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Original Research

The Role of Dynamic Changes in Hematologic and Biochemical Parameters in Predicting Mortality in Covid-19 Patients

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Abstract

Objectives: The role of hematologic, inflammatory and biochemical parameters as biomarkers, their role in identifying risky patients in the early stage and their role in prognosis in COVID-19 Coronavirus disease 2019 (COVID-19) were investigated.

Methods: The study included patients who were hospitalized and followed up with a prediagnosis of COVID-19 in the first wave in our country at the University of Health Sciences, Sisli Hamidiye Etfal Training and Research Hospital Demographic and clinical characteristics as well as complete blood count, C reactive protein (CRP), procalcitonin (PCT), fibrinogen (FIB), ferritin, albumin (ALB), lactate dehydrogenase (LDH) levels on admission, third, seventh and 14th days were analyzed. Patients were grouped and compared according to the occurrence of death during hospital follow-up. Variables considered significant on mortality were analyzed with univariate and multivariate logistic regression models.

Results: The study was conducted with 485 patients, 273 (56.3%) males and 212 (43.72%) females. The mean age of the patients was 58±16.2 years, and 71% were in the mild-moderate and 29% in the severe-critical disease group. Disease severity, the need for intensive care unit (ICU) follow-up, and the development of death were positively correlated with age, comorbidity, neutrophil (NE), leukocyte, neutrophil-lymphocyte ratio (NLR), PCT, CRP, ferritin, LDH values, and negatively correlated with lymphocyte (LE), ALB and hemoglobin (HGB) values. In multivariate analysis, elevated PCT at hospital admission (OR: 6.96 [1.63;39.65]), LDH ≥ 352U/L (OR: 4.35 [1.23;16.61]), LE<0.810 × 109/L (OR: 3.0 [1.16;7.85]) and advanced age (OR: 1.08 [1.03;1.14]) were independently associated with in-hospital death. In hemogram and acute phase reactant monitoring, PCT, CRP and LDH were the most valuable markers for predicting death, respectively (third-day AUC: 0.90;0.83;0.83 and seventh-day AUC: 0.95;0.90;0.89, respectively).

Conclusion: In our study, leukocytes, lymphocytes, NLR, CRP, PCT, ferritin, albumin and LDH at admission were valuable in predicting poor prognosis. In addition, it was determined that increases in PCT, LDH and CRP during follow-up could be used to predict in-hospital death and to identify patients requiring close follow-up.

Keywords: COVID-19, lymphopenia, mortality, neutrophil-lymphocyte ratio, procalcitonin, prognosis

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In December 2019, a new virus identified as severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2) showed us again after 17 years that CoVs can pose a serious threat to global health.[1] The World Health Organization emphasizes that COVID-19, which has caused new cases and deaths worldwide and in our country, should be considered a global health threat as it is predicted that it may cause an increase in new diseases and deaths with highly transmissible different variants such as JN.1.[2] This viral disease has a wide spectrum ranging from asymptomatic infection to life-threatening clinical pictures. The individual risk of severe illness varies by age, underlying comorbidities, different SARS-CoV-2 variants, vaccination status and most importantly immune reactions to infection.[3] It is an infectious disease with a complex pathogenesis that can cause multisystem inflammatory syndrome and progresses with multiple organ involvement and damage.[4] Disease severity and poor prognosis are correlated with the severity of this inflammatory response.[5-7] While oral antiviral drug and monoclonal antibodies studies continue, early detection of patients in the risk group remains important. In addition, studies show that POSTCOVID-19 syndrome is often increased in cases with high systemic inflammation, and monitoring of inflammatory indicators is also important in recognizing the patient group expected to have prolonged symptoms.[8] Our study aimed to determine the value of monitoring different inflammatory indicators in predicting disease prognosis.

Methods

The study was designed as a retrospective observational study. The study included patients aged 18 years and older who were followed up as inpatients with a pre-diagnosis of COVID-19 disease at the University of Health Sciences, Sisli Hamidiye Etfal Training and Research Hospital , between March 10, 2020 and April 20, 2020, with at least one SARS CoV-2 polymer ase chain reaction (PCR) positive or PCR negative and whose clinical and radiological findings were compatible with CO-RADS (COVID-19 Reporting and Data System-CORADS 4-5) and could not be explained by another agent and disease. Pregnant women and the patients who have hematologic malignity, solid organ malignity or who have been receiving radiotherapy (RT) or chemotherapy (CT) are excluded from the study since they may affect the results (Fig. 1). Demographic and clinical characteristics, comorbidities, laboratory results, radiologic findings, SARS-CoV-2 PCR results, and in-hospital mortality of eligible patients were recorded on the study form. Complete blood count, CRP, PCT, fibrinogen, ferritin, albumin, fibrinogen and LDH levels were analyzed on admission, third, seventh and fourteenth days. Follow-up values were compared, and patients were grouped according to the occurrence of death.

