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Analysis of Clinical and Radiologic Parameters in Children Diagnosed with COVID-19 Infection at Admission and Discharge

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Abstract

Background: Recognizing risk factors for poor prognosis among COVID-19 patients is crucial, especially given the absence of standardized treatments and medications.

Objectives: In the present study, our aim was to survey changes in clinical parameters in children diagnosed with COVID-19 infection from admission to discharge.

Methods: The present retrospective cross-sectional study focused on children with COVID-19 infection. All demographic data and clinical information of patients were extracted upon admission and at discharge from the hospital. Data analysis utilized the Mann-Whitney U test and Fisher exact test. Multivariable regression modeling was employed to identify factors predicting the probability and duration of hospitalization in ICUs for children with COVID-19.

Results: Elevated levels of ESR, CRP, creatinine, and ferritin were found in 51.7%, 67.4%, 69.3%, and 53.6% of patients upon admission. Moreover, 98.2% and 38.3% of patients had high levels of ALP and AST. Platelet (PLT) and neutrophil levels were higher at discharge compared to admission ($P < 0.001$), while creatinine levels were lower at admission than at discharge ($P < 0.001$). Patients admitted to ICUs exhibited significantly higher levels of pulse rate ($P < 0.001$), respiratory rate ($P < 0.001$), mean corpuscular volume (MCV) ($P = 0.01$), red cell distribution width (RDW) ($P = 0.002$), prothrombin time (PT) ($P = 0.006$), and ESR ($P = 0.04$).

Conclusions: Pulse rate, respiratory rate, MCV, RDW, PT, ESR, and oxygen saturation (SPO_2) percentage can be used to predict the severity of COVID-19 disease. However, further studies are needed to determine the prognosis and severity of COVID-19 infection in children.

Keywords: Hematological Parameters, Coronavirus Disease 2019, COVID-19, SARS-CoV-2, Inflammatory Response, Iran

1. Background

COVID-19, also known as Coronavirus Disease 2019, was first discovered in December 2019 in Wuhan, China (1). The World Health Organization (WHO) designated this novel coronavirus as severe acute respiratory syndrome Coronavirus 2 (SARS-CoV-2) on February 12, 2020. On January 30, 2021, the WHO declared COVID-19 a global public health emergency (2, 3). The spread of SARS-CoV-2, a single-stranded RNA virus, has been rapid worldwide, with a high level of transmissibility (4). Currently, SARS-CoV-2 has affected more than 222 countries. World Health Organization reports indicate that as of March 10, 2024, there have been 774,889,074 confirmed cases of COVID-19 worldwide, resulting in 7,038,623 deaths (https://covid19.who.int/).

In Iran, as of November 26, 2023, a total of 155,460,000 vaccine doses have been administered. Despite vaccination efforts, from January 3, 2020, to April 28, 2024, the COVID-19 pandemic has led to over 7,627,186 confirmed cases and more than 146,811 deaths (https://covid19.who.int/region/emro/country/ir). The primary modes of transmission for SARS-CoV-2 are through respiratory droplets and contact (5).

COVID-19 infection affects all organ systems, including the gastrointestinal tract, neurological

system, cardiovascular system, hepatocellular system, pulmonary system, urinary system, and immune system (6, 7). All age groups can be affected by SARS-CoV-2, with older adults (people over 50), immunocompromised individuals, and patients with chronic diseases being the most vulnerable to severe infections (8, 9).

World Health Organization classifies COVID-19 infections as mild, severe, or critical based on clinical symptoms (10, 11). Infants and children generally experience lower rates of COVID-19 infection, with up to 45% either being asymptomatic carriers or having a moderate clinical course of the disease. Children with underlying medical conditions may develop severe COVID-19 infections (12).

