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Original Article

Predictors of prolonged stay in the pediatric intensive care unit

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Abstract

Background Prolonged stay in the pediatric intensive care unit (PICU) reflects not only disease severity and patient health status, but also the performance and quality of patient care.

Objective To to determine whether surgical procedure, severe malnourishment, cardiovascular condition, sepsis, and ventilator use were the predictors of prolonged PICU stay.

Methods This nested, case-control study was conducted with secondary data from medical records of pediatric inpatients at Dr. Sardjito General Hospital, Yogyakarta, Indonesia. We included pediatric patients aged 1 month-18 years treated in the PICU between January 1 to December 31, 2018. Predictors of prolonged stay were identified including surgical procedures, severe malnourishment, cardiovascular conditions, sepsis, and ventilator use. Logistic regression was used to identify independent predictors.

Results Subjects' overall median age was 3.12 (IQR 0.76-18.8) years and the male to female ratio was 1:1. Median duration of ventilator use was 4 (IQR 1-21) days. The most common diagnosis was neurological disease (26.7%). Multivariate analysis showed that surgical procedure (OR 5.75; 95%CI 2.06 to 14.61) was statistically significant as an independent predictor of prolonged PICU stay.

Conclusion Surgical procedure is the significant predictor of prolonged stay in PICU. **[Paediatr Indones. 2020;60:37-41; doi: http://dx.doi.org/10.14238/pi60.1.2020.37-41]**.

Keywords: *prolonged stay; predictor; PICU*

The pediatric intensive care unit (PICU) is designed to treat children with life-threatening conditions, trauma, recovery from surgery, or who need intensive treatment, comprehensive observation, or special care.[1] The reported mortality rate of PICU patients in the United States was 20%, whereas the global mortality rate was 25% per year. Mortality may be caused by infection, prolonged stay, and/or inadequate treatment.[2]

Prolonged PICU stay is reflective of disease severity and patient health status. It also indirectly describes the performance and quality of the PICU.[3] Prolonged PICU stay has been well studied in developed countries, but few studies have been conducted in low-to-middle income countries like Indonesia. Previous studies have also lacked agreement on predictors of prolonged PICU stay. A study noted that heart abnormalities were not predictors of prolonged stay,[4] but another study showed the opposite.[5] In addition, another previous study concluded that sepsis was

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not a predictor of prolonged stay,[5] but this result was not in agreement with results from other previous studies.[6,7]

We aimed to determine whether surgical procedure, severe malnourishment, cardiovascular condition, sepsis, and ventilator use were predictors of prolonged PICU stay in children at Dr Sardjito General Hospital, Yogyakarta.

Methods

A nested, case-control study was done using secondary data. Inclusion criteria were PICU patients aged 1 month to 18 years who were treated from January 1 until December 31, 2018, in Dr. Sardjito General Hospital, Yogyakarta. The exclusion criteria were children with incomplete medical records or who were discharged against medical advice. The outcome was prolonged stay. Prolonged stay was defined as length of stay (LoS) in the PICU ≥7 days starting from PICU admission until discharge, transfer to the ward, or death. The independent variables were surgical procedures, severe malnourishment, cardiovascular conditions, sepsis, and ventilator use. A surgical procedure was defined when patient had undergone major non-cardiac surgical procedure. Nutritional status was determined based on the *World Health Organization* (WHO) *z*-score growth charts. Subjects were classified as severely malnourished if weight-for-height or body mass index (BMI)-for-age was <-3SD. Sepsis was determined based on warning signs, clinical manifestatitions, and evidence of organ failure by PELOD-2 score.[8,9] Cardiovascular condition was defined as having congenital heart disease (acyanotic or cyanotic) that was confirmed by echocardiography. We used 0.05 confidence level and 80% power to calculate for the minimum required sample size.

Data were analyzed using *Software Package for Social Science (SPSS) version 11.0 for Mac OS Sierra*. Chi-square test was used for bivariate analysis. Variables with P values <0.05 were further analyzed by multivariate using logistic regression method to find potential correlations with prolonged PICU stay. The risk of prolonged stay was calculated using odds ratios and confidence intervals. This study received approval from the Medical and Health Research Ethics Committee of the Faculty of Medicine, Public Health and Nursing, Gadjah Mada University/ Dr. Sardjito General Hospital, Yogyakarta, Indonesia.

