

A survey on clinical profile and outcome of critically ill children admitted to a paediatric intensive care unit: A retrospective study from a tertiary care hospital for children, Sri Lanka

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Abstract

Introduction: Understanding the clinical profile and outcome of critically ill children plays a substantial role in planning policies, improving existing essential healthcare and the quality of patient care.

Objectives: To describe the clinical profile and outcomes of children admitted to the Paediatric Intensive Care Unit (PICU) of Lady Ridgeway Hospital for Children, Colombo, Sri Lanka.

Method: Children from 1 month to 16 years of age treated in the PICU from 1st January, 2017 to 31st December, 2019 were retrospectively reviewed and information was obtained on age, sex, mode of admission, length of stay, survivors, mortality, system involvement and disease classification.

Results: A total of 2983 patients were admitted and 1791 (60%) were included in the study. Majority (52.5%) were males. Median age at admission was 56 months. In-hospital transfers (68.4%) were more than referred transfers (31.6%). Median length of stay was 7 (IQR 5-9) days. Most frequent clinical PICU admissions were respiratory disorders (32.4%) and the most common single primary diagnosis was sepsis (40.1%). Overall, survival and mortality rates were 77.3% and 22.7% respectively.

Conclusions: Respiratory (32.4%), multi-system-sepsis (23%) and nervous system (18.5%) were the major causes for admission to the PICU.

Commonest single primary diagnosis was sepsis (40.1%). Overall mortality rate was 22.7%.

(Key words: PICU, Survivors, Mortality rate)

Introduction

The Paediatric Intensive Care Unit (PICU) is principally concerned with the treatment of children with critical illness. Abundant conditions that were previously incurable are now treatable¹. The primary goal of basic paediatric treatment is not only to significantly reduce the mortality rate but also to return patients who are in distress from a deadly condition to a state of wellbeing, thereby minimizing suffering and complications and giving comfort and support to the family of the child².

Understanding the clinical spectrum and epidemiological profile of gravely ill children is crucial to the development of health strategies. Descriptive epidemiology is concerned with identifying the pattern and frequency of events that impact the health of a community³. It not only identifies the most vulnerable demographic groups but also determines the general characteristics of the disease under investigation. Even though the PICU at Lady Ridgeway Hospital for Children (LRH) delivers unprecedented services for children, there is little information available about the range of clinical conditions, epidemiological profile, and outcomes of patients in this unit. This survey helps us gain an insight into the current performance of our unit which could be used for future assessment. It can also serve as a benchmark to compare the current performance against the results of other PICUs, both within and outside Sri Lanka.

Objectives

To describe the characteristics of clinical profile and the outcomes of patients admitted to the medical PICU of LRH, Sri Lanka.

Method

This is an institution-based, retrospective, descriptive survey conducted in the PICU of a tertiary care centre, LRH, Sri Lanka. All data were obtained from the database maintained by the National Intensive Care Surveillance Unit and from the medical records department following due permission.

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Inclusion criteria: The following criteria were fulfilled by the patient to be included in the data collection:

- Patients between the ages of one month and sixteen years, with or without comorbidities.
- Patients with medical or surgical conditions.
- Patients who spent at least 24 hours in a medical PICU, with or without haemodynamic, respiratory, or other organ support.

Exclusion criteria included temporary admissions with a length of stay of less than 24 hours (plasmapheresis, observation following certain procedures) and neonates. Neonates were excluded primarily due to 1) the availability of the neonatal intensive care unit, 2) the minimal number of admissions to PICU and 3) many of those who were admitted were given only temporary treatment prior to definite treatment.

Patients' demographic information (age and gender), organ involvement, disease distribution (ICD 10), overall outcome of patients admitted to PICU (ICD 10), monthly pattern of admission, and mean length of stay in PICU were all collected.

Ethical issues: Approval for the study was obtained from the Ethics Review Committee of the Lady Ridgeway Hospital for Children, Colombo, Sri Lanka, on 12 June, 2020 (Ref. No.

