Section: Respiratory Medicine

Original Research Article

SPUTUM BACTERIOLOGICAL AND ANTIBIOTIC SENSITIVITY PATTERN AMONG PATIENTS WITH COPD EXACERBATION IN A TERTIARY CARE CENTER – A PROSPECTIVE OBSERVATIONAL STUDY

R Bimal Raj[1], S Praveen Kumar[2]

[1]*Associate Professor, Department of Respiratory Medicine, Sree Mookambika Institute of Medical Sciences, Kulasekharam, India.*
[2]*Junior Resident, Department of Respiratory Medicine, Sree Mookambika Institute of Medical Sciences, Kulasekharam, India.*

Received *: 12/01/2026*
Received in revised form *: 20/02/2026*
Accepted *: 10/03/2026*

Corresponding Author:
Dr. S Praveen Kumar,
Junior Resident, Department of Respiratory Medicine, Sree Mookambika Institute of Medical Sciences, Kulasekharam, India..
Email: praveendr13@gmail.com

DOI: 10.70034/ijmedph.2026.1.453

Source of Support: Nil,
Conflict of Interest: None declared

Int J Med Pub Health
2026; 16 (1); 2629-2633

ABSTRACT

Background: Acute exacerbations of Chronic Obstructive Pulmonary Disease (AECOPD) are commonly triggered by bacterial infections, contributing significantly to morbidity and hospitalization rates. Identifying the predominant pathogens and their antibiotic sensitivity patterns is critical for effective management, especially in the context of rising antimicrobial resistance.
Objectives: 1. To identify the bacterial pathogens associated with AECOPD. 2. To assess their antibiotic sensitivity patterns in a tertiary care setting.
Materials and Methods: This prospective observational study was conducted over 12 months at a tertiary care center in South India, involving 175 patients with AECOPD as defined by GOLD 2025 guidelines. Adequate sputum samples underwent Gram staining, culture, and antibiotic susceptibility testing by the Kirby-Bauer disc diffusion method, following CLSI standards.
Results: Out of 175 sputum samples, 110 (62.9%) yielded positive bacterial growth. The most frequently isolated organism was Klebsiella pneumoniae (38.2%), followed by Pseudomonas aeruginosa (22.7%), Streptococcus pneumoniae (16.4%), Escherichia coli (9.1%), and Acinetobacter spp. (5.5%). Gram-negative isolates showed highest sensitivity to meropenem (89.7%) and amikacin (76.9%), with considerable resistance to ceftriaxone (48.7%) and levofloxacin (51.3%). Gram-positive isolates were highly sensitive to linezolid (93.8%) and vancomycin (87.5%).
Conclusion: Klebsiella pneumoniae emerged as the predominant pathogen in AECOPD, followed by Pseudomonas and Streptococcus species. The findings underscore the increasing resistance to commonly used antibiotics, advocating for routine culture and sensitivity testing to guide evidence-based therapy and improve patient outcomes.
Keywords: Acute Exacerbation, Antibiotic Sensitivity, Chronic Obstructive Pulmonary Disease, Klebsiella pneumoniae, Multidrug Resistance, Sputum Culture.

INTRODUCTION

Chronic Obstructive Pulmonary Disease (COPD) is a progressive respiratory condition characterized by persistent airflow limitation and an enhanced inflammatory response of the lungs to harmful particles and gases.[1] It represents a significant global public health concern due to its increasing prevalence, chronic nature, and associated mortality. According to the Global Burden of Disease Study, COPD is the third leading cause of death worldwide, accounting for over 3 million deaths annually.[2] The disease is most commonly linked to tobacco smoking, but other factors such as indoor air pollution, occupational exposures, and respiratory infections also contribute to its development, particularly in low- and middle-income countries.[3]
A hallmark of COPD is the occurrence of acute exacerbations, defined as episodes of worsening respiratory symptoms that necessitate additional

therapy. These exacerbations substantially affect patients' quality of life, accelerate the decline in lung function, and increase the risk of hospitalization and death.[4] Among the multiple triggers of exacerbations, bacterial infections are recognized as one of the most frequent causes, especially in moderate to severe cases.[5] Common pathogens implicated in COPD exacerbations include Haemophilus influenzae, Streptococcus pneumoniae, Moraxella catarrhalis, and in advanced disease, Pseudomonas aeruginosa.[6,7]

Several studies have explored the bacteriological profile of COPD exacerbations and their antimicrobial susceptibility patterns. Saxena et al. reported Klebsiella pneumoniae as the predominant isolate in COPD patients, followed by Staphylococcus aureus and Pseudomonas aeruginosa. Their study also emphasized increasing resistance to commonly used antibiotics.[8,9]

Despite the availability of guidelines for COPD management, empirical antibiotic use remains common, often without microbiological confirmation. This practice may lead to inappropriate treatment, prolonged hospital stays, and the emergence of multidrug-resistant organisms. Therefore, understanding the local bacteriological patterns and resistance profiles is essential for guiding effective antimicrobial therapy.