The inflammatory response significantly influences the progression of COVID-19, with disease severity and mortality often indicated by hematological and inflammatory parameters (13, 14). Neutrophil-to-monocyte ratio (NMR), lymphocyte count, neutrophil-to-lymphocyte ratio (NLR), C-reactive protein (CRP), platelet-to-lymphocyte ratio (PLR), D-dimer, white blood cell count (WBC), ferritin, fibrinogen, procalcitonin, and levels of various inflammatory cytokines are commonly considered prognostic indicators of COVID-19 severity (15, 16). According to Abdulla and colleagues, patients with severe illness exhibit significant differences in serum levels of IL-6, CRP, and S-ferritin compared to those with mild or moderate illness (11). Yuan et al. demonstrated that severe and critically ill patients often present with lower lymphocyte counts, reduced red blood cells and hemoglobin, and decreased levels of immunoglobulin G antibodies specific to SARS-CoV-2. They also noted elevated levels of D-dimer, fibrinogen, WBC count, neutrophil count, IL-6, CRP, procalcitonin, ESR, ferritin, and LDH in patients with severe or critical illness (14). Alkan et al. found that hospitalized children with COVID-19 frequently have elevated WBC, lymphocyte, and platelet counts, as well as higher RDW, CRP, procalcitonin, D-dimer, and lymphocyte-to-monocyte ratio values (12).

Recognizing the risk factors for severe prognosis in COVID-19 patients is crucial, especially given the absence of standardized treatments and medications (17).

2. Objectives

In the present study, we conducted a retrospective cross-sectional study to investigate the role of hematological parameters in assessing the severity of COVID-19 infection among children admitted to Mofid Children's Hospital, Tehran, Iran.

3. Methods

3.1. Inclusion Criteria

Patients who met all the following criteria were included in the current study: (1) patients without any underlying disease; and (2) patients with a positive COVID-19 real-time PCR test.

3.2. Exclusion Criteria

Patients who met any of the following criteria were excluded from the current study: (1) patients who had underlying diseases; (2) patients who did not undergo hematologic tests; (3) patients with incomplete medical records; and (4) patients with negative real-time PCR tests.

3.3. Study Design

The hematological parameters of children with COVID-19 infection admitted to Mofid Children's Hospital were examined retrospectively from 2019 to December 2022. After reviewing the medical records, all patients' demographic data and clinical information were extracted at admission and discharge from the hospital. The demographic data and clinical information included: Age, gender, pulse rate, respiratory rate, blood pressure, fever, oxygen saturation (SpO_2), duration of hospitalization, admission to Intensive Care Units (ICUs), use of a ventilator, mortality rate, WBC count, red blood cell (RBC) count, hemoglobin level (Hb), mean corpuscular volume (MCV), platelet count (PLT), percentages of neutrophils and lymphocytes, red cell distribution width (RDW), erythrocyte sedimentation rate (ESR), CRP, creatine phosphokinase (CPK), lactate dehydrogenase (LDH), ferritin, fibrinogen, aspartate aminotransferase (AST), alanine transaminase (ALT), alkaline phosphatase (ALP), and creatinine.

3.4. Data Analyses

All data were included in SPSS 25 and analyzed using statistical tests. A Mann-Whitney U test was used to compare quantitative variables between patients admitted to the ICU and those hospitalized in general wards. The Fisher exact test was employed to compare

qualitative variables between these two groups. Additionally, the relationship between variables and the duration of hospitalization was assessed using the Mann-Whitney U test and Fisher exact test. Multivariable regression modeling was conducted to identify factors predicting the probability and duration of hospitalization for children with COVID-19 in the ICUs.

3.5. Ethic Statements

This study was approved by the Ethics Committee of Shahid Beheshti University of Medical Sciences, Tehran, Iran (IR.SBMU.RICH.REC.1402.004).

4. Results

4.1. Basic Characteristics of the Patients at Admission

Table 1 displays the demographic data and clinical information of patients at admission. There were 408 patients with COVID-19 infection, comprising 219 (57.7%) males and 189 (46.3%) females. The median age of patients was 24 months (ranging from 20 days to 204 months), and 379 patients (92.9%) had fever. Blood pressure increase was observed in 74% (304/408) of patients, while respiratory rate increase was noted in 8.8% (36/408). Elevated levels of WBC and neutrophils were found in 17.7% (72/408) and 74.8% (305/408) of patients, respectively. Hematology tests indicated elevated levels of ESR, CRP, creatinine, and ferritin in 51.7% (185/358), 67.4% (190/282), 69.3% (266/384), and 53.6% (90/168) of patients, respectively. Additionally, high levels of ALP and AST were detected in 98.2% (277/283) and 38.3% (118/308) of patients, respectively.

4.2. Patients' Hematological Parameters at Discharge

The hematological parameters collected from patients before discharge from the hospital are displayed in Table 2. High levels of WBC, HB, PLT, and creatinine were found in 23.3% (38/163), 74.7% (121/162), 25.3% (41/162), and 50% (13/26) of patients, respectively. Moreover, MCV levels were normal in 85.7% of patients. Results showed that 37.7% (61/162) and 54.3% (88/162) of patients had high levels of neutrophils and lymphocytes, respectively.