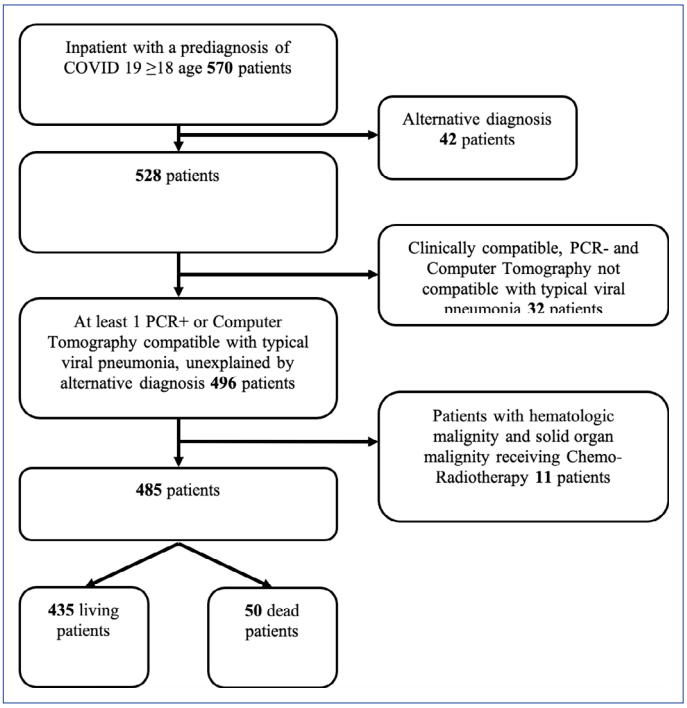


Figure 1. Case flowchart.

Statistical Method

Descriptive statistics were presented as numbers with percentages or as medians with the 25th-75th percentile range. Normal distribution was assessed through histograms and the Shapiro-Wilk test. Categorical variables were compared using either the Pearson chi-square test or Fisher's exact test. Continuous variables were compared by Student's t-test or Mann-Whitney U test, depending on the presence of normal distribution. Receiver-operating characteristic (ROC) curves were generated to investigate the binary classification performance of laboratory variables. The performance of ROC curves was assessed based on the Area Under the Curve (AUC). To determine optimal cut-off points, the Youden index [YI(c) = max_c(sensitivity(c) + specificity(c) - 1] was employed. Univariate and multivariate logistic regression models were estimated using baseline clinical and laboratory variables upon admission to predict in-hospital mortality. Independent variables identified as statistically significant in the univariate analysis were included in the final multivariate model. We excluded CRP from the multivariate model due to multicollinearity with PCT. Statistical analyses and visualizations were conducted using R version 4.0.2, a language and environment for statistical computing provided by the R Foundation for Statistical Computing, Vienna, Austria (http://www.R-project.org). Two-sided p-values of<0.05 were considered statistically significant.

The study protocol was designed in accordance with the principles outlined in the Declaration of Helsinki. Ethical approval for the protocol was obtained from the Clinical Research Ethics Committee of University of Health Sciences, Sisli Hamidiye Etfal Training and Research Hospital under application dated on April 22, 2020, and decision number 1482.

Results

The mean age of the patients included in the study was 58±16.2 years. The mean age of patients who needed ICU follow-up was 67.5±11.5 years, and the mean age of patients who died was 70.3±11.2 years (p<0.001). Of the patients who died, 84% were 60 or older and 70% were male (Table 1).

The relationship between hemogram parameters and acute phase reactants at admission and death was analyzed and presented in Table 2. The median values of WBC, Neutrophil, NLR, CRP, PCT, LDH and ferritin were statistically significantly higher in patients who died (p<0.001). Lymphocyte median value was statistically significantly lower in deceased patients (p<0.001). Monocyte (MO), platelet (PLT) counts, mean platelet volume (MPV) and fibrinogen values were analyzed, and no significant difference was found between living and deceased patients. However, platelet-to-lymphocyte ratio (PLR), monocyte-to-lymphocyte ratio (MLR) and MPV-to-platelet ratio (MPR) were analyzed, and PLR and MLR were statistically significantly higher in deceased patients (p<0.001).

ROC analysis was performed to determine the predictive values of the seven parameters (NLR, LE, NE, CRP, ferritin, PCT and LDH) that showed a significant difference as a result of univariate statistical analysis and their predictive values in terms of death prediction with admission, third and seventh-day follow-up values and are given in Figures 2, 3 and 4. AUC values for all parameters were statistically significant. NLR > LE > NE > CRP > ferritin > PCT = LDH at admission (AUC: 0.80, 0.79, 0.74, 0.72, 0.72); PCT > NLR = CRP = LDH > ferritin > LE > NE on the third day (AUC: 0.90; 0.83; 0.78; 0.77; 0.74); on the seventh day PCT > CRP > NLR > LDH > LE > ferritin = NE (AUC: 0.95; 0.90; 0.89; 0.88; 0.81; 0.79). It was found that procalcitonin measurement gained importance in predicting death, especially on the third and seventh day of follow-up.

