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Original Article

Prognostic Factors Affecting the Mortality of Neonates with Duodenal Obstruction at RSUD Dr. Soetomo

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ABSTRACT

Background: Duodenal obstruction is a common congenital abnormality in neonates, frequently resulting in mortality due to delayed treatment and postoperative complications. The delay in treatment often stems from suboptimal patient conditions for surgery, underscoring the critical role of laboratory examinations in guiding perioperative decisions.
Objective: This study aims to investigate the relationship between preoperative laboratory parameters and mortality in neonates with duodenal obstruction.
Methods: This descriptive-analytic study with a retrospective cohort design was conducted on neonates with duodenal obstruction treated at Dr. Soetomo Regional Public Hospital (RSUD Dr. Soetomo) in Surabaya from 2016 to 2023.
Results: This study comprised 56 subjects, including 33 females (58.9%) and 23 males (41.1%). The p-values of the factors, in order of their influence on mortality, were as follows: platelet count (p = 0.002), hemoglobin level (p = 0.086), and age at surgery (p = 0.086). Correspondingly, the odds ratios (OR) for each factor were determined as follows: 4.048 for age at surgery, 4.259 for hemoglobin level, and 6.206 for platelet count. Platelet count demonstrated the highest accuracy value at 71.4%, with a sensitivity of 70.8% and specificity of 76.7%. Hemoglobin level exhibited an accuracy value of 67.8%, a sensitivity of 62.5%, and a specificity of 71.9%, while age at surgery showed an accuracy value of 66%, a sensitivity of 70.8%, and a specificity of 62.5%.
Conclusion: In neonates with duodenal obstruction, a significant association exists between age at surgery, hemoglobin level, and platelet count with mortality. Among these factors, platelet count emerges as the most influential.

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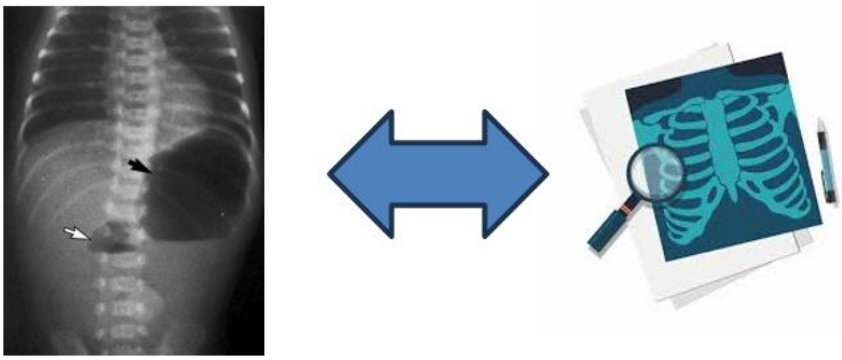
GRAPHICALABSTRACT



