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A CROSS SECTIONAL STUDY OF BACTERIAL PATHOGENS IN SPUTUM CULTURE OF PATIENTS WITH ACUTE EXACERBATION OF CHRONIC OBSTRUCTIVE PULMONARY DISEASE AND THEIR SENSITIVITY PATTERNS

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ABSTRACT

INTRODUCTION- COPD exacerbations are serious events that are often caused by bacterial infections, requiring effective antibiotic treatment. It is essential to have a clear understanding of the bacterial pathogens responsible for these exacerbations and their sensitivity patterns to optimize therapeutic approaches.

METHODOLOGY: For this study, a total of 90 patients with COPD who were currently experiencing acute exacerbations were enrolled. Detailed clinical assessments were conducted and sputum samples were collected before administering antibiotics. The analysis of sputum samples involved the utilization of Gram's stain, culture, and sensitivity testing.

RESULTS: Out of the 90 cases examined, the majority (81%) were males. The most prevalent clinical symptoms observed were cough with expectoration, exertional dyspnea, and mucopurulent sputum production. The majority of isolates were gram-negative bacteria, with Pseudomonas aeruginosa being the most common at 28%, followed by Klebsiella pneumoniae at 16%. Based on the sensitivity pattern analysis, it was found that the combination of Ciprofloxacin and gentamicin was the most effective empirical antibiotic combination, with a success rate of 79.55%. In terms of single antibiotics, piperacillin+tazobactam showed the highest sensitivity at 68.18%, followed by Amoxicillin and clavulanic acid at 54.55%.

CONCLUSION: Our study sheds light on the prevalence of Gram-negative bacteria in acute exacerbations of COPD and offers valuable information on antibiotic sensitivity patterns. These findings highlight the significance of customizing antibiotic therapy according to local resistance patterns in order to enhance treatment outcomes in COPD exacerbations.

Keywords:

Chronic Obstructive Pulmonary Disease (COPD), Acute Exacerbation(AE), Bacterial Pathogens, Sputum Culture, Antibiotic Sensitivity

Introduction

COPD, a major cause of morbidity and mortality throughout the world, is a multifaceted respiratory condition that presents persistent symptoms and airflow limitations, often caused by detrimental environmental exposures. Episodes of acute exacerbations in COPD (AECOPD) are marked by heightened airway inflammation, increased mucus production, and significant gas trapping. This leads to elevated dyspnea, intensified cough with an increase in sputum purulence, volume, and wheezing. Consequently, more intensive therapeutic interventions are necessary. AECOPD severity is typically assessed using the Winnipeg criteria, which considers the above symptoms.(1,2)

Bacterial infections are important in AECOPD, but their exact role is still being studied. There are six pathways that demonstrate the potential impact of bacteria on COPD. These pathways include childhood respiratory infections that can hinder lung growth, bacteria that can worsen chronic bronchitis, chronic colonization that can lead to progressive airway obstruction, bacterial invasion that can alter host responses, bacterial antigens that can induce hypersensitivity, and defects in immune function that can affect pathogen clearance.(3,4)

To gain insights into the microbial aspects of AECOPD, researchers have used advanced sampling techniques such as tracheobronchial aspirated samples and bronchoalveolar lavage fluid analyses. However, sputum culture has traditionally played a crucial role in diagnosing respiratory infections, especially in cases of chronic bronchitis and COPD exacerbations. Extensive data has consistently supported this practice since the 1950s. It highlights the identification of bacteria such as Haemophilus influenzae and Streptococcus pneumoniae in purulent sputum, which is closely associated with exacerbations of chronic bronchitis. Evaluating the quality of sputum samples is crucial, with a particular emphasis on analyzing squamous epithelial cell and neutrophil counts to determine the suitability of the sample. Higher levels of squamous epithelial cells can indicate the presence of contamination, while an increase in neutrophil counts can suggest ongoing inflammatory processes. This can help differentiate between harmful pathogens and harmless commensals. This thorough assessment aids in avoiding misunderstandings and guarantees precise identification of causative agents, assisting clinicians in choosing suitable antibiotics and enhancing patient outcomes while reducing the risks of antibiotic resistance.(3,5–8)

We aim to conduct a cross-sectional examination of bacterial pathogens isolated in sputum cultures from patients with acute exacerbations of chronic obstructive pulmonary disease (AECOPD). Our objective is to gain insight into the frequency of bacterial infections, analyze the trends in antibiotic susceptibility, and examine the potential impact on personalized antibiotic treatments. Through a thorough examination of the microbiological environment during acute exacerbations of COPD, our study aims to enhance treatment approaches, optimize antibiotic usage, and ultimately enhance outcomes for individuals experiencing AECOPD.

