

# Characteristics, Outcomes and Bed Utilization of 15-to-18-Year-Old Adolescents in a Pediatric Intensive Care Unit in Thailand

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## ABSTRACT

**Objective:** There is a trend toward expanding pediatric age range. At the borderline age of 15-18 years, the characteristics of patients requiring intensive care admission in low- and middle-income countries are unknown. Our institution recently changed the cut-off age for pediatric care from 15 to 18 years. The objective of this study was to determine the characteristics, outcomes and bed utilization of patients aged 15-18 years admitted to pediatric intensive care unit (PICU) after this change.

**Materials and Methods:** This is an observational study at a tertiary medical PICU. Patients aged 15-18 years admitted to PICU in 2019-2020 were eligible. Medical records were reviewed.

**Results:** There were 1030 PICU admissions from all age groups. Fifty-two patients aged 15-18 years were admitted, with a total of 68 admissions. Eighty-seven percent had chronic conditions. The most common acute conditions were septic shock and infection, the most common chronic conditions were systemic lupus erythematosus (SLE) and hematologic malignancies. Forty-seven percent required mechanical ventilation, 36% required vasoactive medications and 27% required continuous renal replacement therapy. PICU mortality rate in patients aged 15-18 years old was significantly higher than that in the younger age group (13.24% vs 3.64%,  $p = 0.002$ ). Hospital mortality rate was 22%.

**Conclusion:** Patients aged 15-18 years requiring PICU admission had high prevalence of chronic conditions and high mortality risk. Special attention should be given to the care of this group. The most common acute conditions were septic shock and infection. The most common chronic conditions were SLE and hematologic malignancies.

**Keywords:** Mortality; epidemiology; diagnosis (Siriraj Med J 2023; 75: 555-559)

## INTRODUCTION

The pediatric age range varies across different countries. In the US, the cut-off age for pediatric inpatient care ranges between 15 and 18 years.<sup>1</sup> In the UK, this cut-off is generally 16 years.<sup>2,3</sup> In Thailand, this cut-off is 15 years for most hospitals. There has been a trend toward increasing the pediatric age range.<sup>4</sup> In fact, the American Academy of Pediatrics issued a policy toward eliminating

the age limit for pediatric care in 2017.<sup>5</sup> Diseases affecting adolescents are likely to be different from those affecting younger children and may be more similar to those affecting young adults. Moreover, the prevalence of chronic conditions in adolescents and young adults is currently high.<sup>6</sup> Pediatric residency training generally puts an emphasis on child health supervision, growth, development and childhood diseases, but training in

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adult diseases and chronic diseases may be inadequate. With the expanding age range, pediatricians will likely encounter different disease characteristics from what they have been trained for during residency.

Pediatric intensive care unit (PICU) is an important patient care setting because its patients are critically ill and require appropriate emergency treatment. Therefore, it is important to know the disease characteristics of patients in the expanding pediatric age range – 15 to 18 years old – who are admitted to intensive care units (ICU), so that pediatric training can be tailored to serve this age group as well. To our knowledge, ICU data of patients in this age range from low- and middle-income countries are lacking. Our institution changed the cut-off age for pediatric care from 15 to 18 years on 1 Jan 2019. The primary objective of this study was to determine the characteristics and clinical outcomes of patients aged 15 to 18 years old admitted to PICU after this change. With the expanding age range, it is expected that an increasing number of patients will be admitted to PICU, but the magnitude of the increase is unknown in our healthcare setting. Therefore, the secondary objective was to determine PICU bed utilization of patients aged 15 to 18 years old using admission numbers and bed-day approach.<sup>7</sup>

## MATERIALS AND METHODS

This is an observational study conducted in patients aged 15 to 18 years old who were admitted to PICU at Siriraj Hospital, Bangkok, Thailand from 1 Jan 2019 to 31 Dec 2020. Siriraj Hospital PICU is a tertiary-level general medical PICU. The study was approved by Siriraj Institutional Review Board (COA no. Si 099/2020) on 3 Feb 2020. Informed consent was obtained from legal guardians for cases with prospective data collection from 3 Feb 2020 onward. Patient assent was also obtained for cases where patients were able to communicate and give assent.

All patients aged 15 to 18 years old admitted to PICU between 1 Jan 2019 and 31 Dec 2020 were eligible. There were no exclusion criteria. Patients' medical records were reviewed. The collected data included age, sex, length of PICU stay, length of hospital stay, PICU mortality, hospital mortality, diagnoses (acute and chronic) and invasive treatment received in PICU. Data from PICU admission database were also reviewed for length of PICU stay and PICU mortality in all patients admitted to PICU.

