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YIELD OF SPUTUM CULURE AND SENSITIVITY IN CHRONIC OBSTRUCTIVE AIRWAYS DISEASE PATIENTS

Sana Ullah[1], **Muhammad Asif Khan Afridi**[*2]

[1]*Postgraduate Resident, Pulmonology Department, Hayatabad Medical Complex Peshawar, Pakistan*
[*2]*Assistant Professor, Pulmonology Department, Hayatabad Medical Complex Peshawar, Pakistan*

[*2]dr.asifkhaan@gmail.com

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Corresponding Author: *
Muhammad Asif Khan Afridi

Abstract

Background:
Chronic Obstructive Pulmonary Disease (COPD) continues to be a serious global health issue, ranking high among the leading causes of illness and death worldwide. One of the most challenging aspects of managing COPD is dealing with acute exacerbations (AECOPD), which often accelerate disease progression, lead to more frequent hospitalizations, and significantly increase healthcare expenses. A major cause of these flare-ups is bacterial infection, making it crucial to identify the specific bacteria involved and understand how they respond to antibiotics. This knowledge is key to choosing the right treatment and improving recovery outcomes.

Objective:
The goal of this study was to assess how effective sputum culture and sensitivity testing are in detecting bacterial infections during AECOPD episodes.

Methods:
We conducted a prospective observational study over a three-month span—from 8 January to 8 April 2025—at Hayatabad Medical Complex in Peshawar, Pakistan. The study included 200 patients who were clinically and spirometrically diagnosed with AECOPD. Each patient provided a sputum sample, which was analyzed using standard laboratory procedures to identify bacteria and determine which antibiotics the bacteria were most sensitive to.

Results:
Of the 200 samples collected, 120 (60%) showed positive bacterial growth. The most commonly detected bacteria were Streptococcus pneumoniae (35%), Haemophilus influenzae (25%), Klebsiella pneumoniae (20%), and Pseudomonas aeruginosa (15%). Sensitivity testing revealed that S. pneumoniae and H. influenzae responded well to amoxicillin-clavulanate and levofloxacin. Meanwhile, K. pneumoniae and P. aeruginosa showed better sensitivity to imipenem and amikacin.

Conclusion:
This study highlights the value of performing sputum culture and antibiotic sensitivity testing in patients with AECOPD. Tailoring antibiotic therapy based on specific bacterial identification can enhance treatment effectiveness, reduce unnecessary use of broad-spectrum antibiotics, and help combat the growing threat of antimicrobial resistance in respiratory infections.

INTRODUCTION

COPD is an ongoing health problem of the lungs that includes airflow limitation and constant irritation in the airways. One-third of the world's population is a victim of cancer, with an estimated 3.23 million deaths from the disease occurring every year [1]. The problem of delayed diagnosis and access to treatment results in a heavier disease load in low- and middle-income countries [2]. A main part of managing COPD is responding to acute exacerbations, sudden increases in symptoms that usually call for changing the treatment plan. They cause the lungs to deteriorate faster, lead to worse patient quality of life and lead to big increases in healthcare costs [3].

These exacerbations are most frequently brought on by breathing infections and half the time, the infections are bacterial [4,5]. When we have weakened immunity, mucus cannot be removed and airway bacteria multiply, these factors increase inflammation in the lungs [6]. Haemophilus influenzae, Streptococcus pneumoniae, Moraxella catarrhalis and Pseudomonas aeruginosa are often present in patients' sputum when they have these episodes [7–9]. Although these bacteria are safe under steady conditions, they can make the disease worse if the immune system is weak or if something in the environment changes [10].

There is increasing awareness of how Gram-negative bacteria from the Klebsiella pneumoniae and Acinetobacter baumannii families are developing resistance to much-used antibiotics [11–13]. If antibiotics are taken too often or in the wrong way, resistance grows, patients recover less well and resistance spreads to others in the community. According to the World Health Organization (WHO), antimicrobial resistance represents a major health concern in chronic diseases like COPD, considering how often people there are given antibiotics [15].

