JOURNAL OF COMMUNITY HOSPITAL INTERNAL MEDICINE PERSPECTIVES
2020, VOL. 10, NO. 6, 514–520
https://doi.org/10.1080/20009666.2020.1816276

Hematological parameters predicting severity and mortality in COVID-19 patients of Pakistan: a retrospective comparative analysis

Muhammad Sohaib Asghar [a], Noman Ahmed Khan[b], Syed Jawad Haider Kazmi[c], Aftab Ahmed[d], Maira Hassan [e], Rumael Jawed[f], Mohammed Akram[e], Uzma Rasheed [e], Gul Muhammad Memon[e], Muhammad Umer Ahmed [g], Umme Tahniyat[e] and Syeda Batool Tirmizi[h]

[a]Resident Physician of Internal Medicine, Dow University of Health Sciences, Karachi, Pakistan; [b]Resident of General Surgery, Liaquat National Hospital & Medical College, Karachi, Pakistan; [c]Resident of Emergency Medicine, Liaquat National Hospital & Medical College, Karachi, Pakistan; [d]Emergency Medicine, Liaquat National Hospital & Medical College, Karachi, Pakistan; [e]Intern of Internal Medicine, Liaquat National Hospital & Medical College, Karachi, Pakistan; [f]Intern of General Surgery, Liaquat National Hospital & Medical College, Karachi, Pakistan; [g]Resident Physician of Internal Medicine, Ziauddin University Hospital, Karachi, Pakistan; [h]Medical Officer of General Surgery, Memon Medical Institute Hospital, Karachi, Pakistan

ABSTRACT

Background and Objectives: COVID-19 is a global pandemic. In our study, we aimed to utilize the hematological parameters in predicting the prognosis and mortality in COVID-19 patients.

Materials and methods: A retrospective, observational study was conducted to include all the admitted patients (n = 191) having COVID-19 Polymerase chain reaction (PCR) positive, and evaluated those for prognosis and disease outcome by utilizing several biochemical and hematological markers.

Results: Amongst the patients admitted in the ward versus in the intensive care unit (ICU), there were significant differences in mean hemoglobin (P = 0.003), total leukocyte count (P = 0.001), absolute neutrophil and lymphocyte counts (P < 0.001), absolute monocyte count (P = 0.019), Neutrophil-to-Lymphocyte ratio (NLR) and Lymphocyte-to-Monocyte ratio (LMR) (P < 0.001), Platelet-to-Lymphocyte ratio (PLR) and Lymphocyte-to C-reactive protein ratio (LCR) (P = 0.002), and C-reactive protein (CRP) levels (P < 0.001). Amongst the deceased patients, there was significant leukocytosis (P = 0.008), neutrophilia and lymphopenia (P < 0.001), increased NLR (P = 0.001), decreased LMR (P < 0.001), increased PLR (p = 0.017), decreased LCR (p = 0.003), and elevated CRP level (P < 0.001). A receiver operating characteristic curve obtained for the above parameters showed NLR (AUC: 0.841, PPV: 83.6%) and PLR (AUC: 0.703, PPV: 81.8%) for ICU patients, while NLR (AUC: 0.860, PPV: 91.1%) and PLR (AUC: 0.677, PPV: 87.5%) for the deceased patients had significant accuracy for predicting the disease severity of COVID-19 in comparison to survivors.

Conclusion: The inflammatory markers and hematological indices are a good guide for predicting the severity and disease outcome of coronavirus disease. NLR and PLR are elevated in severe disease while LMR and LCR are inversely correlating with disease severity.

ARTICLE HISTORY
Received 7 July 2020
Accepted 25 August 2020

KEYWORDS
COVID-19; coronavirus; hematological parameters; biochemical markers; pandemic; indices; survivors; mortality; intensive care; infectious disease

1. Introduction

COVID-19 is a global pandemic, also affecting Pakistan with 287,300 cases, and 6153 deaths as of 14 August 2020. Many hematological parameters are currently been utilized to predict outcomes and mortality in patients infected with SARS CoV-2. The neutrophil to lymphocyte ratio (NLR), is an inflammatory mediator used as predictor of systemic inflammation [1]. Numerous studies conducted around globe have reported about neutrophil to lymphocyte ratio (NLR) as a predictor of prognosis in a variety of cancers (breast, ovary, lung), cardiovascular disorders (coronary procedures and coronary artery bypass grafting), infectious disorders (community-acquired pneumonia, corona) and sepsis in general [1–5].