4.3. Changes in Hematological Parameters at Admission and Discharge

Table 3 displays the changes in hematological parameters of COVID-19 patients during admission and discharge from the hospital. Platelet and neutrophil levels were significantly higher at discharge than at admission ($P < 0.001$), while creatinine levels were significantly lower at discharge ($P < 0.001$).

4.4. Hematological Parameters and Severity of COVID-19 Infection

The study parameters were compared between patients admitted to ICUs and those admitted to general hospital wards. See Table 4 for details. Patients admitted to ICUs exhibited elevated levels of pulse rate ($P < 0.001$), respiratory rate ($P < 0.001$), MCV ($P = 0.01$), RDW ($P = 0.002$), PT ($P = 0.006$), and ESR ($P = 0.04$). Additionally, SPO_2 levels were lower in patients admitted to ICUs ($P < 0.001$).

We also evaluated all variables between patients hospitalized for less than one week and those hospitalized for more than one week. Patients hospitalized for more than a week showed increased pulse rate ($P = 0.002$), respiratory rate ($P < 0.001$), ESR ($P = 0.008$), neutrophil percentage ($P = 0.02$), and lymphocyte percentage ($P = 0.01$) (see Table 4).

4.5. Risk Factors (Predictor Factors) for the ICU Admission

Pulse rate (odds ratio: 0.95) and respiratory rate (odds ratio: 5.42) were associated with a higher risk of ICU admission due to COVID-19 (Table 5). Additionally, we observed that respiratory rate (odds ratio: 0.16) and hemoglobin level below 10 (odds ratio: 4.23) were associated with a higher risk of ICU admission lasting more than a week (Table 6).

5. Discussion

The present study focused on analyzing and summarizing the clinical parameters in children diagnosed with COVID-19 infection at admission and discharge. Our analysis of the patients' basic characteristics at admission revealed that 92.9% of patients had a fever. Additionally, 74% of patients showed an increase in both blood pressure and respiratory rate, and 74.8% of patients had elevated levels of neutrophils. According to previously published studies, typical symptoms of COVID-19 infection include fever, cough, dyspnea, malaise, fatigue, and sputum production (1, 18-20). Results from hematology tests

Table 2. Clinical Characteristics of the Patients at Discharge from the Hospital

Hematological parameters	At Discharge					
	Range	Minimum	Maximum	Mean	Median	Standard Deviation
WBC		1	117	9.05	7.60	9.74
High	38 (23.3)					
Normal	103 (63.2)					
Low	22 (13.5)					
RBC	-	2.42	7.91	4.22	4.20	0.70
HB		7	17.50	11.23	11.1	1.83
≤ 10	41 (25.3)					
> 10	121 (74.7)					
MCV		62	106.05	82.08	81.70	6.15
High	12 (7.5)					
Normal	138 (85.7)					
Low	11 (6.8)					
PLT		6.20	965	341.40	306	171.78
High	41 (25.3)					
Normal	105 (64.8)					
Low	16 (9.9)					
Neutrophils (%)		9	94	52.45	58.35	22.13
High	61 (37.7)					
Normal	28 (17.3)					
Low	73 (45.1)					
Lymphocytes (%)		4	91	40.31	35	21.28
High	88 (54.3)					
Normal	34 (21)					
Low	40 (24.7)					
Creatinine						
Normal	13 (50)					
High	13 (50)	0.43	1	0.67	0.64	0.16

Abbreviations: N, number of patients; WBC, white blood cells; RBC, red blood cells; HB, hemoglobin; MCV, mean corpuscular volume; PLT, platelet.

