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Original Research Article

A Comparative Study of Hematological Parameters in ICU and Non-ICU COVID-19–Positive Patients at a Tertiary Care Hospital in Mumbai

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Abstract

Background: Coronavirus disease 2019 (COVID-19) is associated with significant hematological alterations that correlate with disease severity. Routine complete blood count (CBC) parameters and derived inflammatory indices may serve as accessible predictors of intensive care unit (ICU) admission and mortality.

Objective: To compare hematological parameters between ICU and non-ICU COVID-19–positive patients and evaluate their diagnostic accuracy in predicting ICU admission and mortality.

Methods: This observational, hospital-based study included 3,000 RT-PCR–confirmed COVID-19 patients admitted to hospital from April 2020 to June 2021. Patients were categorized into ICU (n = 1,273) and non-ICU (n = 1,727) groups. Hematological parameters were analyzed using an automated five-part hematology analyzer. Logistic regression was performed to identify independent predictors of ICU admission. Receiver operating characteristic (ROC) curve analysis assessed diagnostic performance for ICU admission and mortality prediction.

Results: Sociodemographic characteristics were comparable between groups. ICU patients demonstrated significantly higher total leukocyte counts, neutrophil percentages, and neutrophil-to-lymphocyte ratio (NLR), along with lower platelet and lymphocyte percentages ($p < 0.05$). On multivariable analysis, total leukocyte count (adjusted OR 1.04; 95% CI: 1.01–1.07), platelet count (adjusted OR 0.998; 95% CI: 0.996–1.000), neutrophil percentage (adjusted OR 1.06; 95% CI: 1.04–1.09), lymphocyte percentage (adjusted OR 0.89; 95% CI: 0.85–0.93), and NLR (adjusted OR 1.61; 95% CI: 1.42–1.82) were independently associated with ICU admission. NLR demonstrated the highest diagnostic accuracy for ICU admission (AUC 0.81; sensitivity 78.9%; specificity 75.4%) and mortality among ICU patients (AUC 0.84; sensitivity 82.1%; specificity 78.3%).

Conclusion: Hematological inflammatory markers, particularly NLR, are significant independent predictors of ICU admission and mortality in COVID-19 patients. Routine CBC-derived parameters may serve as cost-effective and readily available tools for early risk stratification in resource-limited settings.

Keywords: COVID-19, ICU patients, hematological parameters, complete blood count.

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Introduction

Coronavirus disease 2019 (COVID-19), caused by SARS-CoV-2, remains a significant global health concern with clinical manifestations ranging from asymptomatic infection to critical illness requiring intensive care. Early studies identified that abnormalities in routine hematological parameters reflect immune dysregulation and systemic inflammation in affected patients. In particular, lymphopenia, neutrophilia, and elevated inflammatory indices such as the neutrophil-to-lymphocyte ratio (NLR) were found to be significantly associated with increased disease severity and poorer clinical outcomes (Li et al., 2020).[1] Coronavirus disease 2019 (COVID-19), caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), emerged as a global health crisis in late 2019. Although initially recognized as a respiratory illness, COVID-19 is now understood to be a multisystem disease with significant effects on the hematopoietic and immune systems (Thakkar 2020).[2]

Subsequent observational studies have reinforced the role of complete blood count (CBC) alterations as accessible prognostic markers. In a tertiary hospital cohort, Ismail *et al.* (2024) demonstrated that elevated white blood cell and neutrophil counts were independently predictive of ICU admission and survival status in COVID-19 patients, underscoring the clinical relevance of routine hematology in triage and critical care planning. More recent work has expanded this paradigm; a large Indian cohort reported that NLR and other CBC-derived indices such as platelet-to-lymphocyte ratio (PLR) were significantly elevated in severe cases compared with non-severe disease, highlighting the systemic inflammatory milieu characterising patients requiring higher levels of care.[3]

More recent investigations have further strengthened this evidence. Krishnan et al. (2024) demonstrated that elevated neutrophil percentage, lymphocytopenia, and raised NLR were significantly associated with severe COVID-19 requiring intensive care, with NLR showing better discriminative ability than individual leukocyte parameters as a simple and cost-effective prognostic marker.[4] Similarly, Zeidan et al. (2025) reported that inflammation indices derived from routine CBC—particularly NLR—were markedly elevated in critically ill patients, and NLR exhibited the highest predictive accuracy for ICU admission and disease progression, outperforming isolated hematological parameters.[5] On February 11, 2020, the World Health Organization (WHO) announced the name of the epidemic disease caused by SARS-CoV-2 as coronavirus disease 2019 (COVID-19) and declared it a pandemic on March 11, 2020.[6] SARS-CoV-2 spreads primarily through inhalation of virus-laden respiratory droplets. Thus, the main sources of human infection include contact with respiratory droplets from infected individuals during sneezing, coughing, or close physical contact, as well as exposure to contaminated surfaces.[7]

Aim & Objectives

Aim: To compare hematological parameters between ICU and non-ICU COVID-19–positive patients and to evaluate their association and diagnostic accuracy in predicting ICU admission and mortality.

