about age.
b) Ask to point to a family member.
0: Answers both questions correctly.
1: Answers one question correctly.
2: Does not answer either question correctly.

1C. Blinking and touching the nose command (0-2)
0: Performs both tasks correctly.
1: Performs one task correctly.
2: Does not perform either task correctly.

2. Horizontal extraocular movements (0-2)
Only horizontal eye movements are evaluated.
0: Normal
1: Partial gaze palsy: abnormal gaze in one or both eyes, but no forced deviation or complete gaze paresis.
2: Forced deviation or total gaze paresis that cannot be overcome by the oculocerebral maneuver.

3. Visual field (0-3)
In children over 6 years of age, visual field is assessed by finger counting, and in children between 2 and 6 years of age, visual field is assessed using visual threats.
0: No vision loss.
1: Partial hemianopia.
2: Complete hemianopia.
3: Bilateral hemianopia (blindness, including cortical blindness).

4. Facial palsy (0-3)
0: Normal symmetrical movement.
1: Minor paralysis (total or near-total paralysis of the lower part of the face).
3: Complete paralysis of one or both sides (no movement in the upper and lower face).

5 and 6. Assessment of arm and leg motor strength (separate scores for each limb)
The limb being assessed is placed in the appropriate position. For the arms, this position is 45 degrees when lying on the back with the palms facing down, and 90 degrees when sitting. The legs are always assessed in a supine position at 30 degrees. Points are awarded if the arm falls before 10 seconds and the leg falls before 5 seconds. For children who are too young or uncooperative to follow precise instructions, strength is assessed by observing spontaneous or emerging movements.
5A. Left arm (0-9)
5B. Right arm (0-9)
0: No slippage, arm maintains 90 (or 45) degrees for exactly 10 seconds.
1: Slippage, arm maintains 90 (or 45) degrees, but slips down before 10 seconds are up; does not hit the bed or other support.
2: Exerts some effort against gravity, cannot reach or maintain 90 (or 45) degrees (if indicated), slides toward the bed, but exerts some effort against gravity.
3: No effort against gravity, arm falls.
4: No movement.
9: Amputation/joint fusion.

6A. Left leg (0-9) (separate score for each limb)
6B. Right leg (0-9)
0: No slippage, leg maintains 30-degree position for 10 seconds.
1: Slipping, the leg falls before 10 seconds elapse but does not hit the bed.
2: Exerts some effort against gravity but the leg falls onto the bed within 5 seconds.
3: No effort against gravity, the leg falls.
4: No movement.
9: Amputation/joint fusion.

Table 1. Continued

6A. Left leg (0-9) (separate score for each limb)
6B. Right leg (0-9)
0: No slippage, leg maintains 30-degree position for 10 seconds.
1: Slipping, the leg falls before 10 seconds elapse but does not hit the bed.
2: Exerts some effort against gravity but the leg falls onto the bed within 5 seconds.
3: No effort against gravity, the leg falls.
4: No movement.
9: Amputation/joint fusion.

7. Extremity ataxia (0-2)
Ask the child to reach for a toy. For children under 5 years of age or who are unable to cooperate with a standard examination, ask them to kick a toy or the examiner's hand.
0: No ataxia.
1: Present in one extremity.
2: Present in two extremities.

8. Sensory examination (0-2)
Pin-prick test: To determine the degree of sensory loss in small or uncooperative children, any behavioral response to needle pricks is observed.
0: Normal, no sensory loss.
1: Mild to moderate sensory loss; the patient feels that the needle prick is less sharp or dull on the affected side, or there is superficial pain loss with the pinprick, but the patient is aware of being touched.
2: Severe to total sensory loss; the patient is unaware of being touched on the face, arm, or leg.

9. Speech (0-3)
Children with normal language development prior to stroke onset who are ≥6 years of age are asked to describe what is in the picture below, name objects, repeat words from the list, and read sentences from the list (Figures 1, 2, and appendices 1, 2). For children aged 2-6 years, assessment is based on observations of language comprehension and speech during the examination.
0: No aphasia, normal.
1: Mild to moderate aphasia.
2: Severe aphasia.
3: Mute, global aphasia; no usable speech or auditory comprehension.

Figure 1. Picture evaluation test

Figure 2. Object interpretation test

Table 1. Continued

Appendix 1. Repetition test
a. Stop.
b. Stop and go.
c. If it rains, we play inside.
d. The president lives in Washington.

