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Mortality Predictors of COPD Exacerbation Patients in ICU

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ABSTRACT

Background: Chronic Obstructive Pulmonary Disease (COPD) is a leading cause of global mortality, with acute exacerbations frequently necessitating intensive care unit (ICU) admissions. Despite its significant burden, data on specific prognostic factors for ICU outcomes in COPD patients particularly in the Indian context remain limited.

Objective: This study aims to identify key clinical, laboratory, and radiological predictors of outcomes in COPD patients admitted to the ICU following acute exacerbations.

Methods: A prospective observational study was conducted from August 2022 to April 2024 at a tertiary centre of eastern India. Patients aged 40 years and above with a confirmed diagnosis of COPD (as per GOLD 2023/24 guidelines) and admitted for acute exacerbation were included. Exclusion criteria encompassed terminal illnesses and advanced organ failure. Data were collected using a predefined proforma with variables of demographic status, clinical findings, laboratory values, and radiological findings. Statistical analysis was performed using SPSS v26, with a p-value <0.05 considered statistically significant.

Results: Among 205 patients enrolled, the mean age was 64.3 ± 11.5 years, with a predominance of males (70%). ICU mortality was significantly higher in patients aged ≥60 years ($p<0.01$). Malnutrition, reflected by a BMI <18.5 kg/m² in 45% of patients, was strongly associated with increased mortality ($p<0.01$). Most patients belonged to GOLD Group D or E, with Group E showing the highest mortality risk ($p<0.01$). A history of previous exacerbation within the last year was also linked to worse outcomes ($p<0.01$).

Elevated inflammatory markers total leukocyte count >11,000/mm³ and high C-reactive protein (CRP) were significantly associated with poor prognosis ($p<0.01$). While non-invasive ventilation was the most commonly used modality (62%), and invasive ventilation was employed in 18%, no significant difference in mortality was found between ventilation strategies. The duration of ICU stay was notably longer among non-survivors (7.8 vs. 5.2 days; $p<0.05$).

Interestingly, common comorbidities such as hypertension, diabetes, and coronary artery disease did not independently predict ICU mortality, suggesting the dominance of acute respiratory derangement over chronic health conditions in short-term outcomes.

Conclusion: This study underscores the prognostic significance of advanced age, low BMI, prior exacerbation history, GOLD Group E classification, and systemic inflammatory markers in determining ICU outcomes in COPD patients. Surprisingly, the type of ventilatory support and comorbidities were not significant predictors of short-term mortality. These findings advocate for a more personalized, risk-based approach to ICU care in COPD, emphasizing early identification, nutritional intervention, and inflammatory monitoring.

Clinical Implications: Routine assessment of BMI and inflammatory markers such as CRP and TLC on admission can aid in early risk stratification. Nutritional support and proactive management strategies should be prioritized for high-risk patients. The use of composite indices like the BODE score may offer a more comprehensive prognostic framework than GOLD staging alone.

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Introduction

COPD is a chronic, progressive pulmonary condition marked by persistent airflow obstruction, most often due to long-term exposure to noxious inhalants such as tobacco smoke or biomass fuel [1]. It remains a pressing public health concern, responsible for over 3 million deaths annually, making it the third leading cause of death globally [2]. The burden is particularly severe in low- and middle-income countries (LMICs), where diagnostic and therapeutic resources may be limited [3].

Acute exacerbations of COPD (AECOPD) sudden worsening of symptoms like dyspnea, cough, and sputum production which significantly contribute to hospital admissions and frequently necessitate ICU care [4]. Any level of exacerbation specially

those requiring ICU admission is definitely associated with a high risk of mortality and disability on a long-term basis [5].

While several studies have examined the risk factors for COPD exacerbations, there is limited data specifically examining predictors of ICU outcomes in the Indian population. This study fills that gap by evaluating clinical, radiological, and laboratory parameters that may influence outcomes in ICU-admitted COPD patients following an exacerbation.

