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The Relationship of Laboratory Parameters and Rates with Prognosis and Mortality in COVID-19 Infection

Laboratuvar Parametreleri ve Oranlarının COVID-19 Enfeksiyonunda Prognoz ve Mortalite İle İlşkisi

Hasan Ergenç[1], Zeynep Ergenç[1], Songül Araç[2], İbrahim Hakkı Tör[3], Mustafa Usanmaz[4], Cengiz Karacaer[5], Gülsüm Kaya[6]

[1] Department of Internal Medicine, Ayancık Government Hospital, Sinop, Turkey

[2] Department of Emergency Medicine, University of Health Sciences, Diyarbakır Gazi Yaşargil Training and Research Hospital, Diyarbakır, Turkey

[3] Department of Anesthesiologgy and Reanimation, University of Health Sciences, Erzurum, Turkey

[4] Department of Infectious Diseases and Clinical Microbiology, Gazi Government Hospital, Samsun, Turkey

[5] Department of Internal Medicine, Sakarya University Research and Education Hospital, Sakarya, Turkey

[6] Department of Infection Control Committee, Sakarya University Research and Education Hospital, Sakarya, Turkey

ORCID ID: Hasan Ergenc https://orcid.org/0000-0003-0519-0264, Zeynep Ergenc https://orcid.org/0000-0001-7598-4508, Songül Araç https://orcid.org/0000-0001-6830-3639, İbrahim Hakkı Tör https://orcid.org/0000-0003-0246-3220, Mustafa Usanmaz https://orcid.org/0000-0002-5369-2560, Cengiz Karacaer https://orcid.org/0000-0002-7164-4810, Gülsüm Kaya https://orcid.org/0000-0003-2810-0153

***Sorumlu Yazar / Corresponding Author:** Hasan Ergenç, **e-posta / e-mail:** dr.hasanergenc@hotmail.com

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Abstract

Aim In this study, to evaluate the clinical course and prognosis in COVID-19 patients, to evaluate the hematological and biochemical parameters at the time of admission to the hospital.

Material and Method This retrospective study was performed in a multicenter study in April and October 2020. Demographic characteristics, clinical features, age, gender and length of stay of patients who exitus (EX) and were discharged due to COVID-19 were examined.

Results Of the patients (n:180) included in the study, 89 were female and 91 were male. There was a significant difference between the patients who were discharged from the hospital and died gender and complaints at the time of admission ($p<0.05$). There was no significant difference between age distribution and comorbid factors ($p>0.05$). While the length of stay, platelet (PLT), mean corpuscular volume (MCV), serum C-reactive protein (CRP), albumin, lymphocyte, monocyte, alanine aminotransferase, aspartate aminotransferase, lactate dehydrogenase (LDH), ferritin, international normalized ratio (INR), Plateletcrit (PCT), troponin, and white blood cell counts are all increased in EX. There is a statistically significant difference in red blood cell distribution width (RDW) between EX and discharge patients ($p<0.05$), as well as in monocyte/albumin ratios, procalcitonin/albumin ratios, CRP/albumin ratios, LDH/albumin ratios, and ürea/albumin ratios. There is not significant for lymphocyte/monocyte ratio ($p>0.05$). While the RDW, monocyte/albumin, PCT/albumin, CRP/albumin, LDH/albumin, and ürea/albumin ratios are increased in EX patients, the PCT/PLT and MPV/PLT ratios are increased in discharged patients.

Conclusion In this study, we demonstrated that hematological and biochemical markers may be utilized as an early prognostic indicator for patients identified with COVID-19.

Keywords COVID-19, Plateletcrit/Platelet, Platelet/Mean Platelet Volum, Lymphocyte/Monocyte monocytes, C-Reactive Protein/Albumin, Mortality.

Özet

Amaç *Bu çalışma amaç, COVID-19 hastalarında hastaneye başvuru anındaki hematolojik ve biyokimyasal parametreleri ile klinik seyir ve prognozu değerlendirmektir.*

Gereç ve Yöntem *Bu retrospektif çalışma, Nisan ve Ekim 2020'de çok merkezli çalışma olarak yapıldı. COVID-19 nedeniyle taburcu olan ve ölen (EX) hastaların demografik özellikleri, klinik özellikleri, yaşı, cinsiyeti ve kalış süreleri incelendi.*

Sonuçlar *Çalışmaya alınan hastaların (n:180) 89'u kadın, 91'i erkekti. Hastaneden taburcu olan ve ex olan hastalar arasında cinsiyet ve başvuru anındaki şikayetleri arasında anlamlı fark vardı ($p<0.05$). Yaş dağılımı ile komorbid faktörler arasında ise anlamlı fark yoktu ($p>0.05$). Kalış süresi, trombosit (PLT), ortalama korpüsküler hacim (MCV), serum C-reaktif protein (CRP), albümin, lenfosit, monosit, alanin aminotransferaz, aspartat aminotransferaz, laktat dehidrojenaz (LDH), ferritin, international normalized ratio (INR), Plateletcrit (PCT), troponin ve beyaz kan hücresi sayılarının tümünün ex olan hastalarda arttığı gözlendi. EX ve taburcu olan hastalar arasında kırmızı kan hücresi dağılım genişliği (RDW), monosit/albümin oranları, PCT/albümin oranları, CRP/albümin oranları, LDH/albümin oranları, ve üre/albümin oranları arasında anlamlı fark vardı ($p<0.05$). Lenfosit/monosit oranı açısından anlamlı fark yoktu ($p>0.05$). EX olan hastalarında RDW, monosit/albümin, prokalsitonin/albümin, CRP/albümin, LDH/albümin ve üre/albümin oranları artarken, taburcu olan hastalarda PCT/PLT ve MPV/PLT oranları artmaktaydı.*

Sonuç *Çalışmada, COVID-19 ile hastaları için hematolojik ve biyokimyasal belirteçlerin erken prognostik gösterge olarak kullanılabileceğini gösterilmiştir.*

Anahtar Kelimeler *COVID-19, Plateletkrit/Platelet, Platelet/Ortalama Trombosit Hacmi, Lenfosit/Monosit monositleri, C-Reaktif Protein/Albümin, Mortalite.*

INTRODUCTION

SARS-CoV-2, a new severe acute respiratory syndrome coronavirus, has spread around the world, posing a hazard to public health. The signs and symptoms of SARS-CoV-2 might vary from patient to patient. It might be asymptomatic or have a mild, moderate, or severe course. Even though some patients recover after being treated in an intensive care unit, others pass away there[1,2]. The infection with SARS-Cov2 should be regarded a systemic illness. The cardiovascular, pulmonary, gastrointestinal, neurological, hematopoietic, and immunological systems are all impacted[3,4].