In the context of rising antimicrobial resistance and the critical role of infections in COPD exacerbations, this study aims to provide current data on the sputum bacteriology and antibiotic sensitivity patterns among patients with acute COPD exacerbations in a tertiary care setting. The results will contribute to the optimization of empirical antibiotic strategies and support evidence-based clinical decision-making. Furthermore, the study will help in identifying trends in microbial prevalence and resistance, aiding in the development of institutional antibiotic stewardship programs.

Aim and Objectives

- To identify the bacterial pathogens responsible for causing COPD exacerbations and determine their antibiotic sensitivity patterns.
- To assess bacteriological profile, culture & sensitivity pattern among patients with COPD exacerbation.

MATERIALS AND METHODS

Study Design and Setting

This was a hospital-based prospective observational study conducted over a period of 12 months at the Inpatient Ward and Respiratory Intensive Care Unit (RICU) of Sree Mookambika Institute of Medical Sciences, a tertiary care teaching hospital in South India.

Study Population

The study included patients admitted with acute exacerbation of Chronic Obstructive Pulmonary Disease (COPD), as per the Global Initiative for Chronic Obstructive Lung Disease (GOLD) 2025 guidelines. Acute exacerbation was defined by the presence of increased dyspnea, increased sputum volume, and increased sputum purulence.

Inclusion Criteria

- Adults diagnosed with COPD as per GOLD 2025 criteria.
- Patients presenting with acute exacerbation based on clinical symptoms.
- Sputum samples with adequate quality, defined by presence of ≥25 pus cells per low-power field on microscopic examination.

Exclusion Criteria

- Patients with co-existing bronchiectasis, tuberculosis, asthma, pulmonary malignancy, or community-acquired pneumonia.
- Patients with recent hospitalization or antibiotic use within the past 21 days.
- History of ischemic heart disease.
- Inadequate sputum samples.

Sample Size and Sampling Technique

175 patients (calculated using standard sample size formula with 13.1% prevalence)

Data Collection Procedure

Data were collected using a semi-structured questionnaire by trained investigators. It included demographic details, clinical history, comorbidities, smoking status, and clinical examination findings.

Sputum Collection:

An early morning, deep-coughed sputum sample was collected from each participant in a sterile, wide-mouthed container with a screw cap after instructing them to rinse their mouth thoroughly with water and antiseptic mouthwash to reduce contamination. The sample was transported within two hours to the Department of Microbiology and processed according to standard microbiological guidelines.

Laboratory Analysis

Each sputum specimen was subjected to:

- Gross examination (color, consistency, purulence)
- Microscopic examination (Gram staining for cellular content and bacteria)
- Acid-Fast Bacilli (AFB) staining to rule out tuberculosis
- Culture and Sensitivity Testing using standard bacteriological media and protocols (as per CLSI guidelines)
- Antibiotic susceptibility testing was done using the Kirby-Bauer disc diffusion method. Antibiotics tested included β-lactams, fluoroquinolones, aminoglycosides, carbapenems, and others relevant to respiratory pathogens.

Variables

- Independent Variables: Age, gender, smoking status, exposure to indoor air pollution, comorbidities, and severity of COPD.
- Dependent Variables: Sputum bacteriological profile and antibiotic sensitivity pattern.

- Confounding Variables: Smoking status and other comorbid conditions.

Data Analysis

Data were entered in Microsoft Excel 2021 and analyzed using SPSS software version 21.

- Descriptive statistics (mean, standard deviation) were used for continuous variables.
- Categorical variables were expressed in percentages.
- Association between categorical variables was tested using Chi-square test.
- A p-value <0.05 was considered statistically significant.

Ethical Considerations

The study protocol was reviewed and approved by the Institutional Research Committee of Sree Mookambika Institute of Medical Sciences. Written informed consent was obtained from all participants before inclusion. Confidentiality and anonymity were maintained throughout the study.

