CBC Differences between Survived and Deceased COVID-19 Patients: A Cohort Study

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Abstract

The Coronavirus disease 2019 (COVID-19) pandemic showed the importance of simple, low-cost, and accessible tests for patient triage. Complete Blood Count (CBC) can be considered a good option for predicting the prognosis of COVID-19 and daily follow-up of hospitalized patients. CBC tests of 100 COVID-19 patients admitted to the general ward or intensive care unit (ICU) were monitored for ten days. Routine laboratory tests were also performed. In addition, the neutrophil-to-lymphocyte ratio (NLR) and platelet-to-lymphocyte ratio (PLR) were calculated at the time of admission. The WBC count of the ICU-admitted patients was significantly lower than in the non-ICU-admitted group ($P = 0.008$). The mean lymphocyte percentage of deceased patients was significantly lower than in the survived patients ($P = 0.041$), whereas the mean neutrophil percentage of the former group was higher than the latter ($P = 0.012$). Moreover, the mean monocyte percentage of the survivors was significantly more than that of non-survivors ($P = 0.003$). However, there was no significant difference in mean platelet counts, hemoglobin levels, and red blood cell count between the studied groups. A lower WBC, lymphocyte percentage, and monocyte percentage, in addition to a higher neutrophil percentage, may indicate a poor prognosis in moderate to severe COVID-19 patients.

Keywords: Complete Blood Count (CBC), COVID-19, Patients

In Brief

Severe acute respiratory syndrome coronavirus 2, which caused the Coronavirus disease 2019 (COVID-19) pandemic posed a significant challenge to the medical system. Apart from the molecular tests and radiological facilities that helped diagnose and predict the prognosis of the patients, some routine laboratory tests were performed to evaluate the inflammatory status, immunological competence, and hematological abnormalities, including complete blood count (CBC), C-reactive protein (CRP), and erythrocyte sedimentation rate (ESR). These tests, despite the simplicity, could be used to do the initial assessment of the patients in triage, particularly in the overcrowded medical center during pandemics. Moreover, routine tests cost less than specific tests, and they are rapid and available in most centers. In the present study, we aimed to study the correlation between CBC results and disease outcomes (ICU admission\non-ICU admission and

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↑*What is "already known" in this topic:*
CBC alterations have been observed in COVID-19 patients. However, there are discrepancies in the interpretation of CBC test results in association with disease prognosis.

→*What this article adds:*
The present study showed a significantly lower WBC count in the ICU-admitted patients compared to the non-ICU-admitted group. The mean lymphocyte and monocyte percentages of deceased patients were significantly lower than in the survived patients, while the mean neutrophil percentage was higher. Mean platelet counts, hemoglobin levels, and red blood cell counts were comparable between groups.

death/survival) in hospitalized patients with COVID-19.

In the present study, one hundred adult patients who have been admitted with a definitive diagnosis of COVID-19 infection (lung injury in chest CT scan and positive RT-PCR results) in Shoyadaye-Tajrish Hospital between February 2021 and October 2021 were recruited. All patients were categorized as moderate to severe. The national guideline for the treatment of COVID-19 was administered: remdesivir (200 mg on the first day, followed by 100 mg daily) plus dexamethasone 8 mg (1). The routine were performed at the time of hospitalization. CBC test results were recorded daily until the patients were discharged in stable condition or expired. Besides, the neutrophil-to-lymphocyte ratio (NLR) and platelet-to-lymphocyte ratio (PLR) were calculated at admission time. The maximum hospitalization time for the survived patients was ten days. Therefore, ICU-admitted cases were followed up until the tenth day. All death outcomes occurred between the second and sixth days of admission. The patients with interfering medical conditions such as cancer, chronic autoimmune diseases, transplantation, secondary infections, and pregnancy were excluded from the study. To compare the parametric values, independent sample T-test, and non-parametric values Mann-Whitney

