

Original Article

Pattern of Sputum Bacteriology in Acute Exacerbations of Chronic Obstructive Pulmonary Disease

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Received: December 31, 2017 Accepted: April 12, 2018

doi: <http://dx.doi.org/10.3329/jemc.v8i2.36730>

Abstract

Background: Chronic obstructive pulmonary disease (COPD) is a major cause of chronic morbidity and mortality worldwide. Acute exacerbation is an acute and sustained worsening of a patient's condition from a stable state (beyond normal day-to-day variations) and it is caused in majority by infectious agents, particularly bacteria. **Objectives:** The aim of this study was to find out the pattern of sputum bacteriology and antibiotic sensitivity in patients admitted into respiratory ward of Enam Medical College Hospital (EMCH) with acute exacerbation of COPD (AECOPD). **Materials and Methods:** This study included 60 patients who presented with acute exacerbation of COPD. The patients were classified into several groups according to different variables, such as age, pack years, severity, O₂ saturation on admission, sputum type. Bacteriological investigations were performed for all patients and included gram staining together with culture and sensitivity testing of all sputum samples. **Results:** *Klebsiella pneumoniae* was the most common isolate in patients with COPD exacerbations admitted into the respiratory ward of Enam Medical College & Hospital followed by *Staphylococcus aureus* and *Streptococcus pneumoniae*. Three cases of *Pseudomonas aeruginosa* were detected. Gentamicin and meropenem were the most sensitive antibiotics in all patient groups in the ward. Majority of *Klebsiella pneumoniae*, *Streptococcus pneumoniae* and *Staphylococcus aureus* were sensitive to ceftriaxone, levofloxacin and moxifloxacin. **Conclusion:** This study reveals that gentamicin, ceftriaxone and moxifloxacin can be the drugs of choice in treating AECOPD in our setting.

Keywords: AECOPD; *Klebsiella pneumoniae*; Gentamicin; Meropenem

J Enam Med Col 2018; 8(2): 80–84

Introduction

Chronic obstructive pulmonary disease (COPD) is a major cause of morbidity and mortality worldwide.¹ COPD is the fourth leading cause of death in the world, and further increases in its prevalence and mortality can be predicted in the coming decade.² According to Global Initiative for Chronic Obstructive Lung Disease (GOLD), COPD is a common, preventable and treatable disease characterized by persistent respiratory symptoms and airflow limitation due to airway and/or alveolar abnormalities usually caused by significant exposure to noxious particles or gases.²

The chronic airflow limitation characteristic of COPD is caused by a mixture of small airway

disease (obstructive bronchiolitis) and parenchymal destruction (emphysema), the relative contributions of which vary from person to person. Airflow limitation is best measured by spirometry as this is the most widely available, reproducible test of lung function.

COPD can be classified into 4 stages on the basis of post-bronchodilator FEV₁.

Stage I: Mild – FEV₁/FVC <0.70, FEV₁ ≥80% predicted,

Stage II: Moderate – FEV₁/FVC <0.70, 50% ≤ FEV₁ <80% predicted

Stage III: Severe – FEV₁/FVC <0.70, 30% ≤ FEV₁ <50% predicted

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Stage IV: Very severe – FEV1/FVC <0.70, FEV1 <30% predicted or FEV1 <50% predicted plus chronic respiratory failure

COPD is an economic and social burden that is both substantial and increasing.^{3,4} A systematic review and meta-analysis of studies carried out in 28 countries between 1990 and 2004⁵, and an additional study from Japan⁶, provide evidence that the prevalence of COPD is appreciably higher in smokers and ex-smokers than in nonsmokers, in those over 40 years than those under 40, and in men than in women. An exacerbation of COPD is defined as an event in the natural course of the disease characterized by a change in the patient's baseline dyspnea, cough, and/or sputum that is beyond normal day-to-day variations, is acute in onset, and may warrant a change in regular medication in a patient with underlying COPD.^{7,8}

The severity of AECOPD without respiratory failure can be classified traditionally according to Winnipeg criteria. The three-stage system is based on three principal symptoms: 1. Increase in sputum volume 2. Increase in sputum purulence 3. Increase in shortness of breath.

