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HEMATOLOGIC PARAMETERS AS POTENTIAL DIAGNOSTIC TOOLS FOR COVID-19 IN EMERGENCY SETTING

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Abstract

Currently, the real-time reverse transcription-polymerase chain reaction test is the gold standard for diagnosing COVID-19. However, real-time reverse transcription-polymerase chain reaction requires a long turnaround time, expensive equipment, specialized laboratory, and trained personnel. Thus, accessible, fast, and accurate tests are needed, especially in emergency settings. This study aims to evaluate roles and cut off points in hematological parameters for COVID-19 screening in emergency settings.

We retrospectively evaluated hematological features in 250 patients who have visited the emergency department with suspect COVID-19 infection. Hematological parameters were compared in patients with positive and negative COVID-19 group. Receiver operating characteristic curves were made to determine significant hematological parameter cutoff point for diagnosing COVID-19 patients.

Comparisons between positive and negative COVID-19 groups revealed there was no statistical significant difference ($p>0.05$) between test groups regarding eosinophil, mean corpuscular volume, mean corpuscular hemoglobin, mean corpuscular hemoglobin concentration, thrombocytes, red blood cell distribution width, erythrocyte sedimentation rate, sodium, potassium, calcium, and high-sensitivity C-reactive protein. Significant differences ($p<0.05$) were found between test groups regarding hemoglobin, leukocyte, neutrophil, lymphocyte, monocyte, basophil, hematocrit, erythrocyte, mean platelet volume, neutrophil-lymphocyte ratio, absolute lymphocyte count, platelet-to-lymphocyte ratio, and monocyte-lymphocyte ratio. The highest area under the curve was found in lymphocyte with cut off point ≥17.6 (area under curve: 0.721; $p=0.000$; 95% confidence interval: 0.656-0.785).

Blood test analysis might be used as a screening method for COVID-19 using certain hematological parameters. It is instrumental in the emergency department, which needs a fast screening method.

Keywords: *COVID-19, diagnostic value, laboratory screening, triage.*

Introduction

Coronavirus disease 2019 (COVID-19) is a novel coronavirus that was first detected in an outbreak of pneumonia cases with unknown causes in Hubei Province, China, with clinical presentations that are strikingly similar to viral pneumonia [*Li Q et al., 2020a*]. The World Health Organization (WHO) announced a global pandemic on March 11, 2020. Given the rapid global spread of SARS-CoV-2, there is an immediate need for data analysis and clinical testing on cases worldwide. As of August 31, 2020, confirmed COVID-19 infections had infected over 25,1 million people worldwide and claimed over 844,000 lives. COVID-19 has been confirmed in over 220 countries. Meanwhile, in Indonesia, there have been 172.053 of COVID-19 cases and 7.343 total deaths [*WHO, 2020*]. Therefore, vaccines are needed to fight against SARS-CoV-2 [*Nidom R et al., 2020*].

Most healthcare in the world gets overwhelmed by COVID-19 crisis [*Wang J, Wang Z, 2020*]. Various modalities have been developed for this disease [*Aryati A et al., 2020*]. An increase in the number of COVID-19 patients visits to the emergency department caused an increased demand for medical re-

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sources, especially for COVID-19 screening to detecting the virus is essential [*Dwijayanti R, 2020*]. A screening protocol also created to identify patients with symptoms or at risk of having COVID-19 [*Schreyer K et al., 2020*]. Therefore, physician need tools to assess the likelihood of COVID-19 at the initial examination by triage based on epidemiological risks, routine investigations and bedside observation for safe isolation [*Asmarawati T et al., 2020*]. The golden standard diagnosis of COVID-19 requires the detection of viral nucleic acids from samples taken in the patient's respiratory tract [*Li Z et al., 2020*]. Apart from real-time reverse transcription-polymerase chain reaction (rRT-PCR) as a gold standard, chest radiograph and CT Scan are considered necessary for COVID-19 diagnosis [*Weinstock M et al., 2020*]. However, their clinical application is limited by high examination cost, limited medical resources, also excessive radiation [*Peng J et al., 2020*]. As a result, there is a need for simple and cost-effective diagnostic indicators. From prior research, there are some hematologic parameter changes found in COVID-19 patient, which might be useful for diagnosing COVID-19 [*Liu Y et al., 2020a*].