Initial clinical manifestations of SARS-CoV-2 infection are not infection-specific, and further evidence is required to establish the diagnosis. Demonstrated that standard laboratory testing, particularly anomalies in hematological assays, has the ability to rapidly, practically, and economically establish the necessity for specialized laboratory testing for the diagnosis of SARS-CoV-2 infection[5-8]. Among the most often reported hematological abnormalities are lymphocytopenia, neutrophilia, and moderate thrombocytopenia[8,9].

The COVID-19 pandemic has seen a significant increase in the number of patients. Thus, a rapid and thorough knowledge of laboratory data related to the severity of the disease and mortality in the early period provides insight into the clinical course throughout this time frame. Although the indicators indicating the severity of the disease are unknown, it has been established that the clinical course is largely caused by host factors' immunological responses rather than viral genetic changes[10].

In this study, we aimed to investigate the early hematological and biochemical that may be associated with the severity of COVID-19 disease in the light of the available literatüre. We aimed to reveal that determining the parameters that predict the course of the disease will contribute to the literatüre in reducing morbidity and mortality by enabling the effective treatment of patients.

MATERIAL and METHODS

The study was carried out as a multicenter study in Health Sciences University Diyarbakır Gazi Yaşargil Training and Research Hospital and Sinop Ayancık State Hospital in April and October 2020. COVID-19 patients treated in 90 intensive care units and 90 clinics were included in the study. Demographic characteristics, clinical characteristics, age, gender and length of stay of patients discharged and died (EX) due to COVID-19 were retrospectively analyzed from the hospital information system. The blood tests of the patients who were hospitalized with the diagnosis of COVID-19 were taken at the time of admission to the clinic and laboratory tests were analyzed in the microbiology and biochemistry laboratory of our hospital. Complete blood count analyses were carried out in 2 ml tubes containing K3 ethylenediamine tetraacetic acid (EDTA) on a Sysmex XP-300 instrument (Sysmex Corp., Kobe Japan) within 2 hours. Serum lipid parameters (total cholesterol, HDLc, LDLc, and triglyceride), calcium and phosphorus levels and glucose keratin etc.was studied in biochemistry autoanalysis using standard methods on the ARCHITECTc8000 (Abbot, USA) device from the obtained serum. Daily quality control was carried out with commercial quality control materials to ensure the precision and accuracy of measurements in our laboratory. Plateletcrit is the percentage of platelets in peripheral blood and is measured with a hemocounter device.

The data were analyzed using the SPSS 26 software and a confidence level of 95% was used. For categorical (qualitative) variables, frequency and n (%) statistics are provided; for numerical (quantitative) variables, mean, standard deviation (meansd), minimum, maximum, and median (Max-Min(M)) statistics are provided. The prediction levels and probabilities of the cut-off values for the rate variables utilized in the calculated measurements were established using ROC analysis. We computed the sensitivity (rate of detecting ex status), specificity (rate of detecting

discharge status), positive predictive (rate of expiration of positive value of measurement), and negative predictive (rate of discharge of negative value of measurement) probabilities. The chi-square test is a statistical tool for determining the connection between two category variables. The Mann Whitney/independent groups t test is a statistical technique for comparing two independent groups on the basis of a quantitative variable.

To determine if the measurements followed the normal distribution, the Shaphiro Wilk normality test was used. While mean platelet volume (MPV) and hemoglobin (HGB) values indicate normal distribution ($p<0.05$), other data do not ($p>0.05$). Parametric or non-parametric approaches were used for analysis, depending on the normal distribution of the measurement.

RESULTS

Of the patients (n:180) included in the study, 89 were female and 91 were male. When the demographic data of the patients who were discharged from the hospital and died; there was a significant difference between the patients' gender and complaints at the time of admission (respectively, $p=0.005$; $p=0.000$); There was no significant difference between age distribution and comorbid factors (respectively, $p=0.175$; $p=0.119$; $P=0.286$) (Table 1). The majority of EX patients (61.1%) were male, 33.3% had a fever, and complained of dyspnea (36.7 %) (Figure 1).

While the length of stay, platelet (PLT), mean corpuscular volume (MCV), serum C-reactive protein (CRP), albumin, lymphocyte, monocyte, alanine aminotransferase (ALT), aspartate aminotransferase (AST), lactate dehydrogenase (LDH), ferritin, international normalized ratio (INR), procalcitonin, troponin, and white blood cell (WBC) counts are all increased in EX (Table 2).

