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Original Research

Morbidity and mortality results of COVID-19 variant in COVID-19 positive patients treated in the intensive care unit

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Abstract
Aim: COVID-19 has the potential to affect many systems and organs, resulting in serious clinical symptoms that necessitate admission to the intensive care unit. The purpose of this study was to examine the relationship between CAR, other laboratory findings, comorbidities, and mortality in patients infected with the original SARSCoV-2 or other variants.
Materials and Methods: The data of 368 patients admitted to the intensive care unit with COVID-19 pneumonia between March 2020 and July 2021 were analyzed. These patients were divided into two groups. The first group included [(OC) Original SARSCoV-2] COVID-19 infected patients in the first period of the pandemic. The second group [(OV) Other Variants] included patients with COVID-19 infection due to other variants.
Results: The mean age (Mean±SD) in the OC group was 69.79±11.77 years. The mean age of the patients in OC was higher than in the OV group (p=0.001). The most common comorbid disease in both groups was Hypertension (54.1%, 48.8%), followed by diabetes mellitus (DM) (30.2%, 31.6%). The mean age of the survivors in the OC and OV groups was lower (64.53±13.04, 57.85±16.78, p=0.001, p=0.001, respectively). It was observed that albumin and lymphocyte counts were lower in the deceased, while LDH, CRP, Neutrophil, procalcitonin, NLR and CAR were higher (p<0.05).
Discussion: In critically ill COVID-19 patients, high CAR and NLR are good predictors of mortality. In the period when the variants were dominant, the mean age of the patients and the length of stay in the intensive care unit were lower.

Keywords
COVID-19, Variant, CAR, NLR

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Introduction

COVID-19 may affect many systems and organs, leading to the emergence of serious clinical symptoms that require admission to the intensive care unit (ICU). The progression of these symptoms may result in acute respiratory distress syndrome (ARDS), multi-organ failure, and shock, which causes an increased risk of mortality [1]. Many risk factors for mortality and severity of clinical symptoms have been demonstrated. Some of these risk factors are age, gender, underlying diseases and genetic factors [2,3].

According to reports, 14% of COVID-19-infected individuals had a severe clinical course, and 5% of all cases were critically ill patients who were received to an intensive care unit [3,4]. The worldwide case mortality rate of COVID-19 is about 1.2% [5]. With the mutations that occurred in the form of the RNA virus SARS-CoV-2, which became dominant in 2020, new variants emerged. In late 2020, alpha, beta, and gamma variants appeared. The delta (B.1.617.2) variant, which emerged in the summer of 2021, became more dominant globally. The resulting variants generally had increased infectivity and were noted to show greater antibody escape [6,7]. Our aim in this study is to examine the clinical course of patients infected with the original SARS-CoV-2 or other variants after admission to the intensive care unit. In addition, it is to examine the Neutrophil/Lymphocyte ratio (NLR), CRP/Albumin ratio (CAR), other laboratory findings, and comorbidities in predicting the risk of mortality.

Material and Methods

Our study was carried out in the 3rd level COVID-19 Intensive Care Unit of Malatya Training and Research Hospital. This study was approved by the Clinical Ethics Committee of Malatya Turgut Ozal University School of Medicine (protocol code: 2021/109). The study was carried out in in line with the Helsinki declaration. The files of 368 patients among the patients hospitalized in the intensive care unit due to COVID-19 pneumonia between March 2020 and July 2021 were scanned. These patients were divided into two groups. The first group [(OC) Original SARSCoV-2] included patients infected with COVID-19 in the first period of the pandemic. The second group [(OV) Other Variants] included patients with COVID-19 infection due to other variants that became dominant due to mutations as of 2021.

Inclusion criteria of the present study includes patients with >18 age years old, confirmed COVID-19 pneumonia patients. Exclusion criteria of the present study includes patients with malignancy, patients with <18 age years old, pregnant patients, suspected COVID-19 patients, non COVID-19 patients.

The following data were collected and analyzed: patients demographic and clinical data, mortality, laboratory findings. All patients was followed up during their ICU stay or until the death in the ICU. Mortality and other data was obtained from the hospital electronical medical record system and patient files.

Statistical anaylsis

The compatibility of the parameters to the normal distribution was evaluated by Kolmogorov-Smirnov and Shapiro Wilks tests. Normal and homogeneously distributed variables are given as mean value±standard deviation, data that does not show normal and homogeneous distribution are given as median (min-max) values, categorical variables are given as numbers and percentages. Student's t test was used for normally distributed parameters and Mann Whitney U test was used for non-normally distributed data. Chi-square test test were used to compare qualitative data. Significance was evaluated at the p<0.05 level. For statistical analysis, 22 package programs of SPSS (Statistical Package for Social Sciences; SPSS Inc., Chicago) were used.

