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Original article

Neutrophil- and platelet-lymphocyte ratios as valuable prognostic biomarkers in ICU COVID-19 patients

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Abstract:

Background: Coronavirus disease 2019 (COVID-19) is a serious pandemic infectious disease that spread all over the world with a wide variety of complications. The need for easily available markers that can assess the severity and prognosis of the disease nowadays is a great demand. **Aim:** Study the dynamic changes in NLR and PLR during treatment of confirmed COVID-19 patient in the ICU regarding prognosis and mortality. **Method:** A retrospective cross-sectional study included 67 patients, with a confirmed COVID-19 by Real time PCR and meet the criteria of hospitalization. Patients were followed up daily for denoting their outcome. NLR and PLR were calculated and compared with other proven biomarkers for COVID-19 to predict prognosis, mortality, and assess their sensitivity and specificity. **Result**: A total of 67 ICU patients with COVID-19 were enrolled in the current study, 40 were improved and 27 died. Died patients had older age compared with improved patients. Neutrophils were significantly higher among dead patients compared to improved ones (p-value= 0.035). It was found that the NLR & PLR were significantly higher in dead compared to improved patients as follow (p= 0.007) and (p= 0.041), that, may help in the early detection of Covid-19 patients who need more aggressive clinical management. The data showed that there was a high significance of NLR and PLR (p<0.001) in the mortality prediction state. **Conclusion:** Both NLR and PLR are good predictors biomarkers for severity and mortality in ICU COVID-19 patients.

1. Introduction:

Coronavirus disease 2019 (COVID-19) has clinical presentations that differ widely, ranging from mild symptoms, such as fatigue, muscle ache, cough, and fever, to severe pneumonia that may have evolved to acute respiratory distress syndrome (ARDS) (1). However, many patients presenting with mild symptoms may suddenly progress to septic shock ARDS or even multiple organ dysfunction syndromes (MODS) (2). Thus identifying predictive factors for progression and early detection of potentially severe cases is important to improve clinical outcomes, save medical resources and modify medical plans.

Dysregulated inflammation, excessive activation of the adaptive immune system, and the resultant cytokine storms are correlated with deterioration of clinical results in patients with COVID-19 (3,4). Recent work shows that the spike of severe acute COVID-19, encompasses sequences and motifs that resemble those of bacterial super antigens (SAgs) (5). Super antigens can bypass the antigen specificity of the T cell receptors (TCRs), consequently, there is a broad activation of T-lymphocytes that end on cytokine storm and toxic shock syndrome (6,7).

Although age and comorbidities were suggested in some studies as criteria of poor prognosis (8,9), some laboratories indices may be useful for follow-up of disease progression. Therefore, selecting simple, available, and low-cost markers of systemic inflammation is important. For example, C-reactive protein (CRP) is an alternative marker for (IL)-6, a major inflammatory cytokine. CRP was related to poor prognosis in COVID-19 (10).

Neutrophil to lymphocyte ratio (NLR) calculated from peripheral blood differential white cell count. NLR has been shown in several studies to have a good predictive value on the progression and severity of COVID-19 disease (11), as well as other various inflammatory diseases (12-15). The platelet-to-lymphocyte ratio (PLR) is considered a new biomarker that can be used to track COVID-19 patients and can provide information about systemic inflammation (10). In the current study deep investigations of laboratory parameters that could be used for the prediction of the severity and mortality rate in ICU, COVID-19 patients.

2. Material and Methods:

2.1 Subjects methods

2.1.1 Design and subjects

The following retrospective cross-sectional study include 67 ICU patients with COVID-19 in King Fahd Specialist Hospital (KFSH), Buraydah Qasim from October 2020 to January 2020. The ICU admission criteria and treatment decisions for all patients, including the requirement for intubation and mechanical ventilation, were made at the judgment of the treating physicians and were not standardized.

COVID-19 was diagnosed according to the World Health Organization (WHO) technical guidance as severe pneumonia with any of the following criteria:

(1) Dyspnea, Respiratory rate of ≥30 breaths/min;

(2) Peripheral oxygen saturation ≤93% at rest and

(3) Arterial Oxygen partial pressure/ fractional inspired oxygen of ≤300 mmHg (1 mmHg = 0.133 kPa).

The definite outcome of the all patients is death or discharge. All participants provided written informed consent, previously approved by the National Committee of Bio& Med. Ethics (NCBE), registration NO: H-04-Q.001.

2.1.2. Data Collection

From electronic medical records, demographics, clinical events, and results were extracted. Most clinical data were collected on the first day of admission.