Complete blood counts (CBCs) are simple and inexpensive to conduct. The CBC test includes a count of white blood cells, neutrophils, lymphocytes, and platelets. These markers, as well as specific ratios of their values, such as the neutrophil-lymphocyte ratio (NLR), monocyte-lymphocyte ratio (MLR), platelet-lymphocyte ratio (PLR), and absolute lymphocyte count, may be used as inflammatory markers [*Usul E et al., 2020*]. Neutrophil-lymphocyte ratio has been used as one of the parameters in the COVID-19 early warning score [*Song C et al., 2020*]. Monocyte-lymphocyte and platelet-lymphocyte ratio have also been used as biomarkers for diagnosing influenza virus infection [*Merekoulias G et al., 2010; McClain M et al., 2013*]. ALC has been used as an important prognostic marker for determining the clinical course and disease severity of COVID-19 patients [*Wagner J et al., 2020*]. Only a few studies, however, have examined the diagnostic utility of hematologic parameters in COVID-19.

As of March 2020, Nganjuk Regional Public Hospital, Indonesia, is used as a referral hospital for COVID-19. The rRT-PCR test is currently golden standard for diagnosing COVID-19 [*Adriana D, Miftahussurur M, 2020*]; however, it requires a long turnaround time, expensive equipment, specialized laboratory, and trained personnel, making it unsuitable for rapid and large-scale screening methods, especially in emergency departments where quick and accurate judgment are needed. CBC is one of the fastest, affordable, and accessible hematologic parameters. However, it is still unknown if this laboratory examination could be used for COVID-19 screening and diagnostic. Large samples and needed for fast, accurate, and accessible screening methods are the reasons why we were interested in conducting this research. This study aims to evaluate roles and cut off points in hematological parameters for COVID-19 screening in emergency settings.

Material and methods

In this analytic, cross-sectional study, we retrospectively evaluated 250 patients who have visited the emergency department with suspected COVID-19 infection between March 1st and August 31st. Suspected Covid-19 diagnosis was based on pulmonologist decisions using patient's risk factor, clinical features, laboratory result, and chest X-ray imaging data. This study inclusion criteria were complete medical records (Identity, clinical feature, complete blood count, rRT-PCR). The exclusion criteria for this study were suspected COVID-19 patients who do not go through the emergency department. Epidemiological data, clinical features, and laboratory analyses were based on the medical record.

Data analysis was done using the IBM SPSS 23.0. The Kolmogorov Smirnov test was used to assess the normality of the data distribution. The chi-square test was used to assess the patient's categorical variables, which were expressed in terms of numbers and percentages. We analyzed parametric continuous variables using the independent samples t-test. The Mann-Whitney U

To overcome it is possible, due to the uniting the knowledge and will of all doctors in the world

test was used to evaluate nonparametric variables. The receiver operating characteristic curve was developed, the Youden's index (J) was used to determine the cut-off values for COVID-19 diagnosis, and the area under the curve (AUC) was determined. We measured the 95 percent confidence interval (CI) and found a two-tailed p 0.05 to be statistically significant.

Results

Patient epidemiologic and clinical features: This study revealed 250 patients suspected COVID-19 who came to the emergency department 56% were male while the average age was 47.02 ± 1.25 years. rRT-PCR analysis showed that 97 patients (38.8%) were positive and 153 patients (62.2%) were negative. Most of the patients (32.4%) denied the risk factor of COVID-19 transmission. History of contact with positive COVID-19 patients (26%) was the most common risk factor for patients suspected of COVID-19. Most patients with positive COVID-19 did not have any comorbidities (50%). Hypertension was the most frequently encountered comorbidity in the COVID-19 positive group (28.7 percent). Fever (65.5%), cough (62.4%), and dyspnea (47.6%) were the most commonly seen symptoms in COVID-19 positive group (Table 1).

