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Bacterial Prevalence and Antibiotic Resistance Patterns in Acute Exacerbation of COPD Patients Admitted to the Intensive Care Unit in a Tertiary Care Hospital in Uttarakhand: A Retrospective Study

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Abstract

Background:

Acute exacerbation of chronic obstructive pulmonary disease (AECOPD) is a common cause of intensive care unit (ICU) admission, respiratory failure, prolonged hospitalization, and mortality. Bacterial infections contribute substantially to severe exacerbations, while antimicrobial resistance complicates empirical antibiotic selection.

Objective:

To determine the prevalence of bacterial pathogens and their antimicrobial resistance patterns among patients with AECOPD admitted to the ICU of a tertiary care hospital in Uttarakhand.

Methods:

A retrospective observational study was conducted in the Department of Critical Care Medicine at a tertiary care hospital in Uttarakhand from July to December 2025. Data from 50 patients with AECOPD were reviewed. Respiratory specimens, including sputum, endotracheal secretions, and bronchoalveolar lavage (BAL), were evaluated for bacterial isolates and antimicrobial susceptibility patterns.

Results:

Among the 50 patients, 39 (78.0%) were male and 28 (56.0%) belonged to the 61–80-year age group. Endotracheal secretions and BAL each accounted for 18 (36.0%) specimens, while sputum accounted for 14 (28.0%). The predominant bacterial isolate was *Acinetobacter baumannii* (25/50, 50.0%), followed by *Pseudomonas aeruginosa* (20/50, 40.0%) and *Klebsiella pneumoniae* (5/50, 10.0%).

Conclusion:

Acinetobacter baumannii and *Pseudomonas aeruginosa* were the predominant bacterial isolates among ICU patients with AECOPD. Institutional antimicrobial resistance surveillance is essential for guiding appropriate antibiotic selection.

Recommendation:

Regular microbiological surveillance, periodic institutional antibiogram development, and culture-directed antibiotic therapy are recommended to guide appropriate antimicrobial selection and strengthen antimicrobial stewardship in ICU patients with AECOPD.

Keywords: *Acute exacerbation of chronic obstructive pulmonary disease; bacterial infection; antibiotic resistance; intensive care unit; sputum culture; multidrug resistance.*
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Introduction

Chronic obstructive pulmonary disease (COPD) is a chronic respiratory disorder characterized by persistent respiratory symptoms and airflow limitation resulting from abnormalities of the airways and/or alveoli. An acute exacerbation of chronic obstructive pulmonary disease (AECOPD) is defined by a sudden deterioration in dyspnea, cough, and sputum production that necessitates supplementary therapeutic intervention. Severe exacerbations may precipitate acute respiratory failure, necessitate mechanical ventilation, require intensive care unit admission, and result in elevated mortality rates. Infectious pathogens, particularly bacterial and viral agents, represent significant contributing factors to AECOPD (1, 2). Bacterial colonization is determined by disease severity, prior antibiotic utilization, exacerbation frequency, compromised mucociliary clearance mechanisms, pathological lung alterations, and previous hospitalization

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history. Predominant bacterial organisms include Klebsiella pneumoniae, Pseudomonas aeruginosa, Acinetobacter baumannii, Escherichia coli, Haemophilus influenzae, and Staphylococcus aureus. The proportional prevalence of these microorganisms differs based on geographic location, healthcare system exposure, disease severity classification, and regional antimicrobial prescribing patterns (3).

The administration of antibiotics holds considerable significance in managing severe exacerbations that necessitate either invasive or non-invasive mechanical ventilation. Nevertheless, indiscriminate or recurrent antibiotic administration can facilitate the development of resistant microorganisms. Multidrug-resistant Gram-negative bacteria, notably Pseudomonas and Acinetobacter species, represent substantial contributors to therapeutic failure and may constrain available treatment modalities. Research conducted in India has documented considerable antimicrobial resistance among bacterial isolates recovered from patients presenting with acute exacerbations of chronic obstructive pulmonary disease (AECOPD), particularly within intensive care unit environments. A retrospective investigation from South India demonstrated bacterial isolation in 14.3% of evaluated AECOPD patients, with Klebsiella pneumoniae, Pseudomonas aeruginosa, and Acinetobacter baumannii identified as predominant causative organisms (4, 5).