Introduction

Duodenal obstruction stands as a prevalent congenital anomaly among neonates, occurring at a frequency of 1 in 5,000-10,000 live births and displaying a higher incidence in boys than in girls [1]. Despite its relatively low fatality rate of approximately 12%, this condition poses a considerable challenge in pediatric surgery. Notably, from 2016 to 2020, Dr. Soetomo Regioal Public Hospital (RSUD Dr. Soetomo) reported a mortality rate of 30.5% [2, 3]. The significant mortality rate raises concerns, with influences stemming from diverse factors such as delivery complications, delayed referrals, and complications arising from surgical procedures. Addressing this situation requires concerted efforts at all levels [3-5]. Additional variables believed to impact death rates in cases of duodenal obstruction include gestational age, preterm birth, and birth weight. Moreover, congenital duodenal obstruction often coexists with various congenital abnormalities, including congenital heart malformations, Down's syndrome, and other congenital bowel abnormalities. Among infants with trisomy 21 (Down syndrome), intricate cardiac abnormalities emerge as a primary cause of mortality. Risk factors linked to mortality encompass complex cardiac abnormalities, preterm birth, sepsis, pneumonia, and surgical complications like short bowel syndrome, leaky anastomosis, and gastroduodenal dysfunction. Notably, almost 80% of mortality cases are attributed to multiple congenital abnormalities and sepsis [7]. Mortality frequently results from delayed treatment and postoperative complications. The perioperative course for patients is often prolonged due to suboptimal conditions for surgery, underscoring the pivotal role of laboratory examinations in guiding appropriate therapy. In addition, the anesthetic process plays a vital role in the surgical context. However, there is a dearth of studies providing conclusive insights into the components of a comprehensive preoperative assessment for newborns undergoing surgical procedures [8, 9]. A study of 81 infants with congenital duodenal obstruction showed that postoperative infants with congenital duodenal obstruction with a history of prematurity had higher morbidity and mortality rates than infants born at term, where patients with a history of prematurity had higher morbidity and mortality rates than patients with term birth. The same was also found by those who conducted a 12-month follow-up in the UK where patients with prematurity have a worse prognosis compared to full-term babies. Preterm patients have a greater risk of complications and length of hospitalization. Postoperative enteral feeding time was longer in preterm patients with a complete type of duodenal obstruction [10]. The study showed that on average, patients with duodenal obstruction had a birth weight of 2.47 kg (± 0.68) which was divided into two groups, namely groups with good outcomes and poor outcomes.

Patients with good outcomes had an average birth weight of 2.52 kg (± 0.66), while patients with poor outcomes had an average birth weight of 2.17 kg (± 0.70). This suggests that the lower the birth weight of infants with duodenal obstruction, the worse the prognostic factor [10]. This study aims to explore the potential correlation between preoperative laboratory markers and mortality rates in individuals diagnosed with duodenal obstruction.

Materials and methods

This descriptive-analytic study with a retrospective cohort design was conducted on neonates with duodenal obstruction treated at Dr. Soetomo Regional Public Hospital in Surabaya from 2016 to 2023. The study utilized secondary data extracted from medical records at the hospital. Various laboratory parameters were measured, including hemoglobin, white blood cells, platelets, sodium, potassium, chloride, prothrombin time, and activated partial thromboplastin time. The obtained data were analyzed using the SPSS version 23 application. The target population comprised all neonates with duodenal obstruction, while the reachable population encompassed those treated at Dr. Soetomo General Hospital Surabaya from 2016 to 2023. The obtained data were analyzed using the SPSS version 23 application. Profile data are presented descriptively in tables and graphs. The data underwent receiver operating characteristics (ROC) analysis to establish cut-off values for laboratory parameters. The association between independent variables and mortality was assessed using the chi-square test. A p-value less than 0.05 was considered statistically significant. Approval and informed consent for this study was granted by the Research Ethical Committee of Soetomo Hospital Surabaya under a Letter of Approval No. 1304/LOE/301.4.2/V/2023.

Results and Discussion

In this study, a total of 56 neonates met the inclusion criteria. Among these research subjects, there were more females, totaling 33 (58.9%), than males, totaling 23 (41.1%). Regarding their birth weight, 33 (58.9%) had normal birth weight, while 23 (41.1%) had low birth weight. Based on their gestational age, 44 (78.6%) were classified as term, and 12 (21.4%) were categorized as preterm. There was no significant difference observed in their type of obstruction, with partial obstruction noted in 27 (48.2%) cases and total obstruction in 29 (51.8%) cases. Their surgical procedures varied, with 32 (57.1%) undergoing Kimura's procedure, 14 (25%) undergoing duodenoplasty, 7 (12.5%) undergoing Ladd's procedure, and 3 (5.4%) undergoing other procedures. The outcomes varied, with 32 (57.1%) patients surviving and 24 (42.9%) experiencing mortality. Detailed demographic data for the research subjects are presented in Table 1.