Objectives

Primary Objectives

- To compare complete blood count (CBC) parameters between ICU and non-ICU COVID-19–positive patients using Independent Samples t-test.
- To determine the association between hematological parameters and ICU admission using simple and multiple logistic regression analysis.

Secondary Objectives

- To evaluate the diagnostic performance of hematological parameters in predicting ICU admission using Receiver Operating Characteristic (ROC) curve analysis (AUC, sensitivity, specificity, PPV, NPV).
- To assess the predictive accuracy of hematological parameters for mortality among ICU patients using ROC analysis.
- To identify independent hematological predictors of ICU admission after adjustment for confounding variables.

Materials & Methods

Study Design: This was an observational, descriptive, hospital-based study conducted to evaluate and compare hematological parameters among ICU and non-ICU COVID-19 positive patients.

Study Place: The study was carried out in the Department of Pathology, Topiwala National Medical College (T.N.M.C.) in the collaboration with Department of Pathology, Bai Yamunabai Laxman Nair Charitable (B.Y.L. Ch.) Hospital, Mumbai, a tertiary care teaching hospital.

Study Period: The study was conducted over a period of 15 months from April 2020 to June 2021, during which peripheral blood samples of COVID-19 positive patients admitted to the hospital were analyzed.

Study Population: The study population comprised 3000 patients indoor (hospitalized) patients who were confirmed to be COVID-19 positive by real-time reverse transcription polymerase chain reaction (RT-PCR) testing and whose blood samples were received in the hematology laboratory for complete blood count (CBC) analysis. Patients were categorized into ICU and non-ICU groups based on their place of admission:

- **ICU cases** (n=1273)
- **Non-ICU cases** (n=1727)

Ethical Considerations: Approval for the study was obtained from the Ethics Committee for Academic Research and Projects (ECARP) of T.N.M.C. and B.Y.L. Ch. Hospital prior to commencement of data collection. Patient confidentiality was strictly maintained, and all data were anonymized before analysis. As this was an observational study using routinely collected laboratory data, no direct patient intervention was involved.

Inclusion Criteria

- RT-PCR confirmed COVID-19 positive patients
- Hospitalized (indoor) patients admitted to ICU or non-ICU wards
- Peripheral blood samples received for complete blood count analysis

Exclusion Criteria

- COVID-19 negative patients
- Suspected COVID-19 cases without RT-PCR confirmation
- Inadequate, hemolyzed, or clotted blood samples

Methodology

After obtaining ethical clearance, data were collected retrospectively from laboratory records and patient case files. Relevant clinical and demographic details were recorded using a structured case record form. The data were subsequently entered into a Microsoft Excel spreadsheet, with separate datasets maintained for ICU and non-ICU patients. Peripheral venous blood samples were collected in ethylenediaminetetraacetic acid (EDTA) vacutainers under aseptic precautions. Complete blood count analysis was performed using a fully automated five-part hematologyanalyzer, which provided measurements of hemoglobin concentration, total leukocyte count, differential leukocyte count, platelet count, and red blood cell indices.

Investigations: The primary laboratory investigation included:

- Hemoglobin (Hb)
- Total leukocyte count (TLC)
- Differential leukocyte count (neutrophils, lymphocytes, eosinophils, monocytes)
- Platelet count
- Derived hematological indices such as neutrophil-to-lymphocyte ratio (NLR) were calculated where applicable.

Outcome Measures: The primary outcome measure was the comparison of hematological parameters between ICU and non-ICU COVID-19 positive patients. Secondary outcomes included assessment of the association of these parameters with disease severity as reflected by ICU admission.

Statistical Analysis: Data were entered into Microsoft Excel 365 (Microsoft Corporation, Redmond, WA, USA) and analyzed using Statistical Package for the Social Sciences (SPSS) software, version 27 (IBM Corp., Armonk, NY, USA).

- Qualitative variables (such as gender and ICU status) were expressed as frequencies and percentages.
- Quantitative variables (hematological parameters) were expressed as mean ± standard deviation (SD).
- Comparison of mean values of hematological parameters between ICU and non-ICU groups was performed using the independent samples t-test.
- A p-value < 0.05 was considered statistically significant.

Results

A total of 3,000 patients who tested positive for SARS-CoV-2 by RT-PCR were included in the study. The age of the patients ranged from 18 to 70 years, with a mean age of 52.8 years.