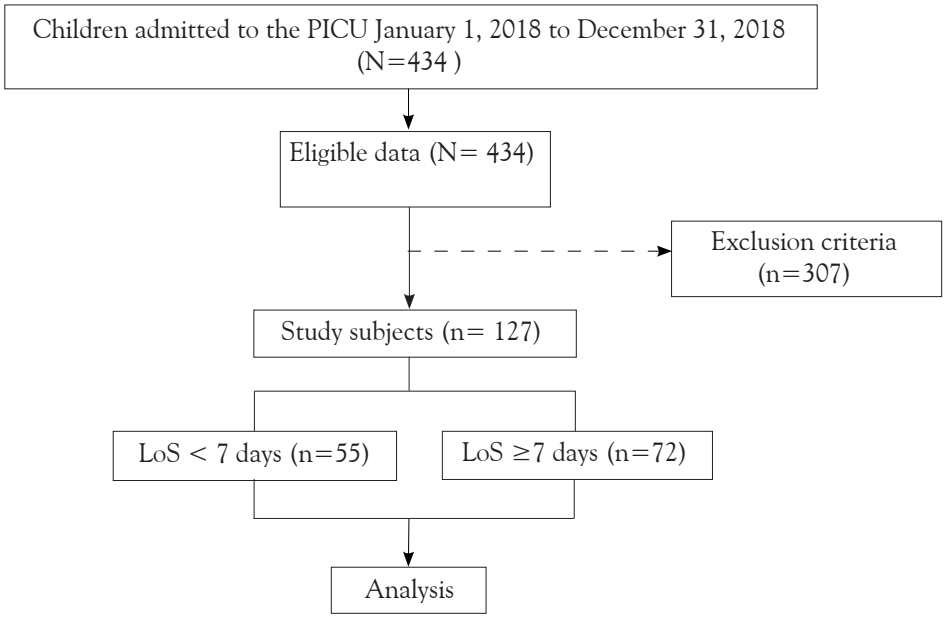

Figure 1. Study flow diagram

Results

Four hundred thirty-four patients fulfilled the inclusion criteria, but 127 were analyzed (**Figure 1**). The characteristics of subjects are shown in **Table 1**.

The bivariate analysis results are presented in **Table 2**. Surgical procedures (OR 6.17; 95%CI 2.34 to 16.25; P<0.001) and sepsis (OR 0.23; 95%CI 0.07 to 0.78; P=0.01) were significant predictors of prolonged PICU stay. Further multivariate analysis results are presented in **Table 3**. Surgical procedures

Table 1. Characteristics of subjects

Characteristics	Admitted to PICU		
	Total (N=127)	LoS<7 days (n=55)	LoS ≥7 days (n=72)
Median age (range), years	3.12 (0.76-18.8)		
Sex, n (%)			
Male	62 (48.8)	33 (60)	29 (40.3)
Female	65 (51.2)	22 (40)	43 (59.7)
Severe malnourishment, n (%)	21(16.5)	6 (10.9)	15 (20.8)
Diagnosis, n (%)			
Neurology	34 (26.7)	17 (30.9)	17 (23.6)
Respiratory	28 (22.0)	13 (23.6)	15 (20.8)
Surgery	24 (18.9)	7 (12.7)	17 (23.6)
Gastro-hepatology	9 (7.0)	2 (3.6)	7 (9.7)
Infection	9 (7.0)	7 (12.7)	2 (2.8)
Hematology-oncology	8 (6.3)	5 (9.1)	3 (4.2)
Nephrology	7 (5.5)	2 (3.6)	5 (6.9)
Cardiology	4 (3.1)	0 (0.0)	4 (5.6)
Immunology	2 (1.5)	0 (0.0)	2 (2.8)
Endocrinology	2 (1.5)	2 (3.6)	0 (0.0)
Surgical procedures, n (%)	n=37	n=6	n=31
Laparotomy	21 (56.7)	3 (5.5)	18 (25.0)
Craniotomy	6 (16.2)	2 (3.6)	4 (5.6)
Thoracotomy	6 (16.2)	0 (0.0)	6 (8.3)
Tracheostomy	2 (0.05)	0 (0.0)	2 (2.8)
Trans-anal surgery	1 (0.03)	1 (1.8)	0 (0.0)
Laparoscopy	1 (0.03)	0 (0.0)	1 (1.4)
Median duration of ventilator use (range), days	4 (1-21)		