Hematologic parameters: Comparisons were made based on the results of the rRT-PCR test. There was no statistically significant difference in eosinophil, MCV, MCH, MCHC, platelet, RDW, erythrocyte sedimentation rate (ESR), sodium, potassium, calcium, or high-sensitivity C-reactive protein (Hs-CRP) levels between the test result groups (positive or negative) (p>0.05). On the other hand, a statistically significant difference (p0.05) in hemoglobin (Hb), leukocyte, neutrophil, lymphocyte, monocyte, basophil, hematocrit, erythrocyte, Mean Platelet Volume (MPV), NLR, ALC, PLR, and MLR was observed between the two classes. Positive rRT-PCR results were associated with lower leukocyte, neutrophil, basophil, NLR, PLR, and MLR counts than negative rRT-PCR results. Our study found that higher lymphocyte, monocyte, erythrocyte, hematocrit, MPV, and ALC were seen in positive rRT-PCR group compared to negative rRT-PCR group (Table 2).

Hematologic parameters optimal cut-off values: Hematologic parameters with statistically significant difference (Hb, leukocyte, neutrophil, lymphocyte, monocyte, basophil, hematocrite, erythrocyte, MPV, NLR, ALC, PLR, and MLR) between groups were then studied using receiver operating characteristic curve analyses. Based on observation of receiver operating characteristic curve, AUC, and Youden index, we determined the optimal cut-off point for COVID-19 diagnosis (Table 3, figure 1, and figure 2). The cut-off point for hemoglobin was ≥ 12.650 (AUC 0.654; p = 0.000; 95% CI: 0.583-0.7254). Cut off point for leukocyte values was ≤ 13.750 (AUC 0.624; p = 0.001; 95% CI: 0.554-0.694). The cut-off point for neutrophil was ≤ 75.15 (AUC 0.681; p = 0.000; 95% CI: 0.614-0.748). The Cut-off point for basophil was ≤ 0.75 (AUC 0.606; p = 0.000; 95% CI: 0.614-0.748). The Cut-off point for lymphocyte was ≥ 17.6 (AUC 0.721; p = 0.000; 95% CI: 0.656-0.785). The Cut-off point for monocyte was ≥ 4.45 (AUC 0.586; p = 0.025; 95% CI: 0.514-0.658). The Cut-off point for MLR was ≤ 0.56 (AUC 0.661; p = 0.000; 95% CI: 0.591-0.730). The Cut-off point for NLR was ≤ 4.37 (AUC 0.699; p = 0.000; 95% CI: 0.634-0.765). The Cut-off point for PLR was ≤ 180.4 (AUC 0.630; p = 0.001; 95% CI: 0.560-0.701). The Cut-off point for erythrocyte was ≥ 4.955 (AUC 0.678; p = 0.000; 95% CI: 0.609-0.746). The Cut-off point for hematocrite was ≥ 41.45 (AUC 0.632; p = 0.001; 95% CI: 0.560-0.704). The Cut-off point for MPV was ≥ 9.19 (AUC 0.611; p = 0.004; 95% CI: 0.538-0.684). The Cut-off point for ALC was ≥ 848.25 (AUC 0.616; p = 0.002; 95% CI: 0.544-0.687) (Table 3).

Table 3 shows that lymphocyte has the highest AUC (0.721), followed by NLR (0.699) and neutrophil (0.681). ALC had the highest sensitivity value (97.9%), followed by monocyte (90.6%) and leukocyte (87.5%). Hematocrit had the highest specificity value (76.9%), followed by MPV (75.5%) and erythrocyte (71.3%).

Additional analysis of these hematological parameters was conducted to determine the patient distribution between positive and negative groups using their cut-off values. Comparing these new groups showed a statistically significant difference

Table 1.

Comparisons of patient epidemiologic and clinical features according to rRT-PCR test results

