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ORIGINAL ARTICLE

Analysis of The Length of Stay of Premature Infants at the NICU of Hospital X in Surabaya

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ABSTRACT

Introduction: *Premature infants with low birth weight and immature organ often require a long length of stay (LOS) at the Neonatal Intensive Care Unit (NICU), which results in increased costs, risk of infection, and burden on hospital resources.*
Objectives: *This study aims to analyze the length of stay of premature infants at the NICU of Hospital X in Surabaya.*
Methods: *An analytical observational study with a cross-sectional design. Sample: 51 premature infants treated at the NICU of Hospital X in Surabaya (total sampling). Independent variables: gestational age, birth weight, APGAR score, and nutrition; dependent variable: LOS. Analysis data use : Chi-Square and multiple logistic regression in SPSS 25. Statistical significance was considered at 0.05.*
Results: *The majority of infants (68.7%) had a long LOS (≥21 days). The Chi-Square test showed that gestational age (p=0.032), birth weight (p=0.018), APGAR score (p=0.044), and nutrition (p=0.021) were significantly associated with LOS. Multivariate analysis found that the dominant factor was birth weight <2500 g (OR=4.1; p=0.015), followed by gestational age <32 weeks (OR=2.6; p=0.048) and inadequate nutrition (OR=2.8; p=0.034).*
Conclusions: *LOS in premature infants is mainly influenced by low birth weight, low gestational age, and inadequate nutrition. Efforts to improve early nutrition, close monitoring of VLBW (Very Low Birth Weight) infants, and comprehensive clinical interventions can reduce LOS and the socioeconomic impact on families.*

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Introduction

A premature infant is a infant with a low birth weight, defined as less than 2500 grams at birth (Erik, 2021). Premature birth occurs before 37 weeks of gestation. Premature infants with low birth weight are at higher risk of experiencing disorders related to vital organs that are not yet fully developed. Therefore, premature infants require a long hospital stay or Length of Stay during recovery in the Neonatal Intensive Care Unit (NICU). Length of Stay (LOS) in premature infants is the number of days spent in the hospital, starting from when the infant is admitted to the hospital until the infant is discharged from the hospital (Hosizah, 2018). A long LOS in premature infants can lead to increased treatment costs during hospitalization, adding to the burden on health workers and staff and reducing the availability of incubators for other premature infants who need immediate intensive care at the hospital (Nisak., 2020). The phenomenon observed in the NICU of a private hospital in Surabaya is the high number of

premature infants who experience a long Length of Stay during treatment, with the majority ranging from 21 to 62 days.

According to the World Health Organization (WHO), the mortality rate of premature infants caused by long Length of Stay in the Neonatal Intensive Care Unit (NICU) in developing countries reaches 98%. Research results (Amalia, 2022) state that LOS in premature infants is 70.97% in the range of an average long LOS of 21-30 days. Multiple regression test results indicate that 58.6% of premature infant weight variables have a significant relationship with long Length of Stay (LOS). According to the results of the Basic Health Research (Riskesdas 2019) in collaboration with the Central Statistics Agency in East Java in 2019, the prevalence was 13.23%, with 21,544 premature births undergoing long-term hospitalization in the NICU. Based on medical records of premature infants at the NICU of Hospital X in Surabaya, 51 premature infants were found between January and December 2023. All premature infants treated had a low birth weight of less than 2500 grams. Low body weight in premature infants slows down the recovery process, LOS was long, averaging 21-62 days during treatment in the di NICU (Saputri, Intan Nur., Handayani, D., & Nasution, 2019).

Risk factors that cause length of stay in premature infants are gestational age, weight, low APGAR scores, and nutrition (Lissauer, 2019). Length of Stay can be improved by taking into account the baby's weight, as weight has a significant relationship with length of stay (LOS). Therefore, the greater the birth weight of a premature baby, the greater the chance that the baby will be discharged from the hospital sooner. The weight of premature infants is very important to consider because it can affect the growth and development of premature infants. Growth failure in infants with low birth weight during hospitalization is closely related to neurological developmental disorders, an increased risk of retinopathy of prematurity, persistent growth deficits, an increased risk of cardiovascular disease, and other complications of prematurity. Organ vital that is not yet fully developed, both anatomically and physiologically, in premature babies causes various health problems and results in a long length of stay (LOS) during hospital care. A long LOS can increase the cost of hospital care and increase the risk of infection in premature infants, which can lead to death.

