

Role of SpO₂/FiO₂ Ratio, CT Severity Score, and Inflammatory Markers in Predicting the Outcome of COVID-19 Patients in ICU: A Prospective Observational Study

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Abstract

Background: COVID-19 has a heterogeneous clinical course, ranging from mild illness to critical respiratory failure. Identifying prognostic markers is crucial for early risk stratification and management in intensive care settings. The objectives is to evaluate the predictive role of SpO₂/FiO₂ ratio, CT severity score, and inflammatory markers (serum ferritin, D-dimer, LDH, CRP) in determining the outcome of COVID-19 patients admitted to the ICU. **Material and Methods:** This prospective observational study included 80 RT-PCR confirmed COVID-19 patients admitted to the ICU between December 2020 and December 2021. Baseline demographics, clinical presentations, comorbidities, and biochemical markers were recorded. Radiological evaluation was performed using CT severity scoring. Outcomes were categorized as survivors and non-survivors. Data were analyzed using appropriate statistical tests, with $p < 0.05$ considered significant. **Results:** Among 80 patients, 60 (75%) survived while 20 (25%) did not. Non-survivors were significantly older (mean age 66.8 years vs. 35.6 years). Breathlessness (52.5%) was the most common presenting symptom. Diabetes (78.8%) and hypertension (46.3%) were predominant comorbidities, with mortality highest among those with chronic pulmonary disease (80%). Non-survivors had markedly lower SpO₂/FiO₂ (152.1 vs. 205, $p < 0.001$) and PaO₂/FiO₂ ratios (91.3 vs. 128.8, $p < 0.001$). CT severity score was significantly higher among non-survivors (19.0 vs. 12.8, $p < 0.001$). Elevated LDH, CRP, ferritin, and D-dimer were strongly associated with poor outcomes (all $p < 0.001$). Survivors had longer hospital stays and oxygen requirements compared to non-survivors. **Conclusion:** SpO₂/FiO₂ ratio, CT severity score, and inflammatory biomarkers independently correlate with adverse outcomes in severe COVID-19. These parameters can be practical risk stratification predictors and guide early clinical interventions in ICU patients.

Keywords: COVID-19, SpO₂/FiO₂ ratio, CT severity score, Inflammatory markers, ICU outcomes, Prognosis.

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INTRODUCTION

Coronavirus disease 2019 (COVID-19), caused by severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2), emerged in late 2019 and rapidly escalated into a global health crisis. Despite advancements in diagnostic modalities and therapeutic interventions, the disease trajectory often remains unpredictable, with a significant subset of patients progressing to severe pneumonia, acute respiratory distress syndrome (ARDS), multi-organ dysfunction, and death.^[1,2] Therefore, early identification of high-risk individuals is essential to optimize intensive care utilization and improve survival.

Hypoxemia is a cardinal feature of severe COVID-19, and oxygenation indices, particularly the SpO₂/FiO₂ ratio, have been validated as practical, non-invasive bedside tools. Several studies have demonstrated its correlation with PaO₂/FiO₂ and its prognostic value when combined with pneumonia severity scores in predicting mortality.^[1,3-5] Parallel to this, chest computed tomography (CT) has been extensively employed to quantify pulmonary involvement,

with higher CT severity scores consistently associated with adverse outcomes.^[3]

Beyond radiological assessment, systemic inflammation and endothelial dysfunction play central roles in COVID-19 pathogenesis. Elevated inflammatory biomarkers, including lactate dehydrogenase (LDH), C-reactive protein (CRP), ferritin, and D-dimer, reflect the severity of immune dysregulation and coagulopathy. Recent investigations have confirmed their strong association with disease progression, cytokine storm, and

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mortality risk.^[2,4]

However, the combined prognostic utility of oxygenation indices, CT severity scoring, and inflammatory biomarkers in critically ill patients requiring intensive care remains an evolving area of research, particularly in resource-constrained environments. Recognizing their predictive value may aid in early risk stratification and timely therapeutic decision-making. Against this background, the present prospective observational study was undertaken to evaluate the role of SpO₂/FiO₂ ratio, CT severity score, and key inflammatory markers in predicting outcomes among COVID-19 patients admitted to the ICU.

