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Original Research Article

STREPTOCOCCAL PREDOMINANCE AND HIGH MULTIDRUG RESISTANCE IN ACUTE EXACERBATION OF COPD: SPUTUM BACTERIOLOGY AND ANTIBIOTIC SENSITIVITY PATTERN AT A TERTIARY CARE CENTRE

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ABSTRACT

Background: Chronic obstructive pulmonary disease (COPD) is a leading cause of morbidity worldwide. Bacterial infections account for approximately 40% of acute exacerbations in Indian patients, yet local bacteriological data from the Telangana region remain sparse. Empirical prescribing without local sensitivity data risks treatment failure and drives resistance. This study aimed to describe the bacteriological profile and antibiotic sensitivity pattern of sputum isolates in patients admitted with acute exacerbation of COPD (AECOPD) at a tertiary care centre. **Materials and Methods:** This was an observational cross-sectional study conducted at a tertiary care hospital in Vikarabad, Telangana over a period of 2 years. A total of 138 patients diagnosed with AECOPD by GOLD criteria were enrolled. Early morning sputum samples were collected and processed by standard culture methods. Organism identification and antibiotic sensitivity testing were performed using the VITEK 2 automated system. Data were analysed with SPSS version 21; descriptive statistics and chi-square tests were used as appropriate. **Result:** Males accounted for 94 patients (68.1%). The majority of patients (37.7%) were in the 51-60 year age group. Current smokers formed the largest exposure group (42.8%). Breathlessness was present in all 138 patients. Sputum culture was positive in 107 patients (77.5%). Streptococcus spp was the most frequent isolate (40.2% of 122 total isolates), followed by Pseudomonas aeruginosa (26.2%) and Klebsiella pneumoniae (13.1%). Multidrug resistance (MDR) was identified in 92 of 107 culture-positive patients (85.98%). Among gram-negative isolates, amikacin showed 93.5% sensitivity and colistin showed 100% sensitivity. Vancomycin and linezolid were 100% sensitive against gram-positive organisms. **Conclusion:** Gram-positive Streptococcus spp predominate in AECOPD at this centre. MDR rates are high. Empirical antibiotic prescribing should be guided by local sensitivity data, and routine culture and sensitivity testing is recommended for all patients admitted with AECOPD.

INTRODUCTION

Chronic obstructive pulmonary disease (COPD) is a preventable and treatable condition characterised by persistent airflow limitation that is usually progressive. It is one of the leading causes of morbidity and mortality globally. COPD was the fourth leading cause of death worldwide at the time of the Global Burden of Disease study, and projections suggested it would rise to third place within two decades.[1] Approximately 210 million people are affected worldwide. The disease places a large burden on health systems through repeated hospitalisations, loss of productive years, and the cost of long-term medications. In India, prevalence estimates range from 1% to 21% depending on the population studied, the diagnostic criteria applied, and whether patients are from rural or urban settings.[2] Approximately 12 million Indians are estimated to carry a diagnosis of COPD, although under-recognition and under-diagnosis mean the true burden is likely higher. Smoking and indoor air pollution from biomass fuel combustion are the two most important risk factors in the Indian subcontinent, and both remain prevalent in low- and middle-income communities.

Acute exacerbations of COPD are episodes of worsening respiratory symptoms that go beyond normal day-to-day variation and require a change in treatment. The GOLD (Global Initiative for Chronic Obstructive Lung Disease) definition describes an exacerbation as an acute event characterised by worsening of dyspnoea, cough, or sputum production. Most patients with moderate-to-severe COPD experience one to three exacerbations per year. Each exacerbation is associated with accelerated decline in lung function, reduced quality of life, and increased risk of death. Hospitalisations for exacerbations account for a large share of total COPD-related healthcare expenditure. [3] Beyond the direct medical costs, exacerbations impose indirect costs through lost work days and reduced productivity, particularly in patients aged 40-65 years who remain in employment. Preventing and effectively treating exacerbations is therefore central to both the clinical and economic management of COPD. Early identification of the causative agent and targeted treatment are likely to improve outcomes and reduce the duration of hospitalisation.