LRH/DA/29/2020). As this was a retrospective study, written informed consent was not a possibility.

Statistical analysis: Abstracted data were entered into an MS Excel 2020 spreadsheet. The quantitative variables were clinical profile and outcome pattern. Analysis was performed using the difference in proportions.

Results

There was a total of 2,983 patients admitted to the PICU during the study period, 2017 to 2019. However, as per study inclusion criteria, only 1,791 (60%) patients were included for the analysis. The remaining 1,192 (40%) patients comprised 1,107 (37.1%) temporary admissions and 85 (2.9%) neonates. Temporary admissions were excluded as the length of stay had been less than 24 hours requiring only monitoring with no deaths. However, in the neonatal category, there were 25 neonatal deaths out of 85 admissions during the study period with an overall mortality rate of 0.8%. The total number of patients admitted to the PICU during each 12-month period is summarized in Table 1. Overall, 2017 saw the highest number of PICU admissions based on patient selection criteria while 2018 and 2019 showed an almost equal number of admissions.

Gender and age distribution patterns of admission are shown in table 2.

Table 1: Summary of admissions to PICU

	2017 (n=942)	2018 (n=1008)	2019 (n=1033)
<i>Excluded from study - n (%)</i>			
Temporary admissions	243 (25.8)	417 (41.3)	447 (43.2)
Neonates	21 (02.2)	38 (03.7)	26 (02.2)
<i>Study subjects - n (%)</i>	678 (72.0)	553 (55.0)	560 (54.6)

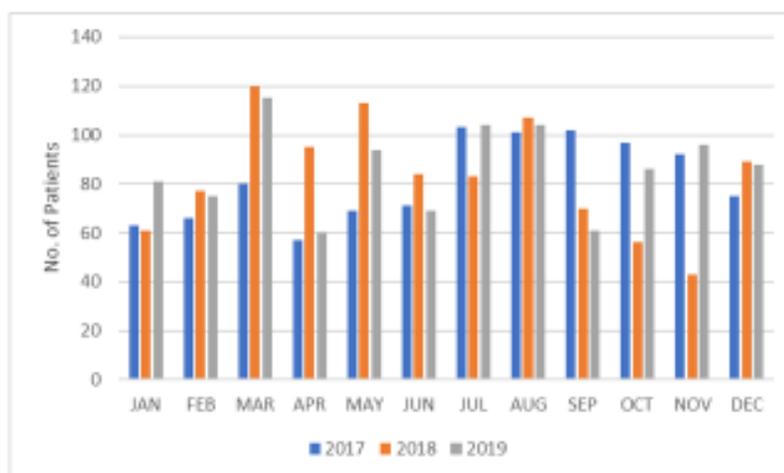
Table 2: Gender and age distribution of study population

Characteristic	Gender	2017	2018	2019	Total
1 month to 1 year	Male	115	123	120	358
	Female	125	91	87	303
	Total (%)	240 (35)	214 (38.6)	207 (36.9)	661 (36.9)
1 to 2 years	Male	39	45	33	117
	Female	33	23	36	92
	Total (%)	72 (10.6)	68 (12.2)	69 (12.3)	209 (11.6)
2 to 5 years	Male	51	55	33	139
	Female	64	37	35	136
	Total (%)	115 (16.9)	92 (16.6)	88 (12.1)	275 (15.3)
5 to 12 years	Male	77	71	91	239
	Female	112	59	72	243
	Total (%)	189 (27.8)	130 (23.5)	163 (29.1)	482 (26.9)
>12 years	Male	33	26	30	89
	Female	29	23	26	78
	Total (%)	62 (09.1)	49 (08.8)	56 (10.0)	167 (09.3)
Total		678	553	560	1791
Male (%)		315 (46.4)	320 (57.8)	307 (54.8)	942 (52.5)
Female (%)		363 (53.5)	233 (42.2)	253 (45.1)	849 (47.5)
M:F		0.8:1	1.3:1	1.2:1	1.1:1