RESULTS

The study included 175 participants, predominantly in the older age groups, with the highest proportion in 60–69 years (34.3%), followed by ≥70 years (28.6%). Males constituted the majority (74.3%), while females accounted for 25.7%. A substantial proportion were current smokers (51.4%), and 28.6% were ex-smokers, indicating significant exposure to smoking-related risk factors. Comorbidities were common, with hypertension (42.9%) and diabetes (34.3%) being the most frequent, while only 5.7% had no associated comorbid condition.

Table 1: Demographic and Clinical Characteristics of Study Participants

Variable	Frequency (n)	Percentage (%)
Age Group (years)		
40–49	20	11.4
50–59	45	25.7
60–69	60	34.3
≥70	50	28.6
Gender		
Male	130	74.3
Female	45	25.7
Smoking Status		
Current smoker	90	51.4
Ex-smoker	50	28.6
Never smoker	35	20.0
Comorbidities		
Diabetes	60	34.3
Hypertension	75	42.9
Others	30	17.1
None	10	5.7

Sputum culture showed positive bacterial growth in 62.9% of samples, while 37.1% demonstrated no growth. Among culture-positive cases (n=110), Klebsiella pneumoniae was the most frequently isolated organism (38.2%), followed by Pseudomonas aeruginosa (22.7%) and Streptococcus pneumoniae (16.4%). [Table 2, 3]

Table 2: Distribution of Sputum Culture Results

Culture Result	Number of Samples (n)	Percentage (%)
Positive bacterial growth	110	62.9
Negative / No growth	65	37.1
Total	175	100

Table 3: Bacteriological Profile of Sputum Culture (n = 110)

Organism Isolated	Frequency (n)	Percentage (%)
Klebsiella pneumoniae	42	38.2%
Pseudomonas aeruginosa	25	22.7%
Streptococcus pneumoniae	18	16.4%
Escherichia coli	10	9.1%
Acinetobacter spp	6	5.5%
Others	9	8.1%

Antibiotic sensitivity testing of Gram-negative bacteria (n=78) revealed highest sensitivity to meropenem (89.7%), followed by amikacin (76.9%) and piperacillin-tazobactam (64.1%). Moderate sensitivity was observed with ciprofloxacin (57.7%) and ceftriaxone (51.3%), while levofloxacin showed comparatively lower sensitivity (48.7%), indicating emerging resistance to commonly used antibiotics. [Table 4]

Table 4: Antibiotic Sensitivity Pattern of Gram-Negative Bacteria (n = 78)

Antibiotic	Sensitive n (%)	Resistant n (%)
Meropenem	70 (89.7%)	8 (10.3%)
Amikacin	60 (76.9%)	18 (23.1%)
Ceftriaxone	40 (51.3%)	38 (48.7%)
Piperacillin-Tazobactam	50 (64.1%)	28 (35.9%)
Ciprofloxacin	45 (57.7%)	33 (42.3%)
Levofloxacin	38 (48.7%)	40 (51.3%)

Among Gram-positive isolates (n=32), linezolid demonstrated the highest sensitivity (93.8%), followed by vancomycin (87.5%) and cefoxitin (78.1%). Sensitivity to amoxicillin-clavulanate (68.8%) and erythromycin (62.5%) was moderate. [Table 5]

Table 5: Antibiotic Sensitivity Pattern of Gram-Positive Bacteria (n = 32)

Antibiotic	Sensitive n (%)	Resistant n (%)
Linezolid	30 (93.8%)	2 (6.2%)
Vancomycin	28 (87.5%)	4 (12.5%)
Cefoxitin	25 (78.1%)	7 (21.9%)
Erythromycin	20 (62.5%)	12 (37.5%)
Amoxicillin-Clav	22 (68.8%)	10 (31.2%)

DISCUSSION

In the present study, 62.9% of patients with acute exacerbation of COPD (AECOPD) demonstrated positive sputum cultures, emphasizing the significant contribution of bacterial infections in acute disease exacerbations. Klebsiella pneumoniae (38.2%) was the most frequently isolated organism, followed by Pseudomonas aeruginosa (22.7%), Streptococcus pneumoniae (16.4%), Escherichia coli (9.1%), and Acinetobacter spp. (5.5%). This predominance of Gram-negative organisms is consistent with the evolving microbiological pattern observed in hospitalized COPD patients.

Similar findings were reported by Saxena et al,[10] who identified Klebsiella pneumoniae as the leading pathogen in AECOPD, reinforcing its emerging role in respiratory infections among COPD patients. Hoque MN et al,[11] also documented K. pneumoniae (38.46%) as the most common isolate, particularly among smokers, further supporting its strong association with COPD. Likewise, Danish I et al,[12] observed a predominance of Gram-negative bacilli (82.9%), with K. pneumoniae (34.1%) and P. aeruginosa (24.4%) being the most frequent pathogens.