There were 1,759 male and 1,241 female patients, resulting in a male-to-female ratio of 1.42:1. Of the 3,000 patients admitted, 1,273 patients required ICU care, as shown in Table 1.

Table 1: Sociodemographic characteristics of COVID-19 positive patients

Sociodemographic parameters	ICU cases (n = 1273)	Non-ICU cases (n = 1727)	*p* value
Age (years), mean ± SD	53.08 ± 13.42	52.59 ± 13.11	0.29*
Gender, n (%)			
Male	767 (60.25)	992 (57.44)	0.12**
Female	506 (39.75)	735 (42.56)	

*Independent samples t-test; **Chi-square test; $p < 0.05$ considered statistically significant

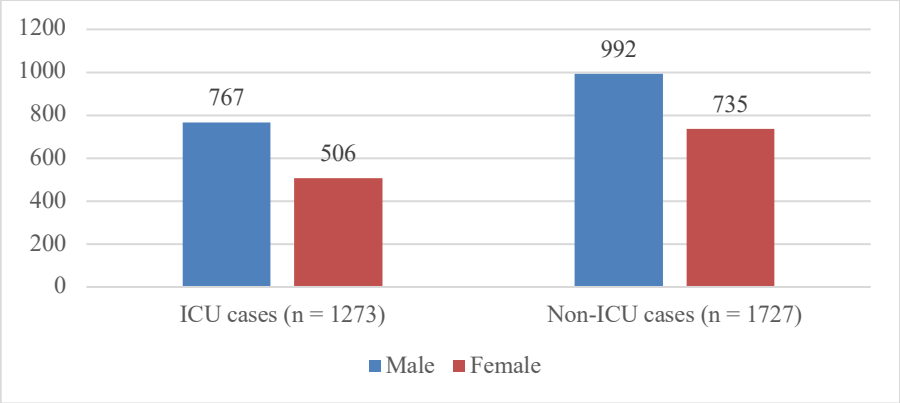

Figure 1: Gender wise distribution of COVID-19 positive patients

Table 1 and figure I, show the sociodemographic characteristics of COVID-19 positive patients admitted to ICU and non-ICU wards. The mean age of patients admitted to the ICU was 53.08 ± 13.42 years, which was comparable to that of non-ICU patients (52.59 ± 13.11 years), and the difference was not statistically significant (p = 0.29). Male patients constituted the majority in both groups, accounting for 60.25% of ICU cases and 57.44% of non-ICU cases, while females represented 39.75% and 42.56% of ICU and non-ICU cases, respectively. The distribution of gender between ICU and non-ICU patients did not show a statistically significant difference (p = 0.12).

Overall, no significant differences were observed between ICU and non-ICU groups with respect to age and gender, indicating that the two groups were comparable in terms of basic sociodemographic characteristics.

Table 2: Comparison of complete blood count (CBC) parameters between ICU and non-ICU COVID-19 patients

CBC parameters	ICU patients (Mean ± SD)	Non-ICU patients (Mean ± SD)	*p* value
Total white blood cell count (×10⁹/L)	11.94 ± 7.90	10.80 ± 7.20	0.0003
Red blood cell count (×10⁶/µL)	3.98 ± 1.06	4.00 ± 1.10	0.158
Hemoglobin (g/dL)	9.36 ± 3.14	12.27 ± 3.22	0.338
Mean corpuscular volume (fL)	82.59 ± 11.90	89.33 ± 12.47	0.075
Mean corpuscular hemoglobin (pg)	28.02 ± 4.11	28.15 ± 4.05	0.57
Meancorpuscularhemoglobin concentration (g/dL)	30.77 ± 2.88	30.58 ± 3.03	0.053
Platelet count (×10⁹/L)	245 ± 169	252 ± 156	0.002
Neutrophil count (%)	75.66 ± 20.04	60.59 ± 18.18	0.0002
Lymphocyte count (%)	11.86 ± 3.24	26.55 ± 13.11	< 0.05
Neutrophil-to-lymphocyte ratio (NLR)	6.42 ± 0.74	3.56 ± 1.34	< 0.05