The third, seventh and fourteenth-day control hemogram data and CRP, PCT, ferritin and LDH values of the patients included in our study. Third, seventh and 14th-day data were available for 410, 277 and 99 patients, respectively. The median values of living and deceased patients were compared and presented in Figures 5 and 6. When the follow-up values for NE and LE were compared between the living and deceased groups, it was observed that NE continued to increase and LE continued to decrease in the deceased group. The statistically significant difference between the deceased and living groups for NE and LE maintained its significance in the follow-up values and the difference between the median numbers of the two groups continued to increase (p<0.001). For NLR, while a decrease was observed in the living group, an increase was observed in the deceased group. It was

Table 1. Patients' demographic characteristics, comorbidities and habits

	Total n=485, %	Living n=435, %	Dead n=50, %	p	n
Age	58.1 (±16.2)	56.7 (±16.1)	70.3 (11.2)	<0.001	485
Sex				0.056	485
Male	273 (56.3)	238 (54.7)	35 (70)		
Female	212 (43.7)	197 (45.3)	15 (30)		
Hypertension	208 (42.9)	179 (41.1)	29 (58)	0.033	485
DM	117 (24.1)	98 (22.5)	19 (38)	0.025	485
CAD	99 (20.4)	81 (18.6)	18 (36)	0.007	485
Heart Failure	14 (2.5)	11 (2.3)	3 (6)	0167	485
CKD	26 (5.4)	21 (4.8)	5 (10)	0.172	485
COPD	30 (6.2)	25 (5.7)	5 (10)	0.220	485
Malignity	11 (2.3)	6 (1.3)	5 (10)	0.003	485
Chronic Liver Disease	16 (3.3)	13 (2.9)	3 (6)	0.222	485
≥ 2 comorbidities	193 (39.8)	158 (36.3)	35 (70)	<0.001	485
Smoking	121 (28)	103 (23.6)	18 (36)	0.109	432
Alcohol	19 (4.4)	19 (4.3)	0 (0)	0.244	432

DM: Diabetes Mellitus; CAD: Coronary artery disease; CKD: Chronic kidney disease; COPD: Chronic obstructive pulmonary disease.

Table 2. Patients' hemogram parameters and acute phase reactants at admission

	Total n=485,%	Living n=435,%	Dead n=50,%	p	n
NE (×109/L)	3.99 [2.98;5.75]	3.87 [2.93;5.28]	6.465 [4.01;10.715]	<0.001	485
LE (×109/L)	1.160 [0.83;1.59]	1.21 [0.89;1.63]	0.765 [0.602;1.088]	<0.001	485
NLR	3.19 [2.21;5.68]	3.03 [2.1;5.1]	7.45 [4.93;13.3]	<0.001	485
MO (×109/L)	0.38 [0.27;0.52]	0.38 [0.27;0.51]	0.375 [0.270;0.615]	0.686	485
PLT(×109/L)	186[153;227]	187 [153;226]	178 [148;248.2]	0.603	485
MPV(fl)	9.3 [8.7;10]	9.3 [8.7;10.0]	9.3 [8.9;10.2]	0.507	485
PLR	159 [116;223]	154 [111;215]	207 [156;350]	<0.001	485
MLR	0.31 [0.23;0.45]	0.30 [0.22;0.42]	0.46 [0.33;0.76]	<0.001	485
MPR	5.05 [3.93;6.28]	4.97[3.94;6.28]	5.37 [3.80;6.66]	0.433	485
HGB(g/dl)	13.5 [12.2;14.6]	13.6 [12.3;14.7]	13.1 [10.8;14.2]	0.022	485
CRP (mg/L)	41 [15;89]	36 [14;79]	116 [71.8;176]	<0.001	485
PCT (µg/L)	0,12 [0.12;0.16]				
≤0.12 n/N (%)	320/479 (%66.8)				
0.13-0.25	85/479 (%17.7)	0.12 [0.12;0.14]	0.25 [0.12;0.53]	<0.001	479
0.26-0.5	38/479 (%8)				
>0.5	36/479 (%7.5)				
LDH(U/L)	259 [216;336]	255 [210;322]	352 [257;468]	<0.001	476
Albumin (g/dl)	3.6 [3.2;3.9]	3.7 [3.3;4.0]	3.1 [2.82;3.4]	<0.001	236
FIB (mg/dl)	367 [326;417]	367 [326;417]	380 [352;442]	0.284	183
Ferritin (µg/l)	190 [83;403]	174 [81;342]	482 [214;880]	<0.001	481

NE: neutrophil; LE: lymphocyte; NLR: neutrophil-lymphocyte ratio; MO: monocyte; PLT: platelet; MPV: Mean platelet volume; fl.: femtoliter; PLR: Platelet-lymphocyte ratio; MLR: monocyte-lymphocyte ratio; MPR: MPV-to-platelet ratio; HGB: Hemoglobin; PCT: procalcitonin; CRP: C reactive protein; LDH: lactate dehydrogenase; FIB: Fibrinogen; L: liter; g: gram; mg: milligram; dl: deciliter; µg: microgram; U: unite.