Based on their age at surgery, the average age of the patients was 17 days, ranging from the youngest age of 2 days to the oldest age of 42 days. Laboratory parameters examined in this study encompassed white blood cells (WBC), Hemoglobin (Hb), Platelets/Thrombocytes, Sodium (Na), Potassium (K), Chloride (Cl), Prothrombin time (PT), and Activated Prothrombin Time Test (APTT). The comprehensive characteristic data is listed in Table 2.

Relationship between age at surgery and outcome in duodenal obstruction

In this study, it was observed that the average age at surgery for patients who survived was 15 days, whereas for those who did not survive, it was 20 days. A t-test was conducted based on their age at surgery, yielding a p-value of 0.032 ($p < 0.05$), signifying a statistically significant difference (Table 3). Subsequently, a ROC test was employed to determine the cut-off value, which was found to be 16.5 days (Figure 1).

Utilizing this cut-off value, a categorical test was conducted using the Chi-square test, categorizing patients into age groups: <= 16 days and > 16 days. Results from this categorical test revealed that among patients with age at surgery <= 16 days, 20 patients survived (62.5%), and 7 patients died (29.2%).

Table 1: Demographic data of research subjects

		Frequency	Percentage
Sex			
	Female	33	58.9
	Male	23	41.1
	Total	56	100.0
Birth weight		Normal (≥ 2,500 gram)	
	Low (< 2,500 gram)	33	58.9
	Total	23	41.1
		56	100.0
Gestational Age		Aterm	
	Preterm	44	78.6
	Total	12	21.4
		56	100.0
Obstruction Type		Partial obstruction	
	Total obstruction	27	48.2
	Total	29	51.8
		56	100.0
Surgery		Kimura's procedure	
	Duodenoplasty	32	57.1
	Ladd's procedure	14	25.0
	Others	7	12.5
	Total	3	5.4
		56	100.0
Outcome		Live	
	Dead	32	57.1
	Total	24	42.9
		56	100.0

Table 2: Descriptive data of nominal variables

	Age at Surgery (Day)	WBC	Hb level	K	Na	CI	Platelet count	PT	APTT
N	56	56	56	56	56	56	56	56	56
Minimum	2	4.87	6.6	1.1	103	60	6	8.6	11.4
Maximum	42	28.67	22.1	6.1	149	119	527	74.7	83.8
Mean	17.34	11.2329	15.470	3.757	133.55	94.96	234.38	17.448	37.300
Median	16.50	9.7500	16.100	3.650	135.00	96.50	223.50	14.650	36.750
Std. Deviation	8.849	516.073	32.520	0.9206	8.932	11.730	143.489	118.014	115.005

Table 3: Analysis of data on the correlation between age at surgery and outcome

Age at surgery							T-test for Equality of Means	95% Confidence Interval of the Difference	
Outcome	N	Minimum	Maximum	Mean	Median	Std. Deviation	Sig. (2-tailed)	Lower	Upper
Live	32	2	30	15.16	14.50	7.692	0.032*	-9.724	-0.463
Dead	24	4	42	20.25	19.50	9.593			
Total	56	2	42	17.34	16.50	8.849			

For patients with age at surgery > 16 days, 12 patients survived (37.5%), and 17 patients died (70.8%). The associated p-value was 0.028, indicating statistical significance (Table 4).

Chi-quare test

Relationship between Hemoglobin and Outcome in Duodenal Obstruction

In this study, the average hemoglobin level for surviving patients was 16 g/dL, while the average for deceased patients was 14 g/dL. A t-test was conducted based on the hemoglobin values, resulting in a p-value of 0.027 ($p < 0.05$), indicating a statistically significant difference (Table 5). Subsequently, a ROC test was employed to determine the cut-off value, which was identified as 15 g/dL (Figure 2). Using this cut-off value, the researchers proceeded with a categorical test using the Chi-square test, categorizing patients into two groups: > 15 g/dL and ≤ 15 g/dL. Results from this categorical test showed that among patients with hemoglobin > 15 g/dL, 23 patients survived (71.9%), and 7 patients died (37.5%). For patients with hemoglobin ≤ 15 g/dL, 9 patients survived (28.1%), and 15 patients died (62.5%). The associated p-value was 0.021, indicating statistical significance (Table 6).

