Original Article

MEDICINE PALLIATIVE CARE

DOI: 10.47582/jompac.1284165

J Med Palliat Care. 2023;4(3):224-228

Profile of critically ill childrenin the pediatric intensive care unit: a tertiary-care single-center experience

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Cite this article as: Durak C, Güney Şahin E, Can YY, et al. Profile of critically ill childrenin the pediatric intensive care unit: a tertiary-care single-center experience. *J Med Palliat Care*. 2023;4(3):224-228.

Received: 16.04.2023 ◆ **Accepted**: 05.06.2023 ◆ **Published**: 28.06.2023

ABSTRACT

Aims: The aim of this study was to present a comprehensive overview of the clinical spectrum and outcomes of critically ill pediatric patients admitted to a tertiary-level pediatric intensive care unit (PICU). Furthermore, we aimed to assess potential factors that could influence the requirement for PICU admission. The findings of this study may aid in the prompt identification and management of critically ill pediatric patients, thereby reducing the likelihood of PICU admission.

Methods: This descriptive study investigated the presentation of critical illness among pediatric patients aged between 1 month-18 years old admitted to the PICU was conducted in Sancaktepe Sehit Prof. Dr. İlhan Varank Training and Research Hospital, from February 2022 to January 2023. Demographic data, clinical variables, and outcome data (alive/expired) were analyzed.

Results: A total of 456 patients were analyzed, of which 258 (56.6%) were males and 198 (43.4%) were females. The median length of stay in the PICU was 5 days (1-114). Respiratory diseases (43.2%) were the most common reasons for admission to the PICU, followed by sepsis (13.2%), and neurological diseases (13.8%). We observed a mortality rate of 6.1%, with no association with age or sex. Variables found to be risk factors for mortality were PRISM III score, presence of sepsis and acute renal failure, the requirement for mechanical ventilation, use of inotropic agents, continuous renal replacement therapy and therapeutic plasma exchange requirement, and length of stay ($p < 0.001$).

Conclusion: The profile of patients admitted to the PICU can serve as a basis for developing dedicated protocols for critical care and redistributing the PICUs' resources.

Keywords: Critical illness, intensive care unit, mechanical ventilation, mortality, sepsis

INTRODUCTION

Caring for critically ill children remains one of the most challenging and important issues all around the world, despite the ever-improving modern medical facilities. According to World Health Organization's global health observatory data, the global under-5 mortality rate reached 5 million in 2020, although it has decreased over the years.[1] Millions of children's lives can be saved each year by providing essential pediatric intensive care services such as fluid resuscitation, basic antibiotic support, oxygen, and mechanical ventilator support.[3] With the pediatric intensive care unit (PICU) first established in Goteborg Children's Hospital in Sweden in 1955, the history of pediatric intensive care has a very short history as a branch of medicine.[2] Since then, PICUs have expanded rapidly. It is a wise and practical method to benefit from old experiences when establishing new PICUs or developing existing PICUs.

In this study, we aimed to report the clinical spectrum, and outcomes of critically ill children admitted to a tertiary pediatric intensive care unit in Turkey, and to evaluate the factors that may be effective in the need for PICU, and accordingly to help early diagnosis and treatment response to reduce the possible need for PICU.

METHODS

This study was conducted in accordance with the Declaration of Helsinki. The study's protocol was approved by the Sancaktepe Sehit Prof. Dr. İlhan Varank Training and Research Hospital Ethics Committee (Date: 15.02.2023, Decision No: 2023/27), and all study-related anonymized data are available upon reasonable request.

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This retrospective study was conducted in the PICU at Sancaktepe Training and Research Hospital, Health Science University between February 2022 and January 2023. Healthcare provision for children aged from 1 month to 18 years is provided in our PICU, which is equipped with 12 beds, 12 ventilators, 5 Prismaflex™ hemofiltration machines (Baxter, USA), and 9 isolation rooms.

Demographic data (age, gender), clinical variables (admitting diagnosis, Pediatric Risk of Mortality III score, co-morbidity, length of PICU stay, presence of acute renal failure and sepsis, culture positivity, PICU therapies like mechanical ventilation, use of inotropes, extracorporeal therapy), and outcome data (alive/expired) were collected. Length of stay (LOS) in PICU is classified as ≤7 days, and >7 days. For age analysis, we adopted the following stratification: <1 year, 1-5 years, 5-10 years, and >10 years. Pediatric risk of mortality III (PRISM III) score corresponding to the first 24 hours of hospitalization were calculated according to the equation described by Pollack et al.[4]