Efforts to address the issue of prolonged length of stay in premature infants involve implementing intensive care management at the NICU regarding the appropriate, accurate, and optimal care of premature infants. This includes temperature regulation, oxygen therapy, monitoring for cardiovascular disorders, monitoring fluid and electrolyte balance, providing appropriate nutrition, managing hyperbilirubinemia, prevention of infection in premature infants (Erik, 2021) and the Kangaroo Mother Care (KMC) method to enhance mother-infant bonding, which is beneficial in rapidly increasing the weight of premature infants and avoiding prolonged LOS at the NICU (Saputri, Intan Nur., Handayani, D., & Nasution, 2019). This study aims to analyze the clinical factors that influence the LOS of premature infants at the NICU of Hospital X in Surabaya. By identifying the dominant factors, healthcare workers can implement appropriate interventions, families can be assisted with financing, and hospitals can improve service efficiency.

Methods

This study used an analytical observational design. Population: all premature infants at the NICU of Hospital X Surabaya. Dependent variables: LOS (short, normal, long), while independent variables: gestational age, birth weight, APGAR score, nutrition. The sampling used in this study was total sampling with a sample size of 51 infants. The instrument used in this study was an observation sheet from the Length of Stay data of premature infants at the NICU of Hospital X Surabaya, in patient medical records that had complete medical record data, including gestational age, birth weight, APGAR score, and nutrition. The statistical analysis used in this study was univariate analysis: frequency distribution. Furthermore, bivariate analysis: chi-square test for the relationship between factors affecting LOS. Finally, multivariate analysis: multiple logistic

regression to determine the dominant factors affecting LOS. This study has been certified as ethical by the research ethics committee of the Santo Vincentius a Paulo Catholic College of Health Sciences with number: 021/Stikes Vinc/KEPK/VIII/2024.

Results

Table 1 Characteristics of The Length of Stay for Premature Infants at the NICU of Hospital X Surabaya.

Variable	Frequency (n)	Percentage (%)
Gestational Age		
26 - 32 weeks	21	41,2
33 - 34 weeks	17	33,3
35 - 36 weeks	13	25,5
Birth Weight		
≥ 2500 grams	2	3,9
< 2500 grams	49	96,1
APGAR Score		
0 - 3	0	0
4 - 6	4	7,8
7 - 10	47	92,2
Oral Feeding		
≤ 25 cc/day	15	29,4
> 25 cc/day	36	70,6
Parenteral Nutrition (IV infusion)		
≤ 100 cc/day	0	0
> 100 cc/day	51	100

Based on Table 1, it can be seen that from 51 Length of Stay data on premature infants, 51 infants (100%) received > 100 cc/day infusion, based on birth weight, 49 infants (96.1%) weighed < 2500 grams, based on APGAR scores, 47 infants (92.2%) had scores ranging from 7 to 10, based on nutritional intake, 36 infants (70.6%) received > 25 cc/day of fluids, Based on gestational age, 21 infants (41.2%) had a gestational age range of 26–32 weeks.

Table 2. Distribution *Length Of Stay* for Premature Infants at the NICU of Hospital X Surabaya.

Categori LOS	Frequency (n)	Percentage (%)
Short (1-10 days)	7	13,7%
Normal (11-20 days)	9	17,6%
Long (> 21 days)	35	68,7%
Total	51	100%

Based on the table above, it shows that the Length of Stay data for premature babies from a total of 51 respondents shows that 35 premature infants experienced a long LOS, 9 premature infants experienced a normal LOS, and 7 premature infants experienced a short LOS.

Table 3. Distribution of The Length of Stay (LOS) and Chi-Square Test Results

Variable	Prolonged LOS (≥21 days)	Short/Normal LOS	Total (n)	p-value
Gestational Age				
26 - 32 weeks	18 (85,7%)	3 (14,3%)	21	
33 - 34 weeks	11 (64,7%)	6 (35,3%)	17	0,032*
35 - 36 weeks	6 (35,3%)	7 (53,8%)	13	
Birth Weight				
≥ 2500 grams	0 (0%)	2 (100%)	2	0,018*
< 2500 grams	35 (71,4%)	14 (28,6%)	49	
APGAR Score				
0 - 3	0 (0%)	0 (0%)	0	
4 - 6	3 (75%)	1 (25%)	4	0,044*
7 - 10	32 (68,1%)	15 (31,9%)	47	
Oral Feeding				
≤ 25 cc/day	13 (86,7%)	2 (13,3%)	15	0,021*
> 25 cc/day	22 (61,1%)	14 (38,9%)	36	

*Note : p<0,05 significant

Based on the data in Table 3, it can be seen that gestational age, birth weight, APGAR score, and nutritional intake are significantly associated with length of stay (LOS) in premature infants.