Table 1. Clinical and paraclinical data of COVID-19 patients

		1- survived vs. deceased		
Variable	Unit	Survived (N:73)	Deceased (N:27)	*P* Value
Age	year(Mean±SD)	64.45±18.9	65.93±17.1	0.895
Gender	(Male/Female)	45/28	14/13	-
Underlying diseases				-
Hypertension		22 (30.1%)	11(40.7%))	
Chronic heart disease		3 (4.1%)	-	
Diabetes mellitus		27 (36.9%)	6 (22.2%)	
Chronic kidney disease		13 (17.8%)	5 (18.5%)	
Smoker/Non-smoker	Yes/no	30/43	13/14	-
BMI	kg/m2 (Mean±SD)	26.24±4.9	26.47±2.3	0.901
First O2 saturation	% (Mean±SD)	84.80±4.9	80.11±4.3	<0.001*
Final O2 saturation	% (Mean±SD)	91.34±3.1	84.38±5.1	<0.001*
BUN	mg/dL (Mean±SD)	56.8±53.5	38.6±25.5	0.088
Creatinine	mg/dL (Mean±SD)	2.03±2.05	1.67±1.32	0.450
Albumin	g/dL (Mean±SD)	3.65±0.52	3.69±0.39	0.922
D-dimer	ng/mL(Mean±SEM)	1507±245	1690±407	0.315
Ferritin	ng/mL (Mean±SD)	507±278	525±244	0.758
FBS	mg/dL (Mean±SD)	141±67	132±58	0.864
CRP	mg/L (Mean±SD)	66.84±45.6	59.43±39.5	0.102
ESR	mm/hr (Mean±SD)	45±33	39±27	0.137
MPV	fL (Mean±SD)	9.1±2.1	9±1.1	1.000
RDW	% (Mean±SD)	14.8±2.2	14.3±1.6	0.946
INR	(Mean±SD)	1.12±0.19	1.05±0.09	0.021*
NLR	(Mean±SD)	8.3±5.4	8.8±6.5	0.811
PLR	(Mean±SD)	235±151	212±153	0.637
		2- ICU-admitted vs. non-ICU-admitted		
		Non-ICU-admitted (N:63)	ICU-admitted (N:37)	*P* Value
Age	year(Mean±SD)	63.58±18.7	66.81±18.0	0.750
Gender	(Male/Female)	36/27	22/15	-
Smoker/Non-smoker		24/39	17/20	-
Underlying diseases				
Hypertension		15 (23.8%)	19 (51%))	
Chronic heart disease		3 (4.7%)	1 (2.7%)	
Diabetes mellitus		16 (25.4%)	19 (51%)	
Chronic kidney disease		10 (15.9%)	12 (32.4%)	
BMI	kg/m^2 (Mean±SD)	26.68±5.01	25.78±3.08	0.762
First O2 saturation	% (Mean±SD)	83.64±5.5	83.11±4.8	1.00
Final O2 saturation	% (Mean±SD)	89.11±5.3	89.70±4.3	1.00
BUN	mg/dL (Mean±SD)	53.45±53.49	48.61±37.79	0.574
Creatinine	mg/dL (Mean±SD)	2.14±2.32	1.59±0.76	0.078
Albumin	g/dL (Mean±SD)	3.68±0.55	3.64±0.37	0.803
D-dimer	ng/mL(Mean±SEM)	1527±243	1610±379	0.610
Ferritin	ng/mL (Mean±SD)	525±269	493±267	0.772
FBS	mg/dL (Mean±SD)	126±53	155±75	0.033*
CRP	mg/L (Mean±SD)	63.45±41.7	66.38±47.6	0.646
ESR	mm/hr (Mean±SD)	41±30	45±34	0.710
MPV	fL (Mean±SD)	9.2±1.2	9±2.1	1.00
RDW	% (Mean±SD)	14.7±2.3	14.7±1.7	1.00
INR	(Mean±SD)	1.12±0.19	1.07±0.14	0.907
NLR	(Mean±SD)	7.8±5.7	9.4±5.6	0.485
PLR	(Mean±SD)	213±152	250±150	0.391

Abbreviations: BMI: body mass index, BUN: blood urea nitrogen, FBS: fasting blood sugar, CRP: C-reactive protein, ESR: erythrocyte sedimentation rate, MPV: mean platelet volume, RDW: red cell distribution width, INR: international normalized ratio, NLR: neutrophil-to-lymphocyte ratio, PLR: platelet-to-lymphocyte ratio. *: statistically significant *P*.value

U test was performed. P-values less than 0.05 were considered significant (SPSS 28; IBM Corp., Chicago, USA).

Out of 100 hospitalized patients, 37 were admitted to the ICU, and 27 died at the hospital. Twenty-one patients were expired in ICU. Initial and final O2 pressure of expired patients were both significantly lower than that of survived patients (both $P < 0.001$), but it showed no significant difference between ICU-admitted and non-ICU-admitted groups. The INR values of the survived patients were higher than the deceased group ($P = 0.019$); moreover, the FBS of ICU-admitted patients was significantly more than the patients in the general ward ($P = 0.032$) (Table 1).