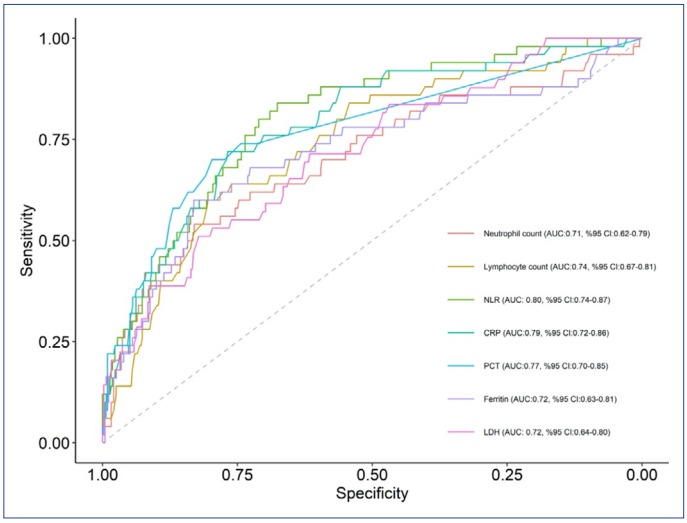


Figure 2. ROC analysis plot with admission values for prediction of death.

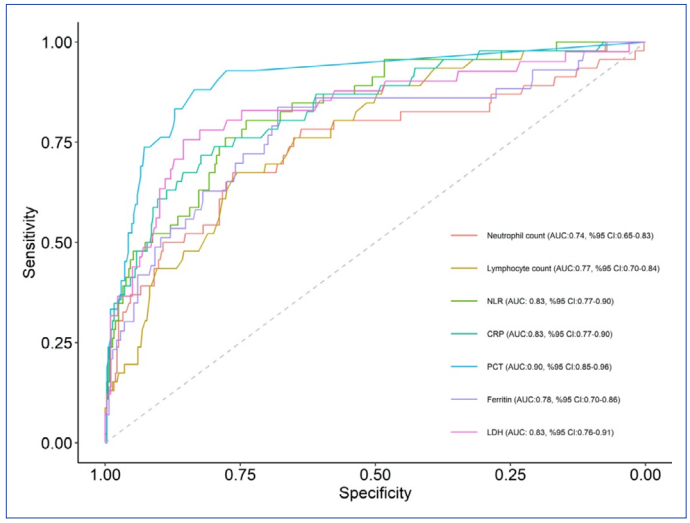


Figure 3. ROC analysis graph with day three follow-up values for prediction of death.

found that the significant statistical difference between the two groups, which was present at admission, was maintained in the follow-up values (p<0.001). For PLT, no significant statistical relationship was observed between the two groups at admission and on the third day. Although there was no significant thrombocytopenia and thrombocytosis on the seventh and fourteenth days, statistically significant lower platelet counts were observed in the deceased group (p=0.002; 0.017). The median values of CRP and ferritin increased to high on the seventh day in both groups and a

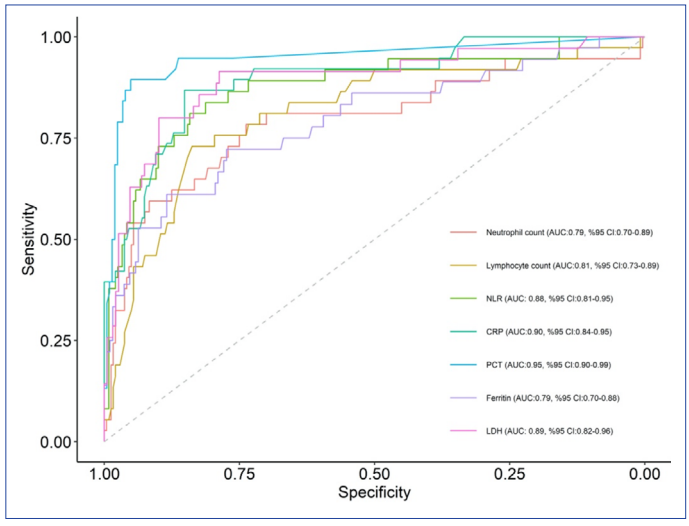


Figure 4. ROC analysis graph with day seven follow-up values for prediction of death.

significant decrease was observed on the 14th day in the living group, while they remained high in the deceased group. While the median values of PCT and LDH were close to the normal range in the living group, they continued to increase in the deceased group.