Neutrophil to lymphocyte ratio (NLR) is promptly accessible parameter calibrated entirely through a report of complete blood count (CBC); it is economical and simple as compared to the rest of mediators making it potential diagnostic criterion [2–4]. Neutrophil to lymphocyte ratio (NLR) is a prominent predictor of severity of disease, if high levels are detected it determines poor prognosis and high mortality within patients of intensive care units [3–5]. Elevating levels of neutrophil to lymphocyte ratio (NLR) projects towards the prediction of mortality among sufferers of acute coronary syndrome, intracerebral hemorrhage, polymyositis, dermatomyositis, and cancers [6,7]. Inflammatory states of the body triggers excessive yield of neutrophils and simultaneously bringing about apoptosis of lymphocytes thus proceeding towards immunological aberration in body and

CONTACT Muhammad Sohaib Asghar sohaib_asghar123@yahoo.com Resident Physician of Internal Medicine, Dow University of Health Sciences, Karachi 73500, Pakistan

potentiating severity of disorder and chances of death [6]. Elevated levels of neutrophil to lymphocyte ratio (NLR) have genetic predilection directed towards males as compared to females in terms of severity of disease [8]. Age of sufferer also plays a vital role in outcomes of neutrophil to lymphocyte ratio (NLR) as this ratio is elevated among the elder population (50- >70 years) as compared to sufferers of younger age group [4]. Racial differences are also reported to be encountered in outcomes of neutrophil to lymphocyte ratio as the values are elevated highly among western populations in comparison with the African and Asian populations [9].

The platelet to lymphocyte ratio (PLR) is also an effective inflammatory mediator utilized in predicting the prognosis of many disorders and mortality among patients [4,10,11]. Platelet to lymphocyte ratio (PLR) is an indicator of prognosis in cardiovascular diseases, rheumatic disorders, infectious diseases, and organ injuring disorders such as systemic erythematous lupus (SLE) and malignancies [10,12] Platelets have dual properties involving both hemostasis and immunity [13,14]. This ratio is easily accessible and is calibrated by a complete blood count (CBC) test [15]. The platelet to lymphocyte ratio is also dependent upon age and gender, with women detected with elevated PLR at the age of 30–59 and decreased levels at the age of 50 as compared to males [15]. Elevated levels of platelet to lymphocyte ratio (PLR) are associated with increased severity and high mortality [15].

The monocyte to lymphocyte ratio (LMR), is also an immune mediator in line with NLR and PLR [16]. The high count of monocytes and low count of lymphocytes are suggestive of increased incidence of mortality and decline of prognosis among patients with severe disease [17]. The monocyte to lymphocyte ratio is an indicator of the prognosis of cardiovascular diseases, a variety of malignancies, autoimmune diseases, and chronic infections like tuberculosis [18].

The lymphocyte to the C-reactive protein ratio (LCR) is another marker linked with severity of the disease [7]. LCR is utilized as a systemic inflammatory mediator predicting the mortality and prognosis in patients with malignancies like colorectal and gastric carcinoma [19]. Sufferers of malignancies with low pre-operative LCR reported to have declined in prognosis as compared to patients with high pre-operative LCR [19]. In our study, we aimed to utilize all these hematological and biochemical parameters in predicting the prognosis and mortality in patients of COVID-19. The study focused on all the hospital admissions, severity of disease with length of hospital stay, and the correlation amongst them.

2. Materials and methods

The study was conducted as a single centered, retrospective, observational study, started from 27 February till 30 June 2020, and including all patients who were diagnosed as COVID-19 positive via Polymerase Chain Reaction (PCR). The outcomes of the disease were followed along with the hospital course at the time of analysis. Out of the total 191 patients admitted, 106 were recovered and discharged with negative PCR for COVID-19, 41 patients who remain asymptomatic were discharged for home isolation without PCR being negative. A total of 44 deaths occurred due to COVID-19, out of whom 19 patients were admitted to ICU for critical care management and ventilators.

The following hematological parameters were used to determine the severity of the disease and predicting the outcomes:

2.1. Neutrophil to lymphocyte ratio (NLR)

It was first created and used by Sato, et al. in the chemotherapeutic response of esophageal carcinoma in 2012 [20]. We calculated NLR by dividing the relative percentage of neutrophils by lymphocytes. Normally, it should be below 3, but a ratio of above 3 signifies acute stress, and a ratio of more than 9 signifies sepsis. But variability occurs in populations regarding the cut-off value of NLR with some studies suggesting a cut-off value of 4 [1].

2.2. Lymphocyte to monocyte ratio (LMR)

It was calculated by dividing absolute lymphocyte count ($x10^3$ cells/uL) with absolute monocyte count ($x10^3$ cells/uL) [17]. The normal range is 3–9 with variability amongst populations [4].

2.3. Platelet to lymphocyte ratio (PLR)

It was calculated by dividing absolute platelet counts ($x10^3$ cells/uL) with absolute lymphocyte count ($x10^3$ cells/uL), which usually lies in between 50 and 150 but subjected to variability amongst populations [4].

2.4. Lymphocyte to C-reactive protein ratio (LCR)

This marker was calculated by dividing the absolute lymphocyte count (number/uL) with CRP levels (mg/dl) [19]. The usual values of CRP were calculated in our laboratory as g/dL; hence, it was converted into mg/dl and lymphocytes ($x10^3$ cells/uL) were also converted into absolute counts (number/uL) before calculating this ratio.