There is a statistically significant difference in red blood cell distribution width (RDW) between EX and released patients ($p<0.05$), as well as in monocyte/albumin ratios, procalcitonin/albumin ratios, CRP/albumin ratios, LDH/albumin ratios, and ürea/albumin ratios. The change was not significant for lymphocyte/monocyte ratio ($p>0.05$). While the RDW, monocyte/albumin, procalcitonin/albumin, CRP/albumin, LDH/albumin, and ürea/albumin ratios are increased in EX patients, the PCT/PLT and MPV/PLT ratios are increased in discharged patients. There was a statistically significant difference in PLT, lymphocyte, creatinine, and INR levels between males and females released ($p<0.05$). The difference was not statistically significant in other metrics ($p >0.05$). While women's PLT and lymphocyte counts are higher, men's creatinine and INR levels are higher. PLT, lymphocyte, creatinine, HGB, and INR levels were significantly different between women and men with EX ($p <0.05$). The difference was not statistically significant in other metrics ($p >0.05$). Men had higher PLT, creatinine, HGB, and INR levels than women do (Table-3). There is a statistically significant difference in MCV, CRP, urea, albumin, creatinine, ALT, Ferritin, INR, procalcitonin, troponin, procalcitonin/albumin, CRP/albumin, and ürea/albumin measurements between discharged persons and those aged 65 years and above ($p=0.05$). The difference was not statistically significant ($p>0.05$) for other metrics. While MCV, CRP, urea, creatinine, ferritin, INR, procalcitonin, troponin, procalcitonin/albumin, CRP/albumin, and urea/albumin levels are higher in people 65 years of age and older, albumin and ALT levels are higher in persons under 65 years of age. There was a statistically significant difference in urea, ALT, ferritin, INR, RDW, and urea/albumin measurements between EX patients aged 65 years and older ($p=0.05$). The difference was not statistically significant ($p >0.05$) for other metrics. While urea, RDW, and urea/albumin concentrations are higher in patients 65 years and older, ALT, ferritin, and INR concentrations are higher in individuals younger than 65 years of age. There was a statistically significant difference in MCV and ferritin levels between patients discharged from the hospital and those who did not develop subsequent illness ($p <0.05$). The difference was not statistically significant ($p>0.05$) for other metrics. Ferritin levels are considerably higher in co-

morbid people, but MCV levels are much higher in those without comorbidity (Table 4).

There was a statistically significant difference between EX patients and those without extra illness in terms of urea, creatinine, INR, potassium, RDW, and urea/albumin values (p <0.05). In other measurements (p >0.05), the difference was not significant. While measures of urea, creatinine, potassium, RDW, and urea/albumin are greater in individuals with comorbidity, INR readings are higher in those without.

Lymphocyte/monocyte, RDW, monocyte/albumin, procalcitonin/albumin, CRP/albumin, LDH/albumin, and ürea/albumin measures all vary statistically significantly in predicting patients' EX status (p <0.05). PCT/PLT values were not significant (p>0.05) for MPV/PLT. Procalcitonin/albumin, CRP/albumin, and LDH/albumin ratios, in particular, are quite useful for determining EX status (Table 5).

The table summarizes the estimation and detection probability for the ratios with a significant predictive level for the EX status based on the cut-off values. Monocytes/albumin, procalcitonin/albumin, and LDH/albumin are the best predictors of patients with EX. Procalcitonin/albumin, CRP/albumin, LDH/albumin, and ürea/albumin are the ratios that most accurately predict the EX status of patients who test positive at the specified cut-off value. The EX status of the patients had a statistically significant association with the lymphocyte/monocyte, RDW, monocyte/albumin, procalcitonin/albumin, CRP/albumin, LDH/albumin, and ürea/albumin groups (p <0.05). The majority of individuals with positive lymphocyte/monocyte, RDW, monocyte/albumin, procalcitonin/albumin, CRP/albumin, LDH/albumin, or ürea/albumin ratios (equal to or more than the cut-off value) are EX patients (Figure 2,3,4). There was a statistically significant difference in the lymphocyte/monocyte, RDW, monocyte/albumin, procalcitonin/albumin, CRP/albumin, LDH/albumin, and ürea/albumin cut-off values (p<0.05). According to the cut-off values, patients with positive lymphocyte/monocyte, RDW, monocyte/albumin, procalcitonin/albumin, CRP/albumin, LDH/albumin, or ürea/albumin ratio readings had a longer hospital stay (Table 6).

Table 1: The Relationship between Demographic Characteristics and Exitus Status

		Discharge	Exitus	X^2	p
Senility	Under 65	19 (21,1)	28 (31,1)	1,843	**0,175**
	Upper 65	71 (78,9)	62 (68,9)		
Gender	Female	54 (60)	35 (38,9)	8,023	**0,005***
	Male	36 (40)	55 (61,1)		
Application complaint	Fever	21 (23,3)	30 (33,3)	45,550	**0,000***
	Cough	28 (31,1)	23 (25,6)		
	Dyspne	7 (7,8)	33 (36,7)		
	GCD	10 (11,1)	4 (4,4)		
	Diğer	24 (26,7)	0 (0)		
Comorbidity	None	17 (18,9)	27 (30)	2,436	**0,119**
	Positive	73 (81,1)	63 (70)		
Comorbidity	HT	38 (52,1)	44 (69,8)	1,138	**0,286**
	CAD	5 (6,8)	3 (4,8)		
	HL	1 (1,4)	0 (0)		
	DM	18 (24,7)	10 (15,9)		
	Other	11 (15,1)	6 (9,5)		

*p<0.05 significant relationship, p>0.05 no significant relationship; Chi-square,
GCD: General Condition Disorder, HT: Hypertension, CAD: Coronary Artery Disease HL: Hyperlipidemia, DM: Diabetes Mellitus