Appendix 2. Reading test
a. Stop.
b. See the dog run.
c. Small children like to play outdoors.

10. Dysarthria assessment (0-9)
Ask the patient to read or repeat the words in Appendix 2.
0: Normal, no dysarthria.
1: Mild to moderate; the patient slurs at least some words, and at worst, can be understood with some difficulty.
2: Severe; the patient's speech is so slow or slurred as to be unintelligible in the absence of or out of proportion to any dysphasia or is mute/anarthric.
9: Intubated or other physical impairment.

11. Inattention or unresponsiveness (0-2)
0: Normal, no unresponsiveness.
1: Inattention or unresponsiveness to simultaneous stimulation from one of the visual, tactile, or auditory modalities.
2: Unidirectional unresponsiveness to more than one modality, failure to recognize one's own hand, or orients to only one side of space.

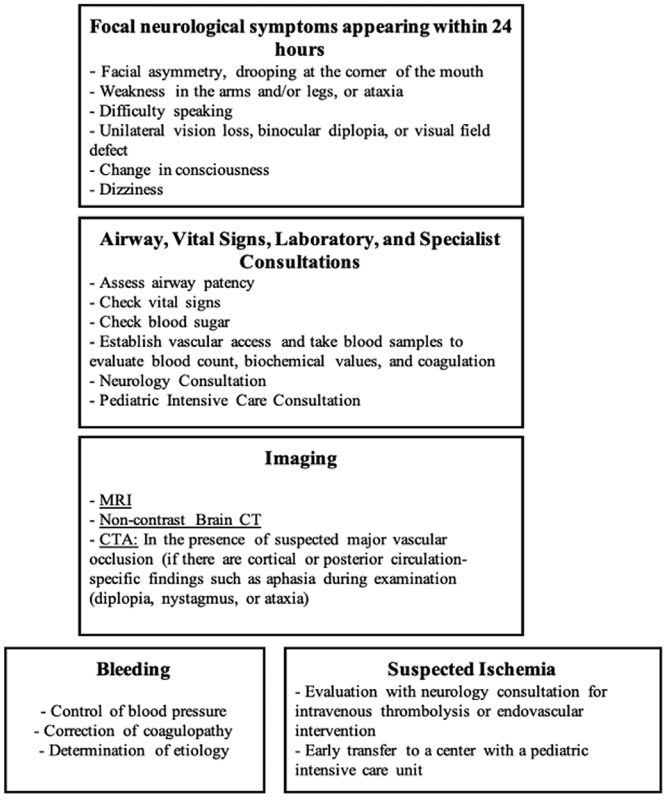

Figure 1. Pediatric stroke algorithm
MRI: Magnetic resonance imaging, CT: Computed tomography, CTA: Computed tomography angiography

A treatment plan tailored to each individual should be developed, taking into account the etiology, the condition of the lesion at the time of diagnosis, and its location. When planning anticoagulant therapy, the effects and side effects of the drugs to be administered should be well understood, and the ability to monitor their effects should be kept in mind. Low molecular weight heparin is used as the first choice in acute anticoagulant therapy in children because it does not require dose adjustment and can be administered subcutaneously. For children under 2 months of age, the initial treatment dose is 1.5 mg/kg/dose, and the prophylactic dose is 0.75 mg/kg/dose, administered every 12 hours. For children over 2 months of age, the treatment dose is 1 mg/kg/dose, and the prophylactic dose is 0.5 mg/kg/dose, administered every 12 hours. Monitoring is performed to maintain the anti-factor Xa level within the range of 0.3-0.7 U/mL.[30]

Non-fractionated heparin is used in the treatment and prophylaxis of venous thromboembolism due to its antithrombotic and anticoagulant effects. The initial loading dose is 30 units/kg, administered as an intravenous infusion over 10 minutes (maximum 5000 units). The maintenance dose of heparin therapy is 28 units/kg/h for children under 1 year of age and 20 units/kg/h (maximum 1000 units/hour) for children 1 year of age and older. For level monitoring, it is recommended to check the activated partial thromboplastin time (aPTT) or anti-factor Xa (anti-Xa) 4 hours after the first dose. It is recommended to maintain aPTT between 65-100 seconds or anti-Xa between 0.35-0.7 units/mL.[30]