2.1.3. Laboratory Measures

All patients subjected to nasopharyngeal swabs for diagnosis of COVID-19 by real-time PCR. Different laboratory parameters were done including biochemical parameters such as liver function tests {alanine aminotransferase (ALT), aspartate aminotransferase (AST), total bilirubin, direct bilirubin, albumin, and prothrombin time (PT) and kidney function test {serum creatinine}, alkaline phosphatase (ALP), blood glucose, creatinine kinase myocardial band (CK-MB), amylase, and lactate dehydrogenase (LDH). Additional parameters included hematological and immune parameters and coagulation tests as white blood cells (WBC) count, lymphocytes, neutrophils, hemoglobin, platelet count, C-reactive protein (CRP), and D-dimer. NLR resulted of dividing the total neutrophil count by the total lymphocyte count. PLR calculated through dividing the

total platelet count by the total lymphocyte count. All laboratory tests were done in the core laboratory of King Fahd Specialist Hospital with standard procedures.

2.1.4. Statistical analysis.

Statistical analysis was done using statistical package for social sciences (SPSS) computer software (version 25), IBM software, USA. Categorical variables were described as the total number and percentage for each category, whereas continuous variables were described as the mean ± standard deviation and Median (IQR) values were specified for continuous variables that did not conform to the normal distribution.

Normally distributed continuous variables were compared with the Student's t-test, non-normally distributed continuous variables were compared with the Mann–Whitney U test and categorical variables were compared with the chi-square test.

Spearman's rank correlation analysis; was done to evaluate linear relationship between NLR and PLR with other studied parameters in all patients totally. Correlation was considered significant at $P < 0.05$. Correlation is considered positive (direct correlation) when r (correlation coefficient) had a + signal and negative (inverse correlation) in case of – signal and it is considered: (weak when r = >0 – 0.35, moderate when r = >0.35 – 0.65; and strong when r = > 0.65).

Uni-variable analysis was performed in all variables to determine statistically significant factors that may have contributed to in-hospital mortality of COVID-19 patients. Only variables with a significant statistical difference were included in the multivariable analysis using the Cox logistic regression method. Hazard risk (HR) and 95% confidence interval (CI) were used as common measures to assess relative risk.

The discriminatory ability for NLR and PLR to predict mortality in COVID-19 patients was determined using the receiver operating characteristic (ROC) curve. These results were reported as area under the curve (AUC) and 95% confidence intervals (CI). A cut-off value was defined as that with the highest validity. Kaplan-Meier survival analysis was used to determine if these cut off values were predictive of in-hospital mortality.

3. Results:

A total of 67 patients with COVID-19 were included in the current study, of them 40 patients were improved and 27 were died. The demographic characteristics of these patients are shown in Table 1. Died patients

had older age as compared with improved patients but without a statistically significant difference (p-value= 0.137). There were no significant differences in gender and BMI between these two groups. The mean diastolic blood pressure was significantly higher among studied improved COVID-19 patients as compared with died patients (75.30 vs. 64.22) in improved and died patients respectively (p-value= 0.001). Other vital signs showed non-statistically significant differences between improved and died COVID-19 patients; (p-values> 0.05).

Table (1): Basic Sociodemographic data and vital signs among studied population; (N= 67):

		Improved N= 40	**Died N= 27**	***P-value***
Age	**Mean ±SD**	56.60 ±14.8	62.74 ±18.4	0.137
Gender	**Male**	25 (62.5%)	13 (48.1%)	0.181
	Female	15 (37.5%)	14 (51.9%)	
BM	**Median (IQR)**	27.30 (7.40)	27.68 (8.00)	0.552
SBP	**Mean ±SD**	126.80 ±20.9	119.52 ±21.2	0.17
DBP	**Mean ±SD**	75.30 ±13.3	64.22 ±12.99	**0.001***
HR	**Mean ±SD**	93.10 ±14.861	99.59 ±17.172	0.104
TEM	**Mean ±SD**	37.19 ±0.84	37.19 ±0.87	0.986
RR	**Mean ±SD**	21.7 ±2.59	22.5 ±3.31	0.235
Sat	**Mean ±SD**	79.4 ±13.00	77.704 ±13.43	0.607

The median length of stay for the entire group was 15.0 days (IQR 13 days, average = 17.15). Median hospital length of stay (LOS) was not different between Improved and died COVID-19 patients (P = 0.279). Median hospital length of stay (LOS) was 16.50 (36.00) in improved vs. 15.00 (14.00) in died COVID-19 patients

Arterial Blood Gas Analysis showed non-statistically significant differences between both studied groups; (p-value> 0.05). Mean ±SD for PH was 7.38 ±0.06 in improved vs. 7.37 ±0.10 in died patients, (p= 0.500), Mean ±SD for pCO2 was 38.98 ±8.37 vs. 35.85 ±7.17, (p= 0.117) and Mean ±SD for HCO3 was 22.63 ±2.64 vs. 20.65 ±4.78, (p= 0.058).