Tablo 2: Comparison of Measurements by EX Condition

	Discharge		EX		U/t	p
	Max-Min(M)	Median±SD	Max-Min(M)	Median±SD		
Age	94-38 (76)	72,91±12,26	92-29 (73)	70,13±13,45	3574,5	**0,173**
Duration of Hospitalization	14-4 (7)	7,18±2,24	30-5 (11)	12,93±6,5	1554,5	**0,000***
PLT	347-73 (167)	171,94±54,64	597-51 (189,5)	199,91±82,28	3277,0	**0,027***
MPV(t)	12,3-6,9 (10)	10,09±1,07	12,5-7,2 (10,1)	10,21±1,04	-0,767	**0,444**
PCT	0,5-0,08 (0,1845)	0,2±0,09	0,52-0,06 (0,19)	0,2±0,07	3793,5	**0,463**
MCV	106,6-70,8 (87,15)	86,96±5,36	109,2-66,2 (90,45)	89,54±7,29	2983,0	**0,002***
CRP	245,5-2 (14,5)	31,68±39,64	350-10,4 (123,5)	121,45±71,26	891,5	**0,000***
Urea	97,7-20,7 (38,7)	42,53±17,31	176-14 (44,5)	55,61±35,69	3494,0	**0,112**
Albumin	51-35 (42)	42,1±3,32	39-16 (29)	29,53±4,34	73,5	**0,000***
Lymphocyte	2,9-0,4 (1,1)	1,18±0,52	2,64-0,21 (0,83)	0,89±0,41	2566,5	**0,000***
Monocyte	0,8-0,07 (0,3)	0,33±0,18	1,19-0,1 (0,37)	0,4±0,2	3124,5	**0,008***
Creatinine	2,1-0,6 (0,9)	1,03±0,35	5,83-0,55 (1,08)	1,3±0,91	3381,0	**0,055**
HGB(t)	17,3-9,3 (13)	13,01±1,7	17,4-9,1 (13,05)	13,06±1,83	-0,182	**0,856**
AST	66-14 (25)	28,3±11,28	135-4 (40)	46,17±26,62	2091,0	**0,000***
ALT	88-6 (17)	21,17±13,17	95-6 (27)	31,46±19,81	2506,0	**0,000***
LDH	472-136 (233,5)	257,74±82,26	971-140 (417,5)	445,87±204,76	1615,5	**0,000***
Ferritin	742,9-15,8 (107,95)	167,44±172,68	2000-21 (588)	756,87±575,46	998,0	**0,000***
INR	1,65-0,78 (1,05)	1,08±0,18	1,64-0,91 (1,2)	1,21±0,15	2158,5	**0,000***
Calcium	9,7-7 (8,6)	8,58±0,55	11-4,84 (8,72)	8,74±0,7	3464,0	**0,093**
Potassium	5,5-3,1 (4,2)	4,27±0,53	6,21-2,77 (4,15)	4,32±0,7	4027,0	**0,948**
Sodium	142-121 (137)	136,19±3,26	151-121 (137)	136,38±5,18	3988,0	**0,859**
Procalcitonin	0,2-0,01 (0,05)	0,06±0,04	5,53-0,02 (0,19)	0,63±1,09	909,0	**0,000***
Troponin	0,33-0 (0,007)	0,02±0,04	0,6-0,1 (0,1)	0,13±0,09	309,0	**0,000***
WBC	9,6-2,6 (5)	5,12±1,56	30,8-3,48 (7,78)	9,04±4,77	1521,0	**0,000***

*p<0.05 significant difference, p>0.05 no significant difference; Mann Whitney/t
Platalet; PLT, Plateletcrit; PCT; Mean Palatelet Volüm; MPV, Mean Corpusclar Volum; MCV, C-Reactive Protein; CRP, Hemoglobin; HGB, aspartate aminotransferase; AST, alaninaminotransferase; ALT, lactate dehydrogenase; LDH, Internalization Ratio: INR, White Blood Cell; WBC

Table 3: Comparison of Proportion Measurements by EX Condition

	Discharge		EX		U/t	p
	Max-Min(M)	Median±SD	Max-Min(M)	Median±SD		
RDW	17,7-12,2 (13,4)	13,64±1,08	22-12,4 (13,95)	14,43±1,71	2748,0	**0,000***
PCT/PLT	0,0031-0,0006 (0,001)	0,0012±0,0005	0,0013-0,0007 (0,001)	0,001±0,0001	3361,0	**0,000***
MPV/PLT	0,16-0,03 (0,06)	0,07±0,02	0,22-0,01 (0,06)	0,06±0,03	3383,5	**0,049***
Lymphocyte/Monocyte	18,06-0,63 (3,67)	4,3±2,54	7,6-0,34 (2,26)	2,69±1,65	2100,5	**0,057**
Monocyte /Albumin	0,02-0,0016 (0,0068)	0,0079±0,0042	0,0519-0,0026 (0,0127)	0,014±0,0078	1806,0	**0,000***
Procalcitonin/Albumin	0,0057-0,0002 (0,0013)	0,0014±0,001	0,2096-0,0006 (0,0067)	0,0222±0,0392	570,0	**0,000***
CRP/Albumin	5,71-0,04 (0,33)	0,77±0,96	16,69-0,27 (3,97)	4,39±3,05	669,0	**0,000***
LDH/Albumin	10,83-3,04 (5,84)	6,17±2,07	41,83-4,24 (14,06)	15,76±8,32	746,5	**0,000***
Urea/Albumin	2,78-0,41 (0,95)	1,03±0,47	6,56-0,37 (1,48)	1,96±1,38	2132,0	**0,000***