Table 2. Bivariate analysis of possible predictors of prolonged PICU stay

Variables	LoS <7 days (n=55)	LoS ≥7 days (n=72)	OR	95% CI	P value
Surgical procedures					
No	49 (89)	41 (57)	6.17	2.34 to 16.25	<0.001
Yes	6 (11)	31 (43)			
Severe malnourishment					
No	49 (89)	57 (79)	2.14	0.77 to 5.96	0.14
Yes	6 (11)	15 (21)			
Cardiovascular condition					
No	48 (87)	59 (82)	1.51	0.55 to 4.08	0.41
Yes	7 (23)	13 (18)			
Sepsis					
No	44 (80)	68 (94)	0.23	0.07 to 0.78	0.01
Yes	11 (20)	4 (6)			
Ventilator					
No	9 (16)	18 (25)	0.58	0.24 to 1.43	0.24
Yes	46 (84)	54 (75)			

Table 3. Multivariate analysis of possible predictors of prolonged PICU stay

Variables	OR	95%CI	P value
Surgical procedure	5.75	2.06 to 14.61	<0.001
Sepsis	0.32	0.09 to 1.12	0.07

(OR 5.75; 95%CI 2.06 to 14.61; P<0.001) remained a statistically significant predictor of prolonged stay. However, severe malnourishment, cardiovascular condition, sepsis, and ventilator use were not significant predictors of prolonged stay.

Discussion

Surgical procedures significantly increased the risk of prolonged PICU stay by almost six times. The outcome of this study is the first to present non-cardiac surgical procedures as a predictor of prolonged stay in the pediatric population. In a study of adults who underwent non-cardiac surgical procedures in Portugal, surgical procedures may have affected the LoS of patients in the ICU due to other co-factors, such as the choice of sedation, amount of intravenous fluids given during surgery, and the severity of the surgical procedure itself.[8,10]

In our study, although severe malnourishment was not a statistically significant predictor of prolonged PICU stay, this associated with a 2-fold increase in the probability of prolonged PICU stay provided that the sample size is sufficiently large. This is similar to a previous study reported that severe malnourishment was significantly related to PICU LoS.[11] Furthermore, children with severe malnourishment who received PICU treatment had 6.8 times higher risk of mortality compared to those with normal nutritional status.[12]

In our study, cardiovascular condition was not a significant predictor of prolonged PICU stay. This finding was consistent a previous study that also noted that cardiovascular condition was unrelated to prolonged PICU stay (P=0.08).[4] This finding of our study is unrelated due to a distribution imbalance which manifest to the outcomes. If the outcomes are evenly distributed and the sample size is large, the result might be statistically significant.

In our study, sepsis was also not a significant predictor of prolonged PICU stay, consistent with a previous study.[5] Children admitted to PICU with sepsis in our study tended to have shorter length of stay. This might because among those who had sepsis might develop septic shock and the mortality was high.[9] In a previous study conducted in the same PICU revealed that the median length of stay of children with septic shock was about 4 days.[9]

We also did not observe that a ventilator usage was not a significant predictor of prolonged PICU stay. The median ventilator use among patients in our PICU was 4 days. This finding had general agreement with other studies who both reported that the length of ventilator use for ≥7 days was associated with longer PICU stay.[10,13]

The main limitation of this study was the use of secondary data collected from medical records and the predictors simply be selected from the available data. This study was conducted in a single national referral hospital that may limit the generalizability of the study. Further cohort studies with evenly distributed samples are needed.

In conclusion, surgical procedure is a predictor of prolonged PICU LoS. Therefore, management of children who undergo surgical procedures should be improved so that PICU LoS can be reduced.

Conflict of Interest

None declared.

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