Materials and Methods

This cross sectional study included 90 patients who were diagnosed with Acute Exacerbation of Chronic Obstructive Pulmonary Disease in CHETTINAD HOSPITAL AND RESEARCH INSTITUTE.
The pretested questionnaire was utilized for gathering information on various variables, including age, sex, smoking history, dyspnea, cough with expectoration, leucocytosis, and fever. Patients admitted with acute exacerbations of chronic obstructive pulmonary disease (AECOPD), and underwent sputum culture and sensitivity tests prior to starting antibiotic treatment were included in the study. The exclusion criteria included individuals with a history of pulmonary tuberculosis, pneumonia or other respiratory conditions (bronchiectasis, bronchial asthma, lung abscess, and lung cancer), patients receiving antibiotics prior to the study, those with ischemic heart disease, and cases of AECOPD with negative culture results.
The sputum samples were collected in the early morning after mouth rinsing and bronchodilator nebulization. They were then labeled, numbered, and processed conventionally in the laboratory. Upon arrival, the patient underwent routine hematological tests and chest radiography. Subsequently, culture and sensitivity testing were conducted in response to the identification of isolated organisms. The study assessed the efficacy of different antibiotics, such as ciprofloxacin, levofloxacin, cephalosporins, amoxicillin-based drugs, gentamicin, amikacin, macrolides, and penicillin derivatives.
The data analysis was performed using Microsoft Excel 2007 for data entry and Statistical Package for Social Sciences (SPSS) version 17 for analysis.

RESULTS

CHARACTERISTIC OF POPULATION-
The study included a total of 90 patients who were diagnosed with Acute Exacerbation of Chronic Obstructive Pulmonary Disease (AECOPD). The patients' ages ranged from 45 to 85 years, with the majority falling between 55 and 65 years (60%). The majority of cases, 81%, were males, while females accounted for only 19%.
SMOKING AND OCCUPATION-

Among the male patients, the majority (95%) were smokers, while the females were primarily employed as Beedi rollers (64%)

SIGNS AND SYMPTOMS-

All patients presented with chronic cough, expectoration, and dyspnea. The majority of patients also had mucopurulent sputum.

BACTERIOLOGICAL PROFILE-

The results of the Gram staining indicated that the majority of the organisms, specifically 68%, were gram-negative, with the remaining 32% being gram-positive. Streptococcus pneumoniae was the most frequently identified gram-positive organism, accounting for 45% of isolates, while Streptococcus pyogenes accounted for 34%. The most prevalent gram-negative organisms were Pseudomonas (42%) and Klebsiella pneumoniae (23%). (Fig. 1-3)

Antibiotic susceptibility patterns

Klebsiella pneumoniae exhibited differential degrees of sensitivity to distinct antibiotics, with fluoroquinolones such as Levofloxacin (91%), aminoglycosides (90%) and levofloxacin being the most sensitive. Isolated instances of comparatively diminished sensitivity to beta-lactams, such as Cefotaxime (60%) and Ceftazidime (44%).