*p<0.05 significant difference, p>0.05 no significant difference; Mann Whitney

Table 4: Comparison of Measurements by Age in the Discharged Group

Discharge	Under 65		Upper 65		U/t	p
	Max-Min(M)	Median±SD	Max-Min(M)	Median±SD		
Duration of hospitalization	14-5 (6)	6,63±2,03	14-4 (7)	7,32±2,29	522,0	**0,124**
PLT	310-122 (178)	187,53±62,86	347-73 (164)	167,77±51,92	587,0	**0,387**
PCT	0,31-0,1 (0,2)	0,18±0,06	0,5-0,08 (0,18)	0,2±0,09	657,0	**0,863**
MPV(t)	11,5-7,8 (10,1)	9,87±1,08	12,3-6,9 (10)	10,15±1,07	-1,001	**0,325**
MCV	92,1-75,2 (85,2)	84,66±4,24	106,6-70,8 (87,5)	87,57±5,49	432,0	**0,016***
CRP	44,5-2 (6,3)	12,79±13,49	245,5-2 (21,2)	36,73±42,76	426,0	**0,014***
Üre	57,8-20,7 (27,5)	29,92±8,84	97,7-21,6 (41,8)	45,91±17,5	230,5	**0,000***
Albumin	51-39 (44)	44,16±3,42	48-35 (41)	41,55±3,08	406,0	**0,008***
Lymphocyte	2,6-0,6 (1,2)	1,29±0,6	2,9-0,4 (1,1)	1,15±0,5	600,5	**0,463**
Monocyte	0,7-0,1 (0,3)	0,35±0,18	0,8-0,07 (0,3)	0,33±0,17	623,5	**0,609**
Creatinine	1,3-0,6 (0,8)	0,81±0,17	2,1-0,6 (1)	1,09±0,36	311,5	**0,000***
HGB(t)	16,7-9,4 (13)	13,04±1,64	17,3-9,3 (13)	13,01±1,72	0,068	**0,946**
AST	61-17 (24)	26,37±10,23	66-14 (25)	28,82±11,56	582,0	**0,360**
ALT	88-11 (22)	25,47±16,87	58-6 (16)	20,01±11,88	470,0	**0,043***
LDH	472-141 (231)	259,16±97,07	468-136 (234)	257,37±78,62	646,0	**0,778**
Ferritin	345,2-15,8 (54,8)	79,08±78,92	742,9-16 (140,2)	191,09±183,37	331,0	**0,001***
INR	1,21-0,87 (0,96)	1±0,11	1,65-0,78 (1,06)	1,11±0,18	434,5	**0,018***
Calcium	9,2-7,7 (8,7)	8,62±0,43	9,7-7 (8,6)	8,57±0,58	645,0	**0,770**
Potassium	4,9-3,1 (4,1)	4,06±0,41	5,5-3,3 (4,3)	4,32±0,55	500,5	**0,085**
Sodium	139-133 (136)	136,11±2,13	142-121 (137)	136,21±3,51	626,0	**0,629**
Procalcitonin	0,14-0,01 (0,04)	0,04±0,03	0,2-0,01 (0,05)	0,06±0,04	469,5	**0,041***
Troponin	0,06-0 (0)	0±0,01	0,33-0 (0,01)	0,02±0,04	282,5	**0,000***
WBC	8,9-2,7 (4,7)	5,08±1,82	9,6-2,6 (5,1)	5,13±1,5	646,5	**0,782**
RDW	17,2-12,2 (13)	13,48±1,25	17,7-12,2 (13,5)	13,69±1,03	514,5	**0,113**
PCT/PLT	0,0011-0,0008 (0,001)	0,001±0,0001	0,0031-0,0006 (0,001)	0,0012±0,0005	486,0	**0,062**
MPV/PLT	0,0839-0,0269 (0,0614)	0,0587±0,0202	0,1557-0,0265 (0,0616)	0,0674±0,0258	568,0	**0,292**
Lymphocyte / Monocyte	9-1,33 (3,8)	4,21±1,89	18,06-0,63 (3,67)	4,32±2,69	634,0	**0,689**
Monocyte /Albumin	0,0175-0,0023 (0,0067)	0,008±0,0041	0,02-0,0016 (0,007)	0,0079±0,0042	671,5	**0,976**
Procalcitonin /Albumin	0,0034-0,0002 (0,0008)	0,001±0,0008	0,0057-0,0002 (0,0013)	0,0016±0,0011	446,0	**0,024***
CRP/Albumin	1,14-0,04 (0,15)	0,3±0,34	5,71-0,04 (0,53)	0,9±1,04	405,5	**0,008***
LDH/Albumin	10,81-3,08 (5,63)	5,89±2,22	10,83-3,04 (5,84)	6,25±2,04	590,5	**0,406**
Urea/Albumin	1,2-0,41 (0,63)	0,68±0,21	2,78-0,48 (1,01)	1,12±0,48	219,0	**0,000***

*p<0.05 significant difference, p>0.05 no significant difference; Mann Whitney/t

Table 5: ROC Analysis of Measurements Determined for EX Condition				
Measurements	**Range**	**p**	**95% CI**	
			lower	**upper**
PCT/PLT	0,575	**0,051**	0,502	0,678
MPV/PLT	0,582	**0,057**	0,499	0,666
Lymphocyte / Monocyte	0,740	**0,000***	0,667	0,813
RDW	0,661	**0,000***	0,582	0,740
Monocyte /Albumin	0,777	**0,000***	0,710	0,844
Procalcitonin /Albumin	0,930	**0,000***	0,891	0,968
CRP/Albumin	0,917	**0,000***	0,879	0,955
LDH/Albumin	0,908	**0,000***	0,865	0,951
Urea/Albumin	0,737	**0,000***	0,665	0,809
*p<0,05 significant difference, p>0,05 no significant difference; ROC				

Table 6: Cutoffs and Estimation Probabilities of Measurements Determined for Case EX					
Mesurements	**Cut off**	**Sensitivity**	**Specificity**	**PP+**	**PP-**
Lymphocyte / Monocyte	2,9848	0,711	0,700	0,703	0,708
RDW	13,85	0,556	0,710	0,658	0,615
Monocyte /Albumin	0,0077	0,833	0,622	0,682	0,786
Procalcitonin/Albumin	0,0025	0,878	0,889	0,888	0,879
CRP/Albumin	2,1189	0,767	0,900	0,885	0,880
LDH/Albumin	7,5874	0,878	0,800	0,859	0,867
Urea/Albumin	1,5638	0,489	0,911	0,846	0,641

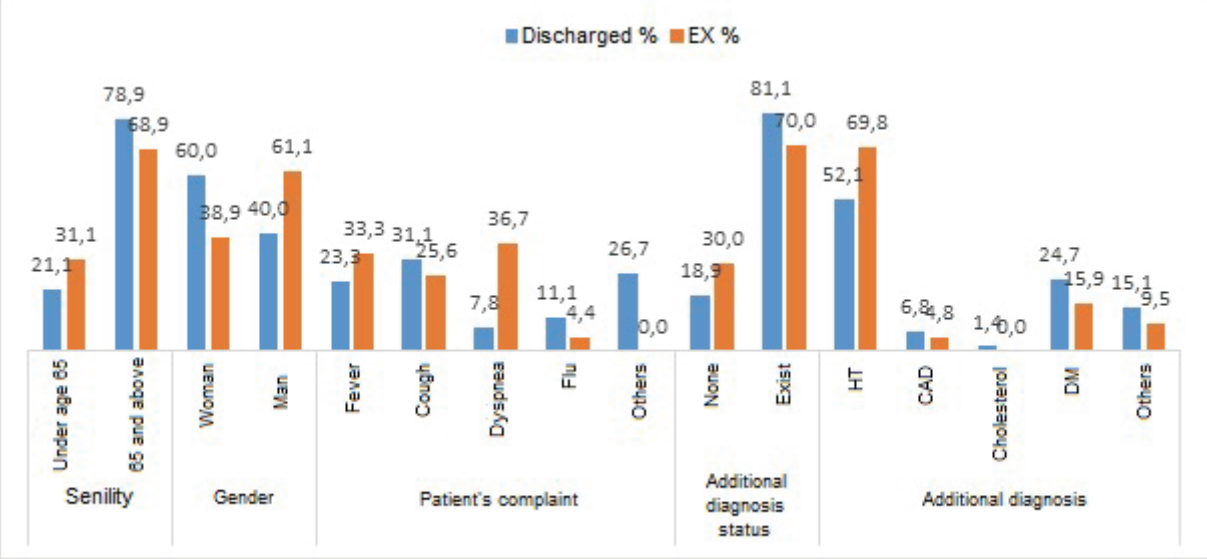

Figure 1: Complaints of COVID-19 patients discharged and exitus at the time of admission

