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Determinants of Extended Neonatal Intensive Care Unit Stay

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ABSTRACT

Background: Prolonged hospitalization in the Neonatal Intensive Care Unit (NICU) escalates healthcare costs and potentially exposes neonates to further complications. This study aimed to identify the significant predictors influencing the length of stay (LOS) in the NICU at Hermina Hospital, Sukabumi, with the potential to facilitate efficient resource optimization and improve the future of neonatal care.

Methods: Employing a retrospective cohort design, we reviewed the medical records of all neonatal admissions from July 1, 2022, to July 1, 2023. Length of stay was evaluated against several factors: gender, birth weight, delivery method, maternal pregnancy status, pregnancy comorbidities, place of birth, and Apgar score. This study computed the descriptive and inferential statistics using SPSS version 29, with linear regression models aiding in bivariate and multivariate analyses.

Results: Among the 156 samples, birth weight and Apgar score emerged as significantly associated with LOS (p-values 0.003 and 0.015, respectively), whereas the other predictors did not reveal a significant association. T-test outcomes suggested a partial impact on birth weight and Apgar score (t-values surpassing the critical t-value, with respective p-values < 0.001 and 0.014). Multiple regression analysis further indicated that all predictors collectively explained 19.3% of the LOS variation.

Conclusion: Our findings underscore the significant contribution of birth weight and Apgar score to prolonged NICU stays. They provide valuable insights into the factors influencing NICU length of stay and the potential for improving neonatal outcomes through adequate neonatal resuscitation. Moreover, the study emphasizes the urgent need for targeted programs to reduce preterm delivery and intrauterine growth retardation, inspiring action and change in the field of neonatal care.

Keywords: Apgar score, Birth wight, Length of stay, Neonatal intensive care unit

Introduction

According to the World Health Organization (WHO), a neonate is a live-born infant aged 0-28 days (1). Global statistics mentioned that 2,3 million children died within the first month of their lives in 2021 (1, 2). In the ASEAN, there were 14 neonatal deaths per 1000 born. In Indonesia, the neonatal mortality rate was 9,3 among 1000 lives (3). Neonates with severe conditions require intensive care in the Neonatal Intensive Care Unit (NICU) (1, 2). Many factors can influence a neonate's condition, such as low birth weight, preterm birth, and the presence of comorbidities, including asphyxia, sepsis, or congenital abnormalities. Length of stay is the duration of hospitalization from the date of admission to the date of discharge (4). The more severe the neonate's condition, the longer the length of NICU stay. The extended length of stay can cause many

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adverse effects or even complications to themselves (4).

Fu Yong, a researcher from China, revealed the harmful effects of the extended length of stay, like nosocomial infection, feeding problems, development problems, and further complications to death (4). Some studies also have shown that extended length of stay could influence development, such as cognitive function, developmental disorders, and chronic diseases. Moreover, it can increase hospital costs and reduce the bed turnover rate of hospitals (1, 4, 5). Contrarily, reduced length of stay was associated with a 16% reduction in readmission within 30 days and an 18% reduction in death within 30 days (4, 6). Acknowledging how to reduce the length of stay during hospitalization is essential for the hospital management and the pediatrician to decide and provide better services (6, 7).

Generally, three factors increased the length of stay of NICU patients: maternal factor, delivery factor, and neonatal factor (8). The maternal factors contributed to fetal development and neonate's condition such as preterm gestational age, maternal comorbidities (diabetes, hypertension, and others), twin pregnancy, and mother's age less than 16 years old or more than 40 years old. Some studies also found a difference in the length of stay of NICU patients based on their delivery method. Meanwhile, the neonatal factors were gestational age less than 27 weeks or more than 42 weeks, birth weight less than 2500 grams or above 4000 grams, unsuccessful resuscitation, and congenital anomalies (4, 8).

Therefore, to reduce complications related to extended length of stay and increase service effectiveness, the length of stay of NICU patients should be optimized. Acknowledging the determinants that influence the LOS of NICU patients could help enhance the Hospital's resources. This study aimed to identify the significant predictors influencing the length of stay (LOS) in the NICU at Hermina Hospital, Sukabumi, thereby facilitating efficient resource optimization. Hospital management and pediatricians must be aware of these predictors and use this knowledge to provide better services and improve neonatal care.

Methods

Study Design, Participants

This retrospective cohort study used a total sampling method and included all Neonatal Intensive Care Unit (NICU) patients admitted to Hermina Hospital Sukabumi from July 1, 2022, to July 1, 2023.

Inclusion and Exclusion Criteria

Inclusion Criteria

This study included all neonates admitted to the NICU of Hermina Hospital Sukabumi from July 1, 2022, to July 1, 2023.

Exclusion Criteria

Exclusion criteria were incomplete medical record(s), congenital anomalies, readmission, or death condition within 24 hours of life.