The Global Initiative for Chronic Obstructive Lung Disease advises that antimicrobial selection should be determined by clinical severity assessment, antecedent microbiological data, and prevailing local antimicrobial resistance epidemiology. Respiratory culture analysis demonstrates particular utility in patients experiencing recurrent exacerbations, pronounced airflow obstruction, prior isolation of resistant organisms, or requiring mechanical ventilation support. This investigation was undertaken to assess the prevalence of bacterial pathogens and their corresponding antibiotic resistance profiles in intensive care unit patients presenting with acute exacerbation of chronic obstructive pulmonary disease at a tertiary healthcare institution in Uttarakhand. The results may contribute to the establishment of an institutional antibiogram, enhance the precision of empirical antimicrobial therapy, and reinforce antimicrobial stewardship initiatives (6, 7).

Therefore, the present study aimed to determine the prevalence and distribution of bacterial pathogens and evaluate their antimicrobial resistance patterns among patients admitted to the intensive care unit (ICU) with acute exacerbation of chronic obstructive pulmonary disease (AECOPD) at a tertiary care hospital associated with Graphic Era University, Dehradun, Uttarakhand.

Materials and Methods

Study design and setting

A retrospective observational study was conducted in the Department of Critical Care Medicine at Graphic Era Institute of Medical Sciences (GEIMS), associated with Graphic Era (Deemed to be University), Dehradun, Uttarakhand, India. The institution provides tertiary-level, multispecialty healthcare services through its associated hospital. The hospital offers outpatient, inpatient, emergency, critical care, diagnostic, and specialized treatment services. Its clinical departments include General Medicine, Respiratory Medicine, Critical Care Medicine, Anaesthesiology, Cardiology, Neurology, Nephrology, General Surgery, Orthopaedics, Paediatrics, and Obstetrics and Gynaecology, among others. The multidisciplinary healthcare infrastructure supports the management of patients with complex medical conditions, including acute respiratory illnesses requiring intensive care. The study was specifically conducted in the Department of Critical Care Medicine, where patients admitted with acute exacerbation of chronic obstructive pulmonary disease were evaluated.

Study period and sample size

The proposed study period was 1st July 2025 to 31st December 2025, corresponding to six months, with sample size of 50.

Study population

The study population comprised patients with a documented diagnosis of COPD who were admitted to the ICU with an acute exacerbation.

Inclusion criteria

1. Patients with a confirmed diagnosis of COPD.
2. Patients admitted to the ICU with AECOPD.
3. Respiratory specimens collected within 24 hours of ICU admission.
4. Availability of microbiological culture and antimicrobial susceptibility results.
5. Sputum, endotracheal aspirate, bronchoalveolar lavage, or molecular respiratory testing, where available.

Exclusion criteria

1. Respiratory samples collected more than 24 hours after ICU admission.
2. Patients with diagnosed bronchiectasis.
3. Records with insufficient microbiological information.
4. Duplicate cultures from the same episode, where applicable.

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Data collection

The following information was planned for extraction from patient records:

- Demographic characteristics
- Clinical presentation
- Comorbidities
- Previous antibiotic exposure
- Requirement for mechanical ventilation
- Type of respiratory sample
- Culture results
- Bacterial species identified
- Antimicrobial susceptibility pattern
- Multidrug-resistant organism status
- ICU outcome and mortality

Microbiological assessment

Respiratory samples were processed in the hospital microbiology laboratory using standard bacterial identification and antimicrobial susceptibility testing procedures. For each isolate, results should be recorded as susceptible (S), intermediate or susceptible with increased exposure (I, according to the standard used), or resistant (R), following the applicable laboratory-approved CLSI or EUCAST breakpoints for the study period. For each organism–antibiotic combination, the percentage resistant should be calculated as R/N × 100, susceptible as S/N × 100, and intermediate as I/N × 100, where N is the number of isolates tested for that specific antibiotic. Missing or untested results must not be counted as susceptible.

MDR should be defined according to an established and explicitly stated definition, such as acquired non-susceptibility to at least one agent in three or more antimicrobial categories.

Statistical analysis

Categorical variables should be expressed as frequencies and percentages. Continuous variables should be presented as mean ± standard deviation or median with interquartile range, depending on data distribution.

The chi-square test may be used for categorical comparisons when expected cell counts are adequate; Fisher's exact test should be used for sparse tables. For each organism–antibiotic pair, report S/I/R counts and percentages using the number tested for that antibiotic as the denominator. Compare resistance proportions between organisms only when the clinical question and denominators are appropriate; report the test used, two-sided p-value, and preferably effect estimates with 95% confidence intervals. Continuous variables may be compared using Student's t-test or Mann–Whitney U test as appropriate.