Chi-square test

Relationship between platelet count and outcome in duodenal obstruction

In this study, the average platelet count for surviving patients was 284,440 µL, whereas for patients who died, it was 167,000 µL. A t-test based on platelet count yielded a p-value of 0.002 ($p < 0.05$), indicating a statistically significant difference (Table 7). Subsequently, a ROC test was conducted to establish the cut-off value, which was determined to be 212,000 µL (Figure 3). Using this cut-off value, a categorical test was performed using the Chi-square test, categorizing patients into two groups: > 212,000 g/dL and ≤ 212,000 g/dL. Results from this categorical test revealed that among patients with platelet count > 212,000 µL, 23 patients survived (71.9%), and 7 patients died (29.2%). For patients with platelet count ≤ 212,000 µL, 9 patients survived (28.1%), and 17 patients died (70.8%). The associated p-value was 0.004, signifying statistical significance (Table 8).

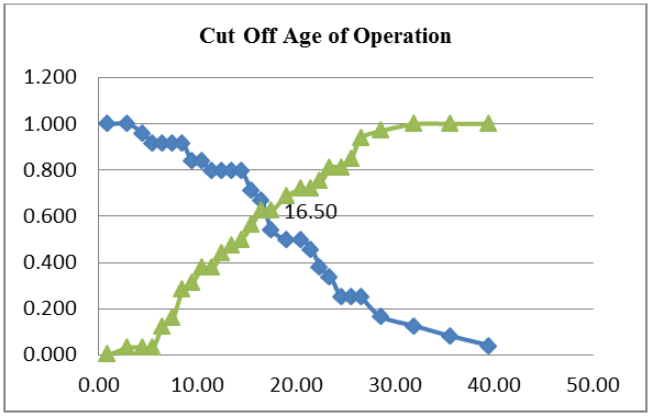


Figure 1: Cut-off value of age at surgery

Table 4: Categorical test on the correlation between age at surgery and outcome

			Outcome			Asymptotic Significance (2-sided)
			Live	Dead	Total	
Age at Surgery						0.028*
	<= 16.5	Total	20	7	27	
		% in Outcome	62.5%	29.2%	48.2%	
	>16.5	Total	12	17	29	
		% in Outcome	37.5%	70.8%	51.8%	

Table 5: Analysis of data on the correlation between hemoglobin level and outcome

Hemoglobin level (Hb)							T-test for Equality of Means	95% Confidence Interval of the Difference	
Outcome	N	Minimum	Maximum	Mean	Median	Std. Deviation	Sig. (2-tailed)	Lower	Upper
Live	32	11.0	22.1	16.347	16.350	25.149	0.027	0.2448	38.489
Dead	24	6.6	19.5	14.300	14.400	37.770			
Total	56	6.6	22.1	15.470	16.100	32.520			

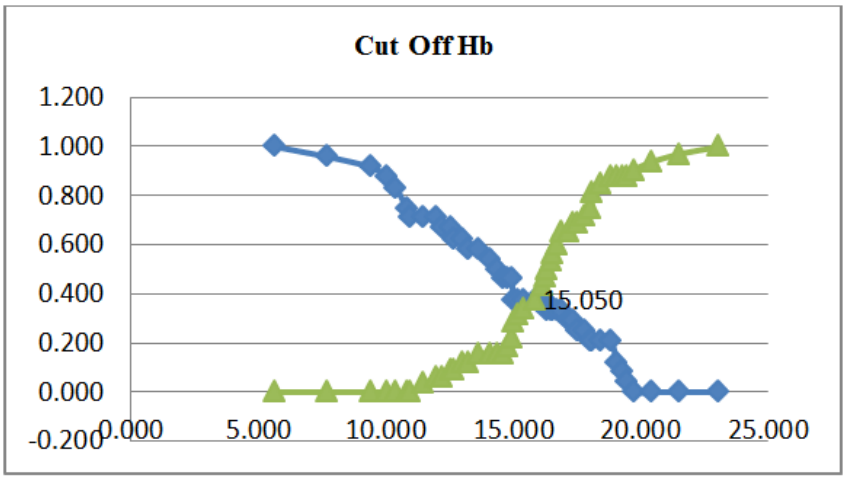


Figure 2: Cut-off value of hemoglobin level

Table 6: Categorical test on the correlation between hemoglobin level and outcome