Table 3. Changes of Hematological in COVID-19 Patients at Admission and Discharge from Hospital

Hematological Parameters	Patients (N)	At Admission	At Discharge	*t*	df	P-Value
WBC	163	8.55 ± 7.21	8.37 ± 4.74	0.38	162	0.70
RBC	159	4.19 ± 0.63	4.22 ± 0.70	-0.79	158	0.42
HB	162	11.78 ± 7.14	11.23 ± 1.83	1.00	161	0.31
MCV	158	81.86 ± 7.03	82.09 ± 6.21	-1.01	157	0.31
PLT	161	265.36 ± 139.00	342.04 ± 172.12	-5.64	160	< 0.001
Neutrophils (%)	162	59.24 ±19.77	52.45 ± 22.13	4.46	161	< 0.001
Lymphocytes (%)	162	36.09 ± 27.84	40.31 ± 21.28	-1.93	161	0.05
Creatinine	26	1.15 ± 0.56	0.67 ± 0.16	4.49	25	< 0.001

Abbreviations: N, number of patients; WBC, white blood cells; RBC, red blood cells; HB, hemoglobin; MCV, mean corpuscular volume; PLT, platelet.

showed that 51.7%, 67.4%, 69.3%, and 53.6% of patients had elevated levels of ESR, CRP, creatinine, and ferritin, respectively. Among the liver function tests, 98.2% of patients were found to have high levels of ALP enzyme.

Our analysis of hematological parameters before discharge from the hospital revealed that 23.3%, 74.7%, 25.3%, and 50% of patients had high levels of WBC, HB, PLT, and creatinine, respectively. Moreover, 85.7% of

Table 5. Multivariate Regression for Referred-to ICU

Independent Variables	Wald	df	Sig	Exp (B)	95% CI for Exp (B)	
Upper	Lower					
Pulse rate	6.22	1	0.01	0.95	0.99	0.92
Respiratory rate	4.64	1	0.03	5.42	25.27	1.16
SPO_2 (%)	1.25	1	0.26	1.11	1.33	0.92
MCV	0.54	1	0.46	0.49	3.20	0.07
RDW	1.02	1	0.31	2.10	8.86	0.49
PT	0.87	1	0.35	4.43	101.49	0.19
ESR	0.004	1	0.44	0.95	3.86	0.23
Creatinine	0.58	1	0.47	0.58	2.27	0.15

Table 6. Multivariate Regression for ICU Admission for More Than a Week

Independent Variables	Wald	Df	Sig	Exp (B)	95% CI for Exp (B)	
Lower	Upper					
Pulse rate	1.04	1	0.30	1.01	0.99	1.03
SPO_2 (%)	0.08	1	0.77	1.01	0.90	1.15
Respiratory rate	14.75	1	< 0.001	0.09	0.02	0.31
RDW	1.03	1	0.30	0.59	0.21	1.62
ESR	0.26	1	0.60	0.77	0.29	2.04
Creatinine	0.75	1	0.38	1.54	0.57	4.15
Neutrophils	1.19	1	0.27	0.23	0.01	3.71
Lymphocytes	0.35		0.55	1.39	0.46	4.17
PLT	6.81	1	0.59	0.22	0.07	0.69
HB	4.91	1	0.02	3.23	1.14	9.15

patients had a normal level of MCV, and 54.3% of patients had a high percentage of lymphocytes.

Several studies have examined the clinical and laboratory parameters of COVID-19 since December 2019. Alkan et al. analyzed hematological parameters and inflammatory markers in children with COVID-19 infection, finding lymphocytosis as the main hematological abnormality. Their study also noted elevated levels of WBC, lymphocytes, PLT, RDW, CRP, procalcitonin, D-dimer, and lymphocyte-to-monocyte ratio in hospitalized patients (12). Akbeyaz et al. identified cough, fever, and vomiting as common clinical symptoms in children with COVID-19, reporting that patients infected with the Omicron variant had lower hemoglobin and lymphocyte levels but higher D-dimer, INR, prothrombin time, and activated partial thromboplastin time (21). Saleh et al. from Saudi Arabia reported fever as the most frequent clinical symptom among COVID-19 patients (22).

Comparison of hematological parameters during admission and discharge from the hospital revealed significantly higher PLT and neutrophil levels at discharge compared to admission, while creatinine levels were significantly lower upon discharge.

Several studies have examined changes in hematologic parameters during COVID-19. A systematic review conducted by Waleed et al. in Pakistan revealed that patients with COVID-19 infection exhibited increased levels of neutrophils, lactate dehydrogenase, serum ferritin, interleukins (IL-6, IL-2, IL-7), CRP, procalcitonin, TNF-α, D-dimer, and fibrinogen degradation products. Additionally, their study reported decreased levels of thrombocytes and lymphocytes in these patients (13). In another study, Abdulla et al. investigated the relationship between changes in hematological parameters and disease severity in COVID-19 patients. They found that lymphocyte counts decreased in severely ill patients compared to those with mild and moderate symptoms. Moreover, severely ill patients exhibited significantly increased serum