Results

The study included 50 patients admitted to the intensive care unit with acute exacerbation of chronic obstructive pulmonary disease. The findings are presented in terms of respiratory specimen distribution, demographic characteristics, bacterial isolates, and specimen-wise distribution of bacterial pathogens.

The distribution of respiratory specimens showed that endotracheal secretions and BAL were the most frequently collected specimens, accounting for 18 (36.0%) each. Sputum samples represented 14 (28.0%) of the total 50 specimens. Thus, lower respiratory tract specimens, including endotracheal secretions and BAL, collectively accounted for 72.0% of the samples.

Table 1. Distribution of Respiratory Specimens

Specimen type	Number of specimens	Percentage (%)
Sputum	14	28.0
Endotracheal secretions	18	36.0
Bronchoalveolar lavage (BAL)	18	36.0
Total	50	100.0

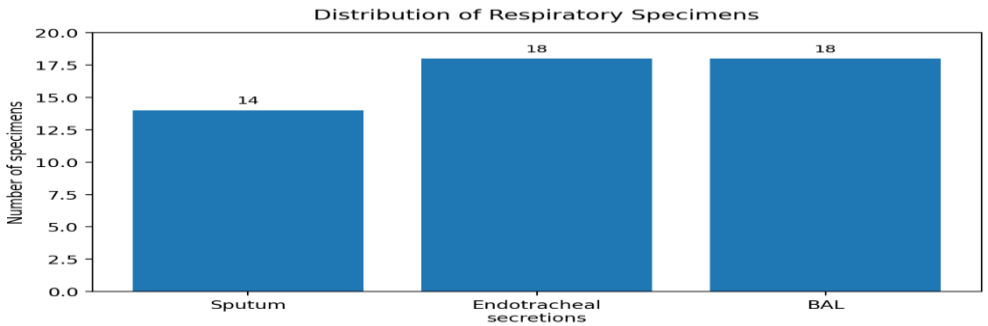


Figure 1. Distribution of respiratory specimens

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Table 2. Demographic Characteristics of Patients

Characteristic	Number (n=50)	Percentage (%)
Age group		
≤40 years	6	12.0
41–60 years	11	22.0
61–80 years	28	56.0
>80 years	5	10.0
Sex		
Male	39	78.0
Female	11	22.0
Total	50	100.0

Regarding age distribution, the majority of patients belonged to the 61–80-year age group (28/50, 56.0%), followed by those aged 41–60 years (11/50, 22.0%). Six patients (12.0%) were aged 40 years or younger, while five (10.0%) were older than 80 years. Regarding sex distribution, males constituted the majority of the study population (39/50, 78.0%), whereas females accounted for 11 patients (22.0%).

