Research Article / Araştırma Makalesi

Platelet and Erythrocyte Indices and Their Impact on Prognosis in Late Neonatal Sepsis

Geç Neonatal Sepsiste, Trombosit ve Eritrosit İndeksleri ve Prognoza Etkisi

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Abstract

Background: One of the most significant causes of mortality and morbidity in newborns is neonatal sepsis. Despite all the advancements in its diagnosis and treatment, it remains a major public health issue. This study aims to evaluate the hemogram parameters of newborns admitted to the neonatal intensive care unit (NICU) with a diagnosis of late-onset neonatal sepsis, both at the start of treatment and on the 7th day.
Materials and Methods: This study was conducted in a cross-sectional manner with 89 newborns who received care and treatment for late-onset neonatal sepsis in the neonatal intensive care unit (NICU) of a university hospital between January 2017 and February 2020. Newborns between the postnatal 72nd hour and 30th day with positive blood or urine cultures were included in the study. The data of the study were obtained retrospectively in the digital environment by screening hemogram parameters, CRP levels, interventional procedure status, body fluid from which the culture was taken, culture result, initial treatment, follow-up and change in treatments, reason for hospitalization and mortality on the 1st and 7th days of sepsis.
Results: It was determined that 58.4% of the newborns were male and 50.6% were term newborns. RBC and MCH levels on the 7th day of sepsis, MCV levels on the 1st day of sepsis, HGB, HCT and PLT levels on the 1st and 7th days of sepsis were found to be statistically significantly lower in newborns who lost their lives compared to living newborns. In addition, MPV levels on the 1st day of sepsis and CRP levels on the 1st and 7th days of sepsis of newborns who died were found to be statistically significantly higher than those of living newborns.
Conclusions: As can be understood from the results, it has been proven that low RBC and MCH levels on the 7th day of sepsis, MCV levels on the 1st day of sepsis, HGB, HCT and PLT levels on the 1st day and 7th day of sepsis, and high CRP levels on the 1st day and 7th day of sepsis and MPV levels on the 1st day of sepsis should be considered as poor prognostic factors and are associated with mortality in the follow-up of newborns diagnosed with late-onset sepsis.

Keywords: Late-onset Neonatal Sepsis, Prognosis, Platelet, Erythrocyte

Öz

Amaç: Yenidoğanların mortalite ve morbiditesinin en önemli nedenlerin biri yenidoğan sepsisidir. Tanı ve tedavisindeki tüm gelişmelere rağmen önemli bir halk sağlığı sorunu olarak karşımıza çıkmaktadır. Bu araştırmada, geç başlangıçlı sepsis tanısı ile yenidoğan yoğun bakım ünitesine (YYBÜ) yatışı yapılan yenidoğanların tedavinin başlangıcı ve 7.gündeki hemogram parametrelerinin değerlendirilmesi amaçlanmaktadır.
Materyal ve Metod: Bu araştırma Ocak 2017-Şubat 2020 tarihleri arasında bir üniversite hastanesinin YYBÜ'sinde geç başlangıçlı yenidoğan sepsisi tanısıyla bakım ve tedavi almış yenidoğanlarla kesitsel tipte yürütülmüştür. Postnatal 72. saat ile 30. günler arasında olan ve kan veya idrar kültüründe üremesi olan yenidoğanlar araştırmaya dahil edildi. Araştırmanın verileri dijital ortamda retrospektif olarak sepsisin 1. ve 7. günlerinde alınan hemogram parametreleri, CRP düzeyleri, girişimsel işlem durumu, kültürün alındığı vücut sıvısı, kültür sonucu, başlangıçta uygulanan tedavi, takip ve tedavilerde yapılan değişim, yatış nedeni ve mortalite gibi durumların taranması sonucunda elde edilmiştir.
Bulgular: Yenidoğanların %58.4'ünün erkek ve %50.6'sının term bebek olduğu belirlenmiştir. Yaşamını kaybeden yenidoğanların sepsisin 7. gününde RBC ve MCH düzeyleri, sepsisin 1. gününde MCV düzeyleri ile 1. ve 7. günlerinde HGB, HCT ve PLT düzeyleri yaşayan yenidoğanlara göre istatistiksel olarak anlamlı düzeyde daha düşük saptanmıştır. Ayrıca, yaşamını kaybeden yenidoğanların sepisinin 1. gününde MPV düzeyleri ile 1. ve 7. günlerinde CRP düzeyleri yaşayan yenidoğanlara göre istatistiksel olarak anlamlı seviyede daha yüksek olarak tespit edilmiştir.
Sonuç: Sonuçlardan anlaşılacağı üzere geç başlangıçlı sepsis tanılı yenidoğanların takibinde sepisinin 7. günü RBC ve MCH düzeyleri, sepsisin 1. günü MCV düzeyleri ile sepsisin 1. günü ve 7. günü HGB, HCT ve PLT düzeylerinin düşüklüğünün ve sepsinin 1. günü ve 7. günü CRP düzeyleri ile sepsisin 1. gününde MPV düzeylerinin yüksekliğinin kötü prognostik faktör olarak değerlendirilmesi gerektiği ve mortalite ile ilişkili olduğu kanıtlanmıştır.