The aetiology of AECOPD is diverse. Bacterial pathogens are responsible for approximately 40-50% of infective exacerbations in Indian patients. Respiratory viruses, particularly rhinovirus and influenza, account for another 30%, while the remaining cases involve environmental pollutants or have no identifiable trigger. [4] Traditionally, western literature has identified Streptococcus pneumoniae, Haemophilus influenzae, and Moraxella catarrhalis as the predominant organisms. These three pathogens are classically described as the bacteria most likely to colonise and infect the lower respiratory tract in COPD patients with mild-to-moderate airflow obstruction. However, studies from South Asian hospital settings have shown a different spectrum. Gram-negative organisms, including Pseudomonas aeruginosa, Klebsiella pneumoniae, and Acinetobacter species, are increasingly recognised in patients with severe obstruction, frequent exacerbations, and prolonged prior antibiotic exposure. This shift in the bacteriological profile has direct implications for the choice of empirical antibiotic therapy.

The decision to prescribe antibiotics in AECOPD is guided by the Anthonisen criteria, which define three cardinal symptoms: increased breathlessness, increased sputum volume, and increased sputum purulence. Patients with all three symptoms, or with two symptoms including purulence, are most likely to benefit from antibiotics. [5] In practice, over 90% of patients admitted to hospital with AECOPD receive antibiotics, and the choice is almost always empirical because culture results take 48 to 72 hours to become available. Empirical prescribing in the absence of local bacteriological knowledge risks using agents to which the prevalent organisms are resistant. Resistance to commonly used agents such as ampicillin, amoxicillin-clavulanic acid, and fluoroquinolones has been rising in India. Without reliable local sensitivity data, clinicians may prescribe broad-spectrum agents unnecessarily or miss effective narrower-spectrum options. Both scenarios contribute to the broader problem of antimicrobial resistance and increase the risk of treatment failure.

The bacteriological profile of AECOPD varies substantially by geography, hospital setting, patient population, and local antibiotic prescribing practices. Western studies consistently identify Haemophilus influenzae as the dominant pathogen. In contrast, Indian hospital-based studies have reported a different Gram-negative spectrum, with greater contributions from Pseudomonas aeruginosa and Klebsiella pneumoniae, particularly in tertiary care centres receiving referred patients with advanced disease. Most published Indian studies on AECOPD bacteriology come from metropolitan centres such as Delhi, Mumbai, or Bengaluru, and may not accurately reflect the pathogen distribution or resistance patterns seen in semi urban Telangana. Local data are therefore needed to guide empirical prescribing in this setting.

MATERIALS AND METHODS

This was an observational cross-sectional study conducted at a tertiary care teaching hospital in Vikarabad, Telangana, India over a period of 2 years. Written informed consent was taken from all enrolled patients.

Patients aged over 18 years admitted to the respiratory medicine ward with a diagnosis of AECOPD based on GOLD criteria were eligible. Demographic data, smoking and exposure history, presenting symptoms, and exacerbation frequency in the prior year were recorded at admission. Early morning sputum samples were collected before initiating antibiotic therapy. Samples were processed in the hospital microbiology laboratory. Organism identification and antibiotic sensitivity testing were performed using the VITEK 2 automated system (bioMerieux). Sensitivity, resistance, and intermediate results were recorded for each antibiotic tested.

Data were entered into Microsoft Excel and analysed using SPSS version 21.0 (IBM Corp). Categorical variables are presented as frequencies and percentages. The chi-square test was used for categorical associations where applicable. A p-value below 0.05 was taken as statistically significant.

Inclusion criteria

- Age above 18 years
- Admitted to the respiratory medicine ward with a diagnosis of COPD established by GOLD criteria
- Presenting with an acute exacerbation, defined by the presence of at least two of the following:

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- Increased dyspnea
- Increased sputum volume
- Increased sputum purulence
- Fever (axillary temperature above 38°C)
- Able to produce an expectorated sputum sample
- Willing to give written informed consent

Exclusion criteria

- Age less than 18 years.
- Refusal to give consent to be part of study.
- Known bronchiectasis
- Active pulmonary tuberculosis, or sputum positive for acid-fast bacilli
- Receipt of systemic antibiotics within the preceding 21 days
- Inability to produce an adequate sputum sample

RESULTS

All 138 enrolled patients were included in the final analysis. The data presented below are derived from patient records and laboratory results collected prospectively during the study period. Males outnumbered females in the study population [Figure 1].