Ethical Approval

Ethics Committee approval for the study was obtained.

Results

A total of 368 critically ill COVID-19 pneumonia patients were admitted to COVID-19 ICU. The mean age (Mean±SD) in the OC group was 69.79±11.77 years. The mean age of the patients in OC was higher than in the OV group (p=0.001). 59.8% (n=220) of the cases included in the study were male. Gender distribution was similar in both groups. The most common comorbid disease in both groups was Hypertension (54.1%, 48.8%), followed by diabetes mellitus (DM) (30.2%, 31.6%). Mortality rates were not statistically significant (OC: 71.7%, OV: 64.6%, p=0.149) (Table 1). In the distribution of comorbidities, obesity, neurological diseases, chronic obstructive pulmonary disease (COPD) and obstructive sleep apnea syndrome (OSAS) were observed at a higher rate in the OC group (p<0.05) (Table 1). The length of stay (LOS) in the intensive care unit was higher in the OC group (median:10, p=0.048) (Table 1).

Table 1. Comparison of the groups in terms of sociodemographic characteristics and chronic diseases.

		OC (n=159)	OV (n=209)	p
Age (Mean±SD)		69,79±11,77	63,96±15,48	[1]0,001*
Gender, n (%)	Male	100 (%62,9)	120 (%57,4)	[2]0,289
	Female	59 (%37,1)	89 (%42,6)	
Mortality, n (%)	Survivors	45 (%28,3)	74 (%35,4)	[2]0,149
	Nonsurvivors	114 (%71,7)	135 (%64,6)	
Chronic Diseases, n (%)	CHF	39 (%24,5)	37 (%17,7)	[2]0,109
	Neurological diseases	15 (%9,4)	8 (%3,8)	[3]0,047*
	Asthma	10 (%6,3)	23 (%11)	[3]0,166
	COPD	43 (%27)	25 (%12)	[2]0,000*
	Diabetes Mellitus	48 (%30,2)	66 (%31,6)	[2]0,775
	CAD	39 (%24,5)	47 (%22,5)	[2]0,647
	Hypertension	86 (%54,1)	102 (%48,8)	[2]0,315
	Stroke	8 (%5)	11 (%5,3)	[3]1,000
	ARF	26 (%16,4)	39 (%18,7)	[2]0,565
	Others	2 (%1,3)	0 (%0)	[4]0,186
	Obesity	29 (%18,2)	20 (%9,6)	[3]0,023*
	OSAS	29 (%18,2)	18 (%8,6)	[3]0,018*
	CKD	8 (%5)	8 (%3,8)	[3]0,762
Length of stay in hospital (days)	Mean±SD (median)	20,42±14,34 (18)	18,98±13,63 (16)	[5]0,354
ICU length of stay (days)	Mean±SD (median)	13,14±13,78 (10)	9,78±9,80 (7)	[5]0,048*

[1] Student t test; [2] Ki-kare test; [3] Continuity (yates) düzeltmesi; [4] Fisher's Exact test; [5] Mann Whitney U Test; *p<0.05 ICU: intensive care unit; LOS: length of stay; CHF: chronic heart failure; CKD: chronic kidney disease; CVD: cerebrovascular disease; ARF: Acute kidney failure; DM: diabetes mellitus; CAD: coronary artery disease; COPD: chronic obstructive pulmonary disease; OSAS : Obstructive Sleep Apnea Syndrome; Me: mean; SD: standard derivation

Table 2. Evaluation of the groups in terms of laboratory parameters and age-mortality. Age-mortality relationship of the patients in the OC and OV groups..