levels of IL-6, CRP, and ferritin (11). Bozkurt et al. identified higher body mass index and lower albumin levels as factors associated with postpartum progression of COVID-19 (23). Yuan et al. conducted a study to assess changes in hematological and immunological parameters in COVID-19 patients, revealing that severe and critically ill patients had significantly elevated levels of D-dimer, fibrinogen, WBC count, neutrophil count, IL-6, CRP, procalcitonin, ESR, ferritin, and lactate dehydrogenase (14). A study by Mermutluoğlu et al. in Turkey indicated that COVID-19 patients had elevated levels of mean platelet volume (MPV), neutrophil-to-lymphocyte ratio (NLR), and PLR (15). Matin et al. found that patients with severe COVID-19 infection had lower lymphocyte counts and increased NLR levels compared to non-severe patients (24). Qin et al., in a systematic review and meta-analysis, investigated immune dysfunction parameters in COVID-19 patients, noting significantly increased levels of cytokines such as IL-1β, IL-1Ra, IL-2R, IL-4, IL-6, IL-8, IL-10, IL-18, TNF-α, IFN-γ, IgA, IgG, CD4+ T/CD8+ T cell ratio, WBC, neutrophils, PLT, ESR, CRP, ferritin, serum amyloid A, D-dimer, and LDH in severely ill patients or non-survivors (25). In contrast, Uzel et al. found no statistically significant differences in blood parameters between COVID-19 patients with mild or severe clinical symptoms (26).

In this study, we investigated the correlation between hematological parameters, ICU hospitalization, and duration of hospital stay. Our findings revealed that increased pulse rate, respiratory rate, MCV, RDW, PT, and ESR were associated with ICU admission. Additionally, patients admitted to ICUs had lower SPO_2 percentages compared to those not admitted. In Iran, Sadeghi et al. demonstrated that initial admission SPO_2, hematocrit (HCT), CRP levels, and myalgia predict ICU admission (27). Moradinia et al., also from Iran, identified age, cough, blood oxygen levels, and diastolic blood pressure as factors associated with ICU hospitalization in COVID-19 patients (28). Candelli et al. reported from Italy that blood type A, PaO_2/FiO_2 ratio, LDH, lactate levels, dyspnea, and SpO_2 were significantly linked to ICU admission in COVID-19 patients (29). A study by Hergens et al. in Sweden found that hypertension, obesity, and type II diabetes were all risk factors for ICU admission with COVID-19 (30). Kurniyanto et al. in Indonesia highlighted age ≥ 60 years, obesity, shortness of breath, leukocyte count > 10,000/L, SPO_2 < 95%, and moderate-severe COVID-19 as strongly associated with ICU referral (20).

We also found that patients hospitalized for more than a week showed increased pulse rate, respiratory rate, ESR, neutrophil percentage, and lymphocyte percentage. Furthermore, these patients had hemoglobin levels above 10 and RDW levels above 13. Mermutluoğlu et al. from Turkey identified a positive correlation between hospitalization duration and fifth-day D-dimer and ferritin levels. They also noted a negative relationship between hospitalization duration and lymphocyte counts on admission day and the fifth day, suggesting that elevated ferritin and D-dimer levels and decreased lymphocyte counts may prolong hospital stays for COVID-19 patients (15). Alkan et al. reported a positive correlation between elevated WBC and procalcitonin levels and hospitalization in children with COVID-19 infections (12). Saleh et al.'s study in Saudi Arabia found that blood group A, hypertension, age < 14 years, and respiratory symptoms were significantly associated with admission to the pediatric intensive care unit (PICU). Their results also indicated that higher levels of factor VIII and fibrinogen were linked to longer hospital stays (22).

However, our study has several limitations: (1) A significant number of patients' clinical information at discharge was inaccessible, preventing a comprehensive analysis of all parameters; (2) Patients were not categorized based on the severity of their illness, limiting our ability to analyze differences between mild and severe COVID-19 cases; and (3) We lacked access to data on treatment outcomes and mortality rates related to COVID-19.

5.1. Conclusions

The present study identified a statistically significant correlation between pulse rate, respiratory rate, MCV, RDW, PT, ESR, and SPO_2 percentage with ICU admission. Hence, these clinical parameters may influence ICU hospitalization. Moreover, these factors could prove valuable in identifying patients at high risk for ICU admission. We observed that increases in pulse rate, respiratory rate, ESR, RDW, neutrophil percentage, and lymphocyte percentage were associated with prolonged hospital stays. However, further studies with larger sample sizes are necessary to ascertain the prognosis and severity of COVID-19 infection in children.