Anahtar Kelimeler: Geç başlangıçlı yenidoğan sepsisi; Prognoz; Trombosit; Eritrosit

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Introduction

According to the World Health Organization (WHO), nearly half of child deaths under the age of five occur during the neonatal period, making it the most vulnerable phase of life (1). Sepsis accounts for 36% of childhood deaths, with this rate being higher in low-income countries. Invasive sepsis leads to the deaths of over 1.4 million newborns annually. A significant majority of sepsis-related deaths are caused by delays in the selection of appropriate antibiotics during diagnosis and treatment. Despite the initiation of appropriate and timely antimicrobial therapy, 39% of neonatal sepsis cases result in mortality or major morbidity (2,3). Neonatal sepsis is a clinical syndrome characterized by the presence of a specific pathogen in blood cultures, showing signs of infection affecting all systems, and is defined by bacteremia (4). Despite all advancements in diagnosis and treatment, it remains a significant global public health issue and is among the primary factors causing neonatal mortality and morbidity (5).

Neonatal sepsis is categorized into three based on the time of onset: early, very late and late onset. Early-onset neonatal sepsis (EONS) occurs primarily through transplacental transmission and, more frequently, maternal-genital tract sources, while late-onset neonatal sepsis (LONS) arises from postnatal nosocomial or community-acquired factors (6-8). The incidence of EONS ranges from 0.57 to 10.96 per 1,000 live births, whereas the incidence of LONS varies between 1.6% and 51.2% (9,10). The main risk factors leading to the development of LONS include prematurity, low birth weight (LBW), admission to the intensive care unit, reliance on mechanical ventilation, frequent invasive procedures, skin infections, feeding aspiration, bottle feeding, poor umbilical care, and poor hygiene (11). There are limited studies showing the prognostic process of hematological changes (hemoglobin, hematocrit and leukocytes etc.) in LONS (12). This study was conducted to retrospectively investigate the relationship between platelet and erythrocyte indices of newborns diagnosed with LONS and treated in the neonatal intensive care unit (NICU) of a university hospital and their prognosis and mortality.

Materials and Methods

Type, Place and Time of The Research

This research is a cross-sectional study conducted on newborns diagnosed with late-onset neonatal sepsis (LONS) who were followed up and treated in the neonatal intensive care unit (NICU) of a university hospital between January 2017 and February 2020.

Population and Sample of The Study

The population of the study consists of 2,180 newborns followed up and treated in the NICU of a university hospital between January 2017 and February 2020, while the sample includes 89 newborns with positive cultures and diagnosed with LONS.

Inclusion and Exclusion Criteria

Newborn patient files were scanned digitally, and those who had positive blood or urine cultures between the 72nd hour and the 30th day postnatally were included in the study. Newborns with intraventricular hemorrhage, those who received erythrocyte or intrauterine transfusions, congenital anomalies, family history of thalassemia, and necrotizing enterocolitis were excluded from the research.

Research Protocol

The study examined the newborns' gender, gestational age, postnatal age, birth weight, mode of delivery, APGAR scores (at 1 and 5 minutes), feeding methods, , body fluids from which cultures were obtained, initial, mortality status, and the file records. When sepsis was suspected, blood samples taken were evaluated as "initial sample," and blood samples taken on the 7th day after the start of treatment were considered as "final sample."