			Outcome			Asymptotic Significance (2-sided)
			Live	Dead	Total	
Hemoglobin level (Hb)						0.021*
	> 15,0	Total	23	9	32	
		% in Outcome	71.9%	37.5%	57.1%	
	<= 15,0	Total	9	15	24	
		% in Outcome	28.1%	62.5%	42.9%	

Table 7: Data analysis on the correlation between platelet count and outcome

Platelet count							T-test for Equality of Means	95% Confidence Interval of the Difference	
Outcome	N	Minimum	Maximum	Mean	Median	Std. Deviation	Sig. (2-tailed)	Lower	Upper
Live	32	25	527	284.440	306.500	137.992	0.002	45.185	188.440
Dead	24	6	413	167.630	145.000	124.232			
Total	56	6	527	234.380	223.500	143.489			

Chi-square test

Multivariate analysis of outcome in duodenal obstruction

In this study, bivariate tests were conducted for age at surgery, hemoglobin level, and platelet count, yielding significant results. Subsequently, a multivariate analysis was performed using the logistic regression test to identify the most influential and robust factors affecting the outcome. According to the multivariate test, the p-values of the factors, in order of their influence on mortality, were as follows: platelet count (p = 0.002), hemoglobin level (p = 0.086), and age at surgery (p = 0.086). Correspondingly, the odds ratios (OR) for each factor were determined as follows: 4.048 for Age at surgery, 4.259 for Hemoglobin, and 6.206 for Platelet (Table 9).

Logistic regression

Diagnostic analysis of the correlation between the prognosis factors and outcome

Diagnostic analysis was performed on variables with significant values identified during the comparison test, utilizing the ROC test. The results of this diagnostic analysis are as follows: Platelet count demonstrated the highest accuracy value of 71.4%, with a cut-off value of 212,000 µL, a p-value of 0.004, a sensitivity of 70.8%, and a specificity of 76.7%. Hemoglobin level exhibited an accuracy of 67.8%, with a cut-off value of 15 g/dL, a p-value of 0.021, a sensitivity of 62.5%, and a specificity of 71.9%. Age at surgery displayed an accuracy of 66.0%, with a cut-off value of 16.5 days, a p-value of 0.028, a sensitivity of 70.8%, and a specificity of 62.5% (Table 10).