Laboratory blood investigations (Table 2) for studied patients showed that neutrophils was significantly higher among died patients as compared with improved COVID-19 patients (8.20 ±6.58 vs. 5.64 ±3.00; p-value= 0.035), on the other hand Hemoglobin

concentration was significantly lower in the dead patients compared to the improved (11.91 ±2.12 vs. 13.18 ±2.05; p-value= 0.018). However, no significant difference was observed in terms of: WBCs, Platelets and Lymphocyte.

C - reactive protein (CRP) was significantly elevated in died as compared with improved patients (99.20 vs. 66.65; p-value= 0.013). The coagulation profile revealed an obvious elevation of D-dimer and prothrombin time (PT) among died as compared with improved patients (p-value= 0.030 and 0.005 respectively). Alkaline Phosphatase Level Test (ALP) was significantly higher in died as compared with improved patients (103.00 vs. 71.00; p-value= 0.008) at the same time; the albumin level in died group was lower (30.20 vs. 35.05, P-value= 0.008). The levels of lactate dehydrogenase (LDH) was higher among died patients; however the values showed non-statistically significant difference (467.00 vs. 544.00, p-value= 0.093) in improved and died patients respectively.

The NLR median value for the dead patients was found as 9.20 which was higher than the NLR median value for improved patients that was determined as 4.166, and the difference between the two groups was statistically significant (p= 0.007). The PLR median value for died patients was found as 308.33 which was higher than the PLR median value for improved group that was determined as 206.99, and the difference between two groups was statistically significant (p= 0.041).

Table (2): Comparison of Laboratory blood Investigations, coagulation profile and inflammatory markers according to disease outcome

		Improved N= 40	**Died N= 27**	***P-value***
WBC (10^9 /L)	**Mean ±SD**	7.23 ±2.9	8.79 ±4.7	0.102
Neutrophil (10^9 /L)	**Mean ±SD**	5.64 ±3.00	8.20 ±6.58	**0.035***
Lymphocyte (10^9 /L)	**Mean ±SD**	1.24 ±1.04	1.01 ±0.7	0.337
Platelets (10^9 /L)	**Mean ±SD**	240.50 ±89.96	262.74 ±96.10	0.338
HB	**Mean ±SD**	13.18 ±2.05	11.91 ±2.12	**0.018***
CRP (mg/L)	**Median (IQR)**	66.65 (72.83)	99.20 (100.80)	**0.013***
d dimer	**Median (IQR)**	1.22 (1.65)	2.69 (6.46)	**0.030***
LDH (U/l)	**Median (IQR)**	467.00 (255.50)	544.00 (453.00)	0.093

AST	**Mean ±SD**	47.20 ±27.15	54.11 ±24.96	0.295
ALT	**Mean ±SD**	39.52 ±39.94	35.59 ±24.14	0.649
ALP	**Median (IQR)**	71.00 (46.50)	103.00 (73.00)	**0.008***
Album	**Median (IQR)**	35.05 (6.48)	30.20 (9.00)	**0.008***
BILIRUBIN	**Median (IQR)**	8.50 (6.80)	8.60 (5.30)	0.222
Direct	**Mean ±SD**	3.61 ±1.45	4.48 ±2.63	0.086
Amylase	**Mean ±SD**	70.92 ±58.61	95.00 ±95.83	0.251
Creatine	**Min – Max**	121.25 ±113.10	170.00 ±231.69	0.256
Ck	**Min – Max**	597.32 ±1467.65	314.44 ±432.52	0.335
PT	**Min – Max**	13.33 ±4.3	15.78 ±8.7	**0.005***
NLR	**Median (IQR)**	4.166 (5.27)	9.20 (6.22)	**0.007***
PLR	**Median (IQR)**	206.99 (191.39)	308.33 (290.25)	**0.041***

Correlation between NLP and PLR with other studied variables is illustrated in Table (3). According to Spearman's rank correlation analysis, NLR showed moderate positive linear correlation with CRP (r= 0.352, p=0.003), D-dimer (r=0.370, p=0.002), ALP (r= 0.319, p=0.009) and with PT (r= 0.358, p=0.003) while it showed a negative moderate linear correlation with albumen level (r= -0.340, p= 0.005). PLR showed a moderate positive linear correlation with CRP (r= 0.320, p=0.008), and a slight positive linear correlation with D-dimer (r=0.266, p=0.030), ALP (r= 0.267, p=0.029), while it showed a negative moderate linear correlation with albumen level (r= -0.311, p= 0.010).