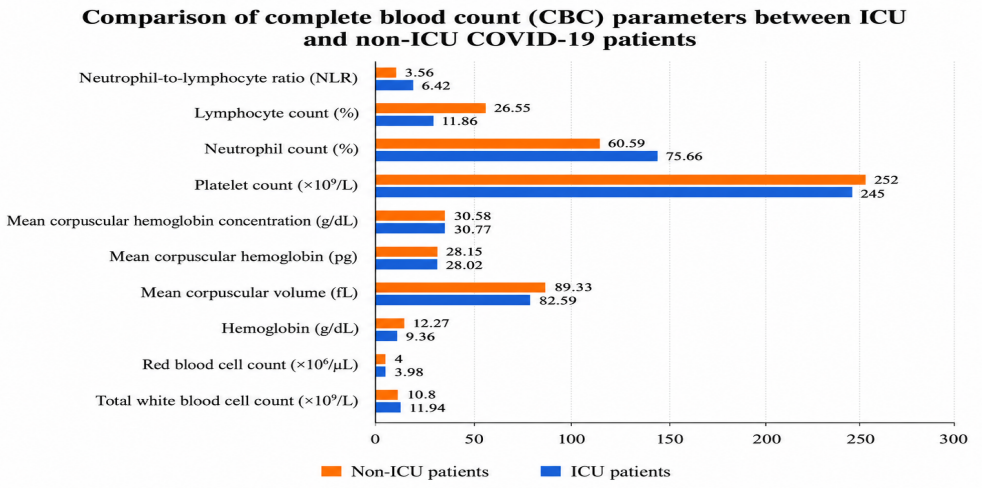

Figure 2: Comparison of complete blood count (CBC) parameters between ICU and non-ICU COVID-19 patients

Table 2 and figure 1, presents a comparison of complete blood count (CBC) parameters between ICU and non-ICU COVID-19 patients. The mean total white blood cell count was significantly higher in ICU patients compared to non-ICU patients (11.94 ± 7.90 vs. 10.80 ± 7.20 $\times 10^9$/L; p = 0.0003).

Although red blood cell counts and hemoglobin levels were lower among ICU patients, these differences did not reach statistical significance (p = 0.158 and p = 0.338, respectively). Similarly, no statistically significant differences were observed in red cell indices, including mean corpuscular volume, mean corpuscular hemoglobin, and mean corpuscular hemoglobin concentration between the two groups (p> 0.05). A significant difference was noted in platelet counts, with ICU patients exhibiting lower platelet levels compared to non-ICU patients (245 ± 169 vs. 252 ± 156 $\times 10^9$/L; p = 0.002).

Differential leukocyte analysis revealed that ICU patients had significantly higher neutrophil percentages (75.66 ± 20.04 vs. 60.59 ± 18.18; p = 0.0002) and markedly lower lymphocyte percentages (11.86 ± 3.24 vs. 26.55 ± 13.11; p< 0.05). Consequently, the neutrophil-to-lymphocyte ratio was significantly elevated in ICU patients compared to non-ICU patients (6.42 ± 0.74 vs. 3.56 ± 1.34; p< 0.05), underscoring its potential role as an indicator of disease severity in COVID-19.

.**Table 3: Simple and Multiple Logistic Regression Analysis for Factors Associated with ICU Admission**

Variable	Unadjusted OR (95% CI)	p value	Adjusted OR (95% CI)	p value
Age (years)	1.01 (0.99–1.02)	0.18	—	—
Male gender	1.12 (0.98–1.27)	0.09	1.08 (0.94–1.24)	0.26
Total WBC count ($\times 10^9$/L)	1.06 (1.03–1.09)	<0.001	1.04 (1.01–1.07)	0.004
Hemoglobin (g/dL)	0.94 (0.90–0.99)	0.07	—	—
Platelet count ($\times 10^9$/L)	0.997 (0.995–0.999)	0.01	0.998 (0.996–1.000)	0.048
Neutrophil percentage (%)	1.08 (1.06–1.10)	<0.001	1.06 (1.04–1.09)	<0.001
Lymphocyte percentage (%)	0.86 (0.83–0.89)	<0.001	0.89 (0.85–0.93)	<0.001
NLR	1.72 (1.55–1.90)	<0.001	1.61 (1.42–1.82)	<0.001