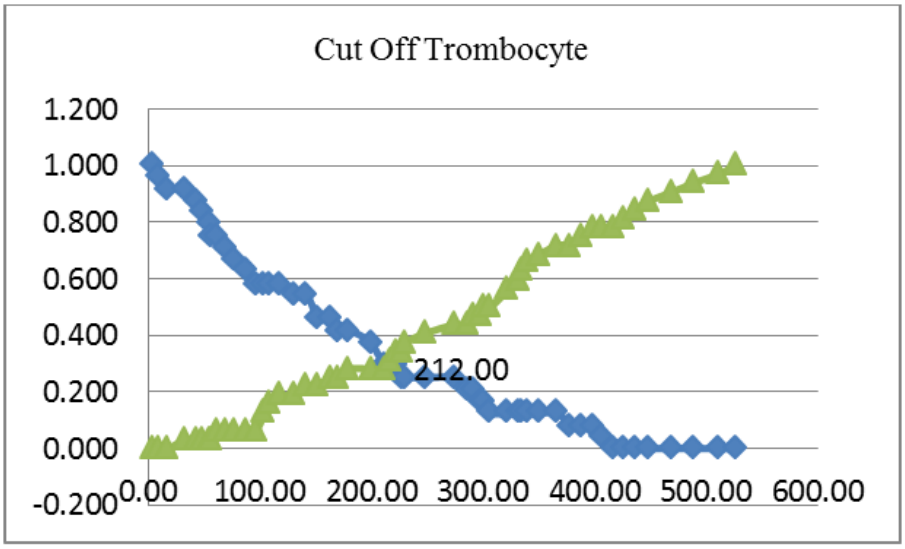


Figure 3: Cut-off value of platelet count

Table 8. Categorical test on the correlation between platelet count and outcome

			Outcome			Asymptotic Significance (2-sided)
			Live	Dead	Total	
Platelet count						0.004*
	> 212	Total	23	7	30	
		% in Outcome	71.9%	29.2%	53.6%	
	<= 212	Total	9	17	26	
		% in Outcome	28.1%	70.8%	46.4%	

Table 9: Multivariate analysis of outcome in duodenal obstruction

	Sig.	Exp(B)	95% C.I.for EXP(B)		Odd Ratio (OR)
			Lower	Upper	
Age at surgery	0.086	3.460	0.840	14.248	4.048
Hb level	0.018	7.441	1.405	39.406	4.259
Platelet count	0.002	14.565	2.739	77.446	6.206

Table 10: Diagnostic analysis of the correlation between the prognosis factors and outcome

	Cut-off value	*P*-value	Sensitivity	Specificity	Accuracy
Age at surgery	16.5	0.028	70.8%	62.5%	66%
Hemoglobin level	15	0.021	62.5%	71.9%	67.8%
Platelet count	212.000	0.004	70.8%	76.7%	71.4%

Risk factors affecting mortality of duodenal obstruction patients based on this study consisted of age at surgery, hemoglobin level, and platelet level. Platelet level was the most influential factor for neonate patients with duodenal obstruction in this study. The risk of mortality increases four times if surgery is performed later than 16 days of age and hemoglobin is less than 15 g/dL. The risk of mortality increases six times if surgery is performed with platelets less than 212,000 uL. While preoperative anemia is recognized as a distinct risk factor for mortality in adults, our study is pioneering in exploring its impact on the juvenile population, particularly newborns. Our hypothesis posits that the presence of anemia before surgery is a distinct risk factor for mortality in newborns. Our study revealed noteworthy findings about the correlation between hemoglobin levels and patient outcomes in individuals with duodenal obstruction. Specifically, patients with hemoglobin levels equal to or less than 15 g/dL exhibited a mortality risk that was four times higher than patients with hemoglobin levels greater than 15 g/dL. This difference was statistically significant, with a p-value of 0.021. Given the absence of a widely agreed-upon definition of anemia in newborns and the broad range of hemoglobin values considered normal for this age group, we established a threshold of < 15 g/dL as the most effective point of differentiation for assessing the risk of mortality. The relationship between preoperative hematocrit levels of less than 40% and increased mortality in neonates has been validated in an independent external cohort study in 2014, this further generalizes that preoperative anemia is associated with postoperative mortality in neonates. However, this study found that postoperative neonatal anemia is most likely caused by multifactor. Iatrogenic blood loss is the most common cause in preoperative preterm infants due to the frequent blood draws in the hospital or from invasive procedures. Preterm infants are the highest risk group because they experience transient erythropoietin deficiency and iron deficiency along with blood loss, chronic diseases, and infections [12, 13]. Despite a lack of existing literature on the correlation between thrombocytopenia and surgical diagnosis in neonates, our hypothesis suggested its role in surgical delays and postoperative complications. Thrombocytopenia is considered as one of the most prevalent hematologic illnesses, with documented occurrence rates ranging from 18% to 35%. Sepsis was identified as one of the risk variables connected with the development of thrombocytopenia while analyzing numerous maternal, neonatal, and perinatal factors. The prevalence of newborn sepsis in that study was greater in comparison to two systematic evaluations carried out in Ethiopia. Similar studies conducted in Nigeria, Turkey, India, Iran,