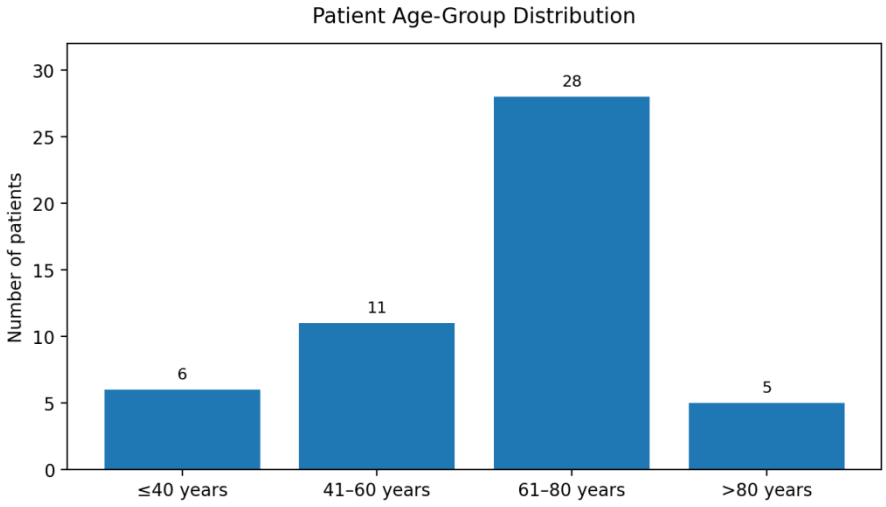


Figure 2. Patient age-group distribution

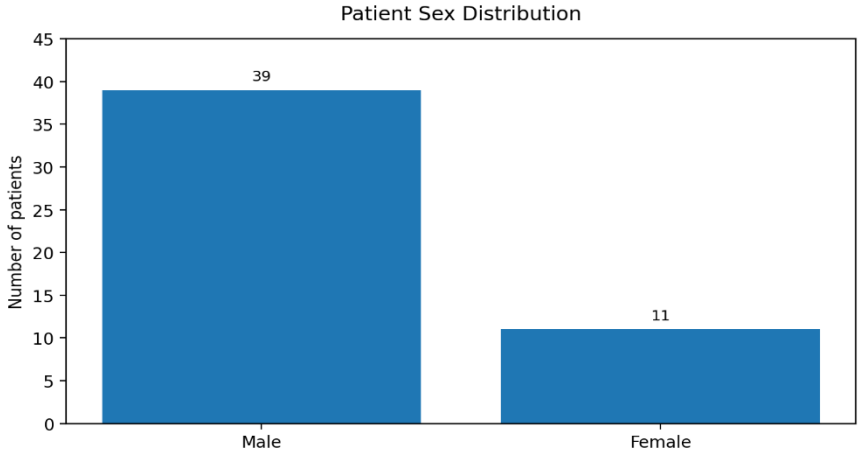


Figure 3. Sex distribution

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Table 3. Distribution of Bacterial Isolates

Bacterial organism	Number of records	Percentage (%)
Acinetobacter baumannii	25	50.0
Pseudomonas aeruginosa	20	40.0
Klebsiella pneumoniae	5	10.0
Total	50	100.0

The bacterial isolate distribution demonstrated that Acinetobacter baumannii was the predominant organism, accounting for 25 (50.0%) isolates. Pseudomonas aeruginosa was the second most frequently identified organism, comprising 20 (40.0%) isolates, while Klebsiella pneumoniae accounted for five (10.0%) isolates. Collectively, A. baumannii and P. aeruginosa represented 90.0% of the identified bacterial isolates.

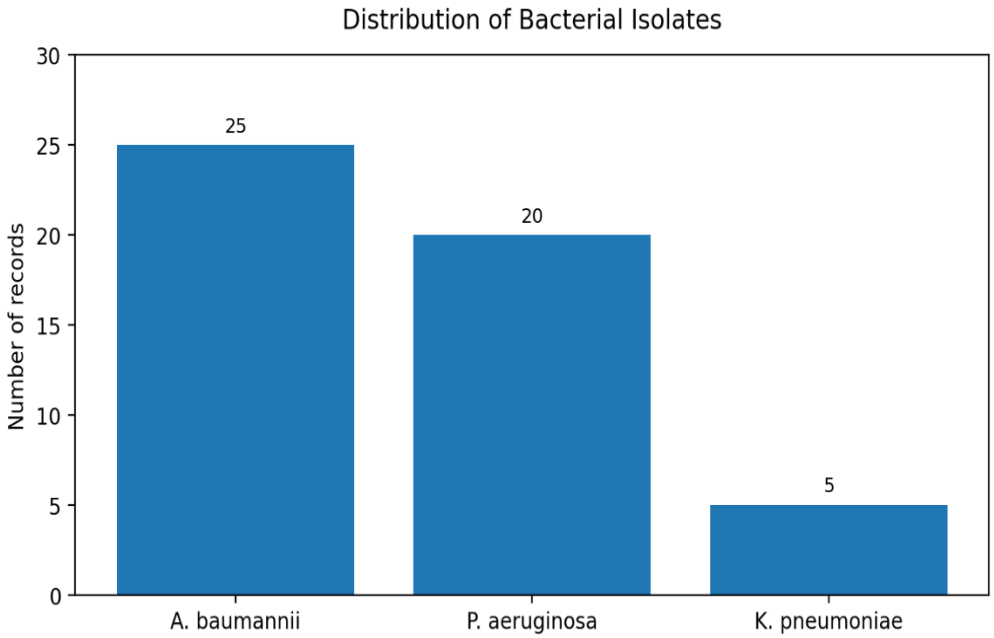


Figure 4. Distribution of bacterial isolates

Table 4. Specimen-wise Distribution of Bacterial Isolates

Specimen	A. baumannii	P. aeruginosa	K. pneumoniae	Total
Sputum	7	6	1	14
Endotracheal secretions	9	7	2	18
BAL	9	7	2	18
Total	25	20	5	50

Specimen-wise analysis showed that Acinetobacter baumannii was the most frequently isolated organism across all three specimen types. Among sputum samples, seven isolates were identified as A. baumannii, six as P. aeruginosa, and one as K. pneumoniae. Similarly, endotracheal secretions yielded nine A. baumannii, seven P. aeruginosa, and two K. pneumoniae isolates. The distribution in BAL specimens was identical, with nine, seven, and two isolates, respectively. These findings indicate that A. baumannii was the predominant organism irrespective of specimen type.