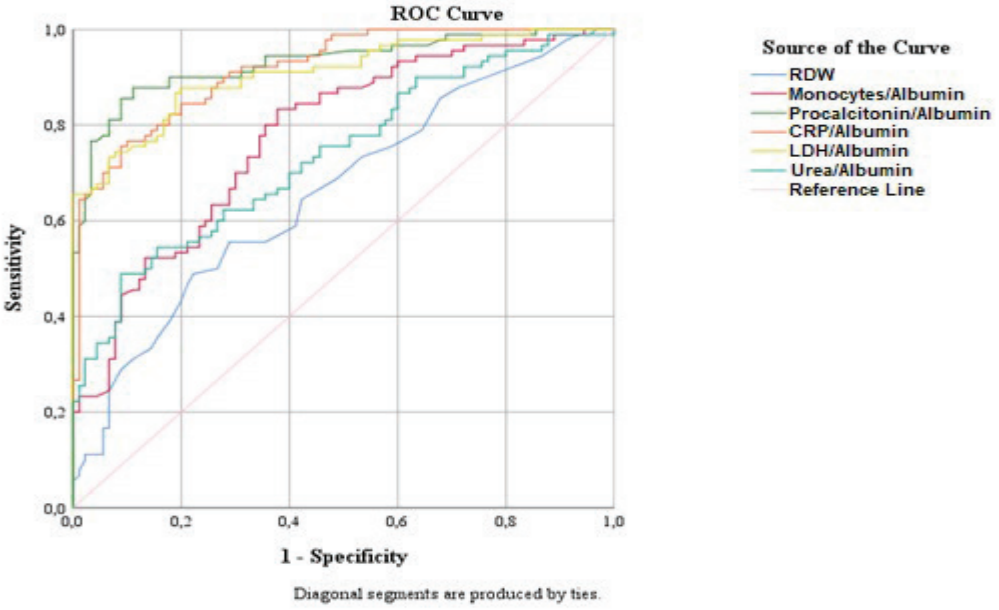

Figure 2: Hematological and biochemical blood parameters (equal to or more than the cut-off value) of COVID-19 patients who were discharged and died

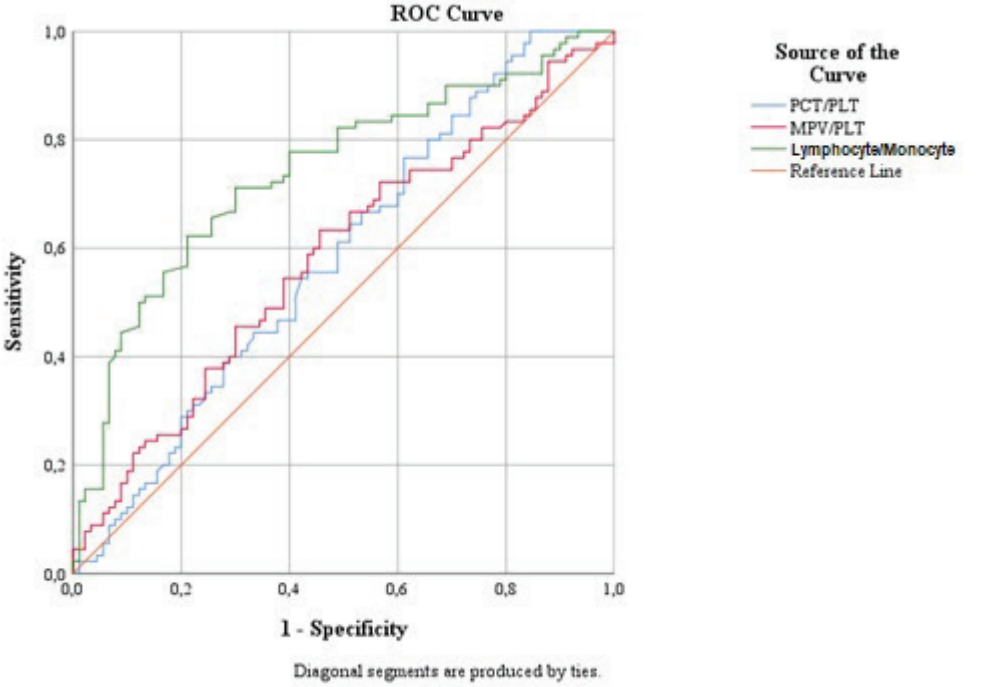

Figure 3: Hematological and biochemical blood parameters (equal to or more than the cut-off value) of COVID-19 patients who were discharged and died