Univariate and multivariate logistic regression models were created with age, gender, coronary artery disease (CAD), diabetes mellitus (DM), hypertension (HT) and laboratory values of the patients at admission, which were considered clinically significant in mortality. All parameters that were significant in the univariate analysis were included except CRP. CRP was not included in the multivariate model because of the high correlation between CRP and PCT. The data obtained from the analysis are given in Table 3. Accordingly, when evaluated alone, age, HT, CAD, DM, low LE, CRP, LDH, ferritin, PCT and high NLR were determined as risk factors for death. In the multivariate model, age, el-

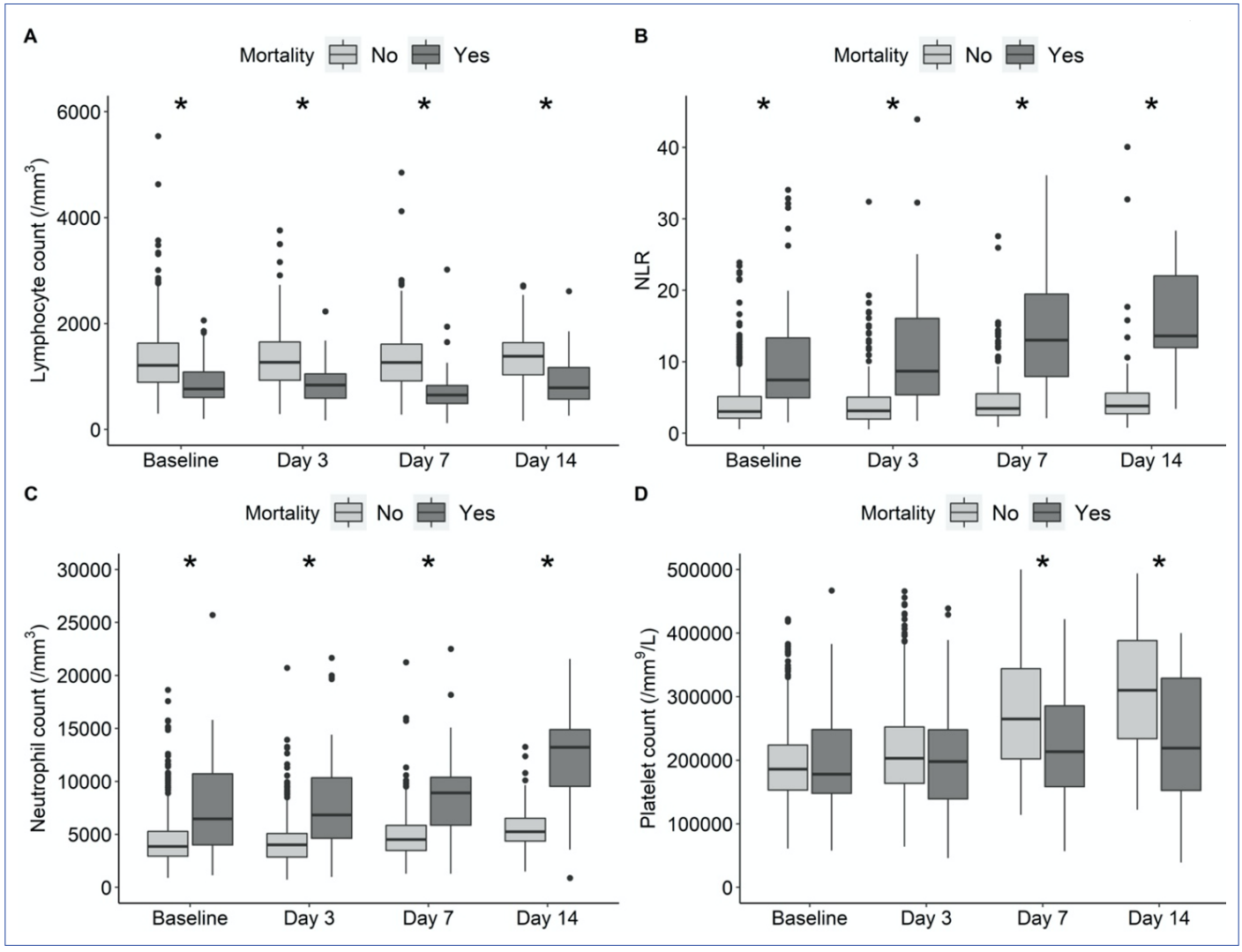


Figure 5. Change graph of LE, NLR, NE, and PLT follow-up values of living and dead patients, *p<0.001.