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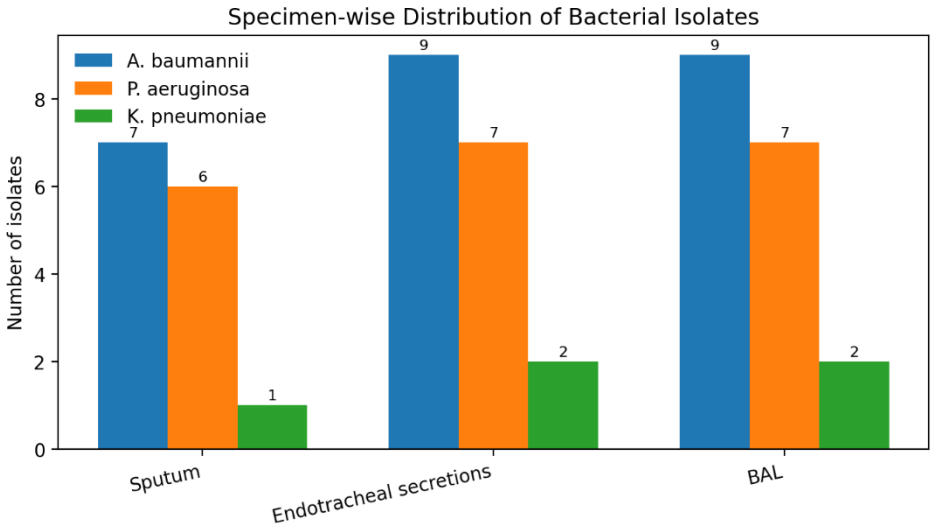


Figure 5. Specimen-wise distribution of bacterial isolates

Discussion

The present retrospective study was designed to evaluate the distribution of respiratory specimens and bacterial isolates among patients investigated for acute exacerbation of chronic obstructive pulmonary disease (AECOPD) in a tertiary care hospital. As shown in Table 1 and Figure 1, endotracheal secretion and bronchoalveolar lavage (BAL) specimens each accounted for 18/50 samples (36.0%), while sputum accounted for 14/50 (28.0%). The equal representation of endotracheal secretions and BAL may reflect the need for lower respiratory tract sampling in critically ill patients. These specimen types can assist pathogen identification in patients requiring intensive respiratory support, including those receiving mechanical ventilation (8).

The demographic summary in Table 2 and Figures 2 and 3 shows that the largest age group was 61–80 years (28/50, 56.0%). The listed cohort also comprised 39 male patients (78.0%) and 11 female patients (22.0%). Older age is clinically relevant in COPD because cumulative exposure to tobacco smoke and other inhaled pollutants, declining pulmonary defences, and coexisting conditions may increase susceptibility to exacerbations and respiratory infections (9).

As presented in Table 3 and Figure 4, the organism distribution comprises Acinetobacter baumannii in 25/50 records (50.0%), Pseudomonas aeruginosa in 20/50 (40.0%), and Klebsiella pneumoniae in 5/50 (10.0%). Non-fermenting Gram-negative organisms such as A. baumannii and P. aeruginosa are important considerations in intensive care because they may be associated with healthcare exposure and antimicrobial resistance. In sputum, the listed counts are 7 A. baumannii, 6 P. aeruginosa, and 1 K. pneumoniae; in endotracheal secretions, they are 9, 7, and 2, respectively; and in BAL, they are 9, 7, and 2, respectively (10, 11).

Respiratory isolation must also be interpreted in its clinical context. Detection of bacteria in sputum, endotracheal secretions, or BAL does not by itself distinguish active infection from airway colonization, particularly in patients with advanced COPD or mechanical ventilation. Clinical presentation, imaging, inflammatory markers, prior antimicrobial exposure, previous cultures, and the overall course of illness should inform interpretation (12).