Table (3): Correlation between NLP and PLR with other studied variables:

		NLR	PLR
Age	**r**	0.206	0.218
	p-value	0.095	0.076
BM	**r**	0.060	0.109
	p-value	0.631	0.381
CRP	**r**	**0.352****	**0.320****
	p-value	**0.003**	**0.008**
d dimer	**r**	**0.370****	**0.266***
	p-value	**0.002**	**0.030**
LDH	**r**	0.000	-0.072
	p-value	0.997	0.560
AST	**r**	-0.027	-0.185
	p-value	0.827	0.134
ALT	**r**	-0.083	-0.190
	p-value	0.504	0.123
Album	**r**	**-0.340****	**-0.311***

	p-value	**0.005**	**0.010**
ALP	**r**	**0.319****	**0.267***
	p-value	**0.009**	**0.029**
BILIRUBIN	**r**	0.157	-0.087
	p-value	0.205	0.482
Direct	**r**	0.219	0.135
	p-value	0.075	0.276
Amylase	**r**	0.030	-0.085
	p-value	0.809	0.492
Creatinine	**r**	0.204	0.007
	p-value	0.097	0.957
Ck	**r**	0.034	-0.120
	p-value	0.782	0.333
PT	**r**	**0.358****	0.170
	p-value	**0.003**	0.169

Univariate Cox regression model analysis was done to identify the factors that affect COVID-19 progression (Table-4), diastolic blood pressure (HR 0.960, 95%CI 0.933 – 0.989), HCO3 (HR 0.879, 95% CI 0.801- 0.964), WBCs (HR 1.162, 95%CI 1.051 – 1.285), Neutrophils (HR 1.192, 95%CI 1.100- 1.291), CRP (HR 1.006, 95%CI 1.001 – 1.011), D-dimer (HR 1.042, 95%CI 1.005 – 1.080) and NLR (HR 1.083, 95% CI 1.030 – 1.139) were significantly correlated with death induced by COVID-19.

Table (4): Univariate Cox Regression Analysis

	B	**p-value**	**Hazard ratio (HR)**	**95.0% CI for HR**	
				Lower	**Upper**
Age	0.017	0.152	1.017	0.994	1.041
Female gender (vs. Male)	-0.477	0.219	0.621	0.290	1.328
DM	0.155	0.689	1.168	0.546	2.496
HTN	-0.157	0.686	0.855	0.400	1.827
CVD	0.001	0.999	1.001	0.401	2.497
Renal	-0.551	0.375	0.577	0.171	1.945
Lung (Normal as REF.)		0.183			
BA	9.873	0.933	19406.312	0.000	4.300
COPD	8.923	0.940	7503.768	0.000	1.670
ILD	12.144	0.918	187946.149	0.000	4.210
Sleep apnea	10.312	0.930	30086.396	0.000	6.730
BM	0.033	0.317	1.034	0.969	1.103
Systolic	-0.007	0.509	0.993	0.974	1.013
Diastolic	-0.040	**0.007***	0.960	0.933	0.989
HR	0.019	0.059	1.019	0.999	1.039

TEM	-0.074	0.774	0.928	0.558	1.544
RR	0.112	0.067	1.118	0.992	1.261
Sat	-0.009	0.533	0.991	0.964	1.019
PH	-2.804	0.179	0.061	0.001	3.622
CO2	-0.059	0.092	0.942	0.879	1.010
HCO3	-0.129	**0.006***	0.879	0.801	0.964
Fever	0.350	0.380	1.420	0.650	3.102
Cough	-0.389	0.321	0.677	0.314	1.462
SOB	-0.633	0.155	0.531	0.222	1.270
WBC	0.150	**0.003***	1.162	1.051	1.285
Neutrophil	0.175	**0.000***	1.192	1.100	1.291
Lymph	-0.408	0.111	0.665	0.403	1.098
platelets	0.002	0.378	1.002	0.998	1.006
HB	-0.151	0.083	0.860	0.725	1.020
CRP	0.006	**0.020***	1.006	1.001	1.011
D-dimer	0.041	**0.025***	1.042	1.005	1.080
LDH	0.001	0.180	1.001	1.000	1.003
AST	0.007	0.382	1.007	0.992	1.021
album	-0.055	0.097	0.947	0.888	1.010
PT	0.007	0.713	1.007	0.970	1.046
NLR	0.080	**0.002***	1.083	1.030	1.139
PLR	0.001	0.146	1.001	1.000	1.002