For all three years, the greatest number of patients admitted to the PICU were those aged 1 month to 1 year, followed by those aged 5 to 12 years. From the total admissions, less than one year and the 5-12-year age group contributed to more than half of the total admissions to PICU. Under each category, 661 (36.9%) were less than one year, 209 (11.6%) were in the 1–2-year age group, 275 (15.3%) were in the 2–5-year age group, 482 (26.9%) were in the 5-12-year age group, and 167 (9.3%) were above 12 years. Table 2 elaborates on the sex and age distribution of patients admitted to the PICU on a yearly basis. Overall, the total number of male and female

patients was 942 (52.5%) and 849 (47.5%) respectively, giving a male: female ratio of 1.1:1.

Bar graph 1 shows the monthly trend of admissions to PICU. Although there were wide fluctuations, the month of August showed almost an equal number of admissions for all three years. The maximum number of admissions was seen during July 2017 (103), and March 2018 (120) and 2019 (115). No month showed any positivity towards any disease, although in-hospital admissions peaked during the monsoon period, probably due to dengue/ leptospirosis/ acute gastroenteritis.



Bar graph 1: Monthly admissions to PICU for years 2017, 2018 and 2019

Based on the type of transfers to PICU, in-hospital transfers were more than referred hospital transfers, contributing to 1226 (68.4%) vs. 565 (31.6%) of total admissions, respectively. Pie chart 1

summarizes the pattern of admissions on a yearly basis. In-hospital transfers show a deceleration pattern, while referred hospital transfers show a rising trend on a year-by-year basis.



Pie chart 1: In-hospital vs referred admission to PICU for years 2017, 2018 and 2019

The PICU caters to all critically ill children, regardless of the system or organ involved. Table 3 illustrates the type of organ or system involved at the time of admission to the PICU. Respiratory, neurologic, cardiac, genitourinary, and multisystem were the five major systems that invariably contributed to the majority of PICU admissions. The respiratory system took more than one quarter of the total admissions to PICU for all three years. Multi-organ involvement was primarily seen as the second

leading cause for admission, with 24%, 17%, and 25% for 2017, 2018, and 2019 respectively, which is closer to one quarter of the total admissions. The cardiovascular system leaped by 7% in 2019 in comparison to the previous two years, and neurology showed no major fluctuations in its contribution to PICU admissions for the same period of study. Other systems' involvement is also shown in table 3, demonstrating a minor contribution to the total admissions.

Table 3: System wise distribution (ICD 10) of admissions to PICU

Characteristic	2017	2018	2019	Total
Respiratory – n (%)	214 (29.0)	212 (38.3)	155 (27.6)	518 (32.4)
Multisystem – n (%)	176 (24.0)	95 (17.0)	143 (25.0)	414 (23.0)
Neurology – n (%)	131 (17.8)	89 (16.0)	107 (19.1)	327 (18.5)
Cardiovascular – n (%)	66 (09.0)	45 (08.1)	85 (15.0)	196 (11.0)
Genitourinary – n (%)	25 (03.4)	28 (05.0)	22 (04.0)	75 (04.2)
Endocrine – n (%)	06 (0.7)	19 (03.4)	07 (01.3)	32 (01.9)
Tumours – n (%)	07 (01.0)	16 (02.8)	10 (01.7)	33 (01.8)
Syndromes – n (%)	05 (0.7)	18 (03.2)	07 (01.3)	30 (01.6)
Hepatobiliary – n (%)	09 (01.3)	09 (01.6)	05 (01.0)	23 (01.2)
Gastrointestinal – n (%)	01 (0.14)	08 (01.4)	13 (02.3)	22 (01.2)
Surgery – n (%)	07 (01.0)	02 (0.3)	12 (02.1)	21 (01.2)
Haematology – n (%)	02 (0.3)	08 (01.4)	10 (01.7)	20 (01.1)
Immunodeficiency – n (%)	03 (0.4)	03 (0.5)	01 (0.2)	07 (0.4)