Footnotes

Authors' Contribution: Hanieh Sadeghi Koupaei and Shiva Nazari, conceptualization, data curation, formal analysis; Hanieh Sadeghi Koupaei, Shiva Nazari, Shahnaz Armin and Vahide Zeinali, data curation, formal analysis, writing–original draft, and writing review & editing; Hanieh Sadeghi Koupaei, Shiva Nazari, and Shahnaz Armin, language editing. All authors reviewed the manuscript.

Conflict of Interests Statement: The authors declare that they have no competing interests.

Data Availability: All data generated or analyzed during this study are included in this published article.

Ethical Approval: This study was approved by the Ethics Committee of Shahid Beheshti University of Medical Sciences, Tehran, Iran (IR.SBMU.RICH.REC.1402.004).

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Table 1. Clinical Characteristics of the 408 Patients at Baseline (Admission) [a]

Hematological Parameters (Normal Range)	Range	Minimum	Maximum	Mean	Median	Standard Deviation
Age						
<1 month	10 (2.5)	20 (day)	204 (month)	56.30 (month)	24	57.03
1 month to <1 year	104 (25.5)					
1 to <3 years	94 (23)					
3 to < 6 years	56 (13.7)					
6 to <12 years	85 (20.8)					
12 to 18 years	59 (14.5)					
Blood pressure (90/60 mmHg and 120/80 mmHg)						
Normal level	104 (25.5)	60.30	130.88	97.22	95.65	11.45
Elevated level	304 (74.5)					
Pulse rate (60 to 100 beats per minute)	-	20	190	112.38	110	21.14
Respiratory rate (12 to 60 breaths per minute)						
Normal level	372 (91.2)	15	85	27.97	25	10.31
Elevated level	36 (8.8)					
SPO $_2$ (%) (95% to 100%)	-	75	100	96.34	97	2.98
WBC (4.5 to 11.0 × 10 ^{9}/L)						
Elevated level	72 (17.7)	1.50	51.70	7.88	6.70	5.35
Normal level	267 (65.6)					
Decreased level	68 (16.7)					
RBC male: 4.7 to 6.1 million cells per microliter (cells/mcL) female: 4.2 to 5.4 million cells/mcL	-	1.91	6.54	4.28	4.30	0.62
HB males:14 to 18 g/dL; females: 12 to 16 g/dL						
≤ 10	73 (18)	5.60	99	11.73	11.60	4.67
> 10	333 (82)					
MCV (80 - 100 femtoliters)						
Elevated level	32 (7.9)	7.40	108.80	81.58	80.90	8.03
Normal level	320 (79.4)					
Decreased level	51 (12.7)					
PLT (150,000 to 450,000 platelets per microliter)						
Elevated level	36 (8.9)	28	756	276.82	254	121.63
Normal level	321 (79.3)					
Decreased level	48 (11.9)					
Neutrophils (%) (40% to 60%)						
Elevated level	305 (74.8)	2	658	57.32	57	36.56
Normal level	82 (20.1)					
Decreased level	21 (5.1)					
Lymphocytes (%) (20% to 40%)						
Elevated level	109 (26.8)	3	300	38.22	35.55	23.92
Normal level	196 (48.3)					
Decreased level	101 (24.9)					
RDW (12% to 15%)						
≤ 13	141 (38.6)	11.30	20.40	13.62	13.20	1.54
> 13	224 (61.4)					
Reticulocytes (0.5% to 2.5%)	-	0.20	2.30	0.68	0.55	0.53