Indonesia, and Austria have similarly identified a correlation between newborn sepsis and thrombocytopenia. This study did not find a significant association between maternal hypertension, preterm, and low birth weight which are known risk factors for thrombocytopenia according to the previous studies. This study found a strong correlation between thrombocytopenia and death. Specifically, patients with preoperative platelet levels of 212,000 uL or lower had a mortality risk that was six times higher than patients with preoperative platelet levels over 212,000 uL (p 0.004) [14-16]. In this study, the researchers determined that the threshold for high hemoglobin levels was 15 g/dL, and for platelets, it was 212,000 uL. The high cut-off value may have been influenced by the fact that preoperative laboratory sampling was conducted in this study, which could have introduced bias if the examination results were obtained from secondary or tertiary services. Therefore, future studies should aim to record the therapy administered and include postoperative laboratory studies as control values [15-17]. This investigation identified people with really severe conditions across several individuals. The minimum values for hemoglobin levels are 6.6 g/dL, platelets have a minimum level of 6,000 U/L, leukocytes or white blood cells (WBC) have a minimum level of 4,870 U/L, sodium has a minimum level of 103 mmol/L, potassium has a minimum level of 1.1 mmol/L, chloride has a minimum level of 60 mmol/L, protrombine time (PT) has a maximum level of 74.7 seconds, and activated protrombine time test (APTT) has a maximum level of 83.8 seconds. These findings were derived from a group of patients whose average age at the time of surgery was 19 days, with the longest recorded age being 42 days [18]. Nonetheless, our analysis found that hemostasis, leukocytes/white blood cells (WBC), electrolytes, and the type of blockage did not have a significant impact on the consequences of duodenal obstruction. According to the study, three primary factors that lead to death in cases of duodenal obstruction include a high occurrence of associated defects, including severe cardiac deformities, prematurity, and low birth weight. This implies that additional investigation is required due to the significant fatality rate (42.9%) seen in this study [18, 19]. The study revealed a strong association between the age at which surgery was performed and the result in patients with duodenal blockage. Specifically, patients who underwent surgery after 16 days of age had a fourfold increase in mortality compared to those who had surgery at or before 16 days of age. This correlation was shown to be statistically significant, with a p-value of 0.028. Before proceeding with surgery for duodenal atresia, it is crucial to ensure that the infant's hemodynamic condition and fluid and electrolyte levels are stable. If the clinical history and physical examination indicate that the newborn is not experiencing any distress, and the x-rays show typical signs of duodenal atresia without air outside the second bubble (excluding malrotation), elective surgery should be conducted. Infants with duodenal obstruction are initially treated by relieving the pressure in the stomach via a tube inserted through the nose or mouth and by providing fluids through a vein. It is advisable to restore the lost gastrointestinal fluid and utilize a peripherally inserted central catheter (PICC) for parenteral nutrition. This is because feeding is typically postponed until a few weeks after the repair. In an another study, the average age at which patients underwent surgery was two days, with a range of 0 to 75 days. The infants that received surgery on day 75 were born exceedingly prematurely and experienced substantial morbidity related to their infancy. As a result, they needed to be stabilized before undergoing surgical repair. There was no significant disparity in the age at the surgery between those born weighing less than or more than 1500 g and those born before or after 36 weeks of complete gestation (2 vs. 3 days (p = 0.38) and 2 vs. 3 days (p = 0.48), respectively) [20].

Conclusion

To sum up, the age of surgery, hemoglobin levels, and platelet level are risk factors for mortality in patients with duodenal obstruction. Operating in age > 16 days increases the risk of mortality 4

times in patients with duodenal obstruction. Hemoglobin < 15 g/dL increases the risk of mortality 4 times in patients with duodenal obstruction. Platelet levels < 212,000 uL increase the risk of mortality 6 times in patients with duodenal obstruction. platelets are the factor that most influences the mortality of patients with duodenal obstruction in neonates.

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