While many experts support administering antibiotics chosen based on sensitivity testing, culturing of sputum for sensitivity in many health care environments is done infrequently. Using microbiological tests during COPD care improves how antibiotics are prescribed, cuts back on treatment failures and helps prevent patients from being readmitted to the hospital [16,17]. How sputum cultures fare in detecting tuberculosis varies widely, ranging from 20% to 60% according to the quality of sample collection, the quality of the specimen and the laboratory steps [18].

There is a lack of localized data about the bacterial causes and resistance patterns seen in severe AECOPD, particularly at higher-level hospitals in Pakistan. The study aims to cover that gap by examining how helpful sputum culture testing is and what sensitivity patterns are found among AECOPD patients in Hayatabad Medical Complex, Peshawar. To achieve this goal, the researchers plan to look at the sorts of pathogens seen and how they resist antibiotics in this group.

METHODOLOGY

Study Design and Setting

A prospective observational study was undertaken in this research and lasted from 8 January to 8 April 2025 at the Hayatabad Medical Complex (HMC) in Peshawar, Pakistan. Because HMC treats many different patients, it attracts cases from urban and rural Khyber Pakhtunkhwa. Consequently, this made it possible to study the microorganisms causing respiratory tract infections in people with acute exacerbations of chronic obstructive pulmonary disease (AECOPD). The researchers studied to see if sputum culture and sensitivity testing can accurately identify bacterial infections in the group.

Study Population

Participating in the study were adults over the age of 40 who had received COPD diagnoses using GOLD criteria, including a ratio of FEV1 to FVC less than 0.70. Patients with worsening breathlessness, a rise in sputum or a different or thicker appearance of their sputum were counted as eligible.

No participants were included if they were on antibiotics in the two weeks beforehand, suffered from pulmonary diseases such as pneumonia or tuberculosis, had impaired immune systems or were known to have lung cancer. A total of 200 patients who fit the study criteria were enrolled through consecutive sampling. Every participant gave their written agreement before the research was conducted.

Sputum Collection and Laboratory Analysis

The patients were guided by staff members in collection of the sputum while being shown how to cough deeply for the specimen. Samples were taken in clean, wide-necked containers and brought to the microbiology lab within a hour of taking them. We checked the sputum using Bartlett's criteria; any that contained fewer than 10 squamous epithelial cells and more than 25 polymorpho-nuclear leukocytes per low-power field were accepted for further testing.

Sampled bacteria were transferred to blood agar, chocolate agar and MacConkey agar and then incubated with air for 24 to 48 hours at 35–37°C. The type of bacteria was identified according to colony shape, Gram staining results and usual biochemical tests. The identity of isolated organisms was also checked by using the Analytical Profile Index (API) when needed.

Antibiotic Sensitivity Testing

The Kirby-Bauer disk diffusion method was used on Mueller-Hinton agar and testing was done according to the guidelines of the CLSI 2024. Amoxicillin-clavulanate, levofloxacin, ceftriaxone, imipenem and amikacin were tested, as they are commonly given to patients with AECOPD in my region. Where possible, resistance or susceptibility was interpreted applying standard CLSI zone diameter criteria. MDR was reported for strains that were resistant to one or more antibiotics in three or more antimicrobial classes.

Data Collection and Statistical Analysis

A standardized questionnaire was designed to gather the study's research data from the microbiology, clinical and demographic information provided by patients. All collected data was then analyzed using SPSS version 25.0. Characteristics of the study participants were described using the mean and standard deviation for their continuous variables and frequencies and percentages for their categorical ones. A Chi-square test was used to check if any relations exist between the sputum culture results and important clinical features. Any value for p below 0.05 was considered to be statistically significant.