	OC (n=159)	OV (n=209)	p
	Mean±SD (median)	Mean±SD (median)	
Ferritin	922,58±653,91 (780,7)	850,59±648,6 (669,8)	0,263
D-dimer	2,94±5,63 (1,16)	3,96±5,33 (1,83)	0,001*
Wbc (10^3/µL)	13,34±10,83 (10,7)	17,61±63,37 (11,9)	0,247
Neu. (10^3/µL)	11,2±6,51 (9,53)	11,56±6,14 (10,56)	0,347
Lymph (10^3/µL)	1,05±1,31 (0,7)	0,9±0,78 (0,69)	0,777
Albumin	2,76±0,52 (2,8)	2,61±0,57 (2,5)	0,001*
Urea (mg/dL)	80,73±61,08 (62)	81,06±60,59 (64)	0,937
Crea (mg/dL)	1,43±1,42 (0,93)	1,41±1,46 (0,8)	0,094
LDH (U/L)	648,45±543,72 (537)	595,67±348,67 (513)	0,371
CRP (mg/dL)	12,41±8,49 (12)	9,06±7,77 (8,39)	0,000*
NLR	19,95±22,1 (13,63)	22,73±27,64 (16,01)	0,425
CAR	4,68±3,4 (4,26)	3,84±3,89 (3,09)	0,002*
Groups	**Survivors (n=119)**	**Nonsurvivors (n=249)**	**p**
OC, Age, Mean±SD	64,53±13,04	71,87±10,59	0,001*
OV, Age, Mean±SD	57,85±16,78	67,31±13,65	0,001*

[1]Student t test, *p<0.05, Mann Whitney U Test; +Student t test; *p<0.05; Wbc: white blood cell; Crea: creatinine; Neu: neutrophils, lymph: lymphocytes, LDH: lactate dehydrogenase, CRP: C-reactive protein; CAR: CRP/Albumin ratio; NLR; Nötrofil7lenfosit oranı

Table 3. Evaluation of laboratory parameters of groups according to mortality.

	Survivors (n=119)	Nonsurvivors (n=249)	p
OC	**Mean±SD (median)**	**Mean±SD (median)**	
Ferritin	785,43±604,26 (657,65)	978,5±667,84 (809,4)	0,116
D-dimer	2,4±4,96 (1,11)	3,17±5,89 (1,18)	0,369
Neu. (10^3/µl)	9,22±4,46 (7,88)	11,96±7,01 (10,61)	0,026*
Lymph (10^3/µl)	1,38±1,21 (0,85)	0,93±1,33 (0,63)	0,001*
Albumin	2,91±0,63 (2,8)	2,71±0,46 (2,7)	0,094
AST (u/l)	47,27±74,12 (32)	157,99±547,63 (39)	0,037*
ALT (u/l))	280,55±345,14 (143)	409,21±558,63 (369)	0,383
LDH (u/l)	487,07±313,51 (472,5)	711,29±599,85 (591)	0,001*
CRP (mg/dl)	9,28±8,57 (6,56)	13,57±8,2 (13,14)	0,003*
PCT	0,55±1,1 (0,21)	1,31±2,46 (0,38)	0,002*
NT-proBNP	1446,04±2548,03 (365)	7654,95±25967,05 (1540,5)	0,000*
NLR	13,86±19,06 (8,62)	22,29±22,82 (16,42)	0,000*
CAR	3,35±3,3 (2,49)	5,18±3,32 (4,86)	0,001*
	Survivors (n=119)	**Nonsurvivors (n=249)**	**p**
OV	**Mean±SD (median)**	**Mean±SD (median)**	
Ferrıtın	651,64±626,64 (404,6)	961,63±636,25 (770,8)	0,000*
D-dimer	3,04±3,59 (1,51)	4,46±6,03 (1,94)	0,149
Neu. (10^3/µl)	9,58±5,58 (8,46)	12,64±6,18 (11,48)	0,000*
Lymph (10^3/µl)	1,17±0,85 (0,89)	0,76±0,7 (0,58)	0,000*
Albumin	2,8±0,5 (2,75)	2,51±0,58 (2,5)	0,000*
AST (u/l)	40,91±43,16 (27,5)	80,43±326,54 (36)	0,022*
ALT (u/l))	113,01±179,38 (40)	260,39±339,57 (56)	0,005*
LDH (u/l)	435,72±244,13 (359,5)	683,35±366,56 (592)	0,000*
CRP (mg/dl)	6,92±7,07 (4,52)	10,23±7,91 (9,27)	0,001*
PCT	1,53±7,02 (0,15)	3,62±15,63 (0,33)	0,000*
NT-proBNP	2840,74±7913,36 (428)	6175,68±9598,25 (1411)	0,000*
NLR	12,58±12,01 (8,92)	28,3±31,92 (19,81)	0,000*
CAR	2,69±2,91 (1,84)	4,47±4,22 (3,62)	0,000*

Mann Whitney U Test, *p<0.05. Neu: neutrophils, lymph: lymphocytes, AST: aspartate aminotransferase; ALT: alanine aminotransferase;, LDH: lactate dehydrogenase, NT-proBNP: N-terminal prohormone of brain natriuretic peptide, CRP: C-reactive protein, PCT: procalcitonin,

The mean age of the survivors in the OC and OV groups was lower (64.53±13.04, 57.85±16.78, p=0.001, p=0.001, respectively) (Table 2).