Considering the results of the univariate analysis; furthermore, the significant factors in univariate analysis (diastolic blood pressure, HCO3, WBCs, Neutrophil, CRP, D-dimer and NLR) were included in multi-variable Cox regression analysis, (Table-5).

Table (5): Multi-Variable Cox Regression Analysis:

			Hazard ratio (HR)	**95.0% CI for (HR)**	
	B	**Sig.**		**Lower**	**Upper**
Diastolic BP	-0.038	**0.017***	0.962	0.932	0.993
hco3	-0.020	0.695	0.980	0.885	1.085
WBC	-0.092	0.250	0.913	0.781	1.067
Neutrophil	0.187	**0.001***	1.206	1.079	1.349
CRP	0.003	0.271	1.003	0.997	1.010
D-dimer	0.041	0.104	1.042	0.992	1.095
NLR	0.019	0.654	1.019	0.937	1.109

Evaluated diastolic blood pressure (HR 0.962, 95%CI 0.932-0.993) and Neutrophil (HR 1.206, 95%CI 1.079 – 1.349) identified by multivariate Cox regression were considered independent factors associated with COVID-19 mortality.

Receiver operating characteristic (ROC) curve analysis was used to assess the discriminative ability of NLR and PLR for mortality among died as compared with improved COVID-19 patients (Figure-1).

The results of NLR (ROC) curve analysis showed p-value <0.05 so; the serum ratio diagnosed the mortality state at a statistically significant level with Area under the curve (AUC) = 0.697, (95% CI of AUC: 0.565 – 0.828), 81.5% Sensitivity (true positive cases) and 57.5% Specificity (true negative cases) at a cutoff point level ≥ 5.07.

The results of PLR (ROC) curve analysis showed p-value <0.05 so; the serum ratio diagnosed the mortality state at a statistically significant level with Area under the curve (AUC) = 0.648, (95% CI of AUC: 0.511 – 0.785), 74.1% Sensitivity (true positive cases) and 55.0%Specificity (true negative cases) at a cutoff point level ≥ 227.78.

According to the Kaplan-Meier curves (vertical distance), the probability of survival patients with COVID-19 in the subjects with NLR <5.07 was significantly higher (p-value< 0.001) as compared with those with NLR≥5.07; 43.6% of these patients would die with the mean time of 20.25 days, (Figure-2)

According to the Kaplan-Meier curves, the probability of survival patients with COVID-19 in the subjects with PLR <227.78 was significantly higher (p-value= 0.046) as compared with those with NLR≥5.07; 47.4% of these patients would die with the mean time of 22.80 days. (Figure-3)

4. Discussion:

Biomarkers that can provide a guide to disease progression, prognosis, and seriousness are of great significance. Health practitioners are looking for an easily available and low-cost prognostic marker to determine those who would progress to serious conditions among the patients of COVID-19. Therefore, the current study analyzed CBC indices between 67 ICU COVID-19 patients, to find the most appropriate indices that give a significant value in the follow-up of patients and in determining the prognosis.

In this study, the routine laboratory findings provide important insights on the strong association between the elevated level of NLR, PLR, and the mortality rate of COVID-19. It was found that the NLR was significantly higher in dead patients compared to improved patients which are concomitant with the results of several studies (9,10,16). Different clinical published

studies discuss the use of NLR as a prognostic marker for severe Covid-19 (17-19). In accordance with this data, our results indicate that neutrophils (HR 1.206, 95% CI 1.079 – 1.349) identified by multivariate Cox regression were considered independent risk factors associated with critically ill patients with COVID-19 mortality. Neutrophils were significantly higher among dead patients as compared with improved COVID-19 patients (8.20 ±6.58 vs. 5.64 ±3.00; p-value= 0.035), So far, our finding corresponding to the evaluation of the prognostic significance of PLR in critically ill COVID-19 represent as one of fewest studies in this point.