Patient features		Total n = 250	rRT-PCR test Positive (+) n = 97	rRT-PCR test Negative (-) n = 153	p-value
Age (years)		47.02 ± 1.255	41.76 ± 17.13	50.35 ± 20.68	0.000 †
Gender	Male	140 (56%)	50 (51.5%)	90 (58.8%)	0.278
	Female	110 (44%)	47 (48.5%)	63 (41.2%)	
Transmission risk factors	History travel to another region	53 (21.2%)	24 (24.7%)	29 (19.0%)	
	History contact with positive COVID-19 patient	65 (26%)	40 (41.2%)	25 (16.3%)	
	History contact with people from another region	34 (13.6%)	7 (7.2%)	27 (17.6%)	
	Work outside the city	17 (6.8%)	7 (7.2%)	10 (6.5%)	
	Denied	81 (32.4%)	19 (19.6%)	62 (40.5%)	
Comorbidities	DM	39 (13.4%)	11 (10.18%)	28 (15.3%)	
	HT	77 (26.46%)	31 (28.7%)	46 (25.14%)	
	CVD	15 (5.15%)	3 (2.78%)	12 (6.56%)	
	CVA	8 (2.75%)	2 (1.85%)	6 (3.28%)	
	Asthma	14 (4.81%)	4 (3.7%)	10 (5.46%)	
	CKD	17 (5.84%)	1 (0.92%)	16 (8.74%)	
	Pulmonary Tuberculosis	10 (3.44%)	2 (1.85%)	8 (4.37%)	
	No comorbidities	111 (38.14%)	54 (50%)	57 (31.15%)	
Symptoms	Fever	164 (65.5%)	63 (64.9%)	101 (66%)	
	Cough	156 (62.4%)	57 (58.8%)	99 (64.7%)	
	Fatigue	23 (9.2%)	6 (6.2%)	17 (11.1%)	
	Sore throat	12 (4.8%)	4 (4.1%)	8 (5.2%)	
	Dyspnea	119 (47.6%)	38 (39.2%)	81 (52.9%)	
	Myalgia	10 (4%)	4 (4.1%)	6 (3.9%)	
	GI disturbance	30 (12%)	14 (14.4%)	16 (10.5%)	

Notes: **Significant independent T-test ($p < 0.05$), rRT-PCR: real-time reverse transcription-polymerase chain reaction; DM: Diabetes melitus; HT: Hypertension; CVD: Cardiovascular disease; CVA: Cerebrovascular attack; CKD: Chronic kidney disease*

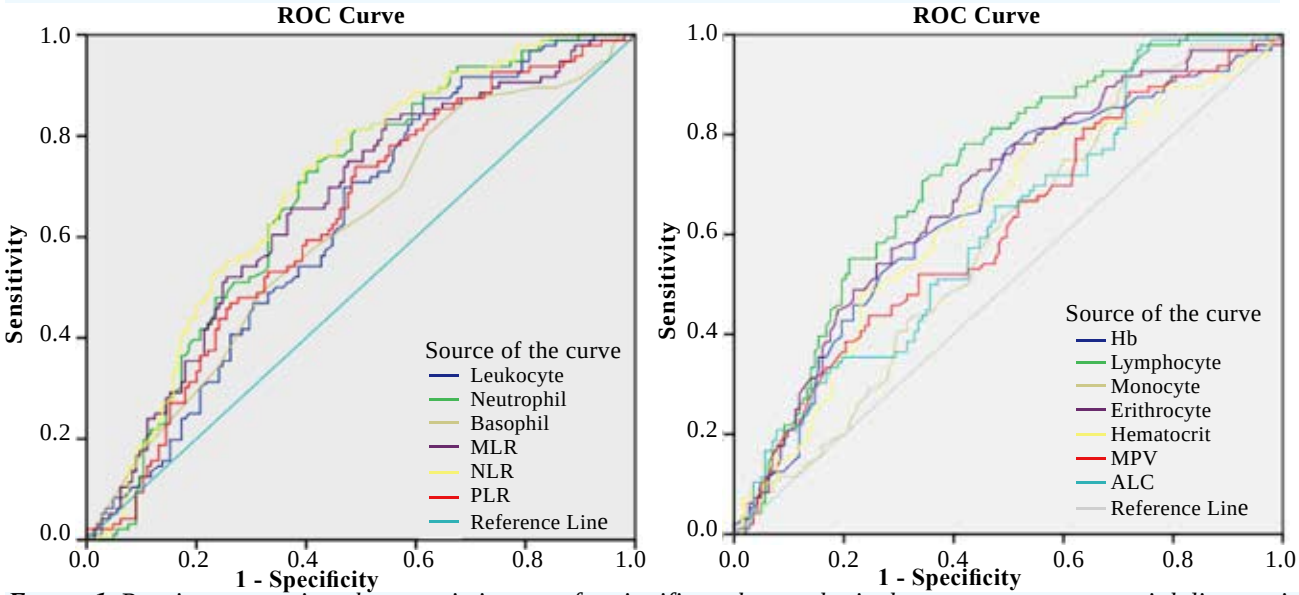

Figure 1. *Receiver-operating characteristic curve for significant hematological parameter as a potential diagnostic tool for COVID-19. Diagonal segments are produced by ties*