MATERIALS AND METHODS

This prospective observational study was conducted in the Department of Respiratory Medicine, Gandhi Medical College and Hospital, Secunderabad, Telangana, from December 2020 to December 2021.

Sample Size: 80 patients were enrolled based on predefined inclusion and exclusion criteria.

Inclusion Criteria:

- Patients aged >18 years.
- Confirmed COVID-19 diagnosis by RT-PCR or rapid antigen test.
- Patients requiring ICU admission.
- HIV-negative status.

Exclusion Criteria:

- Age <18 years.
- HIV-positive patients.
- Patients were already on non-invasive or invasive ventilatory support at admission.

Data Collection: Following initial stabilization with oxygen supplementation (5 L/min via mask or nasal prongs), demographic details, clinical history (symptoms, duration, comorbidities, substance use), and vital parameters were documented. Baseline investigations included complete

blood count, liver and renal function tests, ECG, chest X-ray, and inflammatory markers (LDH, ferritin, D-dimer, CRP). Arterial blood gas (ABG) analysis was performed to calculate PaO₂/FiO₂ ratio, while SpO₂/FiO₂ ratio was obtained using pulse oximetry.

Radiological Evaluation: A high-resolution CT chest was performed within 24 hours of admission. Each lobe was scored from 0 (no involvement) to 5 (>75% involvement). The cumulative CT severity score (0–25) was categorized as mild (0–7), moderate (8–16), and severe (17–25).

Outcome Assessment: Patients were followed until discharge or death. Outcomes were categorized as survivors and non-survivors. Duration of hospital stay, and oxygen requirement were also recorded.

Statistical Analysis: Data were analyzed using SPSS version 26.0 (IBM Corp., Armonk, NY). Continuous variables were expressed as mean ± standard deviation (SD) and compared using Student's t-test. Categorical variables were analyzed using the Chi-square or Fisher's exact test. A p-value <0.05 was considered statistically significant.

Ethical Considerations: The Institutional Ethics Committee, Gandhi Medical College and Hospital, Secunderabad, approved the study. Written informed consent was obtained from all participants, ensuring confidentiality and adherence to the Declaration of Helsinki.

RESULTS

A total of 80 patients with confirmed severe COVID-19 were included in the study. Of these, 60 (75%) survived while 20 (25%) succumbed to the illness.

Baseline Characteristics: The mean age of survivors was 35.6 years, whereas non-survivors had a mean age of 66.8 years. Most patients (67.5%) belonged to the 31–60 age group. Notably, 75% of those aged above 60 years did not survive. Males constituted 61.3% of the cohort, with a male-to-female ratio of 1.6:1. Mortality was higher among males (28.6%) compared to females (19.4%) [Table 1].

Table 1: Baseline Characteristics and Outcomes of Study Subjects (N = 80)

Variable	Survivors (n = 60)	Non-Survivors (n = 20)	Total (%)
Age (years, mean ± SD)	35.6	66.8	-
Age group 18–30	14 (100%)	0 (0%)	14 (17.5%)
Age group 31–40	18 (100%)	0 (0%)	18 (22.5%)
Age group 41–50	16 (84.2%)	3 (15.8%)	19 (23.8%)
Age group 51–60	9 (53.0%)	8 (47.0%)	17 (21.3%)
Age > 60	3 (25%)	9 (75%)	12 (15%)
Gender – Male	35 (71.4%)	14 (28.6%)	49 (61.3%)
Gender – Female	25 (80.6%)	6 (19.4%)	31 (38.7%)

Clinical Presentation: The most frequent presenting symptom was breathlessness, reported in 52.5% of patients, followed by cough/cold (48.7%) and fever (45%). Sore throat was documented in 12.5% of the cases [Table 2, Figure 1].