Another crucial component supporting the use of NLR in clinical practice is that it may help in the early detection of Covid-19 patients who will necessitate a more aggressive clinical management. In essence, survival analyses in our subject revealed that, the probability of survival patients with COVID-19 with NLR <5.07 was significantly higher (p-value< 0.001) as compared with those with NLR≥5.07; 43.6% of these patients died with the meantime of 20.25 days. While the probability of survival patients with COVID-19 in the subjects with PLR <227.78 was significantly higher (p-value= 0.046) as compared with those with NLR≥5.07; 47.4% of these patients died with the meantime of 22.80 days. NLR was found to be the most valuable among multiple variables in determining the severity of the disease by many studies (18-20).

The rationale behind the selection of NLR and PLR as predictor markers for critically ill patients with COVID-19 is that cheap, fast, reliable markers in the hospital and complete blood count with a differential profile can easily yield them. Neutrophils represent the most common form of peripheral WBC and play an important role in acute inflammation by migrating to the diseased tissues in response to chemotactic factor like IL8 (21). In addition, they carry an essential role in protecting the airway epithelium against COVID-19 infection by stimulating the production of IL-1 beta, IL-6, and tumor necrosis factor-alpha (TNF-alpha) (22).

The ability of the virus to infect T cells through the angiotensin-converting enzyme 2 (ACE2) receptors and the cluster of differentiation (CD) 147-spike proteins has been linked to the different mechanisms of lymphopenia in COVID-19 patients (23). The result was a decrease in CD3+, CD4+, and CD8+ T lymphocytes, as well as an increase in regulatory T cells. With T cell lymphopenia, the rise of proinflammatory cytokines predisposes severe COVID-19 patients to cytokine storms, resulting in increased lymphocytic apoptosis and multi-organ failure. Overall, decreased CD4+ and

CD8+ T-lymphocyte levels were more pronounced in critical cases proven that reveal to be a crucial point in suppressing the immune response so affecting disease severity (9,20,24), this was coincide with the reported cases in ICU (25).

NLR has been suggested as a biomarker for systemic inflammation, considering both neutrophil and lymphocyte levels. Increased neutrophil count and reduced lymphocyte count result in a high NLR. The inflammatory response can increase neutrophil output while also hastening lymphocyte apoptosis (26).

Also, platelets play an essential role in blood coagulation, immunity, angiogenesis, and inflammation. Thrombocytopenia occurs due to many factors, e.g., Hematopoietic cells were directly inhibited by coronavirus (27). as well as damage to pulmonary tissue and endothelial cells can cause platelet activation, accumulation, and retention in the lungs, as well as thrombus formation at the damaged area, leading to increased platelet consumption (28,29). Platelet factor 4 released by platelets can prevent agglutinin A from inhibiting lymphocyte generation, and activated platelets promote lymphocyte adhesion to the endothelium, and encouraging lymphocyte proliferation (30).

PLR selection has the advantage of reflecting both aggregation and immune responses, making it potentially more useful than platelet or lymphocyte counts alone in predicting different inflammations (31), the raise in PLR was related to poor prognosis on COVID-19 (25,26). As a result, it is reasonable to state that NLR and PLR represent imbalance among these immune cells, which could be attributed to severe inflammation and poor survival in patients with COVID-19.

The analysis of results showed NLR can assess the mortality state at a statistically significant (p-value <0.05) level with 81.5% sensitivity (true positive cases) and 57.5% specificity (true negative cases) at a cutoff point level ≥ 5.07. This finding was comparable to the study by Wang et al., 2020[10] who assess the mortality rate at a statistically significant (p-value <0.001) level with a sensitivity of 100.0% and a specificity of 84.0%. While the results of PLR result analysis showed a p-value <0.05 so; the serum ratio suspect the mortality state at a statistically significant level with 74.1% sensitivity (true positive cases) and 55.0% specificity (true negative cases) at a cutoff point level ≥ 227.78.

Other laboratory blood investigations for studied patients showed that hemoglobin and albumin concentration was significantly lower in dead patients. Although C - reactive protein (CRP) D-dimer and prothrombin time

(PT) Alkaline Phosphatase Level Test (ALP) were significantly elevated in died as compared with improved patients, those data coincide with several published data about biomarkers of COVID-19 severity (19,31,32).

5. Conclusion:

In conclusion, this study revealed that the NLR is an independent risk factor for mortality in hospitalized patients with confirmed COVID-19. Also, the PLR reflects severity, which could be used as an indicator for monitoring of COVID-19 patients.

Declaration of competing interest

The authors declared no conflict of interest.

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