- The sensitivity of Pseudomonas aeruginosa to Ciprofloxacin (85%) and Levofloxacin (92%) was found to be satisfactory. A reduced sensitivity to beta-lactams, specifically Cefotaxime (58%), and Ceftazidime (70%), was observed.
- Streptococcus pneumoniae exhibited extremely high sensitivity to the majority of antibiotics, especially macrolides such as azithromycin and cephalosporins (100 %).
  Resistance to penicillin (15 %) and erythromycin (37 %) was observed.
- Streptococcus pyogenes exhibited marked susceptibility to the majority of antibiotics, demonstrating a sensitivity of 100% to azithromycin, Cephalosporins, Levofloxacin, and Ciprofloxacin. Penicillin resistance (45%) and Erythromycin resistance (14%) was seen.
- Moderate sensitivity to antibiotics such as Piperacillin tazobactum (85%) and Cephalosporins (40%-60%) was observed in Acinetobacter. Extreme resistance (100 % resistance) to macrolides and penicillin was seen
- Moraxella demonstrated a generally diminished sensitivity to the majority of antibiotics, although it did exhibit a certain degree of sensitivity to Piperacillin tazobactum (75%), and Gentamicin (50%).
  Proved to be extremely resistant to penicillin and macrolides (100 % resistance).
- Extremely sensitive to cephalosporins (100 %), Ciprofloxacin (100 %), and macrolides such as azithromycin (100 %) was Staphylococcus aureus. Resistance to Amoxyclav (16 %) and Penicillin (50 %) was observed.
- Escherichia coli (E. coli) demonstrated excellent sensitivity to quinolones (75–100% for Ciprofloxacin and 100 % for Levofloxacin) and piperacilin tazobactum. Exhibited complete resistance to cephalosporins.
- Klebsiella combined with pseudomonas:
  Sensitivity patterns exhibited were comparable to those of specific isolates, with an elevated sensitivity to Gentamicin, Quinolones, and Piperacillin tazobactum.

Discussion

We examined a total of 90 AECOPD patients' demographics, microbiological profiles, antibiotic sensitivity patterns, and therapy implications.

Firstly, our study found that AECOPD is most common in 55-65-year-olds. This supports previous research suggesting AECOPD is more common in elderly people due to advanced lung illness and impaired bronchial mucosal defenses. (9)

We also found a higher incidence of AECOPD in men than women, supporting smoking as a risk factor. Indoor air pollution contributed to AECOPD among non-smokers, especially women. This finding is in conformity with the observation of otherworkers.(10,11)
The prevalence of Gram negative isolates was 68%, as compared to 32% of gram positive and distinct bacterial strains demonstrated distinct antibiotic sensitivity patterns in our study.
Our study supports starting empirical antibiotic therapy immediately in suspected bacterial AECOPD cases. However, developing bacterial resistance emphasizes the need for prudent antibiotic usage and local antibiotic policy. We recommend Gentamicin and Amikacin as conventional antibiotics for mild to moderate AECOPD. Third-generation cephalosporins and fluoroquinolones like Ciprofloxacin were also beneficial in empirically treating less severe AECOPD, with intravenous treatment advised for Gram-negative infections.
Geographical factors can affect the spectrum of AECOPD-causing bacteria, hence regional variations in microbial pathogens are important. However important comparison investigations validate our conclusions which are mainly from the west. We found Gram-positive organisms including Streptococcus pneumoniae and H. influenza in AECOPD, similar to Hallett Wilbur found (1973). Eller Jorg's (1998) study confirmed non-typable H. influenza's causation, while De Abate Andrew's (1998) study identified H. influenza and parainfluenza as the main pathogens.(5,10,12)
In AECOPD, Gram-negative isolates predominate, as shown by G Iyer Parameshwaran and Timothy F Murphy's investigations (2011) on Non-typable H. influenza, Moraxella catarrhalis, Streptococcus pneumoniae, and Pseudomonas aeruginosa.(13)
Similar to a prior study(14) where for the empirical treatment of less severe AECOPD patients, the most effective antibiotics were found to be third generation cephalosporins and ciprofloxacin administered intravenously, most organisms in our study, displayed susceptibility to these antibiotics. It is important to consider the most effective antibiotic combinations for severe infections caused by gram negative organisms. One option is ciprofloxacin with gentamicin, while another option is an intravenous third generation cephalosporin with gentamicin.
However, we have not yet established a direct correlation between the severity of the condition and the specific organism that was isolated. It is worth noting that a significant portion of our patients had severe or very severe COPD, as we included individuals who required hospital admission.
In future studies, it is important to correlate the severity of COPD, prior antibiotic use, and comorbid illness with the isolated organism.
The newer antibiotics, such as piperacillin+tazobactam and cefoperazone+sulbactam, have proven to be highly effective in treating severe exacerbations of COPD. It is crucial to restrict the regular use of these in order to avoid the development of resistance.