Materials and Methods

Study Design and Population

This prospective observational study was conducted in the ICU of the Department of Respiratory Medicine, Ashwini Hospital, Cuttack, from August 2022 to April 2024. Institutional ethical committee approval and written informed consent were obtained for all enrolled participants.

Inclusion and Exclusion Criteria

Included were patients aged ≥40 years with a prior diagnosis of COPD confirmed by spirometry per GOLD 2023/24 criteria [6], admitted due to acute exacerbation. Patients with terminal malignancy, advanced organ failure (e.g., end-stage renal disease, decompensated cirrhosis), or those managed exclusively in general wards were excluded.

Data Collection

A structured, pre-validated proforma captured demographic data, clinical history, comorbidities, laboratory results (e.g., arterial blood gases, CRP, total leukocyte count), radiological findings, ICU interventions, and outcomes. Radiologic evaluations included chest X-rays and, where indicated, high-resolution CT (HRCT) to rule out alternative diagnoses.

Statistical Analysis

All data were analyzed using SPSS version 26. Descriptive statistics were used for demographic data. Chi-square and independent t-tests were used to analyze categorical and continuous variables, respectively. A p-value <0.05 was considered statistically significant.

Results

Demographic and Clinical Characteristics

Out of 205 enrolled patients, the mean age was 64.3 ± 11.5 years. Patients aged ≥60 experienced significantly higher ICU mortality ($p<0.01$), suggesting diminished physiologic reserve and increased vulnerability. Males comprised 70% of the cohort, likely reflecting higher smoking rates and occupational exposures among men. However, gender was not independently associated with mortality.

BMI emerged as a crucial variable; 45% of patients had a BMI <18.5 kg/m², and this group had significantly higher mortality ($p<0.01$), underscoring the impact of nutritional status on disease outcome. This is shown in Table 1

Table 1: Socio-Demographic Characteristics of the Study Population (N=205)

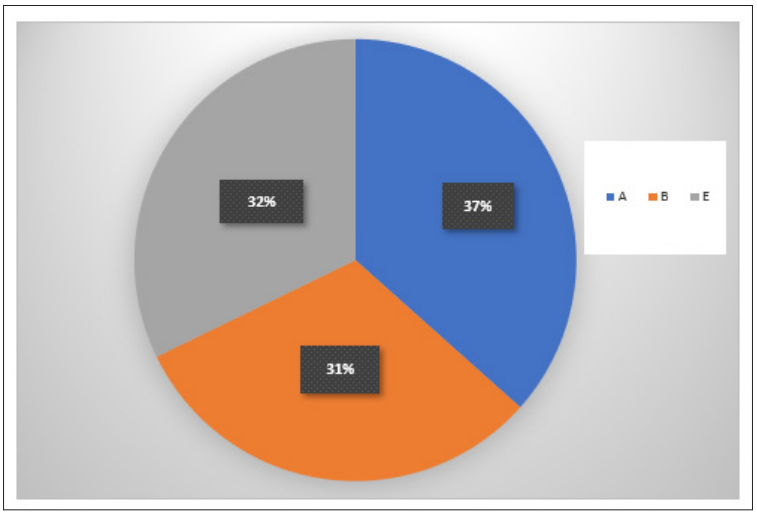
Variables	Discharged N (%)	Death N (%)	P value
Age < 60 years ≥ 60 years	 48 (96.0) 126 (82.9)	 2 (4.0) 26 (17.1)	0.020
Gender Male Female	 91 (82.0) 86 (91.5)	 20 (18.0) 8 (8.5)	0.048
Previous exacerbation Present Absent	 94 (79.7) 83 (95.4)	 24 (20.3) 4 (4.6)	0.001
H/O ICU admission Present Absent	 36 (80.0) 141 (88.1)	 9 (20.0) 19 (11.9)	0.161
Smoking Present Absent	 52 (83.9) 125 (87.4)	 10 (16.1) 18 (12.6)	0.498

Disease Severity and Exacerbation History

Most patients were in GOLD Group D or E, with Group E patients having the highest mortality rate ($p<0.01$). Patients with at least one prior exacerbation in the previous year had significantly poorer outcomes ($p<0.01$), reinforcing the prognostic weight of exacerbation history. This is shown in Table 2 and Graph-1.