The laboratory data of the cases at the time of admission to the intensive care unit are summarized in Table 2. From laboratory values, D-Dimer level was higher in OV group, CAR, CRP and albumin levels were higher in OC. This result was statistically significant (Table 2).

The comparison of the laboratory values of the surviving and deceased patients in the OC and OV groups is given in Table 3. Ferritin level was not significant in terms of mortality in OC (p=0.116, Table 3). However, it was found to be higher in non-survivors in the OV group (p<0.001, Table 3).

Among the other parameters, albumin and lymphocyte counts were lower in the deceased, and LDH, CRP, Neutrophil, procalcitonin, NLR and CAR were higher (p<0.05), (Table 3).

Discussion

In our study, there was no difference in mortality in patients admitted to the intensive care unit in both periods (original SARSCoV-2-other variants). Gender was similar across the groups. The mean age was found to be higher in the OC group. We found that some laboratory parameters (CAR, CRP) were higher in OC. In comparison of the survivors and those who died, the age was lower in the survivors in both groups. As laboratory findings, lymphocytes and albumin were lower in those who died. Neutrophil, LDH, CRP, PCT, NLR and CAR, NT-proBNP levels were higher in those who died. We think that the mortality of the patients in both groups was similar, especially due to the advanced age of the study population, the excess of comorbidities, and the fact that it consisted of patients in a more severe condition. It has been stated in the literature that especially advanced age is an important indicator of mortality [8]. As age progresses, it is likely to cause an increase in mortality due to the increase in comorbid conditions. In the literature, it has been stated that comorbidities that increase with advanced age are an important factor in increased mortality. Hypertension and DM may increase the risk of mortality in patients with COVID-19 [9,10].

In previous studies, patients infected with the alpha variant were shown to be more contagious, and different opinions were reported on the variants in terms of mortality [7]. In different studies, analyzes have shown that Delta variant infection increases the risk of hospitalization, oxygen demand, admission to the intensive care unit, or death [7,11-13].

Patients in the OC group were older than the OV group. Compared to the first period of the epidemic, we found that the age was lower in this period when variants were dominant and the contagion was thought to increase. In a study conducted during the first months of the epidemic, 116 hospitalized COVID-19 patients had a median age of 58.5 years, and 69% (n:80) of the patients were male. The most common co-

morbidities were hypertension (38.8%) in 45 people and DM (16.4%) in 19 people. Severe cases were older than non-severe cases (median, 64 years–56 years, respectively) [14]. Due to the severe clinical course of Covid-19, many studies have been carried out in the literature because it may be useful to detect laboratory findings related to mortality. As laboratory abnormalities, NT-proBNP, neutrophil count, procalcitonin, c-reactive protein, D-dimer and lactate dehydrogenase were found to be high and lymphocyte count was low in severe cases [14]. Similar laboratory abnormalities have been shown in other studies as in our findings [8-10,15-18]. In addition, although the D-Dimer level was found to be higher in the OV group in our study, it was found to be similar in mortality. In another analysis performed on COVID-19 patients over 60 years of age, the rate of severe pneumonia was found to be 71.05% (n:27). Serum aspartate aminotransferase, CRP, serum procalcitonin, D-Dimer and BNP levels were found to be higher in these patients [16]. The findings of our study support this information.

In a delta-dominated study, the median duration of stay in the intensive care unit of 23 patients was 11 days, 70% (n:16) patients were male and the median age was 53 years. Seven patients (30%) had hypertension, and 14 patients (60%) had diabetes mellitus (DM). Laboratory abnormalities were similar. Of the 23 patients, 13 (57%) required invasive oxygenation, and 8 (62%) of these patients died. Nine of 23 patients (39%) died during the follow-up period [15]. In a different study, people aged 65 and older had a higher COVID-19 mortality rate than those aged 55-64 [17].