Notes: *ROC: Receiver-operating characteristic; MLR: Monocyte lymphocyte ratio; NLR: Neutrophil lymphocte ratio; PLR: Platelet lymphocyte ratio, Hb: Hemoglobin; MPV: Mean platelet volume; ALC: Absolut lymphocyte count.*

in these parameters between them. (Table 4).

Discussion

The global pandemic of COVID-19 continues to place a strain on the health system. Thus, diagnosing COVID-19 patients is critical for outbreak management. In the emergency setting, we need quick, accessible, and affordable diagnostic tools. This study provides several hematologic parameters (hemoglobin, leukocyte, neutrophil, lymphocyte, monocyte, basophil, hematocrit, erythrocyte, MPV, NLR, ALC, PLR, and MLR) as a potential diagnostic tool for COVID-19 in an emergency setting. These study results are consistent with the previous research showing low neutrophil and low basophil counts in COVID-19 positive patients [*Dai J et al., 2020; Usul E et al., 2020*]. Our study found that higher lymphocyte count was found in COVID-19 positive patients, similar to prior research that found higher lymphocyte count in COVID-19 positive patients than influenza pneumonia patients [*Peng J et al., 2020*]. Although, there are contradictions with prior research that found lower lymphocyte count was seen in COVID-19 positive patients [*Frater J et al., 2020;*

Table 2.

Comparisons of hematological parameters according to rRT-PCR test results

Hematologic parameters	Total	rRT-PCR test		p-value
		Positive (+) n = 97	Negative (-) n = 153	
Hb (*g/dl*)	12.930 ± 2.45	13.60 ± 2.43	12.49 ± 2.4	0.000 ‡
Leukocyte ($10^3/\mu L$)	11891.65 ± 6819.50	9.828 ± 4.235	13.208 ± 7.777	0.001 ‡
Neutrophil (%)	71.81 ± 16.67	68.10 ± 11.62	74.23 ± 17.43	0.000 ‡
Lymphocyte (%)	18.56 ± 12.10	22.97 ± 10.46	15.70 ± 12.26	0.000 ‡
Monocyte (%)	6.98 ± 3.36	7.51 ± 3.15	6.63 ± 3.46	0.012 ‡
Eosinophil (%)	1.09 ± 1.35	1.19 ± 1.26	1.03 ± 1.4	0.085
Basophil (%)	0.62 ± 0.64	0.496 ± 0.40	0.70 ± 0.75	0.005 ‡
Hematocrit (%)	38.251 ± 7.91	39.69 ± 7.56	37.33 ± 8.02	0.000 ‡
Erythrocyte ($10^6/\mu L$)	5.45 ± 5.53	5.49 ± 3.83	5.43 ± 6.40	0.000 ‡
MCV (*fl*)	80.92 ± 11.03	80.9 ± 10.7	80.9 ± 11.22	0.890
MCH (*pg*)	27.71 ± 3.04	27.7 ± 3.73	27.72 ± 2.52	0.548
MCHC (%)	33.68 ± 2.00	33.67 ± 1.51	33.69 ± 2.26	0.706
Platelet ($10^3/\mu L$)	287128.51 ± 160886.53	288051.55 ± 111138.27	286539.47 ± 186168.22	0.291
RDW (%)	12.85 ± 7.99	13.61 ± 12.51	12.36 ± 2.02	0.488
MPV (*fl*)	8.048 ± 2.084	8.47 ± 2.07	7.77 ± 2.051	0.004 ‡
ESR (*mm/hour*)	53.79 ± 32.85	48.28 ± 29.96 (n = 55)	57.68 ± 34.39 (n = 78)	0.159
NLR	7.96 ± 9.96	4.26 ± 3.6	10.34 ± 11.87	0.000 ‡
ALC	1.850 ± 1.181	2.110 ± 1.193	1.683 ± 1.147	0.003 ‡
PLR	230.13 ± 228.24	179.13 ± 167.87	263.10 ± 255.07	0.001 ‡
MLR	0.590 ± 0.703	0.429 ± 0.370	0.711 ± 0.838	0.000 ‡
Na (*mmol/L*)	133.53 ± 5.82	134.41 ± 5.35 (n = 65)	133.01 ± 6.04 (n = 110)	0.208
K (*mmol/L*)	3.86 ± 0.79	3.85 ± 0.8 n = 64	3.86 ± 0.78 n = 109	0.219
Ca (*mmol/L*)	1.15 ± 0.11	1.14 ± 0.96 (n = 64)	1.15 ± 0.11 (n = 108)	0.938
Hs-CRP (*mg/L*)	49.72 ± 80.97	30.29 ± 52.38 (n = 42)	61.54 ± 92.60 (n = 69)	0.057