This is our protocol for approaching newborns with suspected sepsis in the NICU.

Newborns with at least two clinical and laboratory findings had blood and urine cultures taken for suspected sepsis, and empirical antibiotics were started. Laboratory evaluations included CRP (>1.5 mg/dl), procalcitonin (≥2 ng/ml), platelet count (<100,000/mm³), immature/total NEU ratio (≥0.20), WBC count (>20,000/mm³ or <4,000/mm³), hypoglycemia (<45 mg/dl), hyperglycemia (>180 mg/dl), and metabolic acidosis (base deficit >10 mEq/L or serum lactate >2 mmol/L) (13). Clinically, evaluations were made based on respiratory abnormalities (increased ventilation or oxygen requirement, tachypnea, apnea), cardiovascular system findings (impaired peripheral perfusion, hypotension, tachycardia, bradycardia, urine output <1 ml/kg/h), gastrointestinal system findings (abdominal distension, decreased sucking, feeding intolerance), and body temperature (<36°C or>38.5°C or temperature irregularities).

Ethical Approval

Before the start of the research, ethical approval was obtained from the clinical research ethics committee of a university with decision number 19/09/15 dated 22.10.2019, along with institutional permission from the hospital where the research was conducted. Verbal consent was obtained from the parents of the newborns. The study was conducted in accordance with the principles of the Helsinki Declaration.

Statistical Analysis

The NCSS 2007 software was used for statistical analyses. Descriptive statistical values such as mean, standard deviation, median, frequency, proportion, minimum, and maximum were provided during the evaluation of research data. The normality of quantitative data was assessed using the Kolmogorov-Smirnov test, the Shapiro-Wilk test, and graphical evaluations. For comparing two groups of quantitative

data showing a normal distribution, the Student t-test was used, while the Mann-Whitney U test was applied for two groups of non-normally distributed data. The Wilcoxon Signed Ranks test was used for within-group comparisons of parameters that did not show a normal distribution. Pearson Chi-Square test and Fisher's Exact test were used for comparing qualitative data. A significance level of $p < 0.05$ was considered statistically significant.

Results

It was found that 58.4% of the newborns were male, and 50.6% were term newborns. Additionally, 67.4% were delivered by cesarean section. The average age of the newborns was found to be 6.71 ± 3.11 days. The birth weights of the newborns ranged from 1050 to 4100 grams, with an average birth weight of 2765.79 ± 666.88 grams. Among them, 58.4% had normal weight, 34.9% had low birth weight, and 6.7% had very low birth weight (Table 1).

Table 1. Descriptive Characteristics of Neonatal

Variables		n	(%)
Age (day)	Min-Max (Median)	3-20 (6)	
	Mean±Sd	6.71±3.11	
1st minute APGAR	Min-Max (Median)	4-8 (7)	
	Mean±Sd	6.93±1.04	
5st minute APGAR	Min-Max (Median)	5-10 (9)	
	Mean±Sd	8.62±1.28	
Birth weight (grams)	Min-Max (Median)	1050-4100 (2800)	
	Mean±Sd	2765.79±666.88	
	Very low	6	(6.7)
	Low	31	(34.9)
	Normal	52	(58.4)
Gender	Male	52	(58.4)
	Female	37	(41.6)
Preterm/term	Preterm	44	(49.4)
	Term	45	(50.6)
Type of birth	Vaginal	29	(32.6)
	Caesarean	60	(67.4)
Nutritional Type	Enteral	39	(43.8)
	Parenteral (longer than 7 days)	50	(56.2)
Mortality Rate	Yes	9	(10.1)
	No	80	(89.9)

Sd: Standard deviation, Min: Minimum, Max: Maximum.

Table 2 illustrates the relationship between the hemogram parameters of the newborns and mortality. It was found that the mortality rate was statistically significantly higher in newborns with low birth weight (LBW), those who were preterm, those delivered by cesarean section, and those with lower APGAR scores at 1 minute and 5 minutes, as well as in those who received parenteral nutrition. The final RBC (red blood cell) measurement values, initial MCV (mean corpuscular volume) measurement values, final MCH (mean corpuscular hemoglobin) measurement values, initial and final HGB (hemoglobin) measurement values, initial and final HCT (hematocrit) measurement values, and initial and final PLT (platelet) measurement values of the deceased newborns were found to be lower, and the differences were statistically significant. Additionally, the initial MPV (mean platelet volume) measurement values and initial and final CRP (C-reactive protein) measurement values of the deceased newborns were found to be higher, with the differences also being statistically significant (Table 2).