Operational Definitions

The dependent variable was the duration of hospital stay of NICU patients; it was calculated by counting the gap between the date of admission and the date of discharge. The independent variables were gender, birth weight, delivery method, pregnancy status, comorbidities, place of birth, and Apgar score (Table 1).

Data Collection Technique and Tools

The medical record numbers of the participants were obtained from NICU Statistics. All the required data (eight independent variables) were obtained from medical records. The discharge summary was used to calculate the length of stay from the admission and discharge dates. This study categorized each factor into the abovementioned numbers (Table 1). The principal investigator checked the completeness of the collected data.

Statistical Analysis and Quality Control

Data was then analyzed descriptively and analytically using SPSS version 29.0. The bivariate method used the Chi-Square test for categorical variables and the Kruskal-Wallis test for ordinal variables. After that, the multivariate linear regression was done to find a relation from all independent variables with p-value < 0,05. A classical assumption test was done to exclude multicollinearity and heteroscedasticity, and its significance was tested using the T partial test and the F simultaneous test. All of these statistical analyses were used to control confounding factors.

Ethical Approval

Ethical approval was obtained from the Ethical Committee of Hermina Hospital Sukabumi, West Java, Indonesia (reference no. 1021/RSHSKB/SK/VIII/2023).

Table 1. Operational Definition

Variable(s)	Operational Definition	Measurement tool	Results	Scale
Length of stay	Duration of hospitalization	Medical record	1. < 5 days 2. 5 to 15 days 3. 16 to 30 days 4. > 30 days	Ordinal
Sex	Genre according to physical examination when patient was born	Medical record	Male Female	Nominal
Birth weight	Birth weight according to medical record	Medical record	< 1000 gram 1000 – 1500 gram 1501 – 2500 gram > 2500 gram	Ordinal
Delivery method	Method used when delivery process according to medical record	Medical record Medical record	Spontaneous Vacuum Caesarian section	Nominal
Pregnancy status	Status of pregnancy of mother	Medical record	Primigravida Multigravida	Nominal
Comorbidities	Comorbid existed from early pregnancy until delivery		Yes Preeclampsia Multiple pregnancies Premature rupture of membranes Antepartum hemorrhage Others No	Nominal
Place of birth	Place of birth	Medical record Medical record	Born at hospital Born out hospital	Nominal
Apgar Score	Apgar score at first minute and fifth minute		Less than 3 3 to 7 Above 7	Ordinal

Results

Socio-Demographic Characteristics

A total of 156 newborns met the inclusion criteria. Among 180 of all NICU patients obtained from July 1, 2022, to July 1, 2023, this study excluded 24 patients because of death conditions in 24 hours of life (n=15), incomplete medical records (n=8), and congenital abnormality (n=1). (Table 2) It explains subjects' general characteristics according to gender, pregnancy status, place of birth, delivery method, comorbidities, birth weight, and Apgar score. Based on the Kolmogorov-Smirnov normality test showed that the data of this study was distributed normally.

Neonatal Intensive Care Unit Stay-Related Factors

The result of the bivariate test in (Table 3) showed there was no variable having a significant correlation with length of stay statistically (p values < 0,05). (Table 4) proved that categorical

Table 2. Descriptive characteristics of subjects

Variables	N (%)
Genre	
Male	87 (55,8)
Female	69 (44,2)
Place of birth	
In hospital	118 (75,6)
Out hospital	38 (24,4)
Pregnancy status	
Primigravida	45 (28,8)
Multigravida	111 (71,2)
Delivery method	
Spontaneous	60 (38,5)
Vacuum	5 (3,2)
Caesarian section	91 58,3)
Comorbidities/Complication	
Yes	92 (59)
No	64 (41)
Apgar score	
Less than 3	74 (47,4)
3 to 7	73 (46,8)
Above 7	9 (5,8)

Table 4. Bivariate Analysis for Categorical Ordinal Variables

Variables	Median	IQR	p-values
Birth weight			
< 1000 gram	830	50	0,003
1000-1500 gram	1230	210	
1501 - 2500 gram	1660	370	
>2500 gram	2860	240	
Apgar Score			
Less than 3	1	0,75	0,015
3 to 7	3	0	
Above 7	8	0	

Statistical test using Kruskal Wallis test

ordinal variables have crucial results with p-value = 0,003 for birth weight and p-value = 0,015 for Apgar score. After doing a bivariate test for each variable, a multivariate test using multiple linear regression was done using the T-test and F-test (alpha 95% = 0,05). T-test was used to find partial influence from each variable, and the result was 1,97646 from the T table, compared to the T count. Based on the T table and T count comparison (Table 5), it was obtained that birth weight and Apgar Score have more extensive T counts, so each variable influences the length of stay.