Aspirin has an antithrombotic effect and is the first choice for arterial lesions. It prevents platelet aggregation by inhibiting the production of thromboxane A2 in platelets. It is recommended to use 3-5 mg/kg/day to prevent recurrences in stroke.[30]

Treatment of Hypertension

High blood pressure may increase the risk of damage because it increases the risk of cerebral edema and hemorrhage after

ischemic stroke. Hypertension detected after stroke may be due to pain or stress response, efforts to maintain perfusion of the infarct area, compensation for increased ICP, or pre-existing hypertension. Knowing the cause is important for determining the direction of treatment. In children with cerebral vascular pathology, perfusion pressure is dependent on cerebral blood flow, and rapid correction of hypertension may cause harmful effects. There is a very delicate balance between regulating blood pressure and maintaining cerebral perfusion pressure. There is no clear consensus guideline on how to manage blood pressure in children after a stroke. Existing guidelines recommend controlling systemic hypertension in children who have had ischemic or hemorrhagic strokes. The drug selected for the emergency treatment of hypertension should be intravenously (IV) administered, act rapidly, be titratable, have a short half-life, and have few side effects. The most commonly used drugs for this purpose are labetalol and nicardipine.[31] Labetalol can be administered IV at a dose of 2 mg/kg within 2-3 minutes. Nicardipine can be administered via IV infusion at a dose of 1 mcg/kg/min.[32] Due to the unavailability of these drugs in our country, esmolol and nitroglycerin are frequently used in the treatment of hypertension. Esmolol is administered IV at a dose of 125-500 mcg/kg over a period longer than 1 minute, followed by an infusion at a rate of 25-150 mcg/kg/min.[33] Depending on the clinical situation, dose titrations of 25-50 mcg/kg/min are recommended every 5-10 minutes as needed. In children, nitroglycerin is recommended to be started at an initial dose of 0.25-0.5 mcg/kg/min, titrated to 1-5 mcg/kg/min IV infusion, and administered at a maximum of 20 mcg/kg/min.[34]

Tissue Plasminogen Activator (tPA)

The most comprehensive study conducted to date on stroke and tPA use in pediatrics is the thrombolysis in pediatric stroke (TIPS) study, published in 2010. The TIPS study was an international, multicenter, dose-escalation, phase 1 trial. In this study, IV tPA therapy was administered over a one-hour period at three different doses (0.75, 0.9, and 1.0 mg/kg) to children aged 2 to 17 years who presented within the first 4.5 hours after the onset of acute ischemic stroke symptoms.[35] The aim of the study was to define safety criteria to guide tPA use in pediatric patients; however, it was terminated due to insufficient enrollment.

In a retrospective, multicenter study conducted in France between 2012 and 2015, 11 pediatric patients (mean age 11.8 years) with arterial ischemic stroke received IV recombinant-tPA treatment. The most common clinical findings in the patients were acute hemiplegia, hemiparesis, and dysphagia. The average time from symptom onset to MRI was 165 minutes, and the average time to treatment was 240 minutes. In most patients, the affected region was the middle cerebral artery territory. No post-treatment intracranial or peripheral bleeding was reported.[36]

These two studies demonstrate the challenges in treating pediatric stroke. Although the process of initiating treatment may vary among centers due to uncertainty and concerns regarding the initiation of tPA, the general consensus is that the diagnosis and treatment of stroke should be performed according to a specific standard. Although the TIPS study could not be continued, it plays an important role in optimizing the diagnosis and treatment of acute pediatric stroke.

There is no consensus on the determination of the patient group in which IV thrombolytic therapy should be administered in pediatric patients. The optimal time for thrombolytic therapy is generally accepted to be between 3 and 4.5 hours from the onset of stroke symptoms. The 2019 American Heart Association/American Stroke Association guidelines recommend a 4.5-hour window for thrombolytic therapy in children, with individual assessment based on clinical conditions.[21] Recommendations exist regarding the initiation time and dose based on coagulation factors and fibrinogen levels.[37] Since there are no pediatric randomized controlled trials on this topic, recommendations are generally based on adult guidelines and expert opinions; and a dose range of 0.3 mg/kg to 1.0 mg/kg is recommended.[35]

Mechanical Thrombectomy

Like the use of tPA in pediatric stroke, mechanical thrombectomy is not yet a fully established practice. There are a few retrospective studies conducted on small groups of pediatric patients that examine long-term neurological outcomes in this regard.