Conclusion

Our study on Acute Exacerbation of Chronic Obstructive Pulmonary Disease (AECOPD) highlights the important influence of bacterial infections and antibiotic sensitivity on the effectiveness of treatment. Our findings indicate that the occurrence of AECOPD is higher in older age cohorts, namely among male smokers and persons who have been exposed to indoor air pollution. Gram-negative bacteria, particularly Pseudomonas and Klebsiella pneumoniae, are the most common types of organisms found in cases of acute exacerbations of chronic obstructive pulmonary disease (AECOPD). These bacteria exhibit different patterns of susceptibility to antibiotics. This emphasizes the significance of customized antibiotic treatment plans that are established according to the specific resistance patterns observed in the local area. The results of our study are consistent with previous research, highlighting the importance of using antibiotics judiciously in order to address the issue of antibiotic resistance. It is essential to correlate the severity of diseases with the profiles of microorganisms and to continue monitoring antibiotic

resistance in order to optimize strategies for managing acute exacerbations of chronic obstructive pulmonary disease (AECOPD) and enhance patient care.

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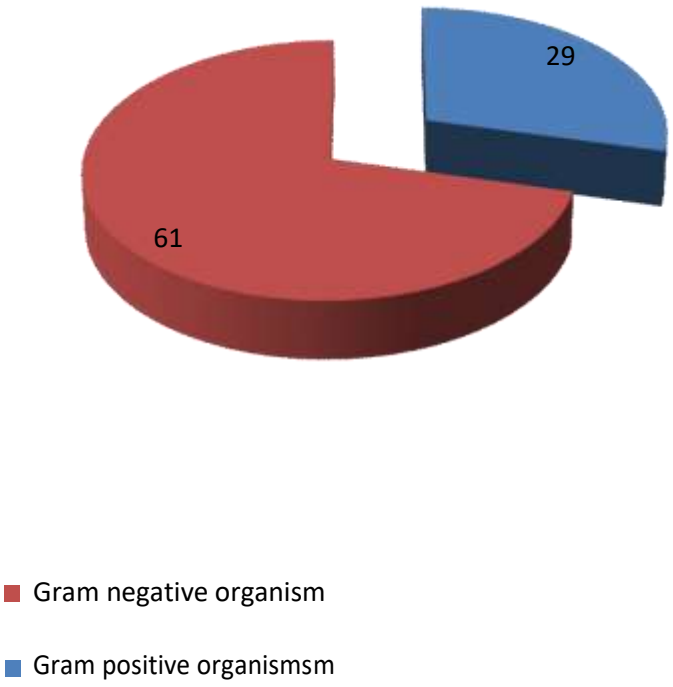


Figure 1: Gram staining profile

On gram staining there were 61 organisms(68%) that were gram negative and 29 organisms(32%) that were grampositive.