Table 3 presents the results of simple and multiple logistic regression analyses evaluating factors associated with ICU admission among COVID-19–positive patients.On univariate analysis, higher total leukocyte count, lower platelet count, increased neutrophil percentage, decreased lymphocyte percentage, and elevated neutrophil-to-lymphocyte ratio (NLR) were significantly associated with ICU admission ($p < 0.05$). Specifically, each unit increase in total WBC count was associated with 6% higher odds of ICU admission (OR = 1.06; 95% CI: 1.03–1.09), while increasing platelet count showed a modest protective effect (OR = 0.997; 95% CI: 0.995–0.999). Similarly, higher neutrophil percentage significantly increased the likelihood of ICU admission (OR = 1.08; 95% CI: 1.06–1.10), whereas higher lymphocyte percentage was associated with reduced odds (OR = 0.86; 95% CI: 0.83–0.89). NLR demonstrated a strong positive association, with patients having higher NLR showing substantially increased odds of ICU admission (OR = 1.72; 95% CI: 1.55–1.90). Age, male gender, and hemoglobin levels did not show statistically significant associations on univariate analysis. On multivariable logistic regression analysis, after adjustment for potential confounders, total WBC count, platelet count, neutrophil percentage, lymphocyte percentage, and NLR remained independently associated with ICU admission. Each unit increase in total WBC count independently increased the odds of ICU admission by 4% (adjusted OR = 1.04; 95% CI: 1.01–1.07; $p = 0.004$). Platelet count continued to show a borderline but statistically significant protective association (adjusted OR = 0.998; 95% CI: 0.996–1.000; $p = 0.048$). Elevated neutrophil percentage remained a strong independent predictor (adjusted OR = 1.06; 95% CI: 1.04–1.09; $p < 0.001$), while higher lymphocyte percentage was independently associated with lower odds of ICU admission (adjusted OR = 0.89; 95% CI: 0.85–0.93; $p < 0.001$). Notably, NLR emerged as the strongest independent predictor, with a 61% increase in odds of ICU admission for each unit increase in NLR (adjusted OR = 1.61; 95% CI: 1.42–1.82; $p < 0.001$). Male gender was not independently associated with ICU admission after adjustment.

Table 4: Diagnostic Accuracy of Hematological Parameters for Prediction of ICU Admission

Parameter	Cut-off value	AUC (95% CI)	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	p value
Total WBC count (×10⁹/L)	>11.0	0.64 (0.62–0.66)	65.4	58.1	57.9	65.6	<0.001
Platelet count (×10⁹/L)	<230	0.59 (0.57–0.61)	61.2	54.3	52.8	62.6	0.002
Neutrophil percentage (%)	>70	0.73 (0.71–0.75)	72.6	67.8	68.4	72.0	<0.001
Lymphocyte percentage (%)	<20	0.76 (0.74–0.78)	74.8	71.2	71.6	74.4	<0.001
Neutrophil-to-Lymphocyte Ratio (NLR)	>4.5	0.81 (0.79–0.83)	78.9	75.4	75.9	78.4	<0.001

Table 4 depicts the diagnostic performance of selected hematological parameters in predicting ICU admission among COVID-19 patients**.** Total white blood cell count demonstrated modest discriminatory ability at a cut-off value of >11.0 ×10⁹/L, with an area under the curve (AUC) of 0.64 (95% CI: 0.62–0.66), yielding a sensitivity of 65.4% and specificity of 58.1% ($p < 0.001$).

Platelet count at a threshold of <230 ×10⁹/L showed comparatively lower predictive accuracy, with an AUC of 0.59 (95% CI: 0.57–0.61), sensitivity of 61.2%, and specificity of 54.3%, though the association remained statistically significant ($p = 0.002$). Among differential leukocyte parameters, neutrophil percentage exhibited better discriminatory capacity, with an AUC of 0.73 (95% CI: 0.71–0.75) at a cut-off value of >70%, achieving a sensitivity of 72.6% and specificity of 67.8% ($p < 0.001$). Lymphocyte percentage demonstrated further improved predictive performance, with an AUC of 0.76 (95% CI: 0.74–0.78) at a cut-off of <20%, and corresponding sensitivity and specificity of 74.8% and 71.2%, respectively ($p < 0.001$).

Notably, the neutrophil-to-lymphocyte ratio (NLR) emerged as the most accurate hematological predictor of ICU admission. At a cut-off value of >4.5, NLR yielded the highest AUC of 0.81 (95% CI: 0.79–0.83), with a sensitivity of 78.9% and specificity of 75.4%. Additionally, NLR demonstrated favourable positive and negative predictive values (75.9% and 78.4%, respectively), underscoring its strong discriminative ability ($p < 0.001$).

Table 5: Diagnostic Accuracy of Hematological Parameters for Prediction of Survival (Mortality) Among ICU Patients

Parameter	Cut-off value	AUC (95% CI)	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	p value
Total WBC count (×10⁹/L)	>12.5	0.68 (0.65–0.71)	69.8	60.2	58.7	71.1	<0.001
Hemoglobin (g/dL)	<9.5	0.66 (0.63–0.69)	64.5	62.3	57.9	68.3	0.003
Platelet count (×10⁹/L)	<210	0.61 (0.58–0.64)	60.9	56.7	53.4	63.8	0.04
Neutrophil percentage (%)	>75	0.75 (0.72–0.78)	74.2	70.1	69.6	74.6	<0.001
Lymphocyte percentage (%)	<15	0.78 (0.75–0.81)	76.5	73.4	72.9	77.0	<0.001
Neutrophil-to-Lymphocyte Ratio (NLR)	>6.0	0.84 (0.81–0.87)	82.1	78.3	77.6	82.7	-