The isolation of Pseudomonas aeruginosa in 22.7% of cases in our study aligns with reports by Khaled et al,[13] and Mood N et al,[14] who identified P. aeruginosa as a major pathogen in severe AECOPD cases. Its presence is often linked to advanced disease, recurrent exacerbations, and frequent hospitalizations, indicating a poorer prognosis and the need for targeted antimicrobial therapy.

Regarding antimicrobial susceptibility, our study demonstrated high sensitivity of Gram-negative isolates to meropenem (89.7%) and amikacin (76.9%), while significant resistance was observed to levofloxacin (51.3%) and ceftriaxone (48.7%). These findings are comparable to those of Sharma et al,[15] who reported increasing resistance to fluoroquinolones and cephalosporins among Gram-negative pathogens. Similarly, Mood N et al,[14] observed high resistance to cefoperazone-sulbactam and fluoroquinolones, whereas carbapenems retained good efficacy. Sobhy KE et al,[16] also highlighted preserved sensitivity to carbapenems against multidrug-resistant (MDR) strains.

Among Gram-positive isolates, linezolid (93.8%) and vancomycin (87.5%) showed high sensitivity in our study, consistent with findings by Sharma et al,[15] where these agents remained effective against Staphylococcus aureus and MRSA. However, moderate resistance to erythromycin and amoxicillin-clavulanate suggests cautious empirical use of these antibiotics.

High rates of MDR organisms reported by Mussema A et al,[17] (93.8% MDR isolates, with ESBL and carbapenemase producers) and Danish I et al,[12] (43.9% MDR prevalence) further corroborate the growing challenge of antimicrobial resistance in AECOPD. These studies emphasize that recurrent exacerbations and prior antibiotic exposure are important determinants of culture positivity and MDR emergence.

In addition, Majumder MM et al,[18] reported that 45.5% of patients showed growth of Klebsiella pneumoniae, with most isolates—except Acinetobacter—demonstrating greater than 85% in vitro sensitivity to meropenem, imipenem, and amikacin. Their study also noted male predominance and higher occurrence in older age groups, with Klebsiella pneumoniae, Pseudomonas, and E. coli being the most common pathogens, which closely parallels our findings.

Furthermore, Shah SJ et al,[19] observed culture positivity in 37.7% of AECOPD patients, with Pseudomonas aeruginosa (41.1%) being the most common isolate, followed by Klebsiella pneumoniae and E. coli. They reported good sensitivity to beta-lactam/beta-lactamase inhibitor combinations, carbapenems, colistin, and polymyxin B, while noting variable resistance patterns. Their recommendation of cefoperazone/sulbactam

combined with an aminoglycoside or levofloxacin for empirical therapy supports the importance of institution-specific antibiotic policies.

The findings of the present study were in concordance with existing literature demonstrating the predominance of Gram-negative bacteria—particularly Klebsiella pneumoniae and Pseudomonas aeruginosa—with rising antimicrobial resistance. These observations underscore the critical importance of routine sputum culture and antibiotic sensitivity testing to guide appropriate therapy, reduce treatment failure, and limit the spread of multidrug-resistant pathogens in COPD patients.

CONCLUSION

The study reveals that bacterial infections significantly contribute to COPD exacerbations. Most patients showed positive sputum cultures, with Klebsiella pneumoniae, Streptococcus pneumoniae, and Pseudomonas aeruginosa being the most common pathogens. Antibiotic sensitivity patterns showed a growing trend of resistance to commonly used antibiotics, emphasizing the need for routine culture and sensitivity testing before treatment. The study emphasizes the importance of region-specific surveillance of microbial patterns and resistance trends for effective antibiotic prescribing. It also emphasizes the need for timely identification of causative organisms and appropriate antibiotic selection for COPD exacerbation management.