Statistical Analysis

SPSS statistical software 20.0 for Windows was used for statistical analyses. Numbers, frequencies [%], ratios, medians, and ranges were used in the descriptive statistics of the data. Continuous variables were tested for normal distribution by Kolmogorov-Smirnov or Shapiro-Wilk test. For analyzes of continuous data, t-test or Mann–Whitney U test was performed to detect differences between the groups, depending on the distribution. Relationships between categorical variables were analyzed by Chi-square test. When Chi-square assumptions were not met, Fisher's exact test was used

RESULTS

During the study period, the total number of children admitted to our PICU was 456. The median age was 38.5 (1-272) months. The majority of the patients (32.2%) were aged 1-5 years, followed by children under the age of 1 (28.5%), and 56.6% were male. A total of 130 patients had co-morbid disease (28.5%), the most common neurological (39.2%), followed by respiratory (11.5%) and hemato-oncological diseases (9.2%). Respiratory diseases such as pneumonia (43.2%) and asthma attacks were the most common reasons for admission to the PICU, followed by sepsis (13.2%), and neurological diseases (13.8%) such as epilepsy and encephalitis. Given that we are in the pandemic period, only 6.1% of patients were Coronavirus disease (COVID-19) polymerase chain reaction (PCR) positive.

The median length of stay in PICU was 5 days, ranging from 1 to 114 days, and 28.5% had hospitalizations longer than 7 days. The median PRISM III score was 2 (0-40).

Table 1. Demographics of patients admitted to pediatric intensive care

	n (%)
Gender	
Male	258 (56.6)
Female	198 (43.4)
Age (month), median (range)	38.5 (1.0-272.0)
Age wisedistribution (month)	
1-12	130 (28.5)
13-60	147 (32.2)
61-120	70 (15.4)
>120	109 (23.9)
Weight, median (range)	15.0 (2.5-215.0)
Comorbiddiseases	
Neurologicaldiseases	51 (39.2)
Respiratorydiseases	15 (11.5)
Hematology-oncologicaldiseases	12 (9.2)
Immunodeficiency	10 (7.7)
Endocrinologicaldiseases	9 (6.9)
Geneticsyndromes	8 (6.2)
Cardiologicaldiseases	7 (5.4)
Metabolicdiseases	7 (5.4)
Chronicrenalfailure	7 (5.4)
Chronicliverfailure	3 (2.3)
Gastrointestinaldiseases	1 (0.8)
Etiologies of admission	
Respiratorydiseases	197 (43.2)
Neurologicaldiseases	63 (13.8)
Sepsis	60 (13.2)
Intoxication	39 (8.6)
Trauma	36 (7.9)
Endocrinologicaldiseases	21 (4.6)
Acuterenalfailure	9 (2.0)
Postoperativeadmissions	8 (1.8)
Cardiologicaldiseases	8 (1.8)
Hematology-oncologicaldiseases	6 (1.3)
Metabolicdiseases	2 (0.4)
Others	7 (1.5)
COVID-19 PCR positivity	28 (6.1)

COVID-19 :Coronavirus 19 PCR: polymerasechainreaction

Invasive mechanical ventilation (IMV) was required in 129 patients (28.3%), and the median duration of IMV was 6 (1-102) days. A total of 237 patients (52.1%) required non-invasive mechanical ventilation (NIMV) support during their stay in PICU. NIMV support was required after extubation in 21.2% of the patients. High-flow nasal oxygen therapy was given in 82.7% of the patients as NIMV support, followed by NIMV-pressure control in 10.5% and NIMV-pressure support in 6.8%. The median duration of NIMV was 3 (1-29) days.

Of the hospitalized patients, 25.7% had sepsis and 13.0% had acute renal failure. Inotropic drugs were used in 58 patients (12.7%). While therapeutic plasma exchange (TPE) was performed on 42 patients (9.2%), continuous renal replacement therapy (CRRT) was performed on 35 patients (7.7%).

Table 2. Clinical characteristics of patients admitted to pediatric intensive care

	n (%)
Length of stay (day), median (range)	5 (1-114)
Length of staywisedistribution	
≤7 days	326 (71.5)
>7 days	130 (28.5)
Sepsis	117 (25.7)
Development of acuterenalfailure	59 (13.0)
Requirement of IMV	129 (28.3)
Length of stay on IMV (day), median (range) (n=129)	6 (1-102)
Requirement of NIMV	
Yes	237 (52.1)
No	218 (47.9)
NIMV duration, median (range)	3 (1-29)
NIMV modality	
AIRVO	196 (82.7)
NIV-PCV	25 (10.5)
NIV-PSV	16 (6.8)
NIMV	
Inisial	186 (78.8)
Postextubation	50 (21.2)
Requirement of CRRT	35 (7.7)
Requirement of inotropicagents	58 (12.7)
Requirement of TPE	42 (9.2)
PRISM III score	2 (0-40)
Mortality	28 (6.1)