Table 2. The Relationship Between Hemogram Parameters of Neonatal and Mortality

			Mortality		[a]p
			No (n=80)	Yes (n=9)	
RBC (10^3/mm^3)	Initial measurement (day 1 of sepsis)	Min /Max (Median)	2.1/ 8.8 (4.6)	3/ 7.6 (4)	0.066
		Mean±Sd	4.64±0.88	4.31±1.37	
	Final measurement (day 7 of sepsis)	Min/Max (Median)	2/ 6.2 (4.2)	2.2/ 3.8 (3.2)	0.001**
		Mean±Sd	4.12±0.81	3.12±0.57	
		[c]p	0.001**	0.021*	
	Initial-Final measurement difference	Min /Max (Median)	-4.3/ 1.3 (-0.4)	-3.8/ 0.1 (-1)	0.047*
		Mean±Sd	-0.52±0.85	-1.19±1.15	
MCV (fL)	Initial measurement (day 1 of sepsis)	Min /Max (Median)	73.3/ 706 (100)	85.6/ 100 (96)	0.018*
		Mean±Sd	107.12±68.28	93.66±5.62	
	Final measurement (day 7 of sepsis)	Min /Max (Median)	75.1/ 113 (94.6)	82/ 114 (89)	0.075
		Mean±Sd	94.99±7.19	91.62±9.42	
		[c]p	0.001**	0.139	
	Initial-Final measurement difference	Min /Max (Median)	-598/ 6 (-5)	-8/ 15 (-4.3)	0.314
		Mean±Sd	-12.14±66.46	-2.03±6.88	
MCH (pg)	Initial measurement (day 1 of sepsis)	Min /Max (Median)	24.5/ 40.4 (33.6)	28/ 35.7 (31.9)	0.055
		Mean±Sd	33.69±2.71	32.03±2.34	
	Final measurement (day 7 of sepsis)	Min /Max (Median)	18.4/ 97.6 (32.4)	26.2/ 33.7 (30.4)	0.004**
		Mean±Sd	33.57±7.93	30.26±2.24	
		[c]p	0.001**	0.017*	
	Initial-Final measurement difference	Min /Max (Median)	-13.4/ 64.9 (-1)	-3.4/ 0.1 (-2)	0.080
		Mean±Sd	-0.12±7.77	-1.77±1.22	
MCHC (g/dl)	Initial measurement (day 1 of sepsis)	Min /Max (Median)	30.3/ 40.6 (34)	31.8/ 37.1 (33.7)	0.881
		Mean±Sd	33.9±1.7	33.88±1.77	
	Final measurement (day 7 of sepsis)	Min /Max (Median)	28.8/ 42.9 (33.8)	31.2/ 38.1 (33.6)	0.791
		Mean±Sd	34.17±2.29	34.03±2.17	
		[c]p	0.431	0.779	
	Initial-Final measurement difference	Min /Max (Median)	-5/ 7.8 (0.2)	-2.2/ 2.1 (0.3)	0.995
		Mean±Sd	0.28±2.34	0.16±1.50	
HCT (%)	Initial measurement (day 1 of sepsis)	Min /Max (Median)	17.8/ 60.4 (45.2)	27.2/ 50.6 (35.3)	0.005**
		Mean±Sd	45.48±8.52	37.29±6.85	
	Final measurement (day 7 of sepsis)	Min /Max (Median)	21.5/ 59.9 (38.5)	20/ 41.1 (28)	0.001**
		Mean±Sd	39.13±7.55	28.94±7.03	
		[c]p	0.001**	0.021*	
	Initial-Final measurement difference	Min /Max (Median)	-26.3/ 11.1 (-6.4)	-17.3/ 6.2 (-7.3)	0.324
		Mean±Sd	-6.34±7.15	-8.34±7.73	
HGB (g/dl)	Initial measurement (day 1 of sepsis)	Min /Max (Median)	1/ 19.9 (15.6)	10.1/ 16.2 (12.6)	0.002**
		Mean±Sd	15.23±3.02	12.59±1.99	
	Final measurement (day 7 of sepsis)	Min /Max (Median)	8.2/ 19.5 (13.9)	6.5/ 13.9 (9.3)	0.001**
		Mean±Sd	13.64±2.43	9.59±2.26	
		[c]p	0.001**	0.015*	
	Initial-Final measurement difference	Min /Max (Median)	-7.7/ 8.3 (-1.8)	-5.7/ 1.3 (-3.7)	0.058
		Mean±Sd	-1.59±2.40	-2.99±2.30	
RDW (%)	Initial measurement (day 1 of sepsis)	Min /Max (Median)	11/ 24 (14.5)	13.6/ 17.3 (14.8)	0.334
		Mean±Sd	14.92±2.03	15.20±1.09	
	Final measurement (day 7 of sepsis)	Min /Max (Median)	1.9/ 19.2 (13.9)	12.6/ 16.6 (14.1)	0.500
		Mean±Sd	13.92±2.12	14.36±1.43	
		[c]p	0.001**	0.066	
	Initial-Final measurement difference	Min /Max (Median)	-11.7/ 6 (-0.7)	-3/ 0.6 (-0.9)	0.989
		Mean±Sd	-1.00±2.48	-0.84±1.19	