Hematological Parameters (Normal Range)	Range	Minimum	Maximum	Mean	Median	Standard Deviation
Normal level	111 (95.7)	12	23	12.45	12	1.19
Elevated level	5 (4.3)					
INR (0.9 to 1.1)	-	1	2.50	1.05	1	0.16
PTT (25 to 35 seconds)	-	23	80	32.48	30	8.18
ESR (≤ 20 mm/hr)						
Normal level	173 (48.3)	2	99	27.04	21	20.98
>20	185 (51.7)					
CRP (< 0.3 mg/dL)						
Normal level	92 (32.6)	4	221	24.86	15	25.44
Elevated level	190 (67.4)					
LDH (160 to 370 units/L)						
Elevated level	180 (100)	3	2587	669.00	609	321.27
Normal level	0 (0)					
Fibrinogen (200 to 400 mg/dL) (2.0 to 4.0 g/L)	-	101	801	387.13	403	99.91
Ferritin (7 to 140 ng/mL)						
Normal level	78 (46.4)	14	800	201.66	102	230.53
Elevated level	90 (53.6)					
CPK (10 to 120 mcg/L)						
Normal level	56 (50.5)	20	2058	219.09	120	293.21
Elevated level	55 (49.5)					
Creatinine (0.7 to 1.3 mg/dL)						
Normal level	118 (30.7)	0.19	3.39	0.68	0.64	0.24
Elevated level	266 (69.3)					
AST(8 to 33 U/L)						
Elevated level	118 (38.3)	10	488	54.81	43.50	49.18
Normal level	63 (20.5)					
Decreased level	127 (41.2)					
ALT (7 to 56 U/L)	-	8	392	37.02	24	44.53
ALP (90 to 340 U/L)						
Elevated level	277 (98.2)	69	2310	472.30	429.69	226.11
Normal level	5 (1.8)					

Abbreviations: N, number of patients; WBC, white blood cells; RBC, red blood cells; HB, hemoglobin; MCV, mean corpuscular volume; PLT, platelet; RDW, red cell distribution width; PT, prothrombin time; INR, international normalised ratio; PTT, partial thromboplastin time; ESR, erythrocyte sedimentation rate; CRP, C-reactive protein; LDH, lactate dehydrogenase; CPK, creatine phosphokinase; AST, aspartate aminotransferase; ALT, alanine transaminase; ALP, alkaline phosphatase.

[a] Values are expressed as No%.