The Winnipeg criteria:

Type of exacerbation	Criteria
Type 1	All the 3 symptoms above
Type 2	Any 2 of above symptoms
Type 3	Any 1 of the above plus at least 1 of the following features: upper respiratory tract infection lasting ≥ 5 days, fever, increase in wheezes, increase in cough, and increase in heart rate 20% above baseline. ⁹

The most common causes of an exacerbation are infection of the tracheobronchial tree and air pollution¹⁰, but the cause of about one-third of severe exacerbations cannot be identified. The role of bacterial infections is controversial, but recent investigations with newer research techniques like bronchoscopic studies have shown that at least 50% of patients have bacteria in high concentrations in their lower airways during exacerbations.¹¹⁻¹³

Three classes of pathogens have been implicated as causing acute exacerbation of COPD by infecting the lower respiratory tract: respiratory viruses, atypical

bacteria, and aerobic gram-positive and gram-negative bacteria. The relative contributions of these three different classes of pathogens may change depending on the severity of the underlying obstructive airway disease. Such changes may also happen within a class, especially for bacterial pathogens.¹⁴

Many studies have been conducted on the role of bacterial infection in COPD and have isolated bacteria in significant numbers from patients with clinically stable COPD, indicating the presence of lower airway bacterial colonization. The presence of bacteria in the lower airway can result in a range of important effects on the lungs, including activation of host defences with release of inflammatory cytokines and subsequent neutrophil recruitment, mucus hypersecretion, impaired mucociliary clearance, and respiratory epithelial cell damage.¹⁵ We designed this study to search the pattern of sputum bacteriology and antibiotic sensitivity for acute exacerbation of COPD in patients admitted in a peripheral tertiary hospital, Enam Medical College & Hospital.

Materials and Methods

This cross-sectional descriptive study was conducted in the department of Respiratory Medicine of Enam Medical College & Hospital during the period January to December 2017. Sixty clinically diagnosed cases of acute exacerbation of COPD (AECOPD) were included in the study. Cases of bronchial asthma, pneumonia, pulmonary tuberculosis, bronchial carcinoma and heart diseases were excluded from the study. All collected data were summarized and presented in tabular forms.

Results

In this study the age of the patients ranged from 46–88 years with most of the patients (56%) in the age group 55–65 years (Table I).

Table 1: Age distribution of study subjects

Age in years	Number	Percentage
45–55	11	18
55–65	34	56
65–75	9	15
75–85	6	10

Bacteriological profile: Klebsiella pneumoniae were the commonest (16 cases) bacteria isolated followed by Staphylococcus aureus (9 cases). Streptococcus

pneumoniae was isolated in seven cases and *Pseudomonas aeruginosa* in three cases.

Antibiotic sensitivity patterns of the isolates: *Klebsiella pneumoniae*, which was the most common isolate, was sensitive to gentamicin, meropenem, followed by ceftriaxone, moxifloxacin, levofloxacin, ciprofloxacin and azithromycin. *Staphylococcus aureus*, which was the next common isolate, was sensitive to gentamicin, meropenem, linezolid followed by ceftriaxone, moxifloxacin, levofloxacin, ciprofloxacin and azithromycin. *Streptococcus pneumoniae* was sensitive to gentamicin, meropenem, linezolid followed by ceftriaxone, moxifloxacin, levofloxacin, ciprofloxacin and azithromycin. *Pseudomonas aeruginosa* was mainly sensitive to meropenem and gentamicin.

Table II: Bacteriological profile

Organisms	Number	Percentage
No growth	25	42
<i>Klebsiella pneumoniae</i>	16	26
<i>Staphylococcus aureus</i>	9	15
<i>Streptococcus pneumoniae</i>	7	11
<i>Pseudomonas aeruginosa</i>	3	5

organisms and respiratory viruses)¹⁸, 10% are due to environmental pollution (depending on season and geographical placement)¹⁹ and up to 30% are of unknown etiology¹⁶. So early introduction of empirical antibiotics can improve outcome and reduce mortality.²⁰ Since culture facilities are not readily available and time consuming, it is better to know the pattern of bacterial flora and their sensitivity of a particular geographical area.

In our study it was observed that AECOPD was prevalent in 45–85 years age group. However among them, 55–65 years age constituted 56% which is similar to that of the study by Narayanagowda et al²³ and this can be explained by the fact that chronic bronchitis has maximum prevalence in the same age group.

The prevalence of gram-negative isolates was 55%, as compared to 45% of gram-positive which matched with study conducted by Rakesh et al²¹ who found that among the thirty seven single pathogenic microbial growths, 19 (51.35%) were gram-negative bacteria and 18 (48.64%) were gram-positive bacteria. Among the isolates, *K. pneumoniae* was the predominant organism (26%) followed by *Staphylococcus aureus* (15%), *S. pneumoniae* (11%) and *P. aeruginosa* (3%).

This finding is similar to that of Narayanagowda et al