2.5. Statistical analysis

The statistical analysis was conducted by the Statistical Package for the Social Sciences (SPSS version 25.0). All continuous variables were described as both mean & standard deviation as well as median &

interquartile range. The means were then compared using both independent sample t-test and Mann–Whitney U-test, and amongst them, the p-value was considered more significant according to Levene statistics. The comparison of categorical data was done either using the Chi-square test or Fisher's exact test according to the limitation of data. In a paired sample t-test, each subject or entity was measured twice, resulting in pairs of observations (such as the progress of labs before and after treatment). A p-value of <0.05 was considered statistically significant. All the highly significant values were rounded off as <0.001.

3. Results

The mean age of the study population was 52.65 ± 16.13 with females slightly younger than males (P = 0.232). The most common age group has been 50–75 years with two-thirds of them being males (P = 0.469). The majority of the patients were having mild to moderate symptoms hence admitted in isolation ward (68.07%), while rest 31.93% having a severe disease were admitted in the Intensive care unit (ICU). The length of the hospital was significantly more in ICU patients (P = 0.001) as shown in Table 1. The descriptive statistics of admitting laboratory investigations are given in Table 2.

Amongst the patients admitted in the ward vs in ICU, there were significant differences in mean hemoglobin (P = 0.003), total leukocyte count (P = 0.001), absolute neutrophil and lymphocyte counts (P < 0.001), absolute monocyte count (P = 0.019), NLR and LMR (P < 0.001), PLR and LCR (P = 0.002), as shown in Table 3. Amongst the deceased patients, there was significant leukocytosis (P < 0.008), neutrophilia and lymphopenia (P < 0.001), increased NLR (P = 0.001), decreased LMR (P < 0.001), increased PLR (P = 0.017), and decreased LCR (P = 0.003), as shown in Table 4.

A receiver operating characteristic (ROC) curve obtained for the above parameters showed NLR (AUC: 0.841, PPV: 83.6%) and PLR (AUC: 0.703, PPV: 81.8%) for ICU patients, while NLR (AUC: 0.860, PPV: 91.1%) and PLR (AUC: 0.677, PPV: 87.5%) for the deceased patients had significant accuracy in predicting the disease severity of COVID-19 as shown in Table 2 as well as Figures 1 and 2. LMR and LCR were found inversely related to the severity of the disease.

4. Discussion

In this study majority of individuals included in our study population reported ages above 50 years with a study population of 54 individuals comprising a majority of males. In our study, we detected elevated counts of neutrophils (neutrophilia) but in contrast, low lymphocyte counts (lymphopenia) thus resulting in an elevated ratio of neutrophil-to-lymphocyte ratio in critically ill suffering for coronavirus disease 19 (COVID-19) coinciding with outcomes of several studies [6–8,11,21–25]. In our study, we also detected significantly high counts of neutrophils and lowest counts of lymphocytes along with prominent elevation of neutrophil-to-lymphocyte ratios among patients with refractory disease admitted to intensive care units and deceased patients when compared with patients in isolation wards and at initial phases of disease synchronizing with detections of numerous studies [6–8,21–25]. Total leukocyte count (TLC) was significantly elevated in patients who are critically infected or deceased in comparison with patients in isolation wards or recovered correlating with findings of countable studies [6–8,21–25]. Prominently elevated levels of neutrophil-to-lymphocyte ratio in deceased patients were detected in our study rendering NLR as a predictor of mortality thus independent parameter for prognosis among sufferers of coronavirus disease (COVID-19) this outcome detected in our study coincides with results and findings of several studies [6–8,21–25]. In our study median of patients residing within isolation wards and median of patients under critical condition is in similar accord in comparison with a study conducted in similar patterns thus coinciding with our findings [6,7,11,21–25].

In our study, elevated count of platelets (thrombocytosis) was detected in patients of coronavirus disease (COVID-19) at time of initial phase of infection (admission) and critical phase of infection (intensive care unit) and death as compared with patients in isolation wards or recovered synchronizing with outcomes of countable studies [11]. In contrast, a decline in counts of lymphocytes (lymphocytopenia) was detected in patients of critical phase thus resulting in predominant high levels of platelet-to-lymphocyte ratio among sufferers under treatment in intensive care units or deceased as compared with sufferers in their initial phase of infection (admission) or residing in isolation wards thus proving platelet-to-lymphocyte ratio as one of independent mediator predicting prognosis and mortality in critically ill sufferers correlating with the outcome of another study [11]. The means of platelet-to-lymphocyte ratio detected among patients under treatment in the isolation ward and intensive care units coincide with the means of the study mentioned above [11].

In our study, elevated counts of monocytes and decreased counts of lymphocyte (lymphocytopenia) were detected among patients under treatment in intensive care units or deceased as compared with patients admitted at recent intervals or in isolation wards coinciding with findings of negligible study [26]. Increased

Table 1. Showing Demographic data of the study population.