Table 2: Clinical Presentation of Study Subjects

Symptoms	Frequency (%)
Breathlessness	42 (52.5%)
Cold/Cough	39 (48.7%)
Fever	36 (45.0%)
Sore Throat	10 (12.5%)

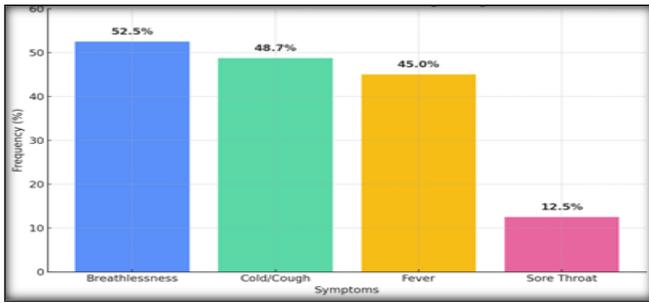


Figure 1: Clinical Presentation of Study Subjects

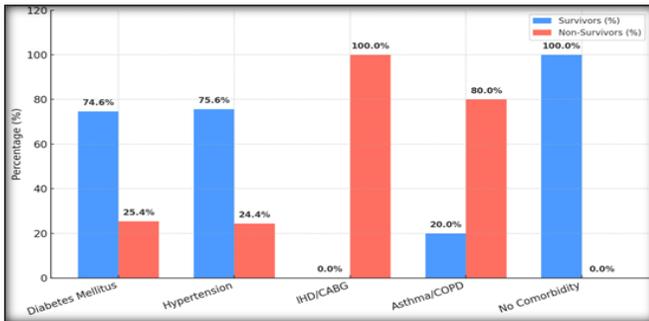


Figure 2: Comorbidities and Outcomes

Comorbidities: Diabetes mellitus was the most prevalent comorbidity, present in 78.8% of patients, followed by hypertension (46.3%). Among non-survivors, 80% had diabetes mellitus and 45% had hypertension. Chronic pulmonary disease (asthma/COPD) was strongly associated with poor outcomes, as 80% of these patients did not survive. Patients without comorbidities had a 100% survival rate [Table 3, Figure 2].

Association of Clinical Parameters and Inflammatory Markers with Outcome: Non-survivors demonstrated significantly worse oxygenation indices, with mean SpO₂/FiO₂ and PaO₂/FiO₂ ratios of 152.1 and 91.3, respectively, compared to 205 and 128.8 among survivors (p < 0.001 for both). The mean CT severity score was also markedly higher in non-survivors (19.0 vs. 12.8; p < 0.001). Inflammatory markers were consistently elevated in non-survivors. Mean LDH (462.8 U/L), CRP (76.3 mg/dL), serum ferritin (587.3 µg/L), and D-dimer (3.6 µg/mL) levels were significantly higher compared to survivors (p < 0.001 for all). Survivors had longer average hospital stay (20.6 vs. 12.7 days) and oxygen requirement duration (15.8 vs. 8.4 days), reflecting earlier mortality in the non-survivor group [Table 4].

Table 3: Comorbidities and Outcomes

Comorbidity	Survivors	Non-Survivors	Total (%)
Diabetes Mellitus	47 (74.6%)	16 (25.4%)	63 (78.8%)
Hypertension	28 (75.6%)	9 (24.4%)	37 (46.3%)
IHD/CABG	0 (0%)	1 (100%)	1 (1.3%)
Asthma/COPD	1 (20%)	4 (80%)	5 (6.3%)
No Comorbidity	7 (100%)	0 (0%)	7 (8.8%)

Table 4. Association of Clinical Parameters and Inflammatory Markers with Outcome

Parameter	Survivors (Mean ± SD)	Non-Survivors (Mean ± SD)	p-value
SpO ₂ /FiO ₂	205 ± 28.4	152.1 ± 32.2	<0.001
PaO ₂ /FiO ₂	128.8 ± 21.2	91.3 ± 16.1	<0.001
CT Severity Score	12.8 ± 6.4	19.0 ± 5.7	<0.001
LDH (U/L)	236.0 ± 53.8	462.8 ± 93.8	<0.001
CRP (mg/dL)	64.8 ± 30.7	76.3 ± 31.2	<0.001
Serum Ferritin (µg/L)	540.5 ± 268.0	587.3 ± 301.7	<0.001
D-Dimer (µg/mL)	2.3 ± 0.95	3.6 ± 1.12	<0.001
Avg. Hospital Stay (days)	20.6	12.7	-
Avg. O ₂ Duration (days)	15.8	8.4	-

DISCUSSION

The present study evaluated the prognostic value of SpO₂/FiO₂ ratio, CT severity score, and inflammatory biomarkers in predicting outcomes among critically ill COVID-19 patients admitted to the ICU. One-fourth of the cohort (25%) did not survive, with mortality primarily observed in elderly patients and those with comorbidities.