Table 4 shows the outcomes of in-hospital and referred patients to the PICU. Overall, the mortality rate shows a fluctuating pattern for in-hospital transfers with a maximum of 18.8% in 2018 and a rising trend for referred transfers of 8.9% in 2019. Despite this rising trend, overall survival rate stands just above 77% for both groups of admissions, while the mortality rate is around 23% for both groups. The trend has been similar for all three years for both mortality and survival groups. Mortality was slightly higher in males than females but not statistically

significant ($p=0.07$). Non-survivors showed a significantly higher PRISM mean score compared with survivors (26 vs. 17). In comparison with survivors, non-survivors were significantly younger (24 months) with a shorter length of stay (5.6 vs. 9.1 days). Overall, the median length of stay was seven days (interquartile range 5-9 days).

Table 5 displays the annual results of patients hospitalized in the PICU for common diseases.

Table 4: Clinical outcomes of survivors versus non-survivors for years 2017, 2018 and 2019

Characteristic	Outcome	2017	2018	2019	Total
<i>In-hospital patients - n (%)</i>	Survivors	403 (59.4)	273 (49.3)	262 (46.8)	938 (52.4)
	Non-survivors	105 (15.4)	104 (18.8)	79 (14.1)	288 (16.0)
<i>Referred patients - n (%)</i>	Survivors	130 (19.2)	147 (26.5)	169 (30.1)	446 (24.9)
	Non-survivors	40 (05.8)	29 (05.2)	50 (08.9)	119 (06/4)
Total		678	553	560	1791
<i>Survival rate</i>		78.6%	75.8%	76.8%	1384/77.3%
<i>Mortality rate</i>		21.4%	24.2%	23.2%	407/22.7%

Table 5: Mortality based on disease (ICD 10)

Diagnosis	2017		2018		2019	
	Total	Non-survivors	Total	Non-survivors	Total	Non-survivors
Sepsis/Septic shock	43	18 (41.8%)	53	19 (35.8%)	60	12 (20.0%)
DHF/Dengue shock syndrome	132	01 (0.75%)	32	02 (06.3%)	77	06 (07.7%)
Encephalitis/Meningitis	70	16 (22.8%)	31	03 (09.6%)	39	05 (12.8%)
Chronic neurological conditions (cerebral palsy, neurodegenerative)	12	08 (66.6%)	09	08 (88.0%)	16	10 (62.5%)
Severe pneumonia/PARDS/Aspiration	105	19 (18.0%)	147	17 (11.5%)	76	16 (21.0%)
Chronic lung disease with sepsis/ Pulmonary hypertension	07	04 (57.0%)	05	04 (80.0)	05	05 (100.0%)
Congenital heart disease Acyanotic/Cyanotic	43	19 (44.1%)	27	11 (40.7%)	49	21 (42.8%)
Heart failure/Myocarditis/Cardiomyopathy	16	02 (12.5%)	16	0 (0%)	16	04 (25.0)
Acute liver failure	05	04 (80.0%)	10	02 (20%)	02	01 (50.0)
Chronic liver failure	04	03 (75.0%)	03	03 (100.0%)	05	04 (80.0%)
Acute renal failure (HUS/RPGN/RTA)	09	05 (55.5%)	09	03 (33.3%)	09	03 (33.3%)
Chronic renal failure	07	03 (42.8%)	04	02 (50.0%)	03	01 (33.3%)
Tumours (Renal/Leukaemia/CNS/Liver)	07	02 (28.0%)	16	05 (31.0%)	10	03 (30.0%)
Immunodeficiency	01	01 (100.0%)	05	05 (100.0%)	02	02 (100.0%)
Syndromes	05	04 (80.0%)	18	14 (77.0%)	07	01 (14.0%)