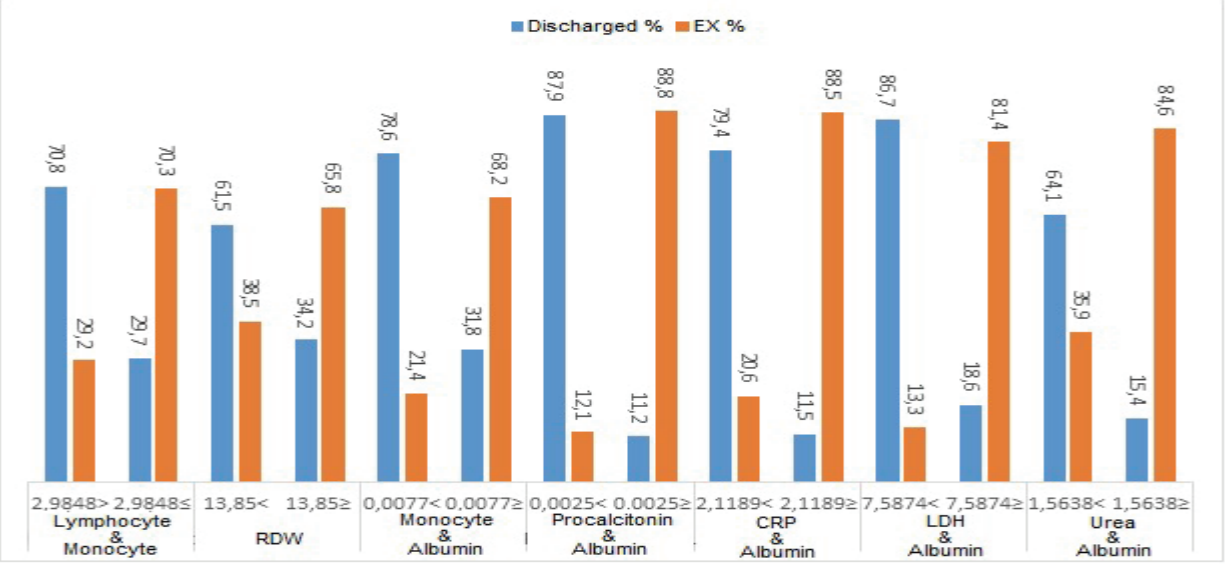

Figure 4: Hematological and biochemical blood parameters of COVID-19 patients who were discharged and died

DISCUSSION

The purpose of this study was to determine the efficacy of using hematological and biochemical markers as an early predictor of prognosis in individuals diagnosed with COVID-19. When our findings were compared to the existing literature, it was discovered that the majority of patients who died in a similar manner were male (61.1 %). Thus, we have proven that mortality may be reduced by predicting and changing treatment choices early in the disease's progression. Males and females have the same incidence of SARS-CoV-2 infection, while men with COVID-19 have a more severe disease course and a greater mortality rate, regardless of their age[11-13].

The infection's clinical course is quite varied, with fever, coughing, and malaise being the most prevalent symptoms[14]. Guan and et al. in a series of 1099 instances, it was revealed that the most often encountered symptoms were fever (88.7 %) and cough (67.8 %)[15]. Another clinical trial done in Spain discovered that the onset of dyspnea indicated a more severe clinical course for the illness[16]. According to the literature, the most common symptoms of patients released in excellent health were cough and fever. In a French observational research, it was shown that patients admitted to the critical care unit had much longer hospital stays than those admitted to the general service[17]. Our investigation yielded comparable findings to those seen in the literature. In our study, individuals who died of COVID-19 infection required a longer inpatient stay than those who recovered. PLT, MCV, CRP, monocytes, AST, ALT, LDH, ferritin, INR, procalcitonin, troponin, and WBC levels were found to be significantly higher in patients who died in line with the literature at the time of admission.

COVID-19; It can cause thrombosis in both venous and arterial systems with the effect of increased inflammation, platelet activation, endothelial dysfunction and stasis in blood flow. This condition, which has started to be named as COVID-19-associated coagulopathy, is thought to be related to the severity of the disease, the pathogenesis is not yet known, but it occurs as a result of the "thrombo-inflammation" picture. This picture becomes evident with coagulopathy, increased D-dimer and fibrinogen levels, minimal change in prothrombin time (PZ), activated partial thromboplastin time (aPTZ), and platelet count. High D-dimer level at admission is associated with increased mortality. The continuation of D-dimer increase after hospitalization is a harbinger of multiorgan failure and intra-

vascular coagulation. Bleeding findings are not common despite coagulopathy . In our study, it was determined that there was a statistically significant difference between the INR levels of ex and surviving COVID-19 patients.

As with inflammatory disorders, increased capillary permeability caused by systemic infection results in albumin leakage into the interstitial space, resulting in hypoalbuminemia[18]. The monocyte albumin ratio has been proven to be a reliable predictor of long-term mortality in patients receiving percutaneous coronary intervention[19]. This rate was substantially higher in patients than previously reported in the literature in our research. Hypoalbuminemia is implicated in the mortality of COVID-19 infected patients with cardiac complications.

Procalcitonin/albumin ratio is a marker for urosepsis in urinary tract infection. Simultaneously, there is evidence that a high procalcitonin/albumin ratio may be a predictor of the development of septic shock, particularly in severe septic shock patients after infection[20]. Our investigation found that patients with a high procalcitonin/albumin ratio had a higher death rate, which was consistent with previous research. These investigations shown that procalcitonin/albumin ratios may be a biomarker for early septic shock development in COVID-19 infection.

CRP concentrations more than 130 mg/l have been linked to an increased risk of death. Simultaneously, it was discovered that the CRP/albumin ratio was considerably greater in individuals with severe disease and those who died than in those with moderate disease in COVID-19 infections[21]. The CRP/albumin ratio was substantially greater in individuals who died according to the literature in our research. The study's limitations include the following: data were gathered from a single clinical research facility, not from many clinical research centers. The findings of this study may differ from those of other scientists in the United States and overseas and should be further explored in clinical situations.

CONCLUSION

According to our research, males are more likely to mortal from COVID-19 disease.

- The disease manifests initially as mild thrombocytopenia and lymphopenia.
- D-Dimer and INR levels are elevated in fatal cases, suggesting that coagulopathy is present.
- Ferritin, RDW, monocyte/albumin ratio, procalcitonin/albumin ratio, BUN/albumin ratio, CRP/albumin ratio, and LDH/albumin ratio all indicate that hypoalbuminemia is a prognostic factor for the disease.
- Comorbid conditions have a significant impact on disease prognosis.

Ethics Approval

The study protocol was approved by the Ethics Committee of Samsun Research and Treatment Hospital and was conducted in accordance with the principles of the Declaration of Helsinki (no:GOKA/2021/9/7)

Conflict of Interest

The authors have no conflicts of interest relevant to this article.