S. no	Table 1: Demographic data of the study population (n = 191).				p-Value
1	Mean age in years Median (IQR) Males (n = 128) 54.04 ± 15.68 (43.50–67.00)	52.65 ± 16.13 55.00 (39.00–65.00) Mean: Median: 55.50 IQR:			- 0.232* 0.300**
	Females (n = 63) Median: 54.00 IQR: (38.00–64.50)		Mean: 49.68 ± 16.93		
2	Age groups (M: males, F: females)	0–50 80	51–75	>75	0.469^
	(41.88%) 103 (53.92%) 08 (4.18%) M: 54, F: 26 M: 67, F: 36 M: 7, F: 1				
3	Confirmation of diagnosis Nasopharyngeal swab (PCR): 86 (45.02%) - Oropharyngeal swab (PCR): 105 (54.97%)				
4	Travel history Positive: 24 (12.56%) Negative: 79 (87.43%) -				
5	Occupation Medical: 19 (9.94%) Non-medical: 82 (90.05%) -				
6	Hospital stay Isolation ward: 130 (68.07%) Males: 84 (64.6%), Females: 46 (35.4%) Intensive care unit: 61 (31.93%) Males: 44 (72.1%), Females: 17 (27.9%) 0.676"				
7	Length of Hospital stay Mean Median IQR Range - All patients 9.18 ± 5.80 7.00 6.0–11.0 2–31 Ward 7.29 ± 3.90 7.00 4.0–9.0 2–22 **0.001*** **0.001**** ICU 12.35 ± 7.04 11.50 7.0–17.0 2–31 Recovered 8.98 ± 6.20 7.00 5.25–10.75 2–31 0.604* 0.235** Deceased 9.78 ± 4.51 9.00 6.0–13.0 2–18				
8	Recovered patients: 55.49% (n = 106) Mean no. of PCR performed: 3.72 ± 1.12 - Home isolation after only 1 PCR 41 (21.46%) No. of deceased patient 44 (23.03%)				

** indicates p-Value calculated by independent sample t-test.*
" indicates p-Value calculated by chi-square test.
^ indicates p-Value calculated by fisher's exact test.
*** indicates p-Value calculated by Mann-Whitney U test.*

monocytes and decreased lymphocytes result in decreased lymphocyte-to-monocyte ratio among patients of ICU or deceased thus rendering declined ratio of lymphocyte-to-monocyte as an indicator of poor prognosis and increased chances of mortality among patients suffering from coronavirus disease correlating with few studies [26]. The mean value of the lymphocyte-to-monocyte ratio coincides with the mean of another study calculating LMR in coronavirus disease patients [26].

Elevated levels of C-reactive protein and decrease in lymphocyte count (lymphocytopenia) were observed within outcomes of study resulting in declined lymphocyte-to-C reactive protein ratio (LCR) within patients critically ill or deceased as compared to outcomes of patients in isolation wards or recovered coinciding with results of a countable study [7]. A decrease in the lymphocyte-to-C reactive protein ratio is suggestive of poor prognosis and potential mortality among sufferers of coronavirus disease (COVID-19) [7].

5. Conclusions

The inflammatory markers and hematological parameters are a good guide for predicting the severity and disease outcome, but the in-hospital management causing changes to these parameters are not predictory to overall mortality or therapeutic benefits, hence these parameters are limited for initial survey only till further extensive studies take place on follow-up laboratory investigations. The hematological markers known to be elevated in the current pandemic were NLR and PLR, but LMR and LCR were considered to be of a lesser concern, however, they are directly correlating with disease severity in our study. NLR and PLR are more likely to be elevated in severe disease as well as LMR and LCR are inversely correlating with disease severity and mortalities.

Disclosure statement

The authors declare no conflicts of interest with this article's content.

Funding

This work is not supported by any sponsors. No funding required in this study.

Table 2. Showing descriptive laboratory investigations at admission amongst the patients of COVID-19.

Table 2: Descriptive laboratory investigations at admission amongst the patients of COVID-19 (n = 191).