During a ten-day follow-up, the mean WBC count of the COVID-19 patients who were admitted to ICU was less than in the other hospitalized patients [9797±1076 vs. 11250±1114 (P-value: 0.008)]; however, the WBC count did not show any significant difference between survived and expired individuals [11000±950 vs. 11000±1300].

The mean lymphocyte percentage of the deceased patients was significantly lower than in the survived patients [13.22±1.52% vs. 10.9±2.67% ($P = 0.041$)], with the least amounts on day 4. Similarly, until the sixth day, the mean lymphocytes percentage of ICU-admitted patients was less than in the patients in general wards, but it displayed a peak on day six and remained high until day nine. Despite this pattern, the mean lymphocyte count did not show any significant difference between the two groups (12.4±3.95% vs. 13.3 ± 2.06%). In contrast to the lymphocyte pattern, the mean neutrophil percentage of the

patients who expired was substantially higher than those who survived [86.07±2.802% vs. 82.76±1.74% ($P = 0.012$)]. Neutrophil percentages of patients admitted to ICU showed an irregular pattern compared to the non-ICU group, with a decline from day six until day 9; however, the mean value difference was not statistically significant (83.9±4.41% vs. 82.8±1.62%). Although the initial monocyte percentages of the COVID-19 patient who were admitted to the ICU was higher than ward-admitted patients, after the third day, the monocyte counts became almost comparable between the two groups. Eventually, there was no significant difference between the mean monocyte percentages of patients (3.17±0.56 vs. 2.73±0.43). On the other hand, the mean monocyte percentage of the patients who survived was significantly more than that of those who expired [2.97±0.29 vs. 2.35±0.38 ($P = 0.003$)]. (Figure 1)

The fluctuation of eosinophil percentages followed a similar pattern in ICU-admitted and general ward-admitted COVID-19 patients (1.33±0.37 vs. 1.31±0.03). It also showed comparable amounts between deceased and survived patients (1.3±0.23 vs. 1.63±0.39). The mean platelet count was comparable between ICU-admitted and non-ICU-admitted groups though it showed a decline between days 4 and 8 in the former group (226.7±29.7*10^3 vs. 227.8±13.9*10^3). The mean platelet count of the expired and survived patients did not show any significant difference (226.9±18.1*10^3 vs. 227.2±30*10^3); however, there was a peak on day 5 in the expired group.

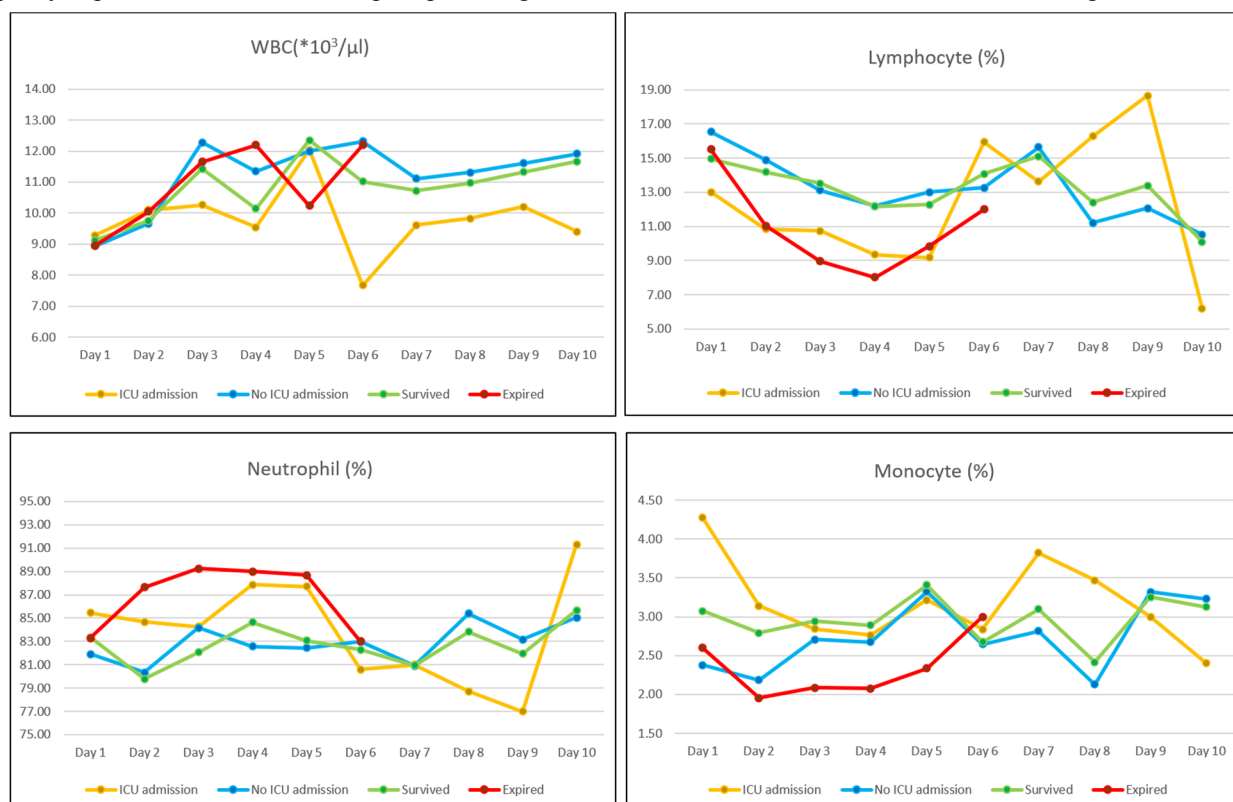The mean RBC counts showed no significant difference