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Author contributions

HE: Contributed to the conception of the work, conducting the study, revising the draft, approval of the final version of the manuscript, and agreed for all aspects of the work. IH: Contributed to the collecting data of the work. ZE: Contributed to the collecting data of the work. SA: Contributed to the collecting data of the work. MU: Contributed to the collecting data of the work. CK: Contributed to the conception of the work, revising the draft, approval of the final version of the manuscript, and agreed for all aspects of the work. GK: Contributed to the collecting data of the work

References

1. Mackenzie JS, Smith DW. COVID-19: a novel zoonotic disease caused by a coronavirus from China: what we know and what we don't. Microbiol Aust. 2020 Mar 17:MA20013. doi: 10.1071/MA20013
2. Oladejo BO, Adeboboye CF, Adebolu TT. Understanding the genetic determinant of severity in viral diseases: a case of SARS-Cov-2 infection. Egypt J Med Hum Genet. 2020;21(1):77. doi: 10.1186/s43042-020-00122-z.
3. Driggin E, Madhavan MV, Bikdeli B. et al. Cardiovascular Considerations for Patients, Health Care Workers, and Health Systems During the COVID-19 Pandemic. J Am Coll Cardiol. 2020 May 12;75(18):2352-2371. doi: 10.1016/j.jacc.2020.03.031.
4. Mehta P, McAuley DF, Brown M. et al. COVID-19: consider cytokine storm syndromes and immunosuppression. Lancet. 2020 Mar 28;395(10229):1033-1034. doi: 10.1016/S0140-6736(20)30628-0.
5. Guan WJ, Ni ZY, Hu Y. et al; China Medical Treatment Expert Group for Covid-19. Clinical Characteristics of Coronavirus Disease 2019 in China. N Engl J Med. 2020 Apr 30;382(18):1708-1720. doi: 10.1056/NEJMoa2002032.
6. Ruan Q, Yang K, Wang W. et al. Clinical predictors of mortality due to COVID-19 based on an analysis of data of 150 patients from Wuhan, China. Intensive Care Med. 2020 May;46(5):846-848. doi: 10.1007/s00134-020-05991-x.
7. Wang F, Nie J, Wang H et al. Characteristics of Peripheral Lymphocyte Subset Alteration in COVID-19 Pneumonia. J Infect Dis. 2020 May 11;221(11):1762-1769. doi: 10.1093/infdis/jiaa150.
8. Sun S, Cai X, Wang H. et al. Abnormalities of peripheral blood system in patients with COVID-19 in Wenzhou, China. Clin Chim Acta. 2020 Aug;507:174-180. doi: 10.1016/j.cca.2020.04.024.
9. Chen N, Zhou M, Dong X. et al. Epidemiological and clinical characteristics of 99 cases of 2019 novel coronavirus pneumonia in Wuhan, China: a descriptive study. Lancet. 2020 Feb 15;395(10223):507-513. doi: 10.1016/S0140-6736(20)30211-7
10. World Health Organization. (2020). Clinical management of COVID-19: interim guidance, 27 May 2020. World Health Organization. https://apps.who.int/iris/handle/10665/332196.
11. Zhang JJ, Dong X, Cao YY. et al. Clinical characteristics of 140 patients infected with SARS-CoV-2 in Wuhan, China. Allergy. 2020 Jul;75(7):1730-1741. doi: 10.1111/all.14238.
12. Li Q, Guan X, Wu P. et al. Early Transmission Dynamics in Wuhan, China, of Novel Coronavirus-Infected Pneumonia. The New England journal of medicine. 2020;382(13):1199-207.
13. Jin JM, Bai P, He W. et al. Gender Differences in Patients With COVID-19: Focus on Severity and Mortality. Front Public Health. 2020 Apr 29;8:152. doi: 10.3389/fpubh.2020.00152.
14. Lovato A, de Filippis C. Clinical Presentation of COVID-19: A Systematic Review Focusing on Upper Airway Symptoms. Ear Nose Throat J. 2020 Nov;99(9):569-576. doi: 10.1177/0145561320920762.
15. Guan WJ, Ni ZY, Hu Y. et al. China Medical Treatment Expert Group for Covid-19. Clinical Characteristics of Coronavirus Disease 2019 in China. N Engl J Med. 2020 Apr 30;382(18):1708-1720. doi: 10.1056/NEJMoa2002032.
16. Rodríguez-Molinero A, Gálvez-Barrón C, Miñarro A. et al; COVID-19 Research Group of CSAPG. Association between COVID-19 prognosis and disease presentation, comorbidities and chronic treatment of hospitalized patients. 2020 Oct 15;15(10):e0239571. doi: 10.1371/journal.pone.0239571.
17. Boëlle PY, Delory T, Maynadier X. et al. Trajectories of Hospitalization in COVID-19 Patients: An Observational Study in France. J Clin Med. 2020 Sep 29;9(10):3148. doi: 10.3390/jcm9103148.
18. Soeters PB, Wolfe RR, Shenkin A. Hypoalbuminemia: Pathogenesis and Clinical Significance. JPEN J Parenter Enteral Nutr. 2019 Feb;43(2):181-193. doi: 10.1002/jpen.1451.
19. Zhang ZL, Guo QQ, Tang JN. et al. Monocyte-to-albumin ratio as a novel predictor of long-term adverse outcomes in patients after percutaneous coronary intervention. Biosci Rep. 2021 Jul 30;41(7):BSR20210154. doi: 10.1042/BSR20210154.
20. Luo X, Yang X, Li J. et al. The procalcitonin/albumin ratio as an early diagnostic predictor in discriminating urosepsis from patients with febrile urinary tract infection. Medicine (Baltimore). 2018 Jul;97(28):e11078. doi: 10.1097/MD.0000000000011078.
21. Gemcioglu E, Davutoglu M, Catalbas R. et al. Predictive values of biochemical markers as early indicators for severe COVID-19 cases in admission. Future Virology. 2021;16(5):353-67. doi.org/10.2217/fvl-2020-0319