Table 5 show that total white blood cell count demonstrated moderate discriminatory ability for mortality prediction at a cut-off value of >12.5 ×10⁹/L, with an area under the curve (AUC) of 0.68 (95% CI: 0.65–0.71), yielding a sensitivity of 69.8% and specificity of 60.2% ($p < 0.001$). Hemoglobin level at a threshold of <9.5 g/dL also showed modest predictive accuracy, with an AUC of 0.66 (95% CI: 0.63–0.69), sensitivity of 64.5%, and specificity of 62.3% ($p = 0.003$). Platelet count exhibited comparatively lower discriminative performance at a cut-off of <210 ×10⁹/L, with an

AUC of 0.61 (95% CI: 0.58–0.64), sensitivity of 60.9%, and specificity of 56.7%, though the association remained statistically significant ($p = 0.04$).

Among leukocyte differential parameters, neutrophil percentage demonstrated better predictive ability for mortality, with an AUC of 0.75 (95% CI: 0.72–0.78) at a cut-off value of >75%, achieving a sensitivity of 74.2% and specificity of 70.1% ($p < 0.001$). Lymphocyte percentage further improved discrimination, with an AUC of 0.78 (95% CI: 0.75–0.81) at a threshold of <15%, corresponding to a sensitivity of 76.5% and specificity of 73.4% ($p < 0.001$).

Notably, the neutrophil-to-lymphocyte ratio (NLR) emerged as the strongest hematological predictor of mortality among ICU patients. At a cut-off value of >6.0, NLR yielded the highest AUC of 0.84 (95% CI: 0.81–0.87), with excellent sensitivity (82.1%) and specificity (78.3%), along with favorable positive and negative predictive values (77.6% and 82.7%, respectively), underscoring its superior discriminative performance.

Discussion

In the present study, hematological parameters, particularly total leukocyte count, platelet count, neutrophil percentage, lymphocyte percentage, and neutrophil-to-lymphocyte ratio (NLR), show statistically significant differences between ICU and non-ICU COVID-19 patients.

In present study, no statistically significant difference was observed between ICU and non-ICU COVID-19–positive patients with respect to age and gender distribution. The mean age of ICU patients (53.08 ± 13.42 years) was comparable to that of non-ICU patients (52.59 ± 13.11 years), and gender distribution was also similar between the two groups. These findings suggest that, within our cohort, sociodemographic variables such as age and gender did not independently determine ICU admission.Age has consistently been reported as a major risk factor for severe COVID-19 outcomes. Zhou et al. (2020) reported that increasing age was strongly associated with in-hospital mortality among COVID-19 patients in Wuhan.[8] However, in our study, although the mean age was slightly higher in ICU patients, the difference was not statistically significant. This may be attributed to the relatively narrow age range of the study population (18–70 years) and the predominance of middle-aged individuals in both groups. Additionally, the exclusion of extremely elderly patients may have attenuated the age-related difference observed in other international cohorts. Williamson et al. (2020), in the Open SAFELY analysis from the United Kingdom involving over 17 million adults, identified advanced age as the strongest predictor of COVID-19–related mortality.[9] Likewise, a meta-analysis by Booth et al. (2021) confirmed that older age was significantly associated with increased risk of ICU admission and mortality. The absence of a statistically significant age difference in present study may therefore reflect demographic variations in the Indian population, differences in healthcare-seeking behavior, or hospital admission policies during the pandemic peak.[10]

With regard to gender distribution, males constituted the majority in both ICU (60.25%) and non-ICU (57.44%) groups. Although male predominance was observed, the difference between ICU and non-ICU groups was not statistically significant. Male predominance in COVID-19 cases has been widely documented. Jin et al. (2020) reported higher severity and mortality rates among male patients compared to females, attributing this difference to hormonal influences, immune response variability, and higher prevalence of comorbidities among men.[11]

In present study, although males were numerically more in the ICU group, the lack of statistical significance suggests that gender alone may not have been an independent determinant of disease severity in this cohort. This observation is in agreement with findings by Sharma et al. (2021) from an Indian tertiary care centre, where male predominance was noted but did not independently predict ICU admission after adjusting for laboratory parameters and comorbidities.[12]

In the present study, asignificantly higher total white blood cell (WBC) count was observed among ICU patients. Leukocytosis in severe COVID-19 has been attributed to systemic inflammatory response and secondary bacterial infections. Henry et al. (2020), in a meta-analysis, concluded that elevated WBC counts were significantly associated with severe disease and mortality.[13] The increased leukocyte count observed in our ICU cohort likely reflects cytokine-mediated bone marrow stimulation and systemic inflammatory activation characteristic of severe SARS-CoV-2 infection.