#	Laboratory investigations	Mean ± SD	95% confidence interval (CI)	Median	Interquartile range (IQR)
1	**Hemoglobin**	12.73 ± 2.31	12.24–13.22	12.90	11.20–14.30
2	**MCV**	81.77 ± 8.49	79.95–83.59	83.00	77.00–87.00
3	**Platelets**	249.21 ± 107.89	226.22–272.21	226.00	185.00–300.00
4	**TLC**	10.26 ± 7.09	8.75–11.78	8.10	5.60–11.60
3	**Neutrophils (%)**	70.58 ± 15.22	67.34–73.83	72.00	61.00–83.00
	Lymphocytes (%)	20.75 ± 12.95	17.99–23.51	20.00	9.00–30.00
	Monocytes (%)	6.83 ± 3.08	6.18–7.49	6.00	5.00–9.00
	Eosinophils (%)	1.50 ± 2.03	1.07–1.94	1.00	0.00–2.00
	Basophils (%)	0.10 ± 0.34	0.03–0.17	0.00	0.00–0.00
5	**NLR**	6.66 ± 7.50	5.05–8.26	3.70	2.00–9.33
	Ward	AUC: 0.159	CI: 0.076–0.242	S.E: 0.042	PPV: 83.6%
	ICU (cut off: 5.48)	**0.841**	**0.758–0.924**	**P < 0.001**	NPV: 68.8%
	Recovered	0.140	0.065–0.216	S.E: 0.039	PPV: 91.1%
	Death (cut off: 5.67)	**0.860**	**0.784–0.935**	**P < 0.001**	NPV: 54.8%
6	**LMR**	3.15 ± 1.66	2.79–3.50	3.00	1.90–4.25
	Ward	AUC: 0.773	CI: 0.672–0.875	S.E: 0.052	PPV: 39.0%
	ICU (cut off: 2.85)	**0.227**	0.125–0.328	**P < 0.001**	NPV: 13.0%
	Recovered	0.813	0.716–0.910	S.E: 0.050	PPV: 42.9%
	Death (cut off: 2.05)	**0.187**	**0.090–0.284**	**P < 0.001**	NPV: 10.2%
7	**PLR**	190.01 ± 123.74	163.64–216.39	147.55	105.82–231.87
	Ward	AUC: 0.297	CI: 0.170–0.423	S.E: 0.065	PPV: 81.8%
	ICU (cutoff: 193.40)	**0.703**	**0.577–0.830**	**P = 0.002** S.E: 0.076	NPV: 65.6%
	Recovered	0.323	0.175–0.472	**P = 0.013**	PPV: 87.5%
	Death (cutoff: 201.16)	**0.677**	**0.528–0.825**		NPV: 48.4%
8	**LCR**	2152.22 ± 4833.10	1090.27–3214.17	192.10	54.32–961.01
	Ward	AUC: 0.794	CI: 0.693–0.894	S.E: 0.051	PPV: 34.2%
	ICU (cut off: 177.07)	**0.206**	**0.106–0.307**	**P < 0.001**	NPV: 13.6%
	Recovered	0.839	0.741–0.937	S.E: 0.050	PPV: 35.7%
	Death (cut off: 84.55)	**0.161**	**0.063–0.259**	**P < 0.001**	NPV: 7.4%
9	**CRP** (n = 83)	112.39 ± 106.19	89.20–135.57	86.40	16.00–176.00
10	**LDH** (n = 53)	578.83 ± 385.67	472.52–685.13	439.00	277.50–800.50
11	**Ferritin** (n = 57)	689.54 ± 753.07	489.72–889.35	316.46	125.27–953.26
12	**Procalcitonin** (n = 29)	4.56 ± 14.84	−1.08–10.20	0.30	0.05–1.21
13	**Troponin I** (n = 17)	128.26 ± 161.80	45.07–211.45	27.70	8.40–234.30
14	**Pro-BNP** (n = 13)	23,630.23 ± 59,035.61	−12,044.63–59,305.05	4224.10	402.15–15,509.10
15	**ESR** (n = 8)	78.25 ± 42.71	42.54–113.95	90.00	30.00–119.50
16	**D-Dimer** (n = 14)	2.61 ± 2.62	1.09–4.12	1.53	0.57–3.92

NLR: neutrophil to lymphocyte ratio, LMR: lymphocyte to monocyte ratio, PLR: platelet to lymphocyte ratio,
LCR: lymphocyte to C-reactive protein ratio, CRP: C-reactive protein, MCV: mean cell volume, TLC: total leukocyte count, LDH: lactate dehydrogenase, BNP: brain natriuretic peptide, ESR: erythrocyte sedimentation rate.
AUC: area under curve, CI: 95% confidence interval, S.E: standard error of mean, P: probability, PPV: positive predictive value, NPV: negative predictive value.

Table 3. Showing a comparison of initial laboratory investigations amongst the patients of COVID-19.

Table 3: Comparison of initial laboratory investigations amongst the patients of COVID-19.