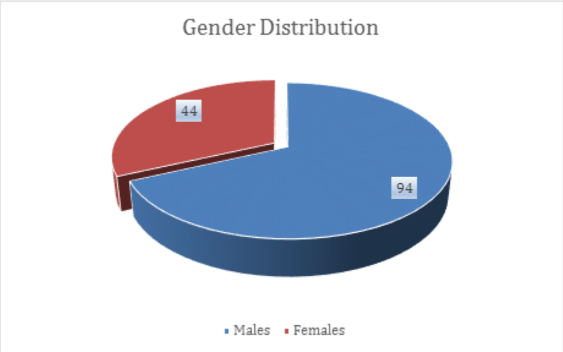

Figure 1: Gender Distribution of Studied cases.

The majority of patients were in the 51-60 (37.7%) year age group followed by 61-70 years (30.4%) and 41-50 years (21.7%) [Table 1].

Table 1: Age distribution of the study population (n = 138). Data presented as n (%).

Parameter	**n**	**%**
Age group (years)		
41-50	30	21.7
51-60	52	37.7
61-70	42	30.4
71-80	9	6.5
>80	5	3.6
Total	138	100

Current smokers were the largest exposure group. Indoor air pollution was the primary exposure in a third of patients [Table 2].

Table 2: Distribution of patients by exposure history (n = 138). Data presented as n (%).

Exposure	**n**	**%**
Current smoker	59	42.8
Indoor air pollution	44	31.9
Ex-smoker	35	25.4
Total	138	100

Breathlessness was nearly universal. Fever was present in nearly three-quarters of patients [Table 3].

Table 3: Distribution of presenting symptoms (n = 138). Data presented as n (%). Patients could have more than one symptom.

Symptom	**n**	**%**
Breathlessness	138	100.0
Cough	125	90.6
Fever	103	74.6
Cough with expectoration	83	60.1

Two exacerbations in the past year was the most common pattern, seen in over a third of patients [Table 4].

Table 4: Distribution of patients by exacerbation frequency in the year preceding enrolment (n = 138). Data presented as n (%).

Exacerbations in prior year	**n**	**%**
None	22	15.9
One	30	21.7
Two	51	37.0
Three	35	25.4
Total	138	100

Culture was positive in more than three-quarters of patients. Single-organism growth was seen in the majority of culture-positive cases [Table 5].

Table 5: Sputum culture positivity and isolate pattern (n = 138; culture-positive n = 107). Data presented as n (%).

Culture result	n	%
Positive	107	77.5
No growth	31	22.5
Total	138	100
Isolate pattern (n = 107)	n	%
Single isolate	96	89.7
Multiple isolates	11	10.3
Total	107	100

Streptococcus species were the most common isolate, followed by Pseudomonas aeruginosa. A total of 122 isolates were recovered [Table 6].

Table 6: Distribution of bacterial isolates from 107 culture-positive patients (total 122 isolates). Data presented as n (%). *Others includes single isolates of Enterobacter aerogenes, Citrobacter freundii, Cryptococcus laurentii, Enterococcus spp, Raoultella ornithinolytica, and Serratia marcescens.

Organism	n	%
Streptococcus spp	49	40.2
Pseudomonas aeruginosa	32	26.2
Klebsiella pneumoniae	16	13.1
Acinetobacter spp	6	4.9
Escherichia coli	5	4.1
Staphylococcus aureus	5	4.1
Enterobacter cloacae	3	2.5
Others*	6	4.9
Total	122	100

Among gram-negative isolates, amikacin and colistin showed the highest sensitivity. Levofloxacin and cefuroxime showed high resistance rates [Table 7].

Table 7: Antibiotic sensitivity pattern of gram-negative isolates. Data presented as n (%). Testing performed using VITEK 2 automated system.

Antibiotic	Tested n	Sensitive n (%)	Resistant n (%)	Intermediate n (%)
Colistin	4	4 (100.0)	0	0
Amikacin	62	58 (93.5)	4 (6.5)	0
Gentamicin	70	59 (84.3)	9 (12.9)	2 (2.9)
Doripenem	32	26 (81.3)	4 (12.5)	2 (6.3)
Imipenem	64	51 (79.7)	11 (17.2)	2 (3.1)
Meropenem	64	51 (79.7)	10 (15.6)	3 (4.7)
Ceftazidime	33	26 (78.8)	7 (21.2)	0
Cefoperazone/Sulbactam	64	49 (76.6)	10 (15.6)	5 (7.8)
Piperacillin/Tazobactam	59	45 (76.3)	11 (18.6)	3 (5.1)
Cefepime	62	47 (75.8)	15 (24.2)	0
Ciprofloxacin	72	50 (69.4)	15 (20.8)	7 (9.7)
Tigecycline	101	70 (69.3)	31 (30.7)	0
Ticarcillin/Clavulanic acid	30	10 (33.3)	10 (33.3)	10 (33.3)
Levofloxacin	87	36 (41.4)	47 (54.0)	4 (4.6)
Cefuroxime	33	10 (30.3)	23 (69.7)	0
Minocycline	19	4 (21.1)	14 (73.7)	1 (5.3)

Vancomycin and linezolid showed complete sensitivity against gram-positive isolates. Ampicillin and erythromycin showed high resistance rates [Table 8].