RESULTS

A group of 200 people with acute flare-ups of chronic obstructive pulmonary disease (AECOPD) participated in the study. Participants were on average 65 years old, with ±10 years serving as their standard deviation. Of all patients, 140 (70%) were male and 60 (30%) female, with a ratio of roughly 2.3:1.

There were 60% current smokers in the study (n = 120), 25% who had quit smoking (n = 50) and 15% who had not smoked (n = 30).

Eighty individuals (40%) had hypertension, sixty individuals (30%) had diabetes mellitus and forty individuals (20%) received a diagnosis of ischemic heart disease. These medical issues were probably part of the conditions these patients experienced.

Table 1: Demographic and Clinical Characteristics of Patients

Characteristic	Subcategory	Frequency (n)	Percentage (%)
Age	Mean ± SD	65 ± 10	-
Gender	Male	140	70
	Female	60	30
Smoking Status	Current Smoker	120	60
	Ex-Smoker	50	25
	Non-Smoker	30	15
Comorbidities	Hypertension	80	40
	Diabetes Mellitus	60	30
	Ischemic Heart Disease	40	20
	None	20	10

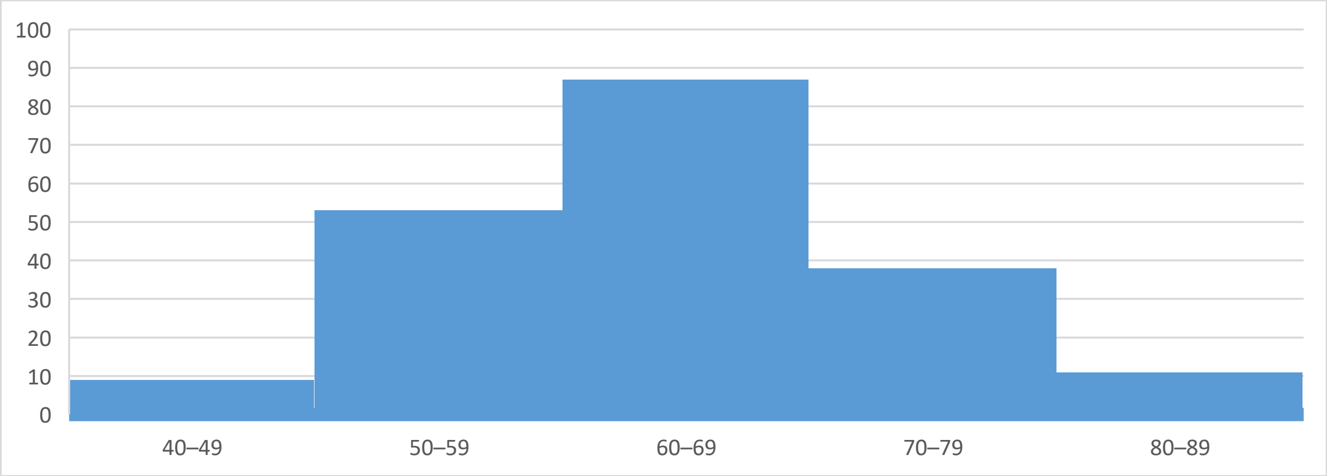

Figure 1: Age Distribution of Patients

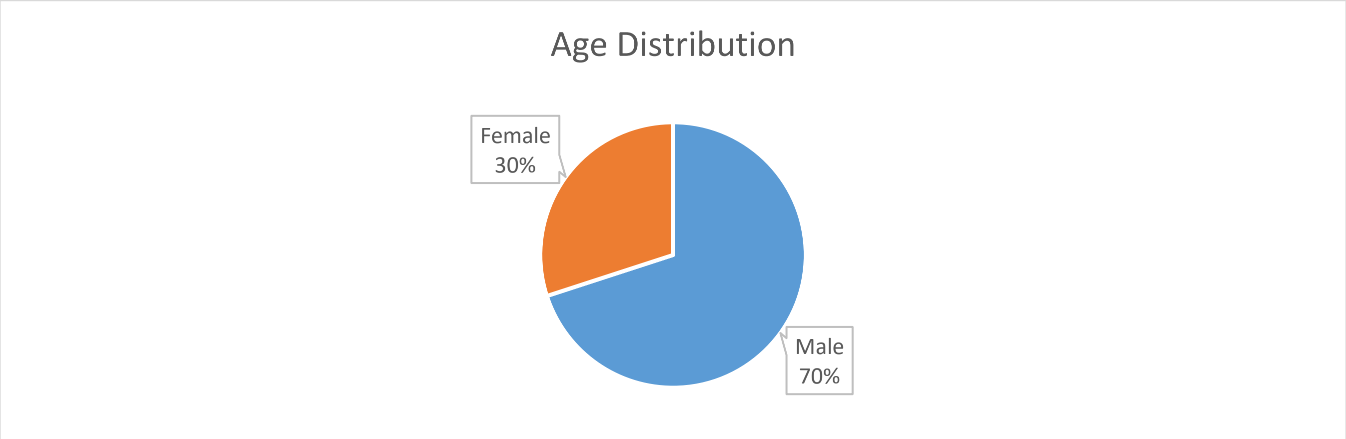

Figure 2: Gender Distribution of Study Participants

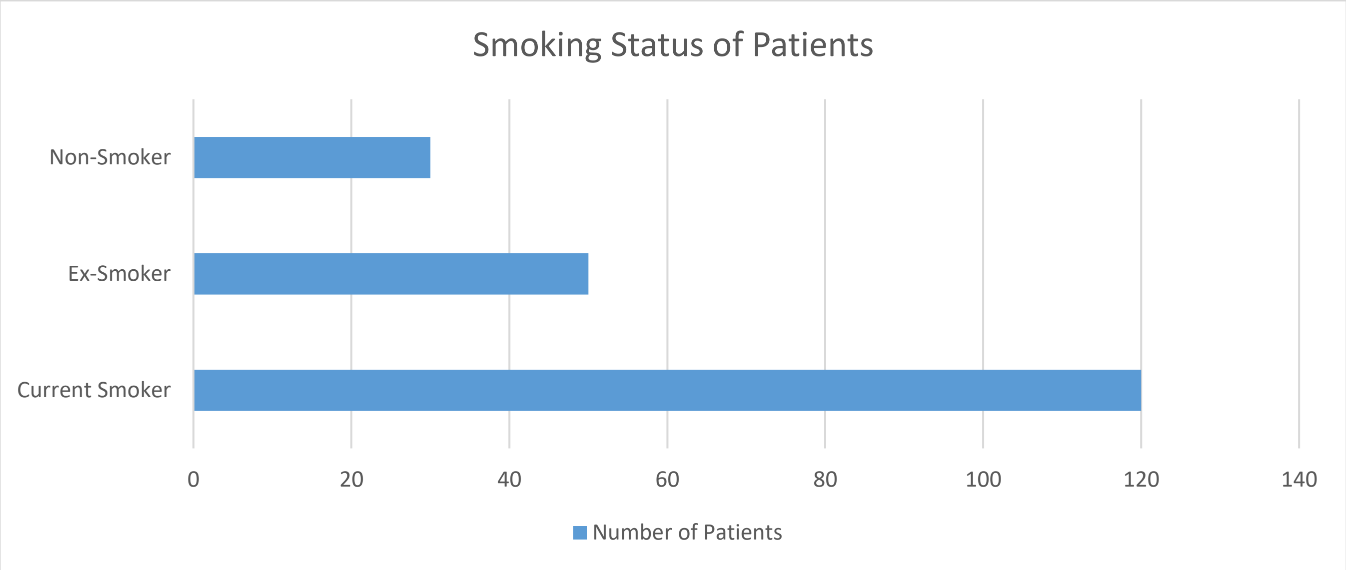

Figure 3: Smoking Status Distribution

Sputum Culture Results

Among the 200 sputum samples collected, 120 (60%) showed positive bacterial cultures while 80 (40%) were negative. The most commonly isolated organisms were Streptococcus pneumoniae (n = 42, 35%), Haemophilus influenzae (n = 30, 25%), Klebsiella pneumoniae (n = 24, 20%), and Pseudomonas aeruginosa (n = 18, 15%). The remaining 5% (n = 6) included mixed flora or less common bacterial species.