Satti et al.[38] reviewed 29 pediatric patients treated for ischemic stroke using modern devices (excluding older techniques such as wire manipulation and balloon angioplasty) between 2008 and 2015 in the literature, and found that the average time to treatment was 8.8 hours. Of the 29 patients included in the study, 23 reported positive clinical outcomes; compared to adults, the delay in initiating treatment was attributed to delays in diagnosis in children, as well as a lack of standardization in neurointerventional diagnosis and treatment.[38]

Bhatia et al.[39], along with Fragata and colleagues, investigated the efficacy of mechanical thrombectomy for pediatric ischemic stroke associated with large vessel occlusion using meta-analyses. They demonstrated that mechanical thrombectomy resulted in good long-term neurological outcomes in 87 of 96 cases, good short-term outcomes in 55 of 79 cases, and successful recanalization in 86 of 98 cases. The study reported two deaths and one case of symptomatic intracranial hemorrhage.[39]

Similar to adult applications, the use of modern devices for mechanical thrombectomy in pediatric populations appears to be associated with low complication rates and good clinical outcomes. While the current literature is still limited to small cohort studies, case series, and case reports in pediatrics, pediatric case applications and related publications have been increasing in recent years.

Supportive Treatment

After the patient with stroke has been stabilized, it is important to provide general care and supportive treatment. A multidisciplinary approach in accordance with the algorithm should be implemented by the stroke team. Appropriate supportive measures include maintaining metabolic balance, controlling seizures, correcting dehydration and anemia, early nutrition, and treating underlying infections.[40] Good care is important for minimizing potential complications and evaluating the patient for physical therapy.

Conclusion

Awareness of pediatric strokes is important, and more education is needed in this area. Due to the wide range of signs and symptoms in children and other diseases that can interfere with differential diagnosis, misdiagnosis or failure to diagnose is common. For this reason, it is often difficult to diagnose early. The diagnosis of stroke in children requires a combined assessment of neurological examination, clinical findings, and radiological imaging. Stroke is an emergency situation that requires rapid diagnosis and treatment. In centers with limited resources, it is important to refer the patient to the nearest center where treatment and follow-up can be provided. Serious neurological defects may result from poorly managed stroke, but early diagnosis and treatment minimize this and ensure long-term positive outcomes. In order to rule out conditions that may be confused with stroke in children and to make a quick diagnosis, MRI is recommended as the first imaging method, if possible. In cases where bleeding is suspected and MRI cannot be performed; CT may be performed. While tPA is a powerful thrombolytic agent commonly used in adults for early treatment, its use in infants and young children is limited to specific cases due to the lack of sufficient clinical studies. Given the challenges involved in the early diagnosis, decision-making, and management of stroke, the importance of having a multidisciplinary pediatric stroke algorithm to support clinicians is clear.

Footnotes

Authorship Contributions

Concept: F.İ.G., M.U.Y., S.Ö., F.K., P.Y.Ö., Ç.K., R.Y., E.U.S., A.Ç., Design: F.İ.G., M.U.Y., S.Ö., F.K., P.Y.Ö., Ç.K., R.Y., E.U.S., A.Ç., Data Collection or Processing: F.İ.G., M.U.Y., S.Ö., F.K., P.Y.Ö., Ç.K., R.Y., E.U.S., A.Ç., Analysis or Interpretation: F.İ.G., M.U.Y., S.Ö., F.K., P.Y.Ö., Ç.K., R.Y., E.U.S., A.Ç., Literature Search: F.İ.G., E.U.S., A.Ç., Writing: F.İ.G., E.U.S., A.Ç.

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Respiratory Support via Laryngeal Mask Airway in a Case with Treacher Collins Syndrome

Treacher Collins Sendromlu Hastada Laringeal Maske Havayolu ile Ventilasyon

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Dear Editor,

According to the American Society of Anesthesiologists' guidelines, a difficult airway refers to a clinical situation in which a trained physician experiences anticipated or unanticipated difficulty or failure.[1] Anatomical and physiological differences in the pediatric airway can complicate emergency airway management. Since life-threatening emergencies in children are often due to respiratory pathologies, alternative airway practices are crucial. Midline deformities such as cleft palate and macroglossia can hinder visualization of the vocal cords and, consequently, intubation. A laryngeal mask airway (LMA) should be employed swiftly for a child with failed intubation if no upper airway obstruction or distorted airway anomaly is present. In emergency situations, ventilation can be accomplished with positive pressure via LMA until an intubation tube or tracheostomy is conducted.