*Sd: Standart deviation, Min: Minimum, Max: Maximum, [a]Mann Whitney U Test, [c]Wilcoxon Signed Ranks Test *p<0.05**p<0.01.*

Table 2. The Relationship Between Hemogram Parameters of Newborns and Mortality (Continued)

			Mortality		[a]p
			No (n=80)	Yes (n=9)	
PLT (10^3/mm^3)	Initial measurement (day 1 of sepsis)	Min /Max (Median)	13.3/ 979 (239.5)	6/ 322 (96)	0.003**
		Mean±Sd	269.37±164.74	117.78±122.09	
	Final measurement (day 7 of sepsis)	Min /Max (Median)	103/ 763 (362)	6/ 255 (50)	0.001**
		Mean±Sd	375.25±131.11	71.89±78.59	
		[c]p	0.001**	0.069	
	Initial-Final measurement difference	Min /Max (Median)	-301/ 478 (86.5)	-201/ 22 (-23)	0.001**
		Mean±Sd	105.88±136.08	-45.89±73.94	
PCT (%)	Initial measurement (day 1 of sepsis)	Min /Max (Median)	0/ 0.5 (0.2)	0/ 0.3 (0.1)	0.055
		Mean±Sd	0.21±0.10	0.13±0.11	
	Final measurement (day 7 of sepsis)	Min /Max (Median)	0/ 0.6 (0.3)	0/ 0.2 (0.1)	0.001**
		Mean±Sd	0.28±0.10	0.10±0.08	
		[c]p	0.001**	0.401	
	Initial-Final measurement difference	Min /Max (Median)	-0.2/ 0.3 (0.1)	-0.2/ 0.2 (0)	0.023*
		Mean±Sd	0.06±0.12	-0.02±0.11	
PDW (fL)	Initial measurement (day 1 of sepsis)	Min /Max (Median)	12.3/ 24.2 (16.2)	9.1/ 22.1 (15.6)	0.833
		Mean±Sd	16.76±3.38	15.80±3.54	
	Final measurement (day 7 of sepsis)	Min /Max (Median)	10.2/ 24.1 (16.1)	13.2/ 24.3 (15.7)	0.395
		Mean±Sd	16.63±3.57	17.61±3.76	
		[c]p	0.903	0.441	
	Initial-Final measurement difference	Min /Max (Median)	-10.4/ 9.6 (0)	-3.1/ 15.2 (0.2)	0.514
		Mean±Sd	-0.13±3.41	1.81±5.40	
CRP (mg/dl)	Initial measurement (day 1 of sepsis)	Min /Max (Median)	0/ 30.4 (2.1)	0/ 17.1 (7.9)	0.013*
		Mean±Sd	3.01±4.01	7.35±5.47	
	Final measurement (day 7 of sepsis)	Min /Max (Median)	0/ 13.2 (0)	9.1/ 22.3 (12.5)	0.001**
		Mean±Sd	0.24±1.50	13.96±4.74	
		[c]p	0.001**	0.008**	
	Initial-Final measurement difference	Min /Max (Median)	-17.2/ 0 (-2.1)	3/ 9.9 (7.2)	0.001**
		Mean±Sd	-2.77±2.96	6.61±2.84	
MPV (fL)	Initial measurement (day 1 of sepsis)	Min /Max (Median)	1.1/ 12 (7)	6.5/ 15.9 (7.6)	0.020*
		Mean±Sd	7.03±1.42	9.66±3.47	
	Final measurement (day 7 of sepsis)	Min /Max (Median)	4.6/ 10.2 (7.5)	6.9/ 16.3 (8.1)	0.081
		Mean±Sd	7.43±1.13	9.46±3.43	
		[c]p	0.001**	0.678	
	Initial-Final measurement difference	Min /Max (Median)	-3.8/ 5.8 (0.3)	-6.6/ 9.2 (-0.3)	0.301
		Mean±Sd	0.40±1.35	-0.20±4.51	