Primary outcomes were diagnoses, PICU mortality and hospital mortality rates. The secondary outcome was PICU bed utilization measured by admission numbers and

bed-days.<sup>7</sup> In patients who had multiple PICU admissions, diagnosis data from multiple admissions were unified to avoid duplication of diagnosis counts. Patients who were electively admitted to PICU only for one-day procedure e.g., dialysis catheter insertion, were excluded from diagnosis data analysis because these patients were not part of the critically-ill population of interest. Chronic condition was defined as a medical condition that could be expected to last at least 12 months.<sup>8</sup> Bed-days were calculated from the sum of the length of stays of patients admitted to PICU during the study period.

Categorical variables were presented as counts and percentages, and they were analyzed with Fisher's exact test. Shapiro-Wilk test was used to determine the normality of continuous variables. Continuous variables were presented as median and interquartile range (IQR) and were analyzed with Mann-Whitney *U* test. Statistical significance was defined as *P* value < 0.05. Statistical analysis was performed with PASW Statistics 18 (SPSS Inc., Chicago, IL).

## RESULTS

There were 1030 PICU admissions from all age groups during the 2-year study period. There were 962 admissions of patients aged 0 to 14 years old. There were 52 patients aged 15 to 18 years old admitted to PICU, with a total of 68 admissions (6 patients were admitted twice, 1 patient was admitted 3 times, 1 patient was admitted 4 times and 1 patient was admitted 6 times). Out of these 52 patients, there were 7 patients who were electively admitted only for a one-day procedure, leaving 45 patients for analysis. Among these 45 patients, 39 (87%) had chronic conditions. Among 39 patients with chronic conditions, 26 patients were admitted to PICU due to progression of their underlying chronic conditions, 13 patients were admitted to PICU due to acute illness (mostly infectious diseases) on top of preexisting chronic conditions. [Table 1](#) shows the most common acute and chronic conditions and disease groups. The most common acute condition requiring PICU admission was septic shock. Infection was the most common acute disease group. The most common chronic condition was systemic lupus erythematosus (SLE). Oncology was the most common chronic disease group. The details of diagnoses of each patient are shown in the supplementary appendix.

Patient demographic characteristics, treatments and outcomes are shown in [Table 2](#). Forty-four percent were female. In terms of intensive care therapies, 47% required invasive mechanical ventilation, 36% required vasoactive medications, and 27% required continuous

**TABLE 1.** The most common acute and chronic conditions and disease groups among PICU patients aged 15 to 18 years old.

Acute conditions (N = 45)	Acute disease groups (N = 45)	Chronic conditions (N = 39)	Chronic disease groups (N = 39)
Septic shock 6 (13%)	Infection 11 (24%)	Systemic lupus erythematosus 5 (13%)	Oncology 14 (36%)
SVC obstruction 3 (7%)	Neurology 9 (20%)	Acute myeloid leukemia 3 (8%)	Rheumatology 5 (13%)
Acute liver failure, dengue shock syndrome, diabetic ketoacidosis 2 (4%) each	Gastroenterology 6 (13%)	Acute lymphoblastic leukemia 3 (8%)	Genetics, neurology 4 (10%) each

SVC = superior vena cava

**TABLE 2.** Patient demographic characteristics, treatments and outcomes.

Characteristics	Results (N = 45)
Age (years) – median (interquartile range)	16 (15.38, 17.04)
Female	20 (44%)
Chronic conditions present	39 (87%)
Source of pediatric intensive care unit admission	
Ward	17 (38%)
Emergency department	10 (22%)
Operating room or procedure room	10 (22%)
Transferred from other hospitals	8 (18%)
Invasive treatment received	
Invasive mechanical ventilation	21 (47%)
Vasoactive medications	16 (36%)
Continuous renal replacement therapy	12 (27%)
High-frequency oscillatory ventilation	1 (2%)
Extracorporeal membrane oxygenation	2 (4%)
Plasmapheresis	3 (7%)
Leukapheresis	1 (2%)
Angiogram and embolization	2 (4%)
Hospital mortality	10 (22%)
Hospital length of stay (days) – median (interquartile range)	20 (9.5, 42)

renal replacement therapy. The overall hospital mortality rate was 22%. The mortality rate was highest in patients who were admitted to PICU due to acute illness on top of preexisting chronic conditions at 38% (5 out of 13 patients). The mortality rate in patients who were admitted to PICU due to progression of their underlying chronic conditions was 15% (4 out of 26 patients), while mortality rate in patients without chronic conditions was 17% (1 out of 6 patients). However, these differences in mortality rates did not reach statistical significance ( $P$  value = 0.247).

PICU mortality rate in adolescents aged 15 to 18 years old was 9/68 (13.24%). PICU mortality rate in patients aged 0 to 14 years was 35/962 (3.64%). PICU mortality was significantly higher in adolescents aged 15 to 18 years old compared to the younger age group; odds ratio = 4.040, 95% confidence interval (1.855, 8.799),  $P$  value = 0.002. Lengths of PICU stays were not different between adolescents aged 15 to 18 years (median = 2 days, IQR = 1, 6) and the younger age group (median = 2 days, IQR = 1, 5;  $P$  value = 0.651).