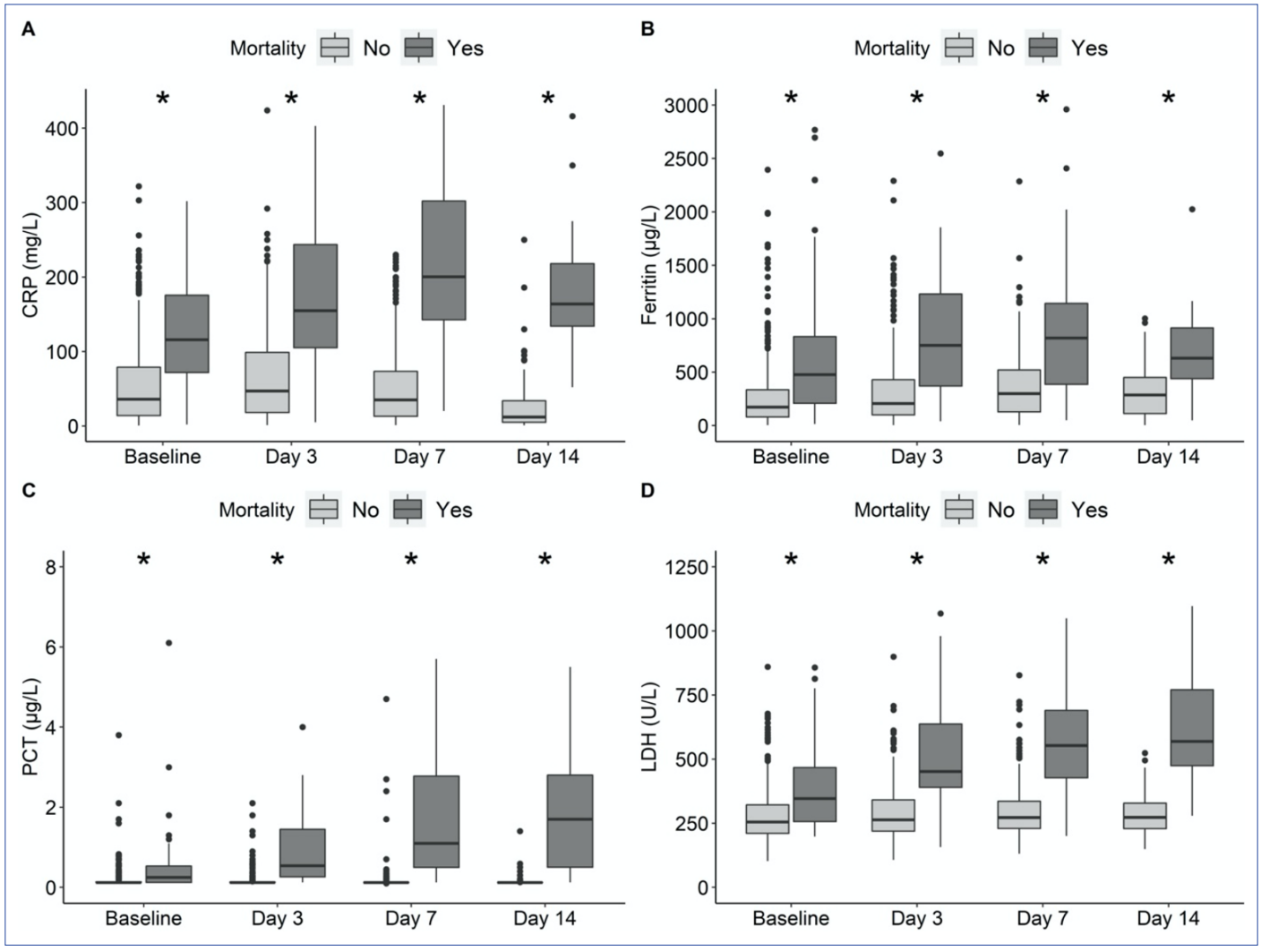


Figure 6. Change graph of CRP, ferritin, PCT, and LDH follow-up values of living and dead patients, *p<0.001.

evated LDH and PCT, and low LE remained significant as risk factors. In addition, female gender, elevated HGB and albumin were found to be protective in univariate analysis but not significant in multivariate models.

Discussion

COVID-19 epidemiology is uncertain. Until we learn more about the seasonality and disease burden of COVID-19 in the future, for prediction poor prognosis the detection and use of simple, stable, achievable parameters is still important. Monitoring laboratory values is useful for the clinician to classify patients in terms of severity and follow-up. Leukocytes and neutrophils are important peripheral blood cells that can be elevated due to infectious and non-infectious causes. COVID-19 is also recommended to indicate secondary bacterial infection, cytokine storm syndrome, severe infection and poor prognosis with increasing values.[9-11] In the study by Chen et al.[12], when the follow-up values at the beginning, middle and end of hospitalization were examined, it was observed that the leukocyte and neutrophil counts, which were significantly higher in the deceased group at the beginning, continued to increase and were evaluated as significant in terms of poor prognosis and death. In our study, leukocyte and neutrophil levels were statistically significantly higher in dying patients. In our patients whose follow-up values on the third, seventh and 14th days were also evaluated, the increase in neutrophil levels continued in the deceased patient group. The continued increase in deceased patients was associated with hyperinflammation, which may be prominent, especially in the second week of the disease, and secondary bacterial infection with prolonged hospitalization. Our findings support the literature that increased leukocyte and neutrophil levels can be monitored regarding disease severity, the need for ICU follow-up, poor prognosis and thus prediction of death.