In one of the studies on critically ill patients, it is stated that 65.4% (n:647) of 990 patients needed mechanical ventilation and 60.4% of the patients who needed MV may have died. Again, in the same study, it is mentioned that 67.17% of all critically ill patients are dead [19]. In another, ICU mortality was 50%, and 57% in patients who were connected to MV [20]. In a systematic review, the overall ICU mortality was found to be 32.3% [21]. When the duration of ICU stay of the patients was examined, it was seen in an analysis that the average ICU stay of 5 studies was 9 days. In another study, it was found that while it was 20.6 days in the first wave, it decreased to 16 days in the third wave [22,23]. The presence of similar results in our study also supports these results. Similarly, we found that the mean age of the patients was lower in the period when other variants were dominant. Mortality rates in the groups (OC, OV) were 71.7% and 64.6%, respectively. The mortality rate was higher in the OC group with older age. Age-related mortality rates were statistically significant in both groups, and those who did not survive were older. In addition, our mortality rate does not represent the rate among all patients admitted to the intensive care unit. This rate represents only a certain number of patient population included in the study. In our study, the LOS in the intensive care unit was longer in the OC group and the median was 10 days, while it was 7 days in the OV group.

Low albumin levels have been related with poor prognosis in patients with COVID-19. In severe cases of COVID-19, it has been reported that an elevated CRP level can be used to identify serious cases in the early period. In addition, the presence of hypoalbuminemia at admission in COVID-19 cases can predict the course of the disease independently of other indicators [8,9,16]. In our study, Albumin level was lower in the OV group and was associated with higher mortality. We found the CRP level to be higher in the OC group and the CRP level was significant in terms of mortality in both groups.

The high CAR and NLR levels can be used to differentiate the severity of COVID-19. It has been shown that high CAR is related with high mortality and can be used as an risk factor. In addition, it has been reported that high CAR is an important prognostic factor in predicting disease progression and mortality in hypertensive COVID-19 patients [3,8,9,16,23,24]. It has been shown in many studies that NLR is higher in critically ill patients [25]. The data in our study showed that CAR and NLR were similar in OC and OV, but were higher in critically ill patients and were significant in mortality.

Our study has some limitations. First, the study is a single-center retrospective study consisting of more severely ill patients admitted to the intensive care unit only. Second, the patients in the study did not include all patients hospitalized in the intensive care unit due to COVID-19. Third, patients' original virus and variant differentiation was made periodically.

Conclusion

In seriously ill COVID-19 patients, high CAR and NLR are predictors of mortality. The mortality rates in OC and OV were similar. The patients in the OV group had a lower mean age and lenght of stay in the intensive care unit.

Scientific Responsibility Statement

The authors declare that they are responsible for the article's scientific content including study design, data collection, analysis and interpretation, writing, some of the main line, or all of the preparation and scientific review of the contents and approval of the final version of the article.

Animal and human rights statement

All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. No animal or human studies were carried out by the authors for this article.

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Conflict of interest

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References

1. Zaim S, Chong JH, Sankaranarayanan V, Harky A. COVID-19 and Multiorgan Response. Curr Probl Cardiol. 2020;45(8):100618.

2. Wolff D, Nee S, Hickey NS, Marschollek M. Risk factors for Covid-19 severity and fatality: a structured literature review. Infection. 2021;49(1):15-28.

3. Şen P, Demirdal T. Factors associated with intensive care unit admission and mortality in COVID-19 infection during May-August 2020 period. Klimik Derg. 2022;35(2):68-73.

4. Wu Z, McGoogan JM. Characteristics of and important lessons from the coronavirus disease 2019 (COVID-19) outbreak in China: Summary of a report of 72 314 cases from the Chinese Center for Disease Control and Prevention. JAMA.2020;323(13):1239-42.

5. Dong E, Du H, Gardner L. An Interactive Web-Based Dashboard to Track COVID-19 in Real Time. Lancet Infect. Dis. 2020, 20 (5), 533–534.

6. Barouch DH. Covid-19 vaccines immunity, variants, boosters. N Engl J Med 2022; 387:1011-1020.

7. Choi JY, Smith DM. SARS-CoV-2 Variants of Concern. Yonsei Med J. 2021;62(11):961-968.

8. Wu C, Chen X, Cai Y, Xia J, Zhou X, Xu S, et al. Risk Factors Associated With Acute Respiratory Distress Syndrome and Death in Patients With Coronavirus Disease 2019 Pneumonia in Wuhan, China. JAMA Intern Med. 2020 Jul 1;180(7):934-943.

9. Wang L. C-reactive protein levels in the early stage of COVID-19. Med. Mal. Infect. 2020;50(4):332–334.

10. Karakoyun I, Colak A, Turken M, Altin Z, Arslan FD, Iyilikci V, Yilmaz N, Kose S. Diagnostic utility of C-reactive protein to albumin ratio as an early warning sign in hospitalized severe COVID-19 patients. Int Immunopharmacol. 2021;91:107285.