A 5-month-old girl with Treacher Collins syndrome was brought to the pediatric emergency service due to irritability, vomiting, and tachypnea. She has a cleft palate and severe gastroesophageal reflux; therefore, she has been fed via a nasogastric tube. Her symptoms included tachypnea, subcostal and suprasternal retractions, cyanosis in room air, and lethargy. Her blood gas analysis indicated metabolic acidosis and the physical findings were consistent with shock. A chest X-ray revealed new bilateral infiltrates. Due to aspiration pneumonia and acute respiratory failure, the pediatrician and anesthetist attempted multiple intubations but were unsuccessful; an LMA was subsequently inserted. The patient was transferred to our pediatric intensive care unit by ground ambulance from a city 5 hours away, using the LMA with self-inflating bag ventilation. Upon admission, her vital signs were recorded as follows: 37 °C fever, 129 beats per minute heart rate, 101/71 mmHg blood pressure, 30 breaths per minute respiratory rate, and 80% oxygen saturation due to inadequate ventilation, despite positive pressure ventilation with the LMA. We attempted to intubate the patient using a video laryngoscope, but visualization of the vocal cords was not possible. Therefore, we reinserted the LMA and initiated invasive mechanical ventilation through the LMA using pressure-controlled synchronized intermittent mandatory ventilation with a peak inspiratory pressure of 30 cm H_2O and a positive end-expiratory pressure of 10 cm H_2O. Oxygen saturation began to increase, and a tidal volume of 8 mL/kg was achieved. Blood gas parameters returned to normal. Otorhinolaryngologists evaluated the patient and decided to perform a tracheostomy. After 8 hours of ventilation with the LMA, the tracheostomy was completed. We anticipated a reduction in the need for high-pressure support; however, even after tracheostomy, we were unable to decrease the pressure support (Figure 1). Upon finishing the patient's acute respiratory distress syndrome (ARDS) treatment, she was transferred to the service following tracheostomy training

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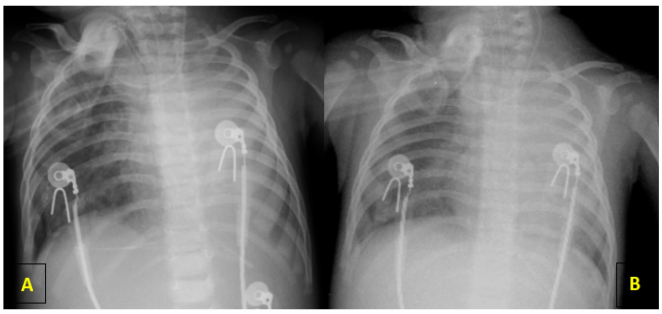

Figure 1. Chest X-ray when the patient with LMA (A) and after tracheostomy performed (B)
LMA: Laryngeal mask airway

for her family. Having completed the family training and with no further need for mechanical ventilation, the patient was discharged to go for outpatient clinic check-ups.

The incidence of difficult airways in healthy children is very low. Valois-Gómez et al.[2] reported an incidence of 7%. Difficult airway management guidelines recommend using an LMA for ventilation in these patients.[1,3] The pediatric difficult intubation registry identifies Treacher Collins as one of the syndromes associated with a difficult airway.[3] Our patient has a cleft palate, micrognathia with retrognathia, limited mouth opening, and a disproportionately large tongue. Repeated attempts at intubation have been unsuccessful; therefore, we used an LMA for ventilation despite her ARDS and the need for high-pressure support.

Aspiration during LMA ventilation is a big concern for managing these patients. Risk factors for aspiration include insufficient anesthesia depth, upper gastrointestinal conditions, a full stomach, repeated attempts, and cuff deflation.[4,5] To mitigate these risks, nasogastric decompression, suitable sedation and analgesia, and proper cuff inflation techniques were implemented during transport and in the intensive care unit. While there is ongoing debate about the use of high airway pressures during ventilation with a LMA, research indicates that it can be utilized safely under such conditions.[6] Considering the patient's existing lung condition, we provided appropriate ventilation using high airway pressures. Throughout this process, the patient was continuously monitored for any potential complications. The requirement for the same airway pressures for ventilation after performing a tracheostomy indicated that we were able to ventilate as if a tracheal route had been established using the LMA.