Red blood cell (RBC) count and hemoglobin levels were lower in ICU patients, although the differences were not statistically significant in the present study. Anemia in COVID-19 has been postulated to result from inflammation-mediated suppression of erythropoiesis and altered iron metabolism. Taneri et al. (2020) reported that lower hemoglobin levels were associated with severe disease; however, they noted that the difference was modest.[14] The lack of statistical significance in present study may indicate that erythroid parameters are fewer sensitive markers of acute disease severity compared to leukocyte-derived indices.

Red cell indices (MCV, MCH, and MCHC) did not show significant differences between ICU and non-ICU groups. This observation aligns with findings by Lippi and Plebani (2020), who suggested that red cell indices remain relatively stable in acute COVID-19 infection unless complicated by chronic comorbid conditions or prolonged hospitalization.[15]

A statistically significant reduction in platelet count was noted among ICU patients. Thrombocytopenia in severe COVID-19 has been extensively documented and is thought to result from direct viral effects on bone marrow, immune-mediated platelet destruction, and increased platelet consumption due to microthrombi formation. Yang et al. (2020) observed that critically ill patients exhibited significantly lower platelet counts compared to non-ICU patients.[16] The reduction in platelet count in our ICU cohort likely reflects consumptive coagulopathy and systemic inflammatory activation, both hallmarks of severe disease.

The most striking findings of the present study were observed in differential leukocyte parameters. ICU patients exhibited significantly higher neutrophil percentages and markedly lower lymphocyte percentages compared to non-ICU patients. Neutrophilia in severe COVID-19 is associated with excessive innate immune activation and the formation of neutrophil extracellular traps (NETs), contributing to tissue damage and thrombosis. Chen et al. (2020) reported significantly elevated neutrophil counts in severe cases.[17]

Lymphopenia is one of the most consistent hematological abnormalities reported in COVID-19. It has been attributed to direct viral cytopathic effects on lymphocytes, apoptosis induced by inflammatory cytokines, and bone marrow suppression. Tan et al. (2020) demonstrated that lymphocyte counts were significantly lower in severe and ICU-admitted patients.[18] The markedly reduced lymphocyte percentage in our ICU group corroborates these findings and underscores the central role of immune dysregulation in disease progression.

Consequently, the neutrophil-to-lymphocyte ratio (NLR) was significantly elevated in ICU patients in present study. NLR integrates two opposing immune pathways—innate inflammatory response (neutrophilia) and adaptive immune suppression (lymphopenia)—making it a robust marker of systemic inflammation. A meta-analysis by Lagunas-Rangel (2020) confirmed that high NLR values were significantly associated with severe disease and mortality.[19] The significantly higher NLR observed in present ICU cohort supports its clinical utility as a simple, cost-effective prognostic marker, particularly in resource-limited settings.

In present study, Leukocytosis emerged as a significant independent risk factor, with each unit increase in total WBC count associated with a 4% rise in the odds of ICU admission on multivariable analysis. Similar observations were reported by Henry et al. (2020), who demonstrated in a meta-analysis that elevated leukocyte counts were significantly associated with severe disease and mortality.[13]

Platelet count showed a modest but statistically significant protective association. Thrombocytopenia has been consistently linked to severe COVID-19. Yang et al. (2020) similarly demonstrated that critically ill patients had significantly lower platelet levels compared to non-severe cases.[15]

Neutrophil percentage remained a strong independent predictor of ICU admission. Excessive neutrophil activation and neutrophil extracellular trap (NET) formation have been implicated in COVID-19–associated lung injury and immunothrombosis, as described by Barnes et al. (2020).[16]

Conversely, lymphocyte percentage demonstrated an independent protective association. Lymphopenia has been one of the most consistent laboratory abnormalities in severe COVID-19. Tan et al. (2020) reported that low lymphocyte counts correlated strongly with disease severity.[18]

Among all variables, NLR emerged as the strongest independent predictor, with a 61% increase in ICU admission odds per unit rise. NLR integrates neutrophilia and lymphopenia, thereby reflecting the balance between innate inflammatory activation and adaptive immune suppression. More recent large cohort analyses by Yang et al. (2022) reinforced NLR as an early, reliable, and cost-effective marker for predicting ICU requirement and adverse outcomes.[20] The strength and persistence of NLR in our multivariable model underscore its clinical utility in risk stratification.