Age and Gender Influence: Advanced age emerged as a strong predictor of mortality, with non-survivors having a mean age of 66.8 years. Nearly three-fourths of patients above 60 years succumbed to illness, corroborating global evidence that elderly individuals with severe COVID-19 have higher fatality rates. Male predominance was noted (61.3%), and mortality was higher among men, consistent

with reports attributing this to gender-based immune differences and a greater burden of comorbidities.

Clinical Features and Comorbidities: Breathlessness was the most common presenting symptom (52.5%), reinforcing hypoxemia as the clinical hallmark of severe disease. Diabetes and hypertension were the leading comorbidities, with diabetes present in nearly 80% of patients. Importantly, mortality was disproportionately higher in those with chronic pulmonary disease, echoing the findings of recent studies which linked pre-existing lung pathology to adverse outcomes.^[6] Patients without comorbidities fared significantly better, highlighting the detrimental effect of multimorbidity in COVID-19 prognosis.

Oxygenation Indices: Both SpO₂/FiO₂ and PaO₂/FiO₂ ratios were significantly lower in non-survivors, underscoring their utility as early prognostic tools. Our findings align with Scala et

al., who demonstrated that oxygenation indices reliably predicted outcomes in hypoxemic COVID-19 patients requiring non-invasive respiratory support.^[6] Given its simplicity, SpO₂/FiO₂ is particularly valuable in resource-limited ICUs where arterial blood gas analysis may not be feasible.

Radiological Assessment: Non-survivors exhibited markedly higher CT severity scores, with mean values approaching the severe category. This concurs with the systematic review and meta-analysis by Prakash et al., which established CT severity scoring as a robust predictor of disease progression and mortality.^[10] Similarly, Calderón-Gerstein et al. demonstrated that higher CT involvement, combined with deranged oxygenation indices and elevated inflammatory markers, strongly correlated with mortality in COVID-19 patients, even in high-altitude populations.^[11]

Inflammatory Biomarkers: All inflammatory biomarkers (LDH, CRP, ferritin, and D-dimer) were significantly elevated in non-survivors, reflecting hyperinflammation and coagulopathy. Genc et al. reported similar associations, noting that elevated levels of these markers were independently linked to mortality in ICU patients.^[7] Hanafi et al. highlighted the predictive value of D-dimer, ferritin, and LDH as strong mortality markers in hospitalized COVID-19 patients,^[8] while Ali et al. reinforced their role in forecasting complications and in-hospital death.^[9] Elevated D-dimer, in particular, has been repeatedly associated with thromboembolic events and poor outcomes.^[8] Furthermore, Asghar et al. demonstrated that refractory hypoxemia strongly correlated with biochemical markers, strengthening their prognostic role in severe COVID-19.^[12]

Strengths and Limitations: This study uniquely integrates clinical, radiological, and biochemical predictors of outcome in a real-world ICU setting. However, the relatively small sample size and single-center design may limit the generalizability of results. Moreover, vaccination status and treatment heterogeneity were not assessed, which could have influenced outcomes.

Clinical Implications: Our findings underscore that a combined approach using SpO₂/FiO₂ ratio, CT severity score, and inflammatory biomarkers provides reliable early prognostic information. Integration of these parameters into ICU protocols may aid in timely triage, guide therapeutic escalation, and improve survival outcomes in patients with severe COVID-19.

CONCLUSION

This prospective observational study highlights the prognostic value of SpO₂/FiO₂ ratio, CT severity score, and inflammatory markers in critically ill COVID-19 patients admitted to the ICU. Older age, male gender, and presence of comorbidities, particularly diabetes and chronic pulmonary disease, were strongly associated with poor outcomes. Non-survivors demonstrated significantly lower oxygenation indices and higher CT scores, along with markedly elevated LDH, CRP, ferritin, and D-dimer levels. These findings suggest that integrating simple bedside parameters with

radiological and biochemical markers enables early risk stratification and timely clinical intervention. Such an approach may optimize ICU resource utilization and improve survival in severe COVID-19.

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Conflicts of interest

There are no conflicts of interest.

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