Conclusion

Bacterial infections and antimicrobial resistance represent critical clinical considerations in patients experiencing acute exacerbation of chronic obstructive pulmonary disease who require intensive care management. This protocol is designed to facilitate the identification of bacterial pathogens isolated from respiratory specimens obtained within twenty-four hours of intensive care unit admission, along with the evaluation of antimicrobial susceptibility patterns and multidrug-resistant organisms. Gram-negative bacteria, particularly Pseudomonas aeruginosa, Acinetobacter baumannii, and Klebsiella pneumoniae, warrant comprehensive assessment due to their demonstrated potential for resistance to frequently prescribed antibiotics. This investigation may facilitate the establishment of institution-specific antibiograms, facilitate evidence-based culture-directed therapeutic approaches, and enhance antimicrobial stewardship initiatives within the intensive care unit setting.

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Limitations

The present study has several limitations. First, its retrospective, single-centre design and relatively small sample size of 50 patients may limit the generalizability of the findings to other healthcare settings. Second, the six-month study period may not adequately capture seasonal variations in bacterial prevalence and antimicrobial resistance patterns. Third, reliance on existing medical and laboratory records may have resulted in incomplete clinical information and limited assessment of potential confounding factors. Fourth, the isolation of bacterial pathogens from respiratory specimens does not necessarily establish active infection, as airway colonization may occur in patients with chronic obstructive pulmonary disease. Furthermore, the available results do not provide detailed antibiotic-specific susceptibility data, limiting the assessment of antimicrobial resistance patterns and multidrug-resistant organisms. Finally, the absence of reported associations between bacterial isolates, clinical severity, treatment response, and patient outcomes restricts the interpretation of the clinical significance of the findings. Larger, multicentre prospective studies incorporating comprehensive antimicrobial susceptibility testing and clinical outcome assessment are warranted.

Recommendations

Routine microbiological examination of respiratory specimens should be encouraged in patients with acute exacerbation of chronic obstructive pulmonary disease requiring intensive care admission. Periodic surveillance of bacterial pathogens and their antimicrobial susceptibility patterns is recommended to facilitate the development of institution-specific antibiograms. Empirical antibiotic selection should be guided by local microbiological data, previous culture results, and individual patient characteristics, followed by culture-directed therapy whenever appropriate. Strengthening antimicrobial stewardship programs may help promote rational antibiotic use and reduce the emergence of multidrug-resistant organisms. Further multicentre prospective studies with larger sample sizes and comprehensive antimicrobial susceptibility testing are recommended to validate the findings and improve clinical management strategies.

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The authors would like to express their sincere gratitude to the Department of Critical Care Medicine and the Department of Microbiology at Graphic Era Institute of Medical Sciences, Dehradun, Uttarakhand, for their support during the study. The authors also acknowledge the contributions of the medical, nursing, and laboratory staff involved in patient care, clinical record maintenance, and microbiological investigations. Their assistance and cooperation were valuable in facilitating the completion of this retrospective study.

List of Abbreviations

AECOPD	Acute Exacerbation of Chronic Obstructive Pulmonary Disease
BAL	Bronchoalveolar Lavage
CLSI	Clinical and Laboratory Standards Institute
COPD	Chronic Obstructive Pulmonary Disease
EUCAST	European Committee on Antimicrobial Susceptibility Testing
ICU	Intensive Care Unit
MDR	Multidrug-Resistant
MIC	Minimum Inhibitory Concentration
SD	Standard Deviation
IQR	Interquartile Range

Source of Funding

The authors declare that no external funding or financial support was received for the conduct of this study.

Conflict of Interest

The authors declare that they have no conflicts of interest related to the conduct, analysis, or publication of this study.

Data Availability

The data supporting the findings of this study were obtained from institutional medical records and microbiological laboratory reports. Due to patient confidentiality and institutional data protection policies, the datasets are not publicly available. De-identified data may be made available from the corresponding author upon reasonable request, subject to institutional approval and applicable ethical requirements.

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Dr. Veena Boswal: [Conceptualization, methodology, manuscript review and editing]
Dr. Imliwati Aier: [Conceptualization, study supervision, methodology, and manuscript review and editing]
Dr. Puneet Tyagi: [Clinical interpretation, methodology, and manuscript review and editing]
Dr. Rohit Kumar: [Data collection, investigation, and manuscript drafting]
Dr. Akash Seepal: [Data collection, data curation, and formal analysis]
Ms. Ankita Saini: [Data collection, clinical documentation, and data curation]
All authors should review and approve the final manuscript and agree to be accountable for their respective contributions.

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