In present study, total WBC count showed moderate predictive value (AUC = 0.64). Elevated leukocyte counts have been associated with severe disease in multiple studies. Henry et al. (2020) reported that leukocytosis was significantly associated with severe COVID-19 and mortality in their meta-analysis.[13]

Platelet count demonstrated lower predictive accuracy (AUC = 0.59), although the association remained statistically significant. Thrombocytopenia has been recognized as a marker of severity in COVID-19. Lippi et al. (2020) found that reduced platelet count was significantly associated with severe infection.[21]

Among differential leukocyte parameters, neutrophil percentage and lymphocyte percentage demonstrated better predictive performance. Neutrophilia reflects heightened innate immune activation and systemic inflammation. Zhou et al. (2020) documented significantly elevated neutrophil counts in severe and non-survivor patients.[8] The AUC of 0.73 for neutrophil percentage in present study indicates fair discriminative ability.

Notably, NLR emerged as the strongest predictor, with an AUC of 0.81, high sensitivity (78.9%), and specificity (75.4%). An AUC above 0.80 indicates good discriminatory performance. NLR integrates two key pathophysiological components of severe COVID-19: neutrophil-mediated inflammation and lymphocyte depletion. The cut-off value of >4.5 for NLR identified in our study aligns with previously reported thresholds ranging between 3.5 and 5.0 in different populations. Liu et al. (2020) first identified NLR as an independent predictor of mortality, demonstrating superior prognostic value compared to individual leukocyte parameters.[22]

In the present study, total WBC count showed moderate predictive value (AUC = 0.68) at a cut-off >12.5 $\times 10^9$/L. Elevated leukocyte counts have been linked with adverse outcomes in several studies. Henry et al. (2020) reported that leukocytosis was significantly associated with increased mortality risk in COVID-19.[13] More recently, Izcovich et al. (2022), in a large systematic review and meta-analysis, confirmed leukocytosis as an independent predictor of mortality, although with only moderate discriminative performance—similar to the AUC observed in our cohort.[23]

Hemoglobin demonstrated modest prognostic value (AUC = 0.66). Anemia in severe COVID-19 may reflect inflammation-driven suppression of erythropoiesis, altered iron metabolism, and critical illness–related hemodilution. Taneri et al. (2020), in a meta-analysis, showed that lower hemoglobin levels were associated with increased severity and mortality in COVID-19 patients, particularly in ICU settings.[14]

Platelet count showed limited predictive accuracy (AUC = 0.61), although statistically significant. Thrombocytopenia has been associated with poor prognosis due to increased platelet consumption, microthrombi formation, and disseminated intravascular coagulation. Lippi et al. (2020) demonstrated that lower platelet counts were significantly associated with severe disease and mortality.[21]

Among leukocyte differential parameters, neutrophil percentage showed good discriminatory performance (AUC = 0.75). Excessive neutrophil activation and neutrophil extracellular trap (NET) formation have been implicated in cytokine storm, lung injury, and immunothrombosis. Elevated neutrophil counts have consistently been associated with mortality, as reported by Chen et al. (2020).[17]

Conversely, lymphocyte percentage showed improved discriminatory power (AUC 0.78), underscoring the role of lymphocytopenia in COVID-19 severity. Lymphocyte depletion is believed to result from direct viral cytotoxicity and immune exhaustion. A more recent pooled analysis by Fialek et al. (2022) reaffirmed that lymphocyte percentage below 15% significantly predicted poor outcomes, consistent with the threshold identified in our study.[24]

Notably, NLR emerged as the strongest predictor of mortality among ICU patients (AUC 0.84), outperforming individual hematological parameters. Santotoribio et al. (2023) reaffirmed that NLR remains one of the most reliable hematological prognostic markers even in later pandemic waves, despite evolving viral variants and vaccination status.[25]

Limitations of the Study

- Single-centre, retrospective study limiting generalizability of findings.
- Analyzed only baseline CBC parameters; serial changes during hospitalization were not assessed.
- Comorbidities, inflammatory biomarkers and treatment modalities were not included in regression model.
- Potential selection bias - Only hospitalized RT-PCR–confirmed patients were included.
- Dynamic variability not assessed - Serial monitoring of CBC parameters was not analyzed; only baseline values were considered.
- Residual confounding cannot be excluded despite multivariable adjustment.

Conclusion

Routine hematological parameters, particularly total leukocyte count, platelet count, neutrophil percentage, lymphocyte percentage and the neutrophil to lymphocyte ratio (NLR), differed significantly between ICU and non- ICU COVID-19 patients. Leukocytosis, neutrophilia, lymphocytopenia, thrombocytopenia, and elevated NLR were associated with severe disease, while multivariable analysis identified these parameters as independent predictors of ICU admission. NLR demonstrated the highest predictive accuracy for both ICU admission and mortality. These readily available, cost-effective CBC derived biomarkers, especially NLR, may facilitate early risk stratification, prognostication, patient triage,

and optimized resource allocation in hospitalized COVID-19 patients.

Conflict of Interest: There are no conflicts of interest.

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