WBC (10^3/mm^3)	Initial measurement (day 1 of sepsis)	Min/Max (Median)	3.3/ 90 (14.3)	6.2/57.2 (14.8)	0.629
		Mean±Sd	17.28±12.61	22.68±17.31	
	Final measurement (day 7 of sepsis)	Min/Max (Median)	5.7/23.3 (11.2)	3.4/25.8 (7.1)	0.189
		Mean±Sd	11.38±3.34	11.00±8.06	
		[c]p	0.001**	0.110	
	Initial-Final measurement difference	Min/Max (Median)	-66.7/15.4(-4.3)	-37/17.1 (-0.6)	0.187
		Mean±Sd	-5.90±11.79	-11.68±17.37	
NEU (10^3/mm^3)	Initial measurement (day 1 of sepsis)	Min/Max (Median)	1.2/ 53 (6.2)	0.5/36.6 (8.3)	0.844
		Mean±Sd	8.26±7.77	12.86±13.71	
	Final measurement (day 7 of sepsis)	Min/Max (Median)	1.3/ 11.6 (3.2)	0.5/ 12.2 (1.5)	0.105
		Mean±Sd	3.91±2.13	4.41±4.85	
		[c]p	0.001**	0.086	
	Initial-Final measurement difference	Min/Max (Median)	-50.6/ 8.2 (-2.9)	-30.3/10 (-7.4)	0.355
		Mean±Sd	-4.35±8.22	-8.46±13.13	
MON (10^3/mm^3)	Initial measurement (day 1 of sepsis)	Min/Max (Median)	0.3/ 4.4 (1.3)	0.7/ 5.3 (2.1)	0.554
		Mean±Sd	1.53±0.72	2.15±1.51	
	Final measurement (day 7 of sepsis)	Min/Max (Median)	0.5/ 3.4 (1.2)	0.2/ 6 (1.1)	0.491
		Mean±Sd	1.31±0.48	1.90±2.00	
		[c]p	0.009**	0.260	
	Initial-Final measurement difference	Min/Max (Median)	-3.7/ 2.9 (-0.1)	-2.8/ 3.9 (-0.6)	0.355
		Mean±Sd	-0.22±0.83	-0.24±1.82	

*Sd: Standart deviation, Min: Minimum, Max: Maximum, [a]Mann Whitney U Test, [c]Wilcoxon Signed Ranks Test *p<0.05**p<0.01.*

Discussion

Among the newborns followed with the diagnosis of late-onset neonatal sepsis (LONS), the final RBC levels, initial MCV levels, final MCH levels, and initial and final HGB, HCT, and PLT levels of those who passed away were found to be statistically significantly lower compared to the surviving newborns. In contrast, the initial MPV levels and the initial and final CRP measurements were found to be statistically significantly higher. In a study, it was reported that in septic patients, while hematocrit (HCT), hemoglobin (HGB), and red blood cell (RBC) counts decreased, there was no statistically significant difference in MCV levels (14). Blood loss resulting from diagnostic phlebotomy performed on newborns is one of the causes of anemia observed in the neonatal period. The shorter lifespan of red blood cells in newborns compared to adults contributes to the reduction in RBC count in newborns (15,16).