CRRT: Continuousrenalreplacementtherapy, IMV: Invasivemechanicalventilation, NIMV: Noninvasivemechanicalventilation, PRISM III: Pediatric Risk of Mortality, TPE: Therapeuticplasmaexchange

Table 3. Relationship between age groups and clinical characteristics

	Age groups (monthes)				p
	1-12	13-60	61-120	>120	
PRISM III score, median (range)	2 (0-22)	2 (0-39)	4 (0-28)	2 (0-40)	0.149
Length of stay>7 day, n (%)	40 (30.8)	43 (29.3)	24 (34.3)	23 (21.1)	0.218
Mortality, n (%)	6 (4.6)	9 (6.1)	5 (7.1)	8 (7.3)	0.821
ARF, n (%)	8 (6.2)	21 (14.3)	10 (14.5)	20 (18.3)	0.037
Requirement of CRRT, n (%)	4 (3.1)	13 (8.8)	8 (11.4)	10 (9.3)	0.115
Requirement of IMV, n (%)	32 (24.6)	42 (28.6)	25 (35.7)	30 (27.5)	0.423
Sepsis, n (%)	31 (23.8)	34 (23.3)	21 (30.0)	31 (28.4)	0.618
Requirement of inotropicagents, n (%)	10 (7.7)	20 (13.6)	13 (18.6)	15 (13.8)	0.149
Requirement of TPE, n (%)	1 (0.8)	14 (9.5)	12 (17.1)	15 (13.8)	<0.001

PRISM III: Pediatric Risk of Mortality, ARF: Acute renal failure, CRRT: Continuous renal replacement therapy IMV: Invasive mechanical ventilation TPE: Therapeutic plasma exchange

The mortality rate was 6.1% (n: 28) and was not associated with age or sex. Variables found to be risk factors for mortality were PRISM III score, presence of sepsis and acute renal failure, the requirement for mechanical ventilation, use of inotropic agents, CRRT and TPE requirement, and length of stay (p<0.001).

Table 4. Relationship between gender and clinical characteristics

	Gender		p
	Male	Female	
PRISM III score, median (range)	2 (0-30)	2 (0-40)	0.898
Length of stay>7 day, n (%)	73 (28.3)	57 (28.8)	0.908
Mortality, n (%)	14 (5.4)	14 (7.1)	0.468
ARY, n (%)	26 (10.1)	33 (16.7)	0.039
CRRT, n (%)	16 (6.2)	19 (9.6)	0.172
Requirement of IMV, n (%)	71 (27.5)	58 (29.3)	0.677
Sepsis, n (%)	62 (24.1)	55 (27.8)	0.377
Requirement of inotropicagents, n (%)	34 (13.2)	24 (12.1)	0.737
Requirement of TPE, n (%)	23 (8.9)	19 (9.6)	0.803

PRISM III: Pediatric risk of mortality, ARF: Acute renal failure, CRRT: Continuous renal replacement therapy IMV: Invasive mechanical ventilation TPE: Therapeutic plasmae xchange

In univariate analyzes for different age groups, there was a statistically significant relationship between the age group older than 120 months and the presence of acute renal failure and TPE requirement. However, in univariate analyzes for gender, only female gender and the presence of acute renal failure was found to be statistically significant. When the etiologies of PICU admission or co-morbid diseases and their relationship with the outcome were examined, no statistical significance could be found due to the low number of patient subgroups.

Table 5. Relationship between outcomes and clinical characteristics

	Outcome		p
	Mortality, n (%)	Survival, n (%)	
Length of stay			<0.001
≤7 day	9 (2,8)	317 (97,2)	
>7 day	19 (14,6)	111 (85,4)	
ARF			<0.001
Yes	15 (25,4)	44 (74,6)	
No	13 (3,3)	383 (96,7)	
Requirement of CRRT			<0.001
Yes	14 (40,0)	21 (60,0)	
No	13 (3,1)	407 (96,9)	
Requirement of IMV			<0.001
Yes	28 (21,7)	101 (78,3)	
No	0 (0,0)	327 (100,0)	
Sepsis			<0.001
Yes	24 (20,5)	93 (79,5)	
No	4 (1,2)	334 (98,8)	
Requirement of inotropicagents			<0.001
Yes	26 (44,8)	32 (55,2)	
No	2 (0,5)	396 (99,5)	
Requirement of TPE			<0.001
Yes	11 (26,2)	31 (73,8)	
No	17 (4,1)	397 (95,9)	
PRISM III score, median (range)	17,5 (3-40)	2 (0-30)	<0.001

PRISM III: Pediatric risk of mortality, ARF: Acute renal failure, CRRT: Continuous renal replacement therapy IMV: Invasive mechanical ventilation TPE: Therapeutic plasmae xchange

DISCUSSION

Care of critically ill patients requires broad-based knowledge to achieve good outcomes. Advances in pediatric critical care medicine have improved the survival rates of children in recent years. During the 12-month study period, 456 children, mostly aged 1-5 years, were admitted to our PICU, comparable to other tertiary PICUs in the country.[9] The median duration of stay in the PICU was found to be 5 days. Consistent with a study by Rady et al.[11] , 71.5% of patients were hospitalized for less than 7 days.