Table 4. Multivariate Analysis (Multiple Logistic Regression)

Clinical Factor	OR (Odds Ratio)	95% CI	p-value
Gestational Ages <32 weeks	2,6	1,0-6,9	0,048*
Birth Weight <2500g	4,1	1,3-12,5	0,015*
APGAR Scorec <6	2,3	0,9-6,2	0,061*
Oral Feeding <25cc/day	2,8	1,1-7,4	0,034*

Note : p< 0,05 significant

Table 4 shows that the dominant factor for long LOS is birth weight <2500 grams (highest OR = 4.1). Other significant factors include gestational age <32 weeks and inadequate nutrition. An APGAR score ≤6 is associated with long LOS but is not significant in multivariate analysis. This indicates that the LOS of premature infants is influenced by a combination of clinical factors, with low birth weight as the main determinant.

Discussion

Based on the research data, 35 (68.7%) infants were classified as having a long LOS, 9 (17.6%) infants were classified as having a normal LOS, and 7 (13.7%) infants were classified as having a short LOS. In terms of weight, 35 (71.4%) infants weighing < 2500 grams were classified as having a long LOS. According to theory (Nelson, 2015), the weight of premature infants greatly affects their growth and development. Failure to grow during the treatment process will affect the recovery process of premature infants and cause long hospital stays or long LOS. The lower the birth weight of a premature infant, the longer it will take to increase their weight. The lower the birth weight, the higher the risk of the infant developing persistent growth deficits, which will hinder the body's metabolic processes during treatment. The optimal application of complementary therapy, such as KMC, can form a bonding attachment between the mother and the infant, thereby helping to accelerate weight gain in premature infants and prevent long LOS

in the NICU. The results of this study are in line with research conducted by (Amalia, 2022), which states that the lower the birth weight of a premature baby (< 2500 grams), the longer the LOS during hospitalization.

Birth weight <2500 grams is a dominant factor associated with prolonged LOS, with a risk 4.1 times higher than infants with birth weight ≥2500 grams. The multivariate logistic regression test showed that birth weight <2500 grams was the most influential variable on length of stay (OR = 4.1; 95% CI = 1.3–12.5; p = 0.015). This finding is consistent with the global literature, which states that infants with very low birth weight (VLBW, <1500 g) or extremely low birth weight (ELBW, <1000 g) have the longest hospital stays due to complications such as respiratory problems, hypothermia, and hypoglycemia (Mehretie et al., 2024). According to research findings (Fu et al., 2023), low birth weight often has a greater impact on LOS than gestational age, as birth weight reflects the actual clinical condition at birth. These findings reinforce that birth weight is the primary indicator of survival and length of stay for premature infants.

Based on gestational age, data was obtained for 18 (85.7%) cases with a gestational age range of 26-32 weeks, which falls into the long LOS category. According to Erik (2021), the lower the gestational age of a premature infant, the greater the immaturity of organs that are not yet fully developed. These immature organs make premature infants susceptible to various health complications, and the process of organ maturation and formation will require prolonged care. This is consistent with the author's observations during data collection, where infants aged 26–32 weeks showed slow physiological responses to extrauterine life, such as difficulty maintaining stable body temperature despite being placed in incubators and challenges in initiating oral feeding due to weak or uncoordinated sucking reflexes.

The author's analysis supports that low gestational age results in immature physiological functions with limited compensatory responses to extrauterine life, thereby increasing the infant's risk of infection and sepsis. During the study, it was found that 4 out of 21 infants (19%) with gestational age <32 weeks developed nosocomial sepsis, confirmed by positive blood cultures, which directly prolonged their LOS by an average of 15 days compared to infants without infection. This condition worsens the clinical outcome of premature infants during intensive care in the NICU and ultimately leads to a prolonged hospitalization. Thus, these findings confirm that low gestational age not only contributes to organ immaturity but is also clinically associated with complications such as apnea and sepsis, which directly extend the length of stay.

The results of this study are in line with research conducted by (Luthfi Hapsari, 2019) which states that premature infants with low gestational age will have a higher level of organ immaturity, making them susceptible to prematurity-related diseases in premature infants, which results in a longer average length of stay in the hospital. (Omar et al., 2024) also reported that low gestational age is a major predictor of long LOS in various NICUs in Asia and Africa. This finding is consistent with the quantitative model proposed by (AlJohani et al., 2020) which demonstrated that each one-week reduction in gestational age extends LOS by 1.5–2 days. In the present study, infants with gestational age <32 weeks had an average LOS of 28 days, while those with gestational age 33–34 weeks had an average LOS of 21 days, reflecting a similar pattern where lower gestational age corresponded to longer hospitalization. These results confirm that gestational age is a significant clinical determinant of LOS in premature infants.