The F-test was used to acknowledge the simultaneous influence from all variables to length of stay, with the F-table result being 1,9 (Table 6). The F-table and F-count comparison showed that the F-value was more significant than the F-table, so it can be concluded that eight independent

Table 3. Bivariate Analysis for Categorical Nominal Variable

Variable	n(%)	P-value
Sex		
male	87 (55,8)	0,271
female	69 (44,2)	
Place of birth		
In hospital	118 (75,6)	0,954
Out hospital	38 (24,4)	
Pregnancy status		
Primigravida	45 (28,8)	0,942
Multigravida	111 (71,2)	
Delivery Method		
Spontaneous	60 (38,5)	
Vacuum	5 (3,2)	0,653
Caesarean section	91 58,3)	
Comorbidities/Complication		
with	92 (59)	0,306
without	64 (41)	

Statistical test using Chi Square

Table 5. T-value test for multiple linear regression and correlation between birth weight and APGAR score with Length of Stay.

Variable	Sig	T-table	T-count	Regression Coefficient	Conclusion
Sex Male Female	0,603	1,97	-,521	0,112	T-count< t-table
Place of birth In hospital Out hospital	0,210	1,97	1,258	0,160	T-count< t-table
Pregnancy status Primigravida (G1) Multigravida (G2 or more)	0,458	1,97	-,744	0,121	T-count< t-table
Delivery method Spontaneous Vacuum Caesarean section	0,089	1,97	1,710	0,082	T-count< t-table
Comorbidities with comorbid without comorbid	0,704	1,97	,380	0,137	T-count< t-table
Birth Weight < 1000 gram (extremely low birth weight) 1000-1500 gram (very low birth weight) 1501 - 2500 gram (low birth weight) >2500 gram (normal birth weight)	0,001	1,97	4,346	0,78	T-count> t-table
Apgar Score Less than 3 (severe asphyxia) 3 to 7 (mild-moderate asphyxia) Above 7 (normal)	0,014	1,97	2,869	0,97	T-count>t-table

Table 6. F-value test multiple linear regression

	R Square	F table	F count	Conclusion
F-test	0,193	1,9	3,462	FH>FT

variables simultaneously influence the length of stay. In the F test, the R square value was 0,193, which can be interpreted as the strength of the simultaneous influence of 8 variables being 19,3%. Therefore, it also can be summarized that there is a simultaneous influence between all factors on length of stay for NICU patients with a percentage of 19,3%.

Discussion

This study found that Apgar score and low birth weight significantly impacted the length of stay. It can be interpreted as the lower the Apgar score, the longer the length of stay of NICU patients. An Apgar score is a tool scoring neonatal birth asphyxia, ranging from 0-10; a lower Apgar score indicates the survival rate and the mortality rate is worsening. Birth asphyxia is a failure to initiate and sustain normal breathing at the first and fifth minute of birth. The result of this study was similar to PT Pepler's research that found the first minute of Apgar score, birth weight, and delivery method significantly influenced the length of stay (9).

This study also found that birth weight significantly influenced the length of stay. The lower the birth weight, the longer the length of stay. Research in America showed that neonates with low birth weights got longer than 79 days, with an average length of stay ranging from 23 to 219 days.16 Moreover, they tend to have septicemia. Fifty-one percent of low-birth-weight neonates (1000-2500 grams) in Ghana had septicemia caused two times longer length of NICU stay, with higher hospital costs than normal-weight babies (10).

Gender did not significantly contribute to the length of stay in this research study, similar to in Ethiopia (11). A study in China found that baby boys had more extended NICU stays than girls. This study aligned with African research in 2012 but showed no statistically significant contribution to the length of stay (4, 9, 11). Multiple pregnancies more than four times or preterm pregnancy (less than 37 weeks) contributed to the low birth weight of their neonates, but this study result in Yaman did not prove any relation to the length of NICU stay (12). It was different from the study in Uganda that found neonates with multiple pregnancy mothers had shorter lengths of NICU stay than neonates with single pregnancies (13).

Spontaneous delivery or cesarian section also did not influence the length of NICU stay in this study result; this was also explained by a researcher from General Hospital Moewardi, who found that the delivery method did not have a significant relation with birth weight, Apgar score, and death (14, 15). Besides, high-risk pregnancy or comorbidities in pregnancy also did not influence the length of stay. A recent study in Iran by Narges Afrasiabi found a significant relationship between the length of stay and the preterm rupture of membranes, preeclampsia, urinary tract infection, multiple pregnancies, and oligohydramnios with p-value < 0,001 (16-18). Incomplete information within medical records causes discrepancies in these studies.

However, this study had some limitations, including incomplete information about comorbidities in pregnancy, especially for those born out of the Hospital, and the probability of inappropriate calculation of the Apgar score. In conclusion, two variables significantly contributed to the length of stay of NICU patients in this study: birth weight and the Apgar score.

Conclusion

The findings emphasize that birth weight and Apgar score significantly contribute to prolonged NICU stay. So, the stakeholder with a pediatrician should make a targeted program to reduce the incidence of preterm delivery and intrauterine growth retardation. Also, efforts towards adequate neonatal resuscitation could improve the Apgar score and decrease the LOS, enhancing overall neonatal outcomes.

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Conflicts of interest

The authors declare no conflict of interest.

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