Notes: *† = Significant independent T-test (p < 0.05), ‡ = Significant mann Whitney-U test (p < 0.05)*
¥ = Significant chi square (p < ٠,٠٥), *rRT-PCR: real-time reverse transcription-polymerase chain reaction; Hb: Hemoglobin; MCV: Mean cell volume; MCH: Mean corpuscular hemoglobin; Mean corpuscular hemoglobin concentration; RDW: red cell distribution width; MLR: Monocyte lymphocyte ratio; NLR: Neutrophils lymphocyte ratio; PLR: Platelet lymphocyte ratio; MPV: Mean platelet volume; ESR: erythrocyte sedimentation rate; ALC: Absolute lymphocyte count; Hs-CRP: High-sensitivity C-reactive protein; Na: Sodium; K: Potassium; Ca: Calcium*

Table 3.

Recommended cut-off values for significant hematologic parameters as a potential diagnostic tool for COVID-19.

Hematologic parameters	AUC	Cut-Off	Sensitivity	Specificity	95% CI	p-value
Hemoglobin (*g/dl*)	0.654	≥ 12.65	77.1	50.3	0.583 – 0.725	0.000*
Leukocytes ($10^3/\mu L$)	0.624	≤ 13.750	87.5	38.6	0.554-0.694	0.001*
Neutrophils (%)	0.681	≤ 75.15	75.0	57.9	0.614 – 0.748	0.000*
Basophil (%)	0.606	≤ 0.75	80.2	37.9	0.534 – 0.679	0.005*
Lymphocytes (%)	0.721	≥ 17.6	70.8	65.7	0.656 – 0.785	0.000*
Monocytes (%)	0.586	≥ 4.45	90.6	29.4	0.514 – 0.658	0.025*
MLR	0.661	≤ 0.56	83.3	45.5	0.591 – 0.730	0.000*
NLR	0.699	≤ 4.37	74.0	60.0	0.634 – 0.765	0.000*
PLR	0.630	≤ 180.4	74.0	51.0	0.560 – 0.701	0.001*
Erithrocytes ($10^6/\mu L$)	0.678	≥ 4.955	57.3	71.3	0.609 – 0.746	0.000*
Hematocrit (%)	0.632	≥ 41.45	47.9	76.9	0.560 – 0.704	0.001*
MPV (*fl*)	0.611	≥ 9.19	43.8	75.5	0.538 – 0.683	0.004*
ALC	0.616	≥ 848.25	97.9	25.9	0.544 – 0.687	0.002*

Notes: ** = Statiscally significant difference ($p < 0.05$)*
AUC: Area under the curve; MLR: Monocyte lymphocyte ratio; NLR: Neutrophils lymphocyte ratio; PLR: Platelet lymphocyte ratio; MPV: Mean platelet volume; ALC: Absolute lymphocyte count

Yuan X et al., 2020]. However, our lymphocyte count in COVID-19 positive patients mean was 22.97% (Laboratory normal range 25%-40%) that still indicated lymphopenia. That value was the same as the prior study in China that showed the distribution of lymphocyte count in COVID-19 around 25.32% [*Peng J et al., 2020*]. In this study, there was no statistically significant difference in eosinophil counts.