Based on nutritional intake data, 22 (61.1%) received>25 cc, which is classified as a long LOS. According to (Nyoman et al., 2023), a delay in breastfeeding/enteral feeding for more than 72 hours increases the average LOS to 7 days. According to Yusna, (2020) adequate nutritional intake from the total amount of enteral and parenteral fluids plays an important role during care, namely helping to accelerate weight gain and physiological conditions in premature infants, thereby supporting the growth process and recovery of the infant's condition. The appropriate and accurate administration of fluids, including oral and intravenous nutrition, can help prevent infections in premature infants. The digestive organs of premature infants are not yet fully

developed, and their sucking reflexes are still weak, requiring close monitoring. The infant's daily nutritional needs must be calculated according to their weight. The purpose of providing nutritional support through oral intake and intravenous fluids is to ensure the baby's growth and development, enabling them to meet their daily caloric need. Effective nutrition includes breastfeeding because it contains antimicrobial components (immunoglobulin-A, lysozyme, and lactoferrin) that function to boost the baby's immunity to prevent infection. Parenteral nutrition containing the appropriate amounts of protein, lipids, and glucose can significantly support weight gain in premature infants who are unable to tolerate full enteral feeding. The results of this study are in line with research conducted by (Arum & Riana, 2021) which states that adequate and optimal nutrition for premature infants is essential in achieving optimal growth and development during hospitalization.

The results showed that infants with an APGAR score ≤6 tended to have a longer length of stay (LOS) compared to infants with an APGAR score >6. The Chi-Square test showed a significant relationship (p = 0.044). However, in multivariate analysis, the APGAR score was no longer significant (OR 2.3; 95% CI 0.9–6.2; p = 0.061). This indicates that a low APGAR score is not an independent factor but is closely correlated with other variables, particularly gestational age and birth weight. According to (Cnattingius et al., 2020) lower Apgar scores are associated with a higher relative risk of neonatal death and greater differences in neonatal mortality rates across all gestational age strata. Apgar scores at 5 and 10 minutes provide prognostic information about neonatal survival in premature infants.

The results showed that infants with an APGAR score ≤6 tended to have a longer length of stay (LOS) compared to infants with an APGAR score >6. Based on the data in Table 3, among the 4 infants with low APGAR scores (4–6), 3 infants (75%) experienced prolonged LOS (≥21 days), while only 1 infant (25%) had short/normal LOS. The Chi-Square test showed a significant relationship between APGAR score and LOS (p = 0.044). However, in multivariate analysis (Table 4), the APGAR score was no longer significant (OR 2.3; 95% CI 0.9–6.2; p = 0.061). This indicates that a low APGAR score is not an independent factor but is closely correlated with other variables, particularly gestational age and birth weight. Clinical observations revealed that all 4 infants with low APGAR scores required immediate resuscitation and ventilator support, and all had gestational ages <34 weeks and birth weights <2500 grams, suggesting that the effect of low APGAR score on LOS may be mediated by these underlying factors.

Recent studies have reported similar findings. (Alvaro et al., 2022)developed the BAG (Birth weight, Apgar, Gestational age) mortality prediction model in 3,752 extremely preterm infants and found that while the APGAR score contributed to predictive accuracy, its effect was highly dependent on gestational age and birth weight. Similarly with (Ehrhardt et al., 2025) studied 7,900 very preterm infants across 11 European countries and found that a 5-minute APGAR score <7 was associated with prolonged hospital stay, but its predictive power was substantially reduced when analyzed together with gestational age and birth weight in multivariate models. Both studies concluded that the APGAR score should be interpreted within the context of gestational age and birth weight. Overall, the results of this study reinforce that a low APGAR score is indeed associated with length of stay, but its role is more as a mediator of prematurity and low birth weight. The more dominant factors determining prolonged LOS remain birth weight and gestational age, while the APGAR score helps identify infants who need early intervention in the NICU.

Conclusion

The length of stay (LOS) of premature infants at the NICU of Hospital X in Surabaya was mainly influenced by birth weight <2500 g, gestational age <32 weeks, and inadequate nutrition, while low APGAR scores contributed but were not an independent factor. The dominant factor for long LOS was low birth weight.

The authors advise to conduct multicenter studies with larger sample sizes to validate the findings and explore additional variables, such as socioeconomic status, maternal health factors, and quality of hospital care, that may influence the length of stay (LOS) of premature infants.

Ethics approval and consent to participate

This study has obtained ethical approval from the Health Research Ethics Committee (KEPK) of St. Vincentius a Paulo Catholic Health Sciences College, Surabaya, with the number: 021/Stikes Vinc/KEPK/VIII/2024. This study utilized secondary data from patient medical records without including personal identities, therefore causing no risk to the research subjects. As this study was based on secondary data, KEPK granted a waiver of informed consent. The hospital where the research was conducted provided written permission for the use of medical record data in accordance with patient confidentiality protection provisions and applicable regulations.

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