Table 2: Association of GOLD Criteria Category with Outcome of Patients

GOLD	Discharged N (%)	Death N (%)	P value
A	70 (93.3)	5 (6.7)	0.047
B	54 (85.7)	9 (14.3)	
E (C+D)	53 (79.1)	14 (20.9)	



Graph 1: Risk of Death in GOLD A, B and E Group

Laboratory and Radiological Findings

Elevated TLC (>11,000/mm³) and high CRP levels correlated strongly with mortality ($p<0.01$), reflecting the systemic inflammatory milieu associated with worse outcomes. HRCT findings helped identify complications such as bullous disease, pneumonia, or pulmonary embolism, although quantitative correlations with mortality were not performed. As shown in Table 3

Table 3: Association General Examination Finding and Laboratory Parameters with Outcome Among the Patients

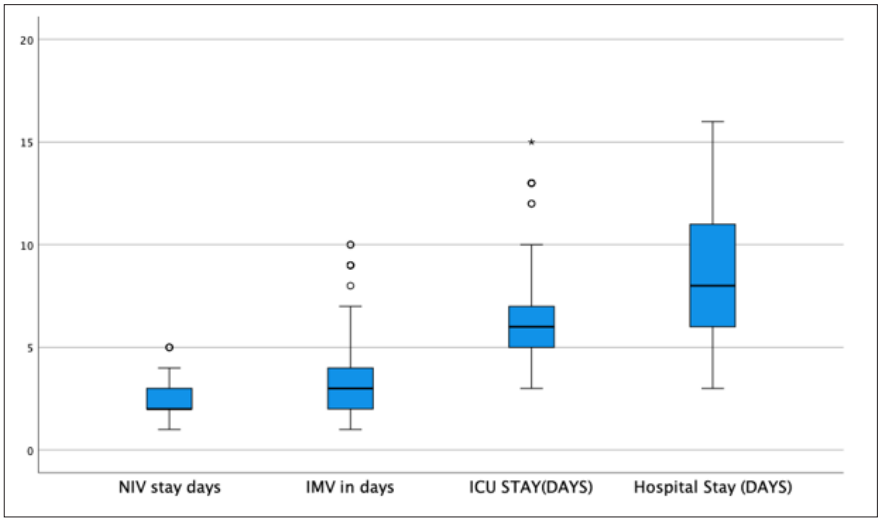
	Discharged		Death		P value
	Mean	SD	Mean	SD	
BMI	25.34	2.075	24.11	2.439	0.005
pH	7.3008	0.10899	7.2925	0.14559	0.722
Pco2	63.05	20.69	57.89	25.388	0.238
Po2	102.79	45.817	89.93	62.091	0.193
Hb	11.751	1.8918	11.921	2.4702	0.673
TLC max	15135.59	5931.161	20150	8022.999	<0.001
TLC min	11986.44	6051.027	16542.86	7747.708	<0.001
CRP	50.4308	48.40067	70.59	87.74636	0.074

ICU Management

Ventilation strategies included non-invasive ventilation (NIV) in 62% and invasive mechanical ventilation (IMV) in 18% of patients. Interestingly, mortality did not significantly differ between patients who received different ventilation modalities. Antibiotic therapy and corticosteroids were administered as per GOLD guidelines. The average ICU stay was longer in non-survivors (7.8 vs. 5.2 days, $p<0.05$), indicating a relationship between disease severity and prolonged hospitalization. As shown in Table 4 and Graph-2

Table 4: Association of Duration of Stay with Outcome of Patients

Duration (in days)	Discharged		Death		P value
	Mean	SD	Mean	SD	
NIV	2.61	1.061	3	1.17	0.121
IMV	3.48	1.514	4.29	3.089	0.117
ICU	3.84	2.14	6.5	3.756	<0.001
Hospital Stay	6.79	2.832	6.82	3.963	0.960



Graph 2: Duration of ICU Stay and Hospitalization

Discussion

This study provides critical insights into the predictors of ICU outcomes in patients with COPD exacerbations. Several themes emerge, highlighting the importance of patient-specific and disease-related factors that should inform clinical decision-making.