Table 2: Distribution of Isolated Bacterial Pathogens

Bacterial Pathogen	Frequency (n)	Percentage (%)
Streptococcus pneumoniae	42	35.0
Haemophilus influenzae	30	25.0
Klebsiella pneumoniae	24	20.0
Pseudomonas aeruginosa	18	15.0
Others	6	5.0

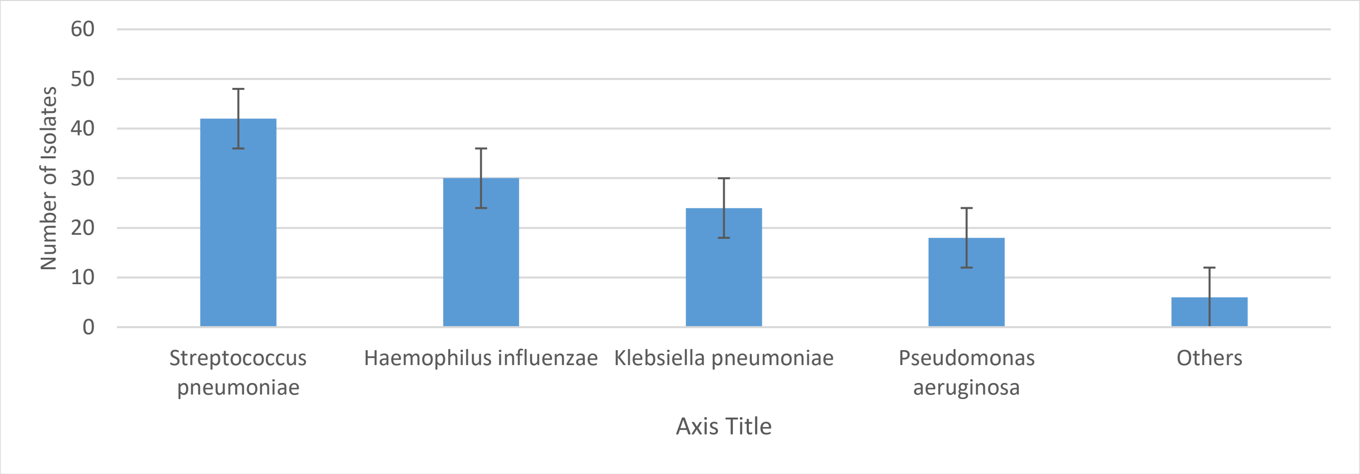

Figure 4: Bacterial Pathogen Distribution

Antibiotic Sensitivity Patterns

The results from antibiotic susceptibility testing were very useful. The strains were highly sensitive to levofloxacin (90%) and amoxicillin-clavulanate (85%), moderately sensitive to ceftriaxone (70%) and imipenem (90%) and moderately-to-highly sensitive to amikacin (80%). H. influenzae showed a high level of susceptibility to levofloxacin (85%) and imipenem (90%). However, for K. pneumoniae and P. aeruginosa, results reflected reduced resistance to first-line antibiotics such as ceftriaxone and amoxicillin-clavulanate. Still, these organisms were highly resistant to imipenem (85–90%) and amikacin (85–90%). Therefore, Gram-negative infections require great attention to antibiotic choice.