Absolute lymphocyte count, neutrophil-lymphocyte, platelet-to-lymphocyte and monocyte-lymphocyte ratio are important biomarkers to differentiate bacterial and viral infections. These biomarkers are also used as inflammatory response markers to predict the prognosis of certain diseases [*Liu Y et al., 2020b; Loonen A et al., 2014; Peng J et al., 2020*]. Low ALC values were found in most COVID-19 patients in China, but a prior study in the emergency department found an insignificant difference in ALC values between COVID-19 positive and negative subjects [*Liu K et al., 2020; Usul E et al., 2020*]. In other studies, we discovered that COVID-19 patients had lower ALC values. While high NLR, MLR, and PLR values were used as prognostic indicators for COVID-19 patients, NLR, MLR, and PLR values were found to be significantly lower in COVID-19 patients on their first visit to the emergency department [*Bastug A et al., 2020; Ferrari D et al., 2020; Liu Y et al., 2020c*]. These biomarkers were significantly higher in COVID-19 patients than in the healthy control group in previous studies. However, NLR, MLR, and PLR had low diagnostic value to differentiate COVID-19 and influenza pneumonia [*Peng J et al., 2020*] . Other study also showed that NLR was associated with COVID-19 mortality in hospital setting in an Indonesian population [*Sensusiati A et al., 2021*]. In our study, NLR and MLR were lower in COVID-19 patients than COVID-19 negative group. Negative group had similar symptoms with positive group and had large variability of differential diagnosis like sepsis, pneumonia of other causes, etc.

Erythrocyte sedimentation rate and C-reactive protein are inflammatory markers often associated with COVID-19 progression and severity [*Zeng F et al., 2020*]. Our analysis found no substantial difference between subjects who tested positive for COVID-19 and those who tested negative. In prior studies, ESR values did not have a statistically significant difference in pneumonia caused by influenza and pneumonia caused by COVID-19 [*Zhang W et al., 2020*]. C-reactive protein level was associated with the diameters of lung lesions and severe

TABLE 4.

Comparison of results according to cut-off points.

Hematologic parameters	Cut-off	Positive	Negative	p-value
Hemoglobin *(g/dl)*	≥ 12.65	75 (77.3%)	75 (49.0%)	0.000*
	< 12.65	22 (22.7%)	78 (51.0%)	
Leukocyte ($10^3/\mu L$)	≤ 13.750	85 (87.6%)	93 (60.8%)	0.000*
	> 13.750	12 (12.4%)	60 (39.2%)	
Neutrophil (%)	≤ 75.15	72 (74.2%)	63 (42.3%)	0.000*
	> 75.15	25 (25.8%)	86 (57.7%)	
Lymphocyte (%)	≥ 17.6	69 (71.1%)	52 (34.7%)	0.000*
	< 17.6	28 (28.9%)	98 (65.3%)	
Monocyte (%)	≥ 4.45	88 (90.7%)	104 (70.3%)	0.000*
	< 4.45	9 (9.3%)	44 (29.7%)	
Basophil (%)	≤ 0.75	77 (80.2%)	91 (62.3%)	0.003*
	> 0.75	19 (19.8%)	55 (37.7%)	
MLR	≤ 0.56	80 (82.5%)	83 (55.7%)	0.000*
	> 0.56	17 (17.5%)	66 (44.3%)	
NLR	≤ 4.37	71 (73.2%)	60 (40.0%)	0.000*
	> 4.37	26 (26.8%)	90 (60.0%)	
PLR	≤ 180.4	71 (73.2%)	72 (48.0%)	0.000*
	> 180.4	26 (26.8%)	78 (52.0%)	
ALC	≥ 848.25	95 (97.9%)	112 (74.7%)	0.000*
	< 848.25	2 (2.1%)	38 (25.3%)	
Erythrocyte ($10^6/\mu L$)	≥ 4.955	56 (57.7%)	42 (27.8%)	0.000*
	< 4.955	41 (42.3%)	109 (72.2%)	
Hematocrit (%)	≥ 41.45	47 (48.5%)	35 (23.0%)	0.000*
	< 41.45	50 (51.5%)	117 (77.0%)	
MPV *(fl)*	≥ 9.19	42 (43.8%)	37 (24.8%)	0.002*
	< 9.19	54 (56.3%)	112 (75.2%)	