Table 8: Antibiotic sensitivity pattern of gram-positive isolates. Data presented as n (%). Testing performed using VITEK 2 automated system.

Antibiotic	Tested n	Sensitive n (%)	Resistant n (%)	Intermediate n (%)
Linezolid	43	43 (100.0)	0	0
Vancomycin	30	30 (100.0)	0	0
Daptomycin	3	3 (100.0)	0	0
Rifampicin	8	8 (100.0)	0	0
Teicoplanin	36	35 (97.2)	1 (2.8)	0
Ertapenem	24	23 (95.8)	1 (4.2)	0
Chloramphenicol	32	28 (87.5)	3 (9.4)	1 (3.1)
Clindamycin	49	20 (40.8)	21 (42.9)	8 (16.3)
Amoxicillin-Clavulanic acid	30	11 (36.7)	16 (53.3)	3 (10.0)
Ceftriaxone	80	37 (46.3)	37 (46.3)	6 (7.5)
Benzyl Penicillin	41	6 (14.6)	22 (53.7)	13 (31.7)
Tetracycline	52	15 (28.8)	37 (71.2)	0
Erythromycin	41	9 (22.0)	32 (78.0)	0
Ampicillin	57	9 (15.8)	45 (78.9)	3 (5.3)

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Multidrug resistance was found in 92 of 107 (85.98%) culture-positive patients. Duration of hospital stay was 8-10 days in the majority of patients (33.3%), followed by 6-7 days and 11-14 days (25.4% each). Extended stay of more than 14 days was seen in 12 patients (8.7%), all of whom had culture-positive specimens with MDR organisms.

DISCUSSION

This study examined the bacteriological profile and antibiotic sensitivity pattern in 138 patients admitted with AECOPD at a tertiary care centre in Vikarabad, Telangana. Sputum culture was positive in 107 patients (77.5%). Streptococcus spp was the predominant isolate at 40.2%, followed by Pseudomonas aeruginosa at 26.2% and Klebsiella pneumoniae at 13.1%. Multidrug resistance was identified in 85.98% of culture-positive patients. These findings have direct implications for antibiotic prescribing in this region.

Ko et al,[6] studied sputum bacteriology in AECOPD patients in Hong Kong and found Haemophilus influenzae to be the most common organism at 23.1% of isolates. This contrasts with the present study, in which Haemophilus influenzae was absent from the isolate list. The difference likely reflects regional variation in colonising flora and differences in the baseline disease severity of the populations studied. The Hong Kong cohort had predominantly mild-to-moderate COPD, while the present tertiary care cohort included a higher proportion of patients with severe disease and frequent exacerbations, factors known to shift the flora towards Gram-negative organisms.

Sharma et al,[7] conducted a study on sputum bacteriology in Indian COPD exacerbations and reported a culture positivity rate of 48.7%, which is considerably lower than the 77.5% seen here. In their study, Gram-negative bacteria predominated and Escherichia coli was the most common isolate, while Streptococcus spp were most common in the present series. The higher positivity rate in the present study may reflect the stricter enrolment criteria, ensuring all patients had active infective exacerbations, and the use of the VITEK 2 automated system, which may improve detection compared with conventional methods.

Shashibhushan et al,[8] studied bacteriological profiles and antibiotic sensitivity patterns at an Indian tertiary care hospital and found Streptococcus pneumoniae to be the most common isolate at 42% of cases, closely matching the 40.2% Streptococcus spp prevalence in the present study. They reported Pseudomonas aeruginosa in 23% of cases, consistent with the 26.2% in the current series. The similarity of findings between these two Indian tertiary care studies suggests that Gram-positive streptococcal species may be more prevalent in Indian AECOPD than has been recognised in international guidelines based on western data.