During the 2-year study period, the number of PICU bed-days of all patients was 5073. The number of PICU bed-days of adolescents aged 15 to 18 years old was 384. The number of PICU bed-days of patients in the younger age group was 4689. PICU bed-days of adolescents aged 15 to 18 years old accounted for 7.57% of total bed-days and was equal to 8.19% of those in the younger age group.

## DISCUSSION

The data from our cohort of adolescent PICU patients aged 15 to 18 years old showed that the most common acute condition was septic shock, and the most common acute disease group was infection. This is not surprising, given that septic shock and infection are commonly encountered in PICUs.<sup>2,9</sup> A large multicenter cohort study showed that the most common diagnosis categories of patients aged 16 to 19 years old admitted to adult ICUs and PICUs in the UK were trauma, respiratory, overdose, neurology, cardiovascular and infection.<sup>2</sup> This is similar to our data except for trauma and overdose. There were no trauma patients in our cohort because our setting is a medical PICU in an urban area where trauma cases are not frequently transferred in. The prevalence of overdose in our cohort was low for unknown reasons. However, it is possible that the types of drugs abused differ in different countries. The most common drugs of abuse in Thailand are cannabis and methamphetamine.<sup>10-12</sup> These drugs do not usually cause respiratory depression requiring endotracheal intubation and ICU admission,

in contrast to other drugs, such as opioids, which can cause respiratory depression necessitating endotracheal intubation and ICU admission.

Regarding chronic conditions, it is notable that the most common chronic condition in our cohort was SLE. SLE is generally viewed as a disease mainly affecting women of childbearing age<sup>13</sup>, but in fact, 10 to 20% of SLE patients are diagnosed during childhood.<sup>14</sup> SLE causes inflammation and dysfunction in multiple organ systems, and childhood-onset SLE is more aggressive than adult-onset SLE.<sup>15</sup> SLE patients who require ICU admission have a high mortality rate, ranging from 18.4 to 78.5% with a median of 29.6% in a recent systematic review.<sup>16</sup> Considering this fact along with the high prevalence of SLE in our cohort, it is important for pediatric intensive care and pediatric residency training to also focus on managing severe SLE and its complications. In terms of disease groups, oncology was the most common chronic disease groups in our cohort. This is probably because our hospital is a tertiary referral center. Pediatric oncologic patients who require PICU admission have mortality risk as high as 15 to 40%<sup>17</sup>, higher than other PICU populations. This probably contributed to the high mortality in our cohort.

The findings that our cohort of adolescents aged 15 to 18 years old had a high hospital mortality rate (22%) and had a significantly higher PICU mortality rate than the younger age group are important. This was probably because of the very high prevalence of chronic conditions in our cohort (87%), and the fact that some chronic conditions are associated with high PICU mortality as mentioned above. Overall, adolescent patients aged 15 to 18 years old with chronic conditions who require ICU admission should be seen as having a higher risk of mortality, and special attention should be given to the care of these patients. Given the high prevalence of chronic conditions seen in our cohort, pediatric training should be tailored to cover common chronic conditions encountered in adolescents. Pediatric nursing education also needs tailoring to serve this adolescent patient population. Many chronic conditions can cause problems in multiple organ systems and necessitate involvement from multiple subspecialties. With this increased complexity, patient care collaboration between multiple subspecialties cannot be overemphasized. If appropriate, a dedicated care coordinator team can facilitate collaboration and communication between multiple subspecialties and families in the care for such complex patients.

In terms of bed utilization in this study, PICU admission number in patients aged 15 to 18 years old

accounted for 6.6% of the total admission number and was equal to 7.07% of admission number in the younger age group. PICU bed-days in this age group accounted for 7.57% of total bed-days and was equal to 8.19% of bed-days in the younger age group. For a tertiary medical PICU with similar setting to ours, if the age cut-off is expanded from 15 to 18 years, one may approximately expect a 7.07% increase in admission number and an 8.19% increase in bed-days.

There are some limitations to this study. Being a single center study conducted in a tertiary medical PICU limits generalizability, and this study has a small sample size. Some disease populations are likely under-represented, such as trauma and surgical patients. The PICU mortality comparison between age groups in this study was analyzed without correction for severity score because this score was not routinely collected at the time that this study was conducted. Nevertheless, the finding that large proportions of patients required invasive treatments implies that our cohort had high disease severity.

In conclusion, this study found that adolescents aged 15 to 18 years old requiring PICU admission had high prevalence of chronic conditions and high mortality risk. Special attention should be given to the care of this group. The most common acute conditions were septic shock and infection. The most common chronic conditions were SLE and hematologic malignancy. Pediatric intensive care training should also be tailored to serve this population of expanding pediatric age range.

### Conflict of interest

All authors have no conflict of interest to disclose.

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