DHF: Dengue haemorrhagic fever, PARDS: paediatric acute respiratory syndrome, HUS: haemolytic uraemic syndrome, RPGN: rapidly progressive glomerulonephritis, RTA: renal tubular acidosis, CNS: central nervous system

From 2017 to 2019, both acute and chronic diseases contributed to death. When compared to acute

sickness, the death rate for chronic illnesses has increased overall. Patients with acute illnesses such

as sepsis or septic shock experienced a 50% reduction in mortality by the end of 2019. Similarly, acute diseases such as acute renal disorders, acute neurological disorders (meningitis/encephalitis), and acute liver disorders indicate a mortality decrease of around 20%, 10%, and 30% by the end of 2019. A few chronic diseases, such as cerebral palsy and neurodegenerative disorders, had the highest fatality rate of 88% in 2018, although encephalitis/meningitis had a lower mortality rate year after year. Congenital heart disease and tumours showed no significant changes despite death rates of more than 40% and 30%, respectively, for all three years, but chronic liver disease had the greatest mortality rate in 2018. Chronic lung illness similarly had a year-to-year increase in mortality, reaching 100% (n=5) in 2019, but acute respiratory disorders showed considerable fluctuation, with many deaths occurring in 2017 (n=19). Similarly, immunodeficiency was at 100% for non-survivors for all three years.

Discussion

Globally, PICUs are equipped with advanced complex machines to provide the best care possible to reduce morbidity and mortality. This ultimately increases the cost of treatment per patient. Hence, assessing the PICU is an integral component of health planning, management, and quality improvement. Clinicians can be guided in decision making, including the appropriateness of therapy, in the presence of well-resourced PICUs^{4,5}. Among SAARC countries, Pakistan, and India, have reported noteworthy variability between PICUs in age and percentage of morbidity and mortality^{1,6}. PICUs with higher death rates may be caring for patients with more severe illnesses and vice versa. However, lower mortality rates do not always imply better long-term outcomes⁶.

Children less than one year of age were the most vulnerable group in our PICU at 36.9% (n=661). This was comparable to studies in Brazil by Einloft PR, *et al*⁷, in Egypt by Rady HI⁸, and in India by Mukhija G, *et al*⁹. Children under the age of five years accounted for more than two-thirds of all PICU admissions. Similar results were obtained in Brazil by El Halal MG, *et al*¹⁰ and in India by Abhulimhen-Iyoha BI *et al*¹¹ where the under-five age group comprised the majority of patients. In our study, the proportion of males was 52.5% which is similar to that reported in Brazil by Einloft PR, *et al*⁷ (58%), in India by Batista NO, *et al*¹² (56%) and in Bangladesh by Hasan SM, *et al*¹³ (55%). We also observed that the majority of those who died belonged to the under five-year age group (67%). Of those, the under one-year age group constituted the major portion (46%). This data was comparable with studies by Shashikala V, *et al*¹⁴ (51%) and Ramnarayan P, *et al*¹⁵ (57.7%). This difference in

age proportion could be due to more severe and complex disease patterns, atypical presentation, anatomical characteristics and poor immunity in infants than older children.

Based on system involvement, our study revealed that respiratory (32.4%), multi-system-sepsis (23%) and nervous system (18.5%) were the major causes for admission to the PICU during all three years. Likewise, an Indian study by Sujay KE, *et al*¹⁶ and a Brazilian study by Lanetzki CS, *et al*³ also reported that respiratory diseases were the most common reason for hospitalization among patients in their PICU. However, an Indian study by Abhulimhen-Iyoha BI *et al*¹¹ reported that cardiovascular disease (41.1%) was the commonest cause of admission to PICU followed by neurological, respiratory, infectious disease while cardiovascular system was the fourth leading cause of admission to PICU in our study. In contrast to our study, a Pakistan study by Haque A, *et al*¹ found that the most common cause of admission in their ICU was neurological (28%) followed by respiratory, sepsis and cardiovascular disease. In Bangladesh, Hasan SM, *et al*¹³ found that sepsis was the most common, followed by gastrointestinal and haematological disorders. Despite varying reasons for PICU admissions, infection-related organ dysfunction was prevalent in all countries.