Age as a Determinant of Mortality

Elderly patients exhibited a markedly higher risk of mortality, a finding consistent with prior studies that demonstrate age-related declines in pulmonary elasticity, immune function, and response to therapy [7]. Given the increasing age of the global COPD population, age must be considered an essential variable in ICU triage and care planning.

Nutritional Status: A Modifiable Risk Factor

BMI was one of the strongest predictors of ICU mortality. Cachexia and malnutrition lead to weakened respiratory muscles, impaired mucociliary clearance, and a blunted immune response [8]. Nutritional support should be prioritized in both inpatient and outpatient COPD management, including tailored dietary plans and early initiation of nutritional supplements.

GOLD Classification and Its Prognostic Value

While GOLD Group E patients had the worst outcomes, ICU admission among patients from lower-risk groups suggests that GOLD criteria alone are insufficient for predicting acute deterioration. This underlines the need for more comprehensive risk indices such as the BODE index (BMI, airflow Obstruction, Dyspnea, and Exercise capacity), which may better capture multidimensional aspects of disease severity [9].

Systemic Inflammation as a Prognostic Marker

Elevated TLC and CRP were significantly associated with mortality, underscoring the impact of systemic inflammation on disease outcomes. These markers are inexpensive and readily available, and their routine use in ICU risk stratification may help identify high-risk patients earlier [10]. Systemic inflammation also contributes to the progression of comorbidities and long-term functional decline [11].

Ventilation Strategies: Rethinking Prognosis

Contrary to prior assumptions, the need for IMV or prolonged NIV did not correlate with increased mortality in this study. Advances in ventilation strategies, including the use of high-flow nasal cannula (HFNC) and improved weaning protocols, may be mitigating previously poor outcomes associated with mechanical support [12]. This challenges conventional ICU practices and calls for more nuanced, individualized respiratory care.

Comorbidities: Less Predictive in Acute Settings

Patient having multiple comorbidities such as hypertension, diabetes, and coronary artery disease were quite prevalent in our study group, but they were not direct predictors of ICU mortality. This may be due to improvements in chronic disease management and the overwhelming influence of acute respiratory failure on short-term outcomes. However, these comorbidities likely influence long-term survival and quality of life and should not be overlooked in comprehensive care planning [13].

Conclusion

This study identifies critical, actionable predictors of ICU outcomes in COPD patients admitted with acute exacerbations. Advanced age, low BMI, elevated inflammatory markers (TLC and CRP), prior exacerbations, and GOLD Group E classification were significantly associated with higher mortality. Interestingly, ventilation modality and comorbidities were not strong predictors of short-term outcomes in the ICU setting.

Clinical Implications

- **Early Identification:** Screening for risk factors such as age, low BMI, and inflammatory markers at the time of admission can guide ICU triage and intensify early interventions.
- **Nutritional Support:** Addressing undernutrition through timely dietetic intervention could substantially improve patient outcomes.
- **Inflammation Monitoring:** Routine measurement of TLC and CRP may serve as cost-effective prognostic tools.
- **Re-Evaluating Ventilation:** The choice of ventilatory support should be individualized, without presumption of poor outcome with mechanical ventilation.
- **Integrated Risk Stratification:** Utilization of composite indices like BODE may offer more accurate risk profiling than GOLD criteria alone.

Future Directions

Multicentric studies with larger sample sizes and longer follow-up periods are needed to validate these findings and develop robust predictive models. Additionally, incorporating radiological scoring and biomarkers such as procalcitonin and interleukin-6 could further enhance prognostication.

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Conflict of Interest statement: None to share

Ethics and Consent

The study was approved by the Institutional Ethics Committee of Panda Cancer Hospital (ECR/909/Inst/OD/2017/RR-20). Written informed consent was obtained from all participants prior to inclusion in the study. The confidentiality and anonymity of all participants were strictly maintained throughout the research process. The Declaration of Helsinki was followed during the whole course of the study.

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