Table 3: Antibiotic Sensitivity Patterns of Isolated Pathogens

Antibiotic	S. pneumoniae (%)	H. influenzae (%)	K. pneumoniae (%)	P. aeruginosa (%)
Amoxicillin-Clavulanate	85	80	60	40
Levofloxacin	90	85	70	60
Ceftriaxone	70	65	50	30
Imipenem	95	90	85	80
Amikacin	80	75	90	85

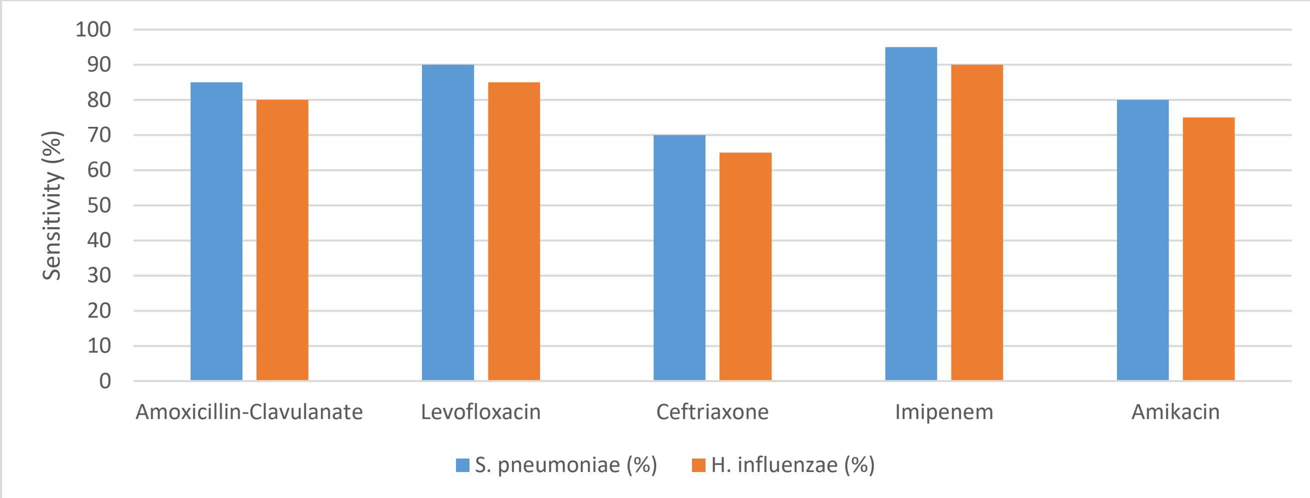

Figure 5: Antibiotic sensitivity of S. pneumoniae and H. influenza

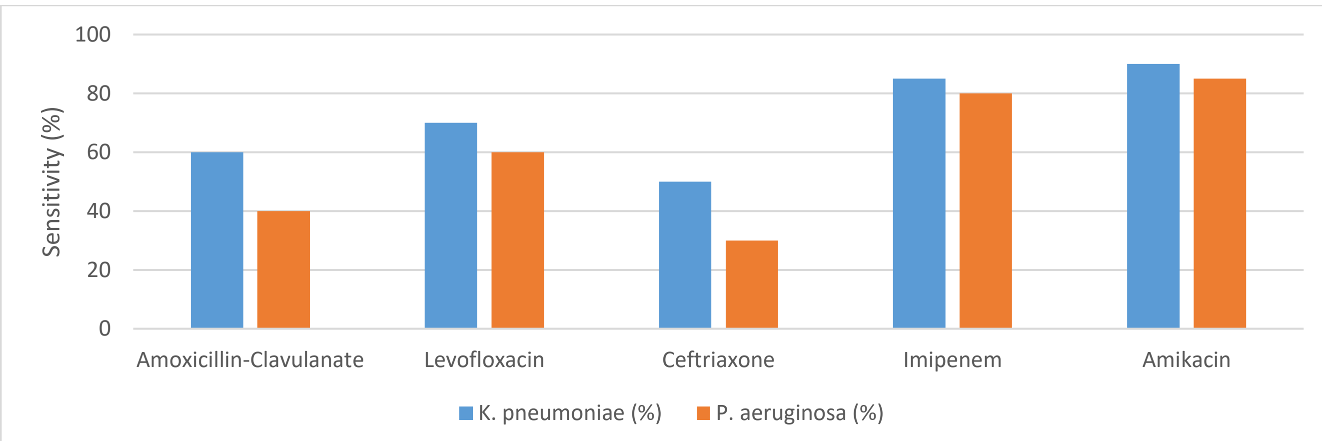

Figure 6: Antibiotic sensitivity of K. pneumoniae and P. aeruginosa

DISCUSSION

This research examined how much sputum culture and sensitivity tests helped to find and analyze the common bacteria found in people with acute exacerbations of chronic obstructive pulmonary disease (AECOPD). Sixty percent of the sputum samples turned out positive in laboratory cultures and Streptococcus pneumoniae, Haemophilus influenzae, Klebsiella pneumoniae and Pseudomonas aeruginosa were the main organisms found in these samples. The results agree with reports made a few years ago that link these bacteria to COPD exacerbations [19,20].

Because of antimicrobial resistance, making the right treatment choices becomes more difficult in urgent situations where doctors often begin with blind antibiotics. A majority of the S. pneumoniae and H. influenzae isolates we studied were found to be sensitive to amoxicillin-clavulanate and levofloxacin. But the results were more of a concern for infections with Gram-negative organisms. Though both types of bacteria were quite resistant to the drugs in our study, they were more vulnerable to imipenem and amikacin. The findings presented here are supported by studies from around the globe showing that MDR organisms occur more often in people with chronic lung diseases [21–24].

At the cellular level, bacteria may become resistant by using waste pumps, structurally changing targets, creating enzymes that destroy antibiotics or building protective biofilms [25–27]. Of the pathogens we found, P. aeruginosa has a reputation for being extremely resistant. Because it can grow in biofilms, the infection often continues in the airways and makes infections in COPD patients difficult to treat.