Table 3. Univariate and multivariate logistic regression analysis for in-hospital mortality

	Living (n=435)	Dead (n=50)	p	Univariate analysis		Multivariate analysis OR (95% CI)
				OR(95% CI)	***	
Age	56.0 (46.5;68.0)	70.5 (63.2;78.2)	<0.001**	1.06 (1.04;1.08)	<0.001	1.08(1.03;1.14)
Sex						
Male	238 (54.7%)	35 (70%)	0.056*			
Female	197 (45.3%)	15 (30%)		0.52 (0.27;0.97)	0.039	0.36 (0.11;1.05)
Hypertension	179 (41%)	29 (58%)	0.033*	1.97 (1.09;3.61)	0.025	0.57 (0.18;1.75)
DM	98 (22.5%)	19 (38.0%)	0.025*	2.11 (1.12;3.88)	0.021	2.29 (0.80;6.82)
CAD	81 (18.6%)	18 (36.0%)	0.007*	2.46 (1.29;4.57)	0.007	1.09 (0.35;3.42)
LE<0.810×109/L	85 (19.5%)	30 (60.0%)	<0.001*	6.13 (3.33;11.5)	<0.001	3.0 (1.16;7.85)
NLR ≥4.24	141 (32.4%)	41 (82%)	<0.001*	9.33 (4.60;21.1)	<0.001	-
HGB g/dl	13.6 (12.3;14.7)	13.1 (10.8;14.2)	0.022**	0.80 (0.69;0.94)	0.005	0.83 (0.63;1.08)
Albumin g/dl	3.70 (3.30;4.00)	3.10 (2.82;3.40)	<0.001**	0.08 (0.03;0.19)	<0.001	0.61 (0.16;2.32)
LDH ≥352U/L	74 (17.3%)	24 (49%)	<0.001*	4.56 (2.45;8.47)	<0.001	4.35 (1.23;16.61)
Ferritin ≥460µg/l	73 (16.9%)	29 (58%)	<0.001*	6.72 (3.64;12.6)	<0.001	1.88 (0.65;5.42)
PCT ug/L	0.12 (0.12;0.14)	0.25 (0.12;0.53)	<0.001**	5.89 (2.44;14.2)	<0.001	6.96 (1.63;39.65)
CRP ≥83mg/L	100 (23.0%)	35 (70.0%)	<0.001*	7.73 (4.12;15.2)	<0.001	-

*Pearson Chi-square **Man Whitney U ***Univariate Logistic regression DM: Diabetes Mellitus, CAD: Coronary artery disease, LE: lymphocyte, NLR: neutrophil-lymphocyte ratio, HGB: Hemoglobin, PCT: procalcitonin, CRP: C reactive protein, LDH: lactate dehydrogenase, L: liter, g: gram, mg: milligram, dl: deciliter, µg: microgram, U: unite.

Lymphopenia is a common finding in COVID-19 and is both helpful in diagnosis and recommended to be evaluated and followed up in terms of disease severity, development of acute respiratory distress syndrome (ARDS), need for ICU follow-up, poor prognosis and prediction of death.[13,14] In our study, lymphocyte values at hospital admission were statistically significantly lower in our patient groups in whom death occurred. It was also found to be a strong indicator in our ROC analysis regarding the prediction of death. High specificity was seen when the cut-off for prediction of death was set at 0.81×109/L. In our patients whose third, seventh and 14th-day follow-up values were also evaluated, the decrease in lymphocyte levels continued in the deceased patient group, and the lowest values were seen on the seventh day (second week of illness) as expected.

NLR is a valuable parameter regarding disease severity and poor prognosis with increasing neutrophil and decreasing lymphocyte counts in COVID-19, as in many diseases.[9,10] In a study by Yan et al.[15], comparing 1004 patients with living and deceased patients, statistically significant, much higher NLR values were found in deceased patients. Repeated examinations were recommended regarding disease severity and prognosis (4.1 in living patients and 49 in deceased patients). In our study, NLR was statistically significantly higher in our patient groups who died. In our patients whose third, seventh and 14th-day follow-up values were also evaluated, the NLR continued to increase in the deceased patient group and the difference between both groups increased significantly. In addition, when analyzed by ROC analysis in terms of prediction of death on the third and seventh day, although it was found to be the most valuable parameter at admission, it was found to be a good indicator after PCT, CRP and LDH for the third and seventh day after the development of secondary bacterial infection, respiratory failure and hypoxia in the later stages of the disease.

Platelet count, MPV and ratios (PLR, MPR) have been the subject of research regarding disease progression, poor prognosis, and mortality in COVID-19 patients with hyperinflammation and hypercoagulopathy.[16] In the study by Chen et al.[12], in which 548 patients were analyzed, no significant difference was found in terms of disease severity and death, while statistically significant lower platelet levels were found in patients who ended with death. PLR, on the other hand, was found to be statistically significant with higher values in terms of both disease severity and prediction of death. In the same study, in patients whose follow-up values at the beginning, middle and end of hospitalization were also examined, it was observed that platelets continued to decrease in the deceased group. It was reported as an independent risk factor for death by multivariate analysis. In our study, although lower median platelet levels were observed in patients who died, no statistically significant difference was found. Thrombocytope-

nia was observed at similar rates between patient groups. In addition, in patients who underwent dynamic follow-up on the third, seventh and 14th days, a significant statistical difference was observed between our living and deceased patient groups on the seventh and 14th days, with inflammation peaking in the first week of hospital follow-up.