		Ward (n = 130)	ICU (n = 61)		(Ward n = 130)	(ICU n = 61)	
#	Laboratory investigation	Mean ± Standard deviation		p-Value	Median (Inter-quartile range)		p-Value
1	**Hemoglobin** (g/dl)	13.26 ± 2.31	11.78 ± 2.00	**0.003***	13.35 (11.72–14.90)	11.90 (10.60–13.30)	**0.004**^
2	**MCV** (fL)	83.56 ± 7.38	78.43 ± 9.50	**0.013***	84.00 (80.00–88.67)	80.50 (73.50–85.50)	**0.016**^
3	**Platelets** (10^9/L)	236.64 ± 77.84	271.93 ± 146.40	0.145*	224.00 (185.25–275.00)	244.00 (182.00–334.00)	0.410^
4	**TLC** (10^9/L)	8.06 ± 4.22	14.24 ± 9.28	**0.001***	6.85 (5.30–9.17)	11.10 (7.80–17.90)	**<0.001**^
	Neutrophils (%)	64.91 ± 14.86	80.83 ± 9.52	**<0.001***	66.00 (56.25–74.75)	83.00 (75.00–88.00)	**<0.001**^
	Lymphocytes (%)	25.96 ± 12.54	11.35 ± 7.11	**<0.001***	26.00 (18.25–33.75)	9.00 (6.00–17.00)	**<0.001**^
	Monocytes (%)	7.41 ± 2.92	5.80 ± 3.15	**0.019***	6.00 (6.00–10.00)	5.00 (3.00–7.00)	**0.009**^
	Eosinophils (%)	1.48 ± 1.95	1.54 ± 2.21	0.886*	1.00 (0.00–2.00)	1.00 (0.00–3.00)	0.674^
	Basophils (%)	0.12 ± 0.33	0.06 ± 0.35	0.433*	0.00 (0.00–0.00)	0.00 (0.00–0.00)	0.173^
5	**Neutrophil to lymphocyte ratio**	4.01 ± 4.24	11.43 ± 9.60	**<0.001***	2.45 (1.54–4.21)	9.77 (4.52–14.50)	**<0.001**^
	Lymphocyte to monocyte ratio	3.67 ± 1.65	2.20 ± 1.20	**<0.001***	3.45 (2.49–4.72)	2.00 (1.20–2.80)	**<0.001**^
	Platelet to lymphocyte ratio	152.60 ± 74.16	257.60 ± 162.71	**0.002***	134.22 (105.41–184.58)	224.76 (140.64–349.61)	**0.002**^
	Lymphocyte to CRP ratio	3212.26 ± 5808.90	408.29 ± 1333.01	**0.002***	391.95 (140.00–4494.23)	68.43 (40.32–158.89)	**<0.001**^
6	**CRP** (mg/L)	75.84 ± 89.30	173.70 ± 105.21	**<0.001***	35.40 (7.10–115.60)	152.30 (105.10–276.30)	**<0.001**^
7	**LDH** (U/L)	454.25 ± 339.89	821.05 ± 360.35	**0.001***	353.00 (261.00–567.00)	806.00 (563.26–975.75)	**<0.001**^
8	**Ferritin** (ng/mL)	492.44 ± 631.51	1083.73 ± 835.79	**0.011***	204.73 (116.61–592.48)	907.50 (360.11–2000.00)	**0.012**^
9	**Procalcitonin** (ng/mL)	0.23 ± 0.43	5.46 ± 16.22	0.484*	0.06 (0.02–0.06)	0.39 (0.06–2.07)	0.112^

** indicates P-value calculated by independent sample t-test. ^ indicates P-value calculated by Mann-Whitney U test.*

Table 4. Showing a comparison of initial laboratory investigations with the prognosis of COVID-19 patients.

Table 4: Comparison of initial laboratory investigations with prognosis of COVID-19 patients.

#	Laboratory investigation	Recovered+Home isolation (n = 147)	Deceased (n = 44)		Recovered+Home isolation (n = 147)	Deceased (n = 44)	
		Mean ± Standard deviation		p-Value	Median (Inter-quartile range)		p-Value
1	**Hemoglobin** (g/dl)	12.82 ± 2.39	12.46 ± 2.09	0.532*	13.10 (11.20–14.55)	12.55 (11.30–13.42)	0.334^
2	**MCV** (fL)	82.54 ± 8.27	79.54 ± 8.91	0.154*	83.50 (78.00–87.00)	80.50 (75.00–85.50)	0.159^
3	**Platelets** (x10^9/L)	249.58 ± 103.56	248.13 ± 122.42	0.957*	226.00 (185.50–299.00)	238.00 (180.00–313.75)	0.992^
4	**TLC** (x10^9/L)	8.71 ± 5.27	14.86 ± 9.56	**0.008***	7.30 (5.30–10.20)	11.35 (7.35–20.42)	**0.001^**
	Neutrophils (%)	66.33 ± 15.01	83.13 ± 6.47	**<0.001***	67.00 (57.50–77.50)	83.00 (77.00–88.00)	**<0.001^**
	Lymphocytes (%)	24.47 ± 12.64	9.77 ± 5.52	**<0.001***	23.00 (15.00–33.00)	8.00 (5.75–14.50)	**<0.001^**
	Monocytes (%)	7.16 ± 2.97	5.86 ± 3.28	0.086*	6.00 (5.00–10.00)	5.50 (3.75–7.00)	**0.042^**
	Eosinophils (%)	1.76 ± 2.22	0.72 ± 1.07	**0.005***	1.00 (0.00–2.50)	0.00 (0.00–1.00)	**0.011^**
	Basophils (%)	0.13 ± 0.39	0.00 ± 0.00	0.101*	0.00 (0.00–0.00)	0.00 (0.00–0.00)	0.086^
5	**Neutrophil-to-lymphocyte ratio**	4.56 ± 4.84	12.86 ± 10.27	**0.001***	3.00 (1.70–5.13)	10.56 (5.50–15.59)	**<0.001^**
	Lymphocyte-to-monocyte ratio	3.57 ± 1.63	1.88 ± 0.98	**<0.001***	3.33 (2.47–4.63)	2.00 (1.20–2.87)	**<0.001^**
	Platelet-to-lymphocyte ratio	165.34 ± 91.81	263.14 ± 171.80	**0.017***	139.96 (105.41–203.61)	220.33 (130.48–353.26)	**0.013^**
	Lymphocyte-to-CRP ratio	2796.12 ± 5445.81	396.13 ± 1536.71	**0.003***	347.98 (106.06–4626.42)	52.51 (30.32–82.41)	**<0.001^**
6	**CRP** (mg/L)	82.07 ± 92.20	196.45 ± 98.37	**<0.001***	36.00 (8.70–124.30)	174.85 (132.07–311.97)	**<0.001^**
7	**LDH** (U/L) (703.00–1029.25)	480.24 ± 339.46	915.67 ± 352.28	**0.001***	393.00 (262.00–579.50)	847.00	
		<0.001					
8	**Ferritin** (ng/mL) (416.93–2000.00)	575.79 ± 712.22	1074.52 ± 787.94	0.055*	224.99 (114.41–781.50)	726.30	
		0.015					
9	**Procalcitonin** (ng/mL)	6.53 ± 21.45	2.96 ± 6.05	0.529*	0.06 (0.02–0.81)	0.47 (0.11–2.07)	**0.041^**