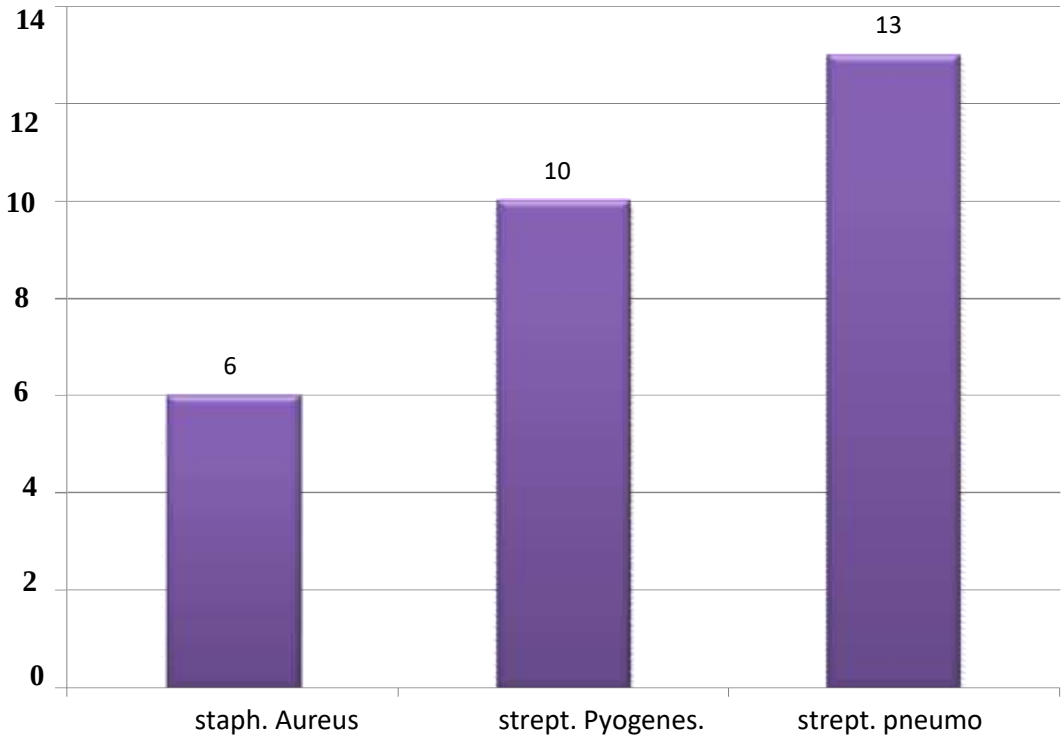
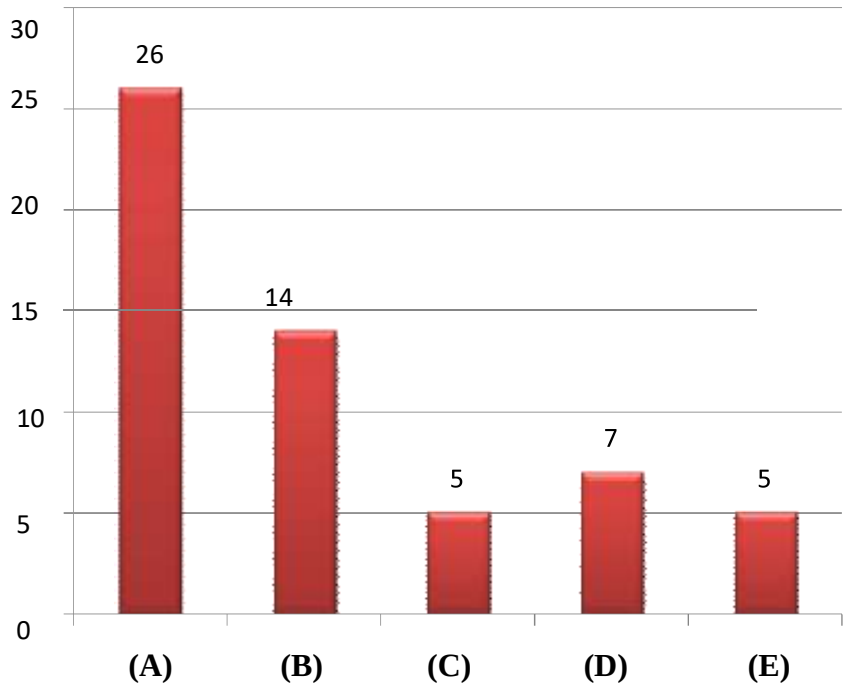


Figure 2 : Gram positive organism distribution

Total number of Gram positive organisms isolated were 29 . Most commonest was streptococcus pneumoniae 45%.The next commonest organism isolated was streptococcus pyogenes 34%.



A-PSEUDOMONAS
B-KLEBSIELLA.PNEUMONIA
C-E.COLI
D-ACINETOBACTER
E-MORAXELLA

Figure 3: Gram negative organism distribution

Total number of gram negative cultures were 61.The commonest organisms yielded in culture was Pseudomonas 42%. The next commonest organism yielded in culture was of Klebsiella pneumonia 23%.