11. David N. Fisman, Ashleigh R. Tuite. Evaluation of the relative virulence of

novel SARS-CoV-2 variants: a retrospective cohort study in Ontario, Canada. CMAJ Oct 2021;193 (42)
12. Twohig KA, Nyberg T, Zaidi A, Thelwall S, Sinnathamby MA, Aliabadi S, et al; COVID-19 Genomics UK (COG-UK) consortium. Hospital admission and emergency care attendance risk for SARS-CoV-2 delta (B.1.617.2) compared with alpha (B.1.1.7) variants of concern: a cohort study. Lancet Infect Dis. 2022;22(1):35-42.
13. Ong SWX, Chiew CJ, Ang LW, Mak TM, Cui L, Toh MPHS, et al. Clinical and Virological Features of Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) Variants of Concern: A Retrospective Cohort Study Comparing B.1.1.7 (Alpha), B.1.351 (Beta), and B.1.617.2 (Delta). Clin Infect Dis. 2022;24;75(1):e1128-e1136.
14. Xiong S, Liu L, Lin F, Shi J, Han L, Liu H, et al. Clinical characteristics of 116 hospitalized patients with COVID-19 in Wuhan, China: a single-centered, retrospective, observational study. BMC Infect Dis. 2020;22;20(1):787.
15. Sekihara K, Shibasaki T, Okamoto T, Matsumoto C, Ito K, Fujimoto K, et al. Poor prognosis of patients with severe COVID-19 admitted to an infectious disease intensive care unit during the pandemic caused by the Delta variant in Japan. Glob Health Med. 2022;30;4(2):122-128.
16. Wang Y, Zhou Y, Yang Z, Xia D, Hu Y, Geng S. Clinical Characteristics of Patients with Severe Pneumonia Caused by the SARS-CoV-2 in Wuhan, China. Respiration. 2020;99(8):649-657.
17. Yanez ND, Weiss NS, Romand JA, Treggiari MM. COVID-19 mortality risk for older men and women. BMC Public Health. 2020;19;20(1):1742.
18. Li X, Xu S, Yu M, Wang K, Tao Y, Zhou Y, et al. Risk factors for severity and mortality in adult COVID-19 inpatients in Wuhan. J Allergy Clin Immunol. 2020;146(1):110-118.
19. Petrilli CM, Jones SA, Yang J, Rajagopalan H, O'Donnell L, Chernyak Y, et al. Factors associated with hospital admission and critical illness among 5279 people with coronavirus disease 2019 in New York City: prospective cohort study. BMJ. 2020;369:m1966.
20. Contou D, Fraissé M, Pajot O, Tirolien JA, Mentec H, Plantefève G. Comparison between first and second wave among critically ill COVID-19 patients admitted to a French ICU: no prognostic improvement during the second wave?. Crit Care. 2021;25(1):3.
21. Serafim RB, Póvoa P, Souza-Dantas V, Kalil AC, Salluh JIF. Clinical course and outcomes of critically ill patients with COVID-19 infection: a systematic review. Clin Microbiol Infect. 2021;27(1):47-54.
22. Dongelmans DA Termorshuizen F, Brinkman S, Bakhshi-Raiez F, Arbous MS, de Lange DW, et al. Dutch COVID-19 Research Consortium. Characteristics and outcome of COVID-19 patients admitted to the ICU: a nationwide cohort study on the comparison between the first and the consecutive upsurges of the second wave of the COVID-19 pandemic in the Netherlands. Annals of intensive care. 2022;13;12(1):5
23. Ranzani O.T, Zampieri F.G, Forte D.N, Azevedo L.C.P, Park M. C-reactive protein/albumin ratio predicts 90-day mortality of septic patients. PloS one. 2013;8(3).
24. Özdemir İH, Özlek B, Özen MB, Gündüz R, Çetin N, Özlek E, et al. Prognostic value of C-reactive protein/albumin ratio in hypertensive COVID-19 patients. Clin Exp Hypertens. 2021;3;43(7):683-689.
25. Ayalew G, Mulugeta B, Haimanot Y, Adane T, Bayleyegn B, Abere A. Neutrophil-to-Lymphocyte Ratio and Platelet-to-Lymphocyte Ratio Can Predict the Severity in COVID-19 Patients from Ethiopia: A Retrospective Study. Int J Gen Med. 2022;7;15:7701-7708.

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