Ferritin is an acute-phase protein that increases during tissue damage and inflammatory response. Increased levels can also be seen in COVID-19 patients with inflammation and lung damage, especially with ARDS. In addition to the acute phase response to viral infection, hyperferritinemia is also seen with the cytokine storm seen in severe COVID-19 patients. Ferritin is thought to play an important role in this excessive response.[17] In a meta-analysis by Taneri et al.[18], evaluating 47 studies and 20810 patients regarding disease severity and survival, statistically significant higher ferritin levels were observed in the severe and deceased patient group (606 vs 473 µg/L). In our study, statistically significant higher ferritin levels were observed in our patient groups in whom death occurred. Although there may be different cut-offs in the literature in ROC analysis, it was observed that it showed high specificity in predicting death. In addition, in patients in whom dynamic follow-up was also performed on the third, seventh and 14th days, inflammation peaked in the first week of hospital follow-up and maximum values on the seventh day and the statistically significant difference between our deceased and living patient groups continued to increase in follow-up values. Our findings support the literature that increased ferritin levels can be followed up in terms of poor prognosis and, thus, prediction of death.

In many studies on COVID-19, increased CRP values were evaluated in terms of severe disease, poor prognosis, need for ICU follow-up and prediction of death, and follow-up was recommended. It has also been included in guidelines for patient management and treatment selection.[19,20] Although interleukin-6 (IL-6) could not be analyzed in our study, CRP, known to increase correlatively, was analyzed. In the meta-analysis by Huang et al.[21], which analyzed 3221 patients from 13 studies with different cut-offs and references, severe disease, poor prognosis, the need for ICU follow-up, and ARDS were reported as risk factors for ARDS but were not found to be significant in terms of mortality. When the cut-off ≥100 mg/L was determined for all studies, 51% sensitivity (18-84%) and 88% specificity (70-95%) were observed, and it was stated that increasing CRP was useful in terms of disease severity with repeated measurements as well as prognosis. In our study, statistically significant higher CRP levels were found in our patient groups who died. In terms of prediction of death in ROC analysis, it was again found to be the second strongest indicator after NLR with a cut-off of 83 mg/L. In addition, in patients who were dynamically followed up on the third, seventh and 14th days, inflammation, which peaked in the first week of hospital follow-up, increased to a peak on the seventh day. When analyzed by ROC analysis in terms of prediction of death on the third and seventh day, it was found to be a strong indicator after PCT.

Procalcitonin (PCT) is an acute phase reactant whose production is induced by an increase in IL-1 and 6, tumor necrotizing factor α (TNFα). TNFα production with increased interferon γ (IFNγ) in most viral infections. While COVID-19 is detected within the normal range in mild-moderate, uncomplicated cases, its increase has been observed, especially with systemic inflammatory response, severe disease, bacterial co-infection and organ dysfunction, and studies have been conducted on its use.[22] Today, when antibiotic resistance is increasing rapidly, large-scale studies are also being conducted regarding antibacterial indication and time in COVID-19.[23] In the study conducted by Mikami et al.[24], to determine risk factors for death in COVID-19, higher PCT levels were observed in those who died, and it was stated that the increase in PCT continued in follow-up values in these patients who died (0.13 vs 0.47 ng/ml). Our study observed that the significant statistical difference between the PCT values of our deceased and living patient groups continued to increase in the follow-up values. When analyzed by ROC analysis, PCT was the strongest predictor of death on the third and seventh day. It was observed that the difference, which was moderate even in uncomplicated disease in the early period, became more pronounced with the progression of the disease, prolonged hospitalization, and development of complications. In addition, patients should be evaluated for bacterial superinfection and the need for antibacterial treatment when high values are detected.

LDH is an indicator of tissue damage, and in meta-analyses, including many studies in COVID-19 patients, its follow-up has been recommended as a prognostic factor in patient groups, resulting in severe disease and death.[8,9] In the study by Castro et al.[25], a cut-off of 320 U/L was set for LDH in terms of poor prognosis, and it was found to be more valuable in terms of poor prognosis in the application compared to other markers due to its biocompatibility. Statistically significant higher LDH levels were observed in our patient groups in whom death occurred. In addition, it was observed to continue to increase in patients who died with dynamic follow-up on the third, seventh and 14th days. When analyzed by ROC analysis in terms of prediction of death on the third and seventh days, it was found to be a good indicator after PCT and CRP.

In our multivariate analysis, we found a 1.08-fold increased risk of death at one year of age, a 3-fold increased risk in patients with lymphopenia (<0.810×109/L), a 4.35-fold increased risk in patients with elevated LDH (≥352U/L) and a 6.96-fold increased risk of death in patients with elevated PCT, in line with the literature.

The limitation of our study, its single center and retrospective nature.

Conclusion

In COVID-19 patients, elevated NLR and CRP values at admission are the most valuable parameters in predicting poor prognosis. While the risk of death increased with increasing age in hospitalized patients, elevated PCT and LDH values on the third and seventh-day follow-up were found to be more valuable in predicting death than other laboratory parameters. Our study contributes to the literature by investigating the role of hematologic parameters in diagnosis as well as examining their dynamic follow-up.

Disclosures

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