Patel et al,[9] reported a culture positivity rate of 82% in their preliminary Indian study, similar to the present findings. Streptococcus was the most common organism at 32% of isolates in their series. They recommended piperacillin-tazobactam as an appropriate empirical choice based on their sensitivity data. In the current study, Pseudomonas aeruginosa showed 76.3% sensitivity to piperacillin-tazobactam, which supports that recommendation for Gram-negative coverage. However, Escherichia coli isolates in the present series showed only about 60% sensitivity to this agent, indicating that piperacillin-tazobactam should not be assumed effective for all Gram-negatives without local sensitivity data.

Rakesh et al,[10] found streptococcal isolates in 38.1% of their AECOPD specimens, consistent with the 40.2% seen in this study. They identified extended-spectrum beta-lactamase (ESBL) production as a concern in their cohort. The high MDR rate of 85.98% in the present series is consistent with a significant ESBL burden, as ESBL-producing organisms are a major driver of multidrug resistance in Gram-negative pathogens. This has practical consequences: agents such as cephalosporins and fluoroquinolones, which are commonly used empirically, are likely to fail in a high proportion of patients.

ElKorashy et al,[11] studied Gram-negative organisms causing AECOPD in an Egyptian cohort and found Pseudomonas aeruginosa to be the most common Gram-negative pathogen. They reported Gram-negative MDR in 28.6% of isolates, far lower than the 85.98% overall MDR rate found in the present study. The difference likely reflects the shorter duration of prior antibiotic exposure and lower baseline antibiotic pressure in the Egyptian cohort compared with patients attending a high-volume Indian tertiary care centre.

Rothberg et al.[12] compared macrolides and quinolones in hospitalised AECOPD patients and found similar clinical failure rates between the two classes. The antibiotic sensitivity data in the present study provide a microbiological basis for caution with empirical quinolone use in this setting: levofloxacin resistance was 54.0% among Gram-negative isolates. Among Gram-positive isolates, the data suggest similarly high resistance rates to fluoroquinolones. Given these resistance rates, empirical quinolone monotherapy for AECOPD in this region is unlikely to provide reliable coverage.

Sharan et al,[13] reported Gram-negative predominance in a central India AECOPD cohort, with Pseudomonas aeruginosa and Klebsiella pneumoniae as the leading organisms. The Gram-negative subset in the present study is consistent with this pattern. Pseudomonas (26.2%) and Klebsiella (13.1%) together accounted for nearly 40% of all isolates, reinforcing the importance of covering these organisms in empirical regimens for patients with severe disease or frequent prior antibiotic exposure.

Chawla et al,[14] studied bacteriological profiles and antibiograms in AECOPD at a hospital in Mangalore, India, and reported high resistance to amoxicillin-clavulanic acid. This is consistent with the 53.3% resistance rate to amoxicillin-clavulanic acid among Gram-positive isolates in the present study. Both studies suggest that amoxicillin-clavulanic acid is no longer a reliable empirical choice for AECOPD in Indian tertiary care settings and that targeted therapy based on sensitivity results is needed.

Arora et al,[15] conducted a hospital-based study of COPD patients in Delhi and reported 77% male predominance, similar to the 68.1% seen here. Both studies attributed this to greater rates of tobacco smoking in men. The male predominance observed across Indian AECOPD studies reflects the higher prevalence of smoking and occupational dust exposure in men in this region.

This study has several limitations. It was conducted at a single centre, which limits generalizability to other regions of India. Sputum is susceptible to oropharyngeal contamination, which may have introduced false positives, although the use of VITEK 2 and standard culture techniques reduces but does not eliminate this risk. Viral pathogens and atypical organisms were not tested, so the proportion of exacerbations with a non-bacterial aetiology could not be established. The cross-sectional design prevents assessment of clinical outcomes in relation to bacteriological findings. Future studies should include viral and atypical pathogen testing, should enrol patients from multiple centers across India, and should link bacteriological findings to patient outcomes.

CONCLUSION

Streptococcus spp was the predominant organism in AECOPD sputum cultures followed by Pseudomonas aeruginosa and Klebsiella pneumoniae. Multidrug resistance was identified in 85.98% of culture-positive patients, a rate that demands attention. Amikacin and colistin were the most active agents against Gram-negative isolates; vancomycin and linezolid were fully effective against Gram-positive organisms. Empirical antibiotic choice must be guided by local sensitivity data. Routine sputum culture and sensitivity testing should be standard practice for all patients admitted with AECOPD at this and similar centres.

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