** indicates p-Value calculated by independent sample t-test. ^ indicates p-Value calculated by Mann-Whitney U test.*
*** indicates p-Value calculated by Fisher's Exact test. " indicates p-Value calculated by Chi-square test.*

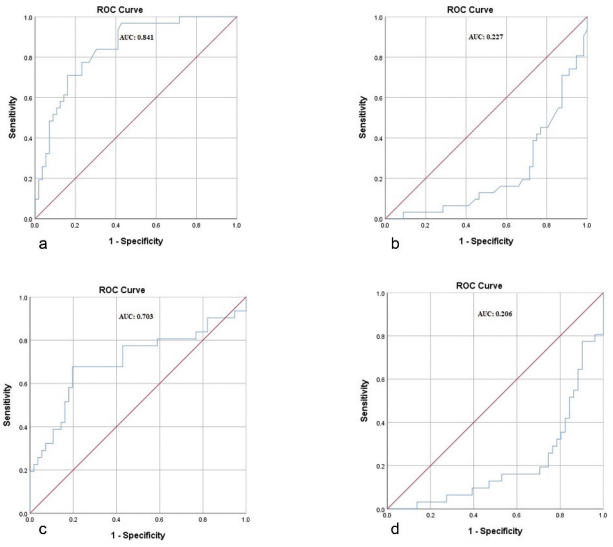

Figure 1. Showing the ROC curve for predicting the severity of Covid-19 in ICU patients.

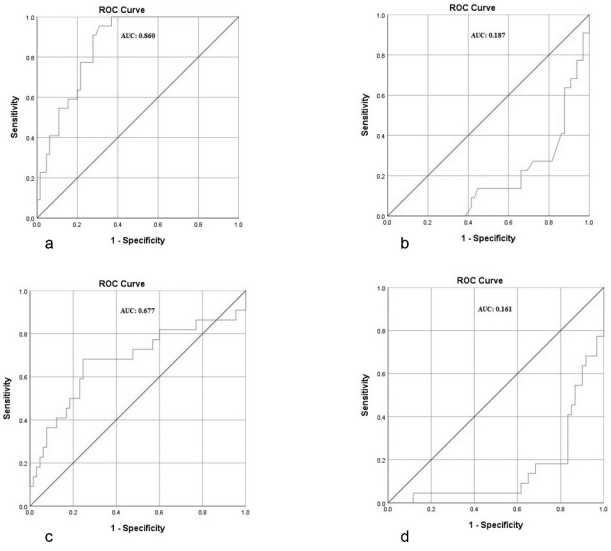

Figure 2. Showing the ROC curve for predicting the severity of COVID-19 in deceased patients.

Ethical approval statement

Ethical approval was taken in this study from the institutional review board and consent to participate has been taken from all the patient's guardians with informed written consent.

ORCID

Muhammad Sohaib Asghar http://orcid.org/0000-0001-6705-2030
Maira Hassan http://orcid.org/0000-0001-6092-0552
Uzma Rasheed http://orcid.org/0000-0003-0596-7766
Muhammad Umer Ahmed http://orcid.org/0000-0002-3796-5792

References

[1] Martins EC, Silveira LDF, Viegas K, et al. Neutrophil-lymphocyte ratio in the early diagnosis of sepsis in an