Deaths due to acute and chronic medical conditions were reported from this PICU. Infection-related conditions such as severe sepsis, septic shock, severe pneumonia, and severe encephalitis were major contributors to acute conditions leading to death, with an overall mortality rate of 18.3%. This was comparable to a study conducted in Nepal in 2018¹⁷. However, a small prospective study performed in India revealed a mortality rate of 58% due to sepsis¹⁸. In contrast, Volakli E, *et al*¹⁹ from Greece found a mortality rate of 11% from infections and 67% from trauma. This discrepancy in mortality could be due to the severity of illness or disease, associated comorbidities, delayed/atypical presentation, the experience, and clinical ability of a treating physician. Deaths from heart diseases showed a declining trend for all three years but were higher than in regional countries. Hasan SM, *et al*¹³ reported a mortality rate of 12% from heart diseases. This low mortality could be due to better availability and allocation of resources, manpower, early screening, and an advanced and sophisticated management approach. Other conditions like liver and renal diseases showed a case fatality rate of 40% for both conditions in this PICU. This rate was comparable to studies conducted in Iran by Deghani SM, *et al*²⁰ and in Nigeria by Sadeghi-Bojd S, *et al*²¹ for liver and renal diseases respectively. Gupta S, *et al*²² also reported a similar rate of mortality in their PICU from India. High

mortality could be explained by a higher severity of organ dysfunction score, a lack of immediate replacement therapy, an acute life-threatening emergency at the time of admission to the PICU, or delayed admission.

Diverse studies carried out in hospitals in non-industrialized countries have revealed a fatality rate ranging from 5% to 14%¹⁶. In our study, out of 1791 patients, 407 died, giving a mortality rate of 22.4% over a period of three years which is higher than that usually reported from developing countries. However, Jyothi AK *et al*²³ in a study from India, reported a mortality rate of 28% which was higher than in our study. In contrast, a study from Nepal by Joshi P, *et al*¹⁷ reported a PICU mortality rate of 18.5% over a period of one year. In Bangladesh, Hasan SM, *et al*¹³ reported a case fatality rate of 4.9% over a three-year period. A study conducted in Latin America by Campos Mino *et al*²⁴ in 2012 showed a mean mortality rate of 13.3% in their PICU. In Argentina, Eulmesekian PG, *et al*²⁵ reported a mortality rate of 2.6% in their PICU. Significant differences in mortality rates may perhaps be attributed to the varying severity of ailments, improved health-care policy, well-resourced PICUs, well established protocols, effective retrieval unit and advanced treatment centres including transplants.

This is one of the first studies from this PICU. Hence, trends in performance cannot be compared. However, it helped us identify the trend and the pattern of diseases and deaths. Higher mortality from this PICU could be due to collective factors. Although our patients' demographic profiles matched those of PICU patients around the world, there are significant disparities in case mix and disease severity. Some of the most effective strategies to improve the current trend would be to increase awareness amongst treating physicians to follow the established protocol, to use a validated organ dysfunction score at the time of admission, topographical allocation of PICUs, optimal utilization of resources, prioritize care at the time of admission to PICU, allocate adequate financial support for transplant, tissue banks and streamline its management through national registry, establish an effective retrieval unit, implement national policies to alter factors associated with poor outcome, and adequate training and recruitment of paediatric intensivist. Effective communication between treating physicians at the level of primary, secondary, and tertiary care centres, nursing staff and policy makers is necessary to enhance the expectation of the current pattern.

Conclusions

Respiratory (32.4%), multi-system-sepsis (23%) and nervous system (18.5%) were the major causes

for admission to the PICU. Most common single primary diagnosis was sepsis (40.1%). Overall mortality rate was 22.7%.

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