Table 4. Hematological Parameters and Severity of COVID-19 Infection

Variables	ICU (n = 44)	NO-ICU (n = 364)	P-Value	≤ 1 Week (n = 363)	> 1 Week (n = 45)	P-Value
Gender			0.15			0.11
Male	19/44 (43.2%)	199/363 (54.8%)		200 (55.1%)	19 (42.2%)	
Female	25/44 (56.8%)	164/363 (45.2%)		163 (44.9%)	26 (57.8%)	
Age (month)	68.03 ± 69.27	55.03 ± 55.32	0.98	55.35 ± 56.06	64.03 ± 64.49	0.87
Blood pressure (mmHg)			0.12			0.06
Normal	22/44 (50%)	82/363 (22.6%)		87/363 (24%)	17/45 (37.8%)	
Increased	22/44 (50%)	281/363 (77.4 %)		276/363 (76%)	28/45 (62.2%)	
Pulse rate	128.86 ± 27.44	110.39 ± 19.37	< 0.001	111.08 ± 20.27	122.88 ± 25.03	0.002
Respiratory rate			< 0.001			<0.001
Normal	29/44 (65.9%)	342/363 (94.2%)		342/363 (94.2%)	30/45 (66.7%)	
Increased	15/44 (34.1%)	21/363 (5.8%)		21/363 (5.8%)	15/45 (33.3%)	
SPO_2 (%)	94.56 ± 4.97	96.56 ± 2.57	< 0.001	96.46 ± 2.82	95.42 ± 3.96	0.03
Fever (yes)	42/44 (95.45%)	336/363 (92.60%)	0.75	55.35 ± 56.06	64.03 ± 64.49	0.54
WBC			0.43			0.07
Normal	25/44 (56.8%)	241/362 (66.6%)		244/362 (67.4%)	23/45 (51.1%)	
Increased	10/44 (22.7%)	62/362 (17.1%)		59/362 (16.3%)	13/45 (28.9%)	
Decreased	9/44 (20.5%)	59/362 (16.3%)		59/362 (16.3%)	9/45 (20%)	
HB			0.67			0.003
< 10	9/44 (20.5%)	63/361 (17.5%)		57/361 (15.8%)	16/45 (35.6%)	
> 10	35/44 (79.5%)	298/361 (82.5%)		304/361 (84.2%)	29/45 (64.4%)	
MCV			0.01			0.41
Normal	29/44 (65.9%)	290/358 (81%)		286/358 (79.9%)	34/45 (75.6%)	
Increased	9/44 (20.5%)	23/358 (6.4%)		26/358 (7.3%)	6/45 (13.3%)	
Decreased	6/44 (13.6%)	45/358 (12.6%)		46/358 (12.8%)	5/45 (11.1%)	
PLT			0.14			0.01
Normal	33/44 (75%)	288/360 (80%)		290/360 (80.6%)	31/45 (68.9%)	
Increased	2/44 (4.5%)	33/360 (9.2%)		34/360 (9.4%)	2/45 (4.4%)	
Decreased	9/44 (20.5%)	39/360 (10.8%)		36/360 (10%)	12/45 (26.7%)	
Neutrophils (%)			0.06			0.02
Normal	5/44 (11.4%)	77/364 (21.2%)		79/363 (21.8%)	3/45 (6.7%)	
Increased	34/44 (77.3%)	271/364 (74.5%)		265/363 (73%)	40/45 (88.9%)	
Decreased	5/44 (11.4%)	16/364 (4.4%)		19/363 (5.2%)	2/45 (4.4%)	
Lymphocytes (%)			0.58			0.01
Normal	23/44 (52.3%)	173/362 (47.8%)		79/363 (21.8%)	3/45 (6.7%)	
Increased	9/44 (20.5%)	100/362 (27.6%)		265/363 (73%)	40/45 (88.9%)	
Decreased	12/44 (27.3%)	89/362 (24.6%)		19/363 (5.2%)	2/45 (4.4%)	
RDW			0.002			0.02
< 13	7/41 (17.1%)	134/324 (41.4%)		133/327 (40.7%)	8/38 (21.1%)	
> 13	34/41 (82.9%)	190/324 (58.6%)		194/327 (59.3%)	30/38 (78.9%)	
PT			0.006			0.08
Normal	19/23 (82.6%)	91/92 (98.9%)		87/89 (97.8%)	24/27 (88.9%)	
Increased	4/23 (17.4%)	1/92 (1.1%)		2/89 (2.2%)	3/27 (11.1%)	
ESR			0.04			0.008
Normal	10/32 (31.3%)	162/325 (49.8%)		163/321 (50.8%)	10/37 (27%)	
Increased	22/32 (68.8%)	163/325 (50.2%)		158/321 (49.2%)	27/37 (73%)	
CRP			0.10			0.83
Normal	10/30 (33.3%)	82/252 (32.6%)		83/252 (32.9%)	9/30 (30%)	
Increased	20/30 (66.7%)	170/252 (67.5%)		169/252 (67.1%)	21/30 (70%)	
Ferritin			0.22			0.06
Normal	10/28 (35.7%)	68/139 (48.9%)		69/138 (50%)	9/30 (30%)	

Variables	ICU (n = 44)	NO-ICU (n = 364)	P-Value	≤ 1 Week (n = 363)	> 1 Week (n = 45)	P-Value
Increased	18/28 (64.3%)	71/139 (51.1%)		69/138 (50%)	21/30 (70%)	
CPK			0.44			1.00
Normal	7/17 (41.2%)	49/94 (52.1%)		46/92 (50%)	10/19 (52.6%)	
Increased	10/17 (58.8%)	45/94 (47.9%)		46/92 (50%)	9/19 (47.4%)	
Creatinine			0.02			0.03
Normal	20/43 (46.5%)	98/341 (28.7%)		98/340 (28.8%)	20/44 (45.5%)	
Increased	23/43 (53.5%)	243/341 (71.3%)		242/340 (71.2%)	24/44 (54.5%)	
Blood culture			0.24			0.05
Positive	4/36 (11.1%)	14/265 (5.3%)		13/264 (4.9%)	5/37 (13.5%)	
Negative	32/36 (88.9%)	251/265 (94.7%)		251/264 (95.1%)	32/37 (86.5%)	
AST			0.16			0.21
Normal	9/34 (26.5%)	54/274 (19.7%)		52/271 (19.2%)	11/37 (29.7%)	
Increased	16/34 (47.1%)	102/274 (37.2%)		103/271 (38%)	15/37 (40.5%)	
Decreased	9/34 (26.5%)	118/274 (43.1%)		116/271 (42.8%)	11/37 (29.7%)	
ALK			0.08			0.08
Normal	2/30 (6.7%)	3/252 (1.2%)		3/252 (1.2%)	2/30 (6.7%)	
Increased	28/30 (93.3%)	249/252 (98.8%)		249/252 (98.8%)	28/30 (93.3%)	

[a] Values are expressed as mean ± SD.