REFERENCES

1. Celli BR, Fabbri LM, Aaron SD, Agusti A, Brook R, Criner GJ, et al. An Updated Definition and Severity Classification of Chronic Obstructive Pulmonary Disease Exacerbations: The Rome Proposal. Am J Respir Crit Care Med 2021;204(11):1251–8.
2. Safiri S, Carson-Chahhoud K, Noori M, Nejadghaderi SA, Sullman MJ, Heris JA et al. Burden of chronic obstructive pulmonary disease and its attributable risk factors in 204 countries and territories, 1990-2019: results from the Global Burden of Disease Study 2019. bmj. 2022;378.
3. Hogg JC. Pathophysiology of airflow limitation in chronic obstructive pulmonary disease. Lancet 2004;364(9435):709–21.
4. MacLeod M, Papi A, Contoli M, Beghé B, Celli BR, Wedzicha JA et al. Chronic obstructive pulmonary disease exacerbation fundamentals: diagnosis, treatment, prevention and disease impact. Respirology. 2021 Jun;26(6):532-51.
5. Leung JM, Tiew PY, Mac Aogáin M, Budden KF, Yong VFL, Thomas SS, et al. The role of acute and chronic respiratory colonization and infections in the pathogenesis of COPD. Respirology 2017;22(4):634–50.
6. Beasley V, Joshi PV, Singanayagam A, Molyneaux PL, Johnston SL, Mallia P. Lung microbiology and exacerbations in COPD. Int J Chron Obstruct Pulmon Dis 2012;7:555–69.
7. Moghoofei M, Azimzadeh Jamalkandi S, Moein M, Salimian J, Ahmadi A. Bacterial infections in acute exacerbation of chronic obstructive pulmonary disease: a systematic review and meta-analysis. Infection. 2020 Feb;48(1):19-35.
8. Rashid MH, Ahmed I. Pattern of sputum bacteriology in acute exacerbations of chronic obstructive pulmonary disease. Journal of Enam Medical College. 2018 May 30;8(2):80-4.
9. Sharma P, Narula S, Sharma K, Kumar N, Lohchab K, Kumar N. Sputum bacteriology and antibiotic sensitivity pattern in COPD exacerbation in India. Egyptian journal of chest diseases and tuberculosis. 2017 Oct 1;66(4):593-7.
10. Saxena S, Ramnani V, Nema S, Tripathi K, Dave L, Srivastava N. Original Article Section: Microbiology Bacteriological Profile in Acute Exacerbation of Chronic Obstructive Lung Disease (AECOPD). Annals of International Medical and Dental Research 2016;2.
11. Hoque MN, Das SK. A study on sputum bacteriology and antibiotic sensitivity pattern of patients with acute exacerbation of chronic obstructive pulmonary disease in a tertiary care hospital. Int J Acad Med Pharm. 2025;7(4):858-60.
12. Danish I, Rehman S, Bibi M, Khan R. Bacterial etiology and antibiotic susceptibility patterns in acute exacerbations of chronic obstructive pulmonary disease: implications for targeted antimicrobial therapy. Pakistan Journal of Chest Medicine. 2025;31(1):37-43.
13. Khaled AA, Ahmed AM, El-Feky MA. Bacterial pathogens and antimicrobial susceptibility in acute exacerbations of chronic obstructive pulmonary disease. Egypt J Chest Dis Tuberc. 2015;64(3):639–645.
14. Mood N, Katta SR, Badam AK, Chundru J. Clinico-bacteriological profile and antibiotic resistance pattern in patients with acute exacerbation of COPD. The Egyptian Journal of Internal Medicine. 2022 Dec;34(1):13.
15. Sharma P, Narula S, Sharma K, Kumar N, Lohchab K, Kumar N. Sputum bacteriology and antibiotic sensitivity pattern in COPD exacerbation in India. Egyptian Journal of Chest Diseases and Tuberculosis 2017;66(4):593–7.
16. Sobhy KE, Abd El-Hafeez AM, Shoukry FA, Refaai ES. Pattern of sputum bacteriology in acute exacerbations of chronic obstructive pulmonary disease. Egypt J Bronchol 2015;9(2):170–7.
17. Mussema A, Beyene G, Gashaw M. Bacterial isolates and antibacterial resistance patterns in a patient with acute exacerbation of chronic obstructive pulmonary disease in a tertiary teaching hospital, Southwest Ethiopia. Canadian Journal of Infectious Diseases and Medical Microbiology. 2022;2022(1):9709253.
18. Majumder MM, Shaha P, Ahmed M, Uddin MN, Rahman M, Ahmed T. Bacteriology and Antibiotic Sensitivity Pattern of Sputum in Patients with Acute Exacerbation of Chronic Obstructive Pulmonary Disease. Medicine Today. 2022 Apr 24;34(1):12-6.
19. Shah SJ, Mehta N, Shah S. Study of Sputum Bacteriology of Patients with Acute Exacerbation of Chronic Obstructive Pulmonary Disease. Journal of Krishna Institute of Medical Sciences (JKIMSU). 2021 Apr 1;10(2).