NOTES: ** = Statiscally significant difference (p < 0.05) MLR: Monocyte lymphocyte ratio; NLR: Neutrophils lymphocyte ratio; PLR: Platelet lymphocyte ratio; MPV: Mean platelet volume; ALC: Absolute lymphocyte count.*

presentation [*Wang L, 2020*]. In a previous report, the combination of eosinopenia and elevated Hs-CRP effectively differentiated suspected COVID-19 patients from other patients with COVID-19-like initial symptoms who presented to the fever clinic [*Li Q et al., 2020a*]. This combination results in a sensitivity of 67.9% and a specificity of 78.2%, as well as an AUC of 0.730 [*Li Q et al., 2020b*].

Our study did not find a significant difference in electrolytes level in COVID-19 positive and negative patients. In prior studies, lower value in sodium, potassium, and calcium levels was found in adult COVID-19 patients admitted to the intensive care unit and significantly correlated with severity and mortality rate [*Lippi G et al., 2020; Sun J et al., 2020*]. Thus, electrolytes such as sodium, potassium, and calcium might be useful as severity and mortality predictors.

COVID-19 infection can affect both women and men. Our study found that there was no statistical difference in the incidence of COVID-19 between women and men. Fever was the most frequently reported symptom in the COVID-19 population, followed by cough and dyspnea. This result had a similar result with the previous study that fever is the most common symptom [*Usul E et al., 2020*]. In contrast, another study found that cough is the most common symptoms [*Garg S et al., 2020; Guan W et al., 2020*].

Hemoglobin concentration is a key factor in determining the oxygen-carrying ability of the blood. Based on a meta-analysis study, it was found that there was a significant decrease in hemoglobin value parallel with the severity of COVID-19 (p <0.001) [*Taneri P et al., 2020*] . However, our study showed different results. Hemoglobin and hematocrit levels were found to be significantly higher in COVID-19 positive patients than in COVID-19 negative patients. Since the population used in this analysis did not assess patient background, hemoglobin values could have been affected.

Platelet and MPV count is used as a marker of inflammatory response [*Yang M et al., 2004*]. Severe non-COVID infections are associated to secondary thrombocytopenia, which may be caused by antibodies attacking thrombocytes or infected hematopoietic stem cells, thus inhibiting hematopoietic function. A low platelet count can stimulate the release of young platelets with larger volumes, resulting in a high MPV, as seen in COVID-19 patients [*Güçlü E et al., 2020*]. Our study showed a significantly higher MPV values in patients with confirmed COVID-19 compared to negative COVID-19 patient. However, there was no statistically significant difference in platelet counts in COVID-19 and non-COVID-19 patients.

This study provides insight for different diagnostic cut-off values in certain hematologic parameters in the emergency setting compared to prior studies

in a non-emergency setting. This difference might happen because of the characteristic samples used in the emergency setting majority were symptomatic patients. Some diseases might alter the hematologic parameter and affect the result of this study.

The study limitation was the relatively inadequate number of patients. Studies conducted with a larger patient group might better portray the importance of hematologic parameters as potential diagnostic tools for COVID-19 patients. Second, patient comorbidities and personal habits were not evaluated in each group. Third, our study did not differentiate the severity of COVID-19 patients; therefore, it may affect the result of this study.

Conclusion

Blood test analysis might be used as a potential diagnostic method for COVID-19 using certain hematologic parameters. In our study, lower values of leukocyte, neutrophil, basophil, MLR, NLR, and PLR indicated COVID-19 infection. On the other hand, higher values of Hb, lymphocytes, monocytes, erythrocyte, hematocrit, MPV, and ALC indicated COVID-19 infection.

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Financial and competing interest disclosure

The authors declare no direct financial ties to any company or institution that has a financial interest in or a financial conflict with the subject matter or content addressed in the manuscript. This manuscript was written without the assistance of a third party.

Ethical conduct of research

This study was carried out in line with research regulations according to the principles of "World Medical Association Helsinki Declaration". Also, approval of the Ethics Committee of Nganjuk Regional Public Hospital.

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