Ventilation with an LMA is a fundamental life-saving tool during cardiopulmonary resuscitation or elective surgeries. In this case, we observed that LMA can be safely utilized even in children with acute respiratory distress syndrome.

Keywords: Laryngeal mask airway, difficult airway, acute respiratory distress syndrome

Anahtar Kelimeler: Laringeal maske havayolu, zor hava yolu, akut solunum yetmezliği

Footnotes

Authorship Contributions

Surgical and Medical Practises: E.T., F.E., A.D.A., Concept: E.E., M.H., T.K., Design: M.H., T.K., Literature Search: E.E., E.T., F.E., A.D.A., M.H., T.K., Writing: E.E., T.K.

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Letter to Editor

Editöre Mektup

Dinçer Yıldızdaş

Çukurova University Faculty of Medicine, Department of Pediatric Intensive Care Unit, Adana, Türkiye

Dear Editor,

Status epilepticus (SE) is among the most common life-threatening neurological emergencies in childhood, with an incidence of approximately 17-23 episodes per 100.000 children annually, peaking within the first five years of life.[1] SE carries a significant risk of neurological morbidity and an overall mortality rate of up to 3%.[1] We read with great interest the recently published protocol titled "2025 SE in Critically Ill Children" by Özcan et al.[2] in the Journal of Pediatric Emergency and Intensive Care Medicine. We commend the authors for their valuable contribution. Compared to previous protocols, a notable difference in the new guideline is the omission of intravenous (IV) midazolam as a first-line treatment option for SE, with IV diazepam recommended exclusively.[3] It is worth noting that if IV lorazepam were readily available in our country, this debate might have been less pronounced. Nonetheless, a national survey conducted prior to the protocol's publication could have provided a more comprehensive reflection of current practice patterns across Türkiye.

The article offers an up-to-date and comprehensive overview of SE management in critically ill children; however, several methodological aspects merit further consideration. Notably, the absence of details regarding systematic literature search strategies, database usage, and study selection criteria represents a gap in methodological transparency. Furthermore, the omission of evidence levels and recommendation strength impedes an independent evaluation of the proposed therapeutic strategies. Although references to meta-analyses and systematic reviews are made, the findings of these studies are not analyzed in depth. Practical factors-such as cost-effectiveness, feasibility, and the limitations imposed by local resources-are also insufficiently addressed, potentially affecting real-world applicability. Additionally, the lack of visual treatment algorithms limits the accessibility and ease of clinical implementation. Patient heterogeneity (e.g., preterm infants, metabolic disorders) is another critical factor inadequately discussed, creating gaps in individualized care strategies. Similarly, the application hierarchy for immunomodulatory therapies remains undefined, potentially complicating clinical decision-making. While a detailed long-term follow-up protocol is not mandatory, including a brief recommendation to refer patients to pediatric neurology or related specialties for longitudinal care would have enhanced the protocol's scientific robustness and patient safety considerations. Addressing these issues would strengthen the methodological rigor and clinical applicability of the protocol within an evidence-based framework.

A comprehensive review of the literature reveals that IV midazolam is at least as effective as diazepam, and in some cases, it may even be considered superior. According to international recommendations, if IV access is available, IV lorazepam (0.1 mg/kg, max 4 mg/dose), IV diazepam (0.2-0.3 mg/kg, max 10 mg/dose), or IV midazolam (0.1 mg/kg, max 5 mg/dose) can all be considered as first-line agents.[4] Their effects typically become apparent within 0.5 to 5 minutes. Current evidence does not strongly favor one over the others in terms of seizure control efficacy.[5,6]

Although the 2018 Cochrane review and a 2016 network meta-analysis found no clear differences in efficacy or safety among diazepam, lorazepam, and midazolam,[5,7] heterogeneity in study designs and patient populations may

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affect the generalizability of these results. Furthermore, no significant difference in seizure cessation rates has been observed when comparing IV midazolam with IV diazepam or lorazepam, or IV lorazepam with the combination of IV diazepam and phenytoin.[5,8-11] However, studies have reported that fewer second doses were required when lorazepam was used compared to diazepam, although no significant difference was noted between midazolam and the other agents.[6] Importantly, IV lorazepam is associated with fewer adverse events, including respiratory depression and excessive sedation, compared to IV diazepam.[5,12]