In studies conducted, it has been reported that increased red cell distribution width (RDW) is a strong and independent risk factor for mortality in critically ill neonatal patients with sepsis and septic shock (17,18). In a study evaluating RDW in cases of intrauterine growth restriction, it was found that RDW values were statistically significantly higher in preterm infants diagnosed with late-onset neonatal sepsis (LONS) compared to term infants (19).

Platelet indices used to assess platelet activation and function, such as platelet count, mean platelet volume (MPV), plateletcrit (PCT), and platelet distribution width (PDW), are also affected. In the presence of endotoxemia, it is known that there is a decrease in PLT and PCT values, along with an increase in MPV and PDW values (20). In a study investigating whether MPV (mean platelet volume) values are predictive for neonatal sepsis, it was found that MPV values increased in newborns with sepsis compared to the control group, while PCT (plateletcrit) values decreased (21). In several studies examining sepsis and its markers, it has been found that an increase in CRP (C-reactive protein) values is associated with both the severity of sepsis and mortality (21, 22). In our study, in line with the literature, CRP (C-reactive protein) values were found to be higher in newborns who experienced mortality compared to those who survived, and this difference was statistically significant.

In our study, the incidence of late-onset neonatal sepsis (LONS) was found to be higher in males compared to females. Similarly, in a study conducted in Egypt that prospectively followed newborns, it was reported that the incidence of early-onset neonatal sepsis (EONS) and LONS was higher in males than in females (23). In another study conducted in Switzerland with newborns, it was determined that the incidence of hospital- and community-acquired late-onset neonatal sepsis (LONS) was higher in males compared to females (24). It is believed that the variation of genes located on the X chromosome is the reason for this situation (25).

In a study conducted in America that examined 15,178 newborns born at or before 32 weeks of gestation and weighing less than 1500 grams, it was found that the incidence of late-onset neonatal sepsis (LONS) increased as gestational age (GA) and birth weight (BW) decreased, and that it was more common in male infants (6). Similarly, in a study conducted in Brazil with 1,506 newborns, it was reported that the frequency of late-onset neonatal sepsis (LONS) increased as gestational age (GA) and birth weight (BW) decreased (26). In contrast to the literature, our study found that the frequency of late-onset neonatal sepsis (LONS) was higher in term (50.6%) and over 2500 grams (58.4%) newborns. This situation is thought to be due to the relatively low number of premature newborns in our unit and the higher number of term newborns. In our study, the cesarean birth rate was found to be higher than the vaginal birth rate. When reviewing the literature, a similar multicenter case-control study conducted in Belgium and the Netherlands involving 755 newborns diagnosed with LONS found that 46.1% were born vaginally and 53.9% were born via cesarean section (27). As can be understood from the results, the mode of delivery, particularly cesarean section, is thought to be a potential risk factor for late-onset neonatal sepsis (LONS).

Limitations of the Study

The study's limitations include the fact that only newborns with positive cultures were included, which means that the true incidence of cases with meningitis could not be determined due to the lack of lumbar punctures performed on all newborns. Additionally, the study was retrospective and conducted only with newborns hospitalized in the neonatal intensive care unit (NICU), which represents another limitation.

Conclusions

While monitoring newborns with late-onset neonatal sepsis, it has been proven that low on day 1 of sepsis and on day 7 of sepsis levels of HGB (hemoglobin), HCT (hematocrit), and PLT (platelet) levels, along with low on day 7 of sepsis RBC (red blood cell) and MCH (mean corpuscular hemoglobin) levels, as well as low on day 1 of sepsis MCV (mean corpuscular volume) levels, and high on day 1 of sepsis MPV (mean platelet volume) levels and high on day 1 of sepsis and on day 7 of sepsis CRP (C-reactive protein) levels are associated with high mortality and poor prognostic factors.

Ethical Approval: *Before starting the study, approval from the clinical research ethics committee of a university was obtained with the decision numbered 19/09/15 dated 22.10.2019 and institutional permission from the hospital where the study was conducted. The study was conducted in accordance with the principles of the Declaration of Helsinki*

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Concept: H.D., D.K.
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Design : H.D., D.K.
Data acquisition: H.D.
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