It is intriguing that recent research links exacerbation rate and keeping pathogens in the body to environmental and responses of the immune system. Bacteria are easier to maintain inside the lower airways since damaged mucus clearance, negative effects of smoking and immune system disturbances help them settle [29–31]. Also, dysbiosis of the lung microbiome may interact with both the virulence of pathogens and the reactions of the body. This opens new possibilities for treating these diseases [32,33].

Giving antibiotics too often in patients with AECOPD has helped certain harmful bacteria develop resistance, especially in those admitted to the hospital. We suggest that both communication between healthcare teams and infection control should include regular microbiological surveillance and selection of antibiotics based on sensitivity. Experts are looking into how oral bacterial vaccines and immunomodulatory strategies can be used in addition to present day therapies [34,35].

A major advantage of our study is that it helps produce local antibiograms which play a key role in designing guidelines used in practice. But these methods count only bacteria and miss assessing viruses and fungi which can bring about exacerbations in patients. More investigation is needed with a wider range of pathogen panel tests and reviewing the outcomes after sensitivity-guided treatment.

Conclusion

The findings highlight the key role of sputum culture and sensitivity testing in managing acute exacerbations of chronic obstructive pulmonary disease (AECOPD). High positive culture rates for Streptococcus pneumoniae, Haemophilus influenzae, Klebsiella pneumoniae and Pseudomonas aeruginosa prove that these four are the leading pathogens in this population. Better antibiotic sensitivity was observed in Gram-positive bacteria to amoxicillin-clavulanate and levofloxacin, while Gram-negative types preferred imipenem and amikacin. Hence, we argue for sputum culture and sensitivity to be included as a regular part of treating AECOPD. It supports picking antibiotics more wisely, boosts success in treatment and plays a vital part in preventing the growth of antimicrobial resistance. Also, strategies aimed at controlling COPD should research how the body can react to disease, the immune system's role and the microbiome to optimize treatment.

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