National variations are also notable. A nationwide survey conducted by the Italian Paediatric SE group revealed that approximately 90% of physicians preferred midazolam as the first-line treatment.[13] The Canadian guidelines recommend either midazolam or lorazepam, Australian protocols favor midazolam, and Japanese protocols support the use of all three benzodiazepines.[14-16] These differences likely reflect variations in drug availability, healthcare infrastructure, and physician training across countries. Future protocols could benefit from including alternative treatment pathways that account for these factors to enhance relevance and applicability.

In conclusion, while we advocate for the inclusion of IV midazolam as a first-line treatment option based on its efficacy, safety, and route flexibility, we also underscore the importance of developing adaptable, evidence-based protocols that reflect national practice variations and evolving literature.

Keywords: Status epilepticus, children, treatment

Anahtar Kelimeler: Status epileptikus, çocuk, tedavi

Footnotes

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Reply from the Authors:

To the Editor,

We sincerely thank the authors for their interest in our article. Their recognition of the importance of our work and their willingness to engage in scholarly discussion are highly appreciated. We welcome the opportunity to respond to the comments and critiques raised regarding our manuscript titled "2025 Status Epilepticus in Critically Ill Children."[1]

The authors note that intravenous diazepam was the sole agent recommended as first-line treatment in our article. However, our manuscript clearly delineates first-line treatment strategies for pediatric status epilepticus based on the availability of intravenous access. Specifically, intravenous diazepam, intramuscular midazolam, and rectal diazepam are all cited as appropriate first-line agents. As mentioned by the authors, intravenous lorazepam is not currently available in our country, and thus, was not included in the treatment recommendations.[1]

The suggestion that a national study on pediatric status epilepticus management should have preceded the development of our guideline is a valuable one. While such a study would undoubtedly provide insight into local clinical practices, the primary objective of our guideline was to evaluate the efficacy of therapeutic agents based on the international literature. As we emphasized in our article, the guideline was developed through rigorous review of global evidence, with the understanding that individual institutions may tailor their implementation according to their own resources and settings.

The Status Epilepticus in Critically Ill Children Guideline was developed under the auspices of the neurocritical care working group of the Turkish Society of Pediatric Emergency and Intensive Care Medicine. Prior to drafting the guideline, the working group conducted a comprehensive literature review using predefined keywords to identify relevant meta-analyses, guidelines, and reviews indexed in the PubMed database up to the final editorial review date of the article. Following this, the group convened weekly meetings over a two-year period to develop and refine the recommendations.

All treatment options, including those for first-line therapy, were discussed extensively and decided upon collectively. The sources referenced by the authors were among those reviewed during this process. However, current evidence continues to support the American Epilepsy Society guideline as the most reliable and evidence-based reference on this topic.[2] Notably, neither the American Epilepsy Society guideline nor the 22nd edition of Nelson Textbook of Pediatrics (March 2024) includes intravenous midazolam as a first-line treatment.[3,4] Consequently, we did not provide a dosage recommendation for intravenous midazolam within that context.

It is important to emphasize that our guideline offers recommendations, not mandates. Each healthcare institution retains the autonomy to adapt practices according to local needs and capabilities. Nonetheless, we believe that guidelines should be grounded in high-quality evidence, rather than reflect variable clinical practices. All treatments and medications included in our guideline were evaluated based on both their evidence-based efficacy and their availability in our country. None of the authors have any financial or professional conflicts of interest related to the pharmaceutical companies manufacturing these drugs.

In conclusion, the current version of the guideline represents the outcome of extensive review and deliberation by our working group. We believe it offers a sound framework for clinical practice while remaining adaptable to local conditions. As the number of pediatric emergency and intensive care specialists continues to grow in our country, we anticipate that further contributions-including clinical studies, in addition to guidelines and reviews-will enrich the global literature on pediatric status epilepticus.

Sincerely,

Serhan Özcan, Mutlu Uysal Yazıcı, Fulya Kamit, Feyza İnceköy Girgin, Pınar Yazıcı Özkaya, Çelebi Kocaoğlu, Resul Yılmaz, Eylem Ulaş Saz, Agop Çıtak

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