Respiratory diseases were the major causes of admission to our PICU, followed by sepsis and neurological diseases. Similarly, as a result of many studies, respiratory system diseases were reported as the most common reason for hospitalization in the intensive care unit.[3,5,6] However, Blessing et al.[7] reported cardiovascular disease (41.1%) as the most common cause of admission. In another study conducted in Pakistan, the most common hospitalization diagnosis was post-cardiac surgery (34%).[8] The reason for this difference can be explained by the lack of a fully equipped cardiovascular surgery team in different facilities. Therefore, clinicians should know the current conditions for the development of facilities and prepare treatment protocols accordingly.

Studies show that the presence of concomitant chronic disease in intensive care patients is effective on mortality and morbidity, and prolongs hospital stay. Poyrazoglu et al.[12] reported that the most common co-morbid disease in patients hospitalized in PICU was neurological disease (34.7%). We also found neurological diseases (39.2%) as the most common chronic disease in our patients. These results show that a significant proportion of intensive care hospitalizations are children with chronic diseases. For such patients, the opening of intermediate intensive care units in addition to the existing intensive care units in hospitals will allow more effective use of intensive care beds.

In previous studies, it has been reported that the requirement of IMV varies between 30-80%.[17,18] The frequency of IMV administration in our study was lower (29.4%) than in other studies. The findings in our study could be attributed to the development of NIMV technology, the frequency of its use, and the reduction in the requirement of IMV in recent years. Multiple NIMV modalities have been identified that could improve the prognosis of pediatric patients with respiratory failure. However, the effect of different modalities of NIMV on children's prognosis remains inconclusive. Many studies aimed to evaluate the efficacy of various NIMV strategies including high-flow nasal cannula (HFNC), bilevel-positive airway pressure, and standard oxygen therapy in children in need of respiratory support.[19,20] Boghi et al.[20] showed that in pediatric patients, NIMV can reduce the rate of intubation compared to standard oxygen therapy or HFNC. Nevertheless, no difference in mortality was observed between modalities. In our study, the requirement for NIMV was 52.1%. However, due to insufficient data on NIMV success, which limited our study, unsuccessful NIMV cases could not be evaluated.

Intensive care mortality is one of the important data in determining the success of PICU. Overall mortality in this study was 6.1%, regardless of age. Although some studies revealed a relationship between age groups and the outcomes of pediatric patients, no statistically significant difference was found between age groups in terms of mortality in our study.[10,11] Various factors and scoring systems are used to predict mortality in the PICU. In our study, PRISM III score, presence of sepsis and acute renal failure, the requirement for mechanical ventilation, use of inotropic agents, need for CRRT and TPE, and length of hospital stay were found to be factors affecting mortality. In many studies, it has been reported that mortality is statistically higher in patients with a high PRISM III score and that the requirement of inotropic agents and mechanical ventilation in the intensive care unit increases the mortality of patients.[13,14] They emphasized that it should be evaluated together with disseminated intravascular coagulation, multi-organ failure, and the need for mechanical ventilation, which are effective on mortality.[16]

CONCLUSION

Epidemiologic analysis of the profiles of patients admitted to PICU shows different etiologies for admission; however, it is seen that a significant portion of inpatients has chronic diseases. It has been concluded that the limited number of intensive care beds could be used more effectively for critically ill patients, through palliative rehabilitation centers that can be established in the near future for such patients.

In addition to the fact that the number of intensive care beds for children in our country should be increased; consideration should be targeted to intensive care units with a 24-hour accessible pediatric intensive care specialist, sufficient technical equipment and support staff, and easy access to other branches.

ETHICAL DECLARATIONS

Ethics Committee Approval: The study was approved by the Sancaktepe Sehit Prof. Dr. İlhan Varank Training and Research Hospital Ethics Committee (Date: 15.02.2023, Decision No: 2023/27).

Informed Consent: Because the study was designed retrospectively, no written informed consent form was obtained from patients.

Referee Evaluation Process: Externally peer-reviewed.

Conflict of Interest Statement: The authors have no conflicts of interest to declare.

Financial Disclosure: The authors declared that this study has received no financial support.

Author Contributions: All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

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