intensive care unit: a case control study. Rev Bras Ter Intensiva. 2019;31(1):63–70.
[2] Ahmed MAS, Mohammed SA. Neutrophil-to-lymphocyte ratio as a prognostic marker in clinically-ill septic patients. Res Opinion Anesthesia Intensive Care. 2018;5:279–286.
[3] Ni J, Wang H, Li Y, et al. Neutrophil to lymphocyte ratio (NLR) as a prognostic marker for in- hospital mortality of patients with sepsis. A secondary analysis based on single-center, retrospective cohort- study. Medicine (Baltimore). 2019;98:46.
[4] Lee JS, Kim NY, Na SH, et al. Reference value of neutrophil-lymphocyte ratio, lymphocyte-monocyte ratio, platelet-lymphocyte ratio, and mean platelet volume in healthy adults in South Korea. Medicine (Baltimore). 2018;97:26.
[5] Arif SK, Rukka ABS, Wahyuni S. Comparison of neutrophils-lymphocytes ratio and procalcitonin parameters in sepsis patient treated in intensive care unit Dr. Wahidin hospital, Makassar, Indonesia. J Med Sci. 2017;17(1):17–21.
[6] Liu Y, Du X, Chen J, et al. Neutrophil- lymphocyte ratio as an independent risk factor for mortality in hospitalized patients with COVID-19. J Infect. 2020;17:28.
[7] Rangel FAL. Neutrophil-to-lymphocyte ratio and lymphocyte-to-C reactive protein in patients with severe coronavirus disease 2019 (COVID-19): A meta-analysis. J Med Virol. 2020. DOI:10.1002/jmv.25819
[8] Mo P, Xing Y, Xiao Y. Clinical characteristics of refractory COVID-19 pneumonia in Wuhan, China. Clinical infectious diseases: an official publication of the infectious diseases society of America. Clin Infect Dis. 2020. DOI:10.1093/cid/ciaa270
[9] Yamanaka T, Matsumoto S, Teramukai S, et al. The baseline ratio of neutrophils to lymphocytes is associated with patient prognosis in advanced gastric cancer. Oncology. 2007;73:215–220.
[10] Ye G, Chen Q, Chen X, et al. The prognostic role of platelet-to-lymphocyte ratio in patients with acute heart failure: A cohort study. Sci Rep. 2019;9. DOI:10.1038/s41598-019-47143-2
[11] Qu R, Ling Y, Zhang Y, Wei L, Chen X, Li X, et al. Platelet-to-lymphocyte ratio is associated with prognosis in patients with coronavirus disease-19. J Med Virol. 2020; 1–9. DOI:10.1002/jmv.25767
[12] Gasparyan AY, Ayvazyan L, Mukanova U, et al. The platelet-to-lymphocyte ratio as an inflammatory marker in rheumatic disease. Ann Lab Med. 2019;39 (4):345–357.
[13] Lalosevic MS, Markovic AP, Stankovic S, et al. Combined diagnostic efficacy of neutrophil-to-lymphocyte ratio (NLR), platelet-to-lymphocyte ratio (PLR), and mean platelet volume (MPV) as biomarkers of systemic inflammation in the diagnosis of colorectal cancer. Dis Markers. 2019;6036979:1–7.
[14] Lam M, Roszik J, Kanikarla-Marie P, et al. The potential role of platelets in the consensus molecular subtypes of colorectal cancer. Cancer Metastasis Rev. 2017;36:273–288.
[15] Wu L, Zou S, Wang C, et al. Neutrophil-to-lymphocyte and platelet-to-lymphocyte ratio in Chinese Han population from Chaoshan region in South China. BMC Cardiovasc Disord. 2019;19:125.
[16] Gong S, Gao X, Xu F, et al. Association of lymphocyte to monocyte ratio with severity of coronary artery disease. Medicine (Baltimore). 2018;97(43):e12813.
[17] Balta S, Demirer Z, Aparci M, et al. The lymphocyte to monocyte ratio in clinical practice. J Clin Pathol. 2015;69(1):88–89.
[18] Hui C, Min L, Lei L, et al. Monocyte/lymphocyte ratio is related to the severity of coronary artery disease and clinical outcome in patients with non-ST-elevation myocardial infarction. Medicine (Baltimore). 2019;98 (26):e16267.
[19] Okugawa Y, Toiyama Y, Yamamoto A, et al. Lymphocyte-to-C reactive protein ratio and score are clinically feasible nutrition-inflammation markers of outcome in patients with gastric cancer. Clin Nutr. 2020;39(4):1209–1217.
[20] Sato H, Tsubosa Y, Kawano T. Correlation between the pretherapeutic neutrophil to lymphocyte ratio and the pathologic response to neoadjuvant chemotherapy in patients with advanced esophageal cancer. World J Surg. 2012;36(3):617–622. PMID 22223293.
[21] Yang A, Liu J, Tao W, et al. The diagnostic and predictive role of NLR, d-NLR and PLR in COVID-19 patients. Int Immunopharmacol. 2020;84:106504.
[22] Zhang B, Zhou X, Zhu C, et al. Immune phenotyping based on neutrophil-to-lymphocyte ratio and IgG predicts disease severity and outcome for patients with COVID-19. MedRvix preprint. 2020. DOI:10.1101/2020.03.12.20035048
[23] Mardani R, Vasmehjani AA, Zali F. et al. Laboratory parameters in detection of COVID-19 patients with positive RT-PCR; a diagnostic accuracy study. Arch Acad Emerg Med. 2020;8(1):e43.
[24] Quin C, Zhou L, Hu Z, et al. Dysregulation of immune response in patients with COVID-19 in Wuhan, China. Clin Infect Dis. 2020;ciaa248. DOI:10.1093/cid/ciaa248
[25] Ma Y, Shi N, Fan Y, et al. Predictive value of the neutrophil-to-lymphocyte ratio (NLR) for diagnosis and worse clinical course of the COVID-19: findings from ten provinces in China. Lancet. preprint. DOI:10.2139/ssrn.3569838
[26] Lissoni P, Rovelli F, Monzon A, et al. Evidence of abnormally low lymphocyte-to-monocyte ratio in covid-19-induced severe acute respiratory syndrome. J Immuno Allerg. 2020;1(2):1–6.