Figure 1. Alteration pattern of white blood cell, lymphocyte, monocyte, and neutrophil count in hospitalized COVID-19 patients, including ICU-admitted and ward-admitted with death or survival outcomes.

between ward-admitted and ICU-admitted COVID-19 patients ($4.01\pm0.28*10^6$ vs. $4.13\pm0.14*10^6$). Likewise, RBC counts showed a stable pattern in both survived and expired patients but declined on the fifth day in the latter group ($4.1\pm0.12*10^6$ vs. $4.04\pm0.48*10^6$). The hemoglobin pattern was similar to the RBC curves. There was no significant difference neither between ICU-admitted and ward-admitted patients (11.33 ± 0.86 vs. 11.70 ± 0.37) nor between survived and expired groups (11.57 ± 0.25 vs. 11.55 ± 1.9) except for a deep decline on day six among deceased patients. In addition, there was no significant difference between PLR, NLR, and MPV values between groups, probably due to the small number of samples.

Taken together, CBC interpretation might be helpful in the triage of COVID-19 patients during the critical times of the epidemic in which there is a need for rapid decision-making about whether or not to admit a patient and, if yes, where to admit them. It could also be a practical tool for the follow-up of hospitalized patients since any significant change in daily lab tests might be an early alarm for upcoming clinical events. Accordingly, some studies have been conducted to reveal the association between CBC alterations and disease severity in COVID-19 patients, including higher WBC, lymphocyte, neutrophil, and eosinophil counts in asymptomatic individuals [2-4] while higher NLR with lower lymphocyte, eosinophil, and basophil counts among non-survivors [5-9]. Moreover, increased MPV and anemia have been suggested as poor prognosis indicators [10].

The present study also showed higher WBC and neutrophil counts in critical patients and non-survivors, respectively. Monocyte percentages were also lower in expired patients, but eosinophil percentages did not show any significant difference between the studied groups. Furthermore, although NLR and PLR values of expired patients were higher than those of the survived group, difference was not statistically significant. Similar to most studies, we could not find any significant alteration in RBC counts and hemoglobin levels of COVID-19 patients. Finally, platelet count and MPV were comparable between ICU-admitted and ward-admitted patients, as well as between survived and expired cases. CBC test might be a useful evaluation to determine the prognosis of hospitalized COVID-19 patients. The patients with lower WBC counts decreased percentages of lymphocyte and monocyte, and higher neutrophil percentages could be considered high risk.

Ethical Statement

All the techniques carried out in the present study involving human participants were under the standards of the institutional research committee and with the Helsinki Declaration and its later amendments or comparable ethical standards. It has ethical approval from Tehran University of medical sciences (Code: IR.TUMS.CHMC.REC.1401.131). Informed consent was obtained from all participants after describing the process and goals of the study.

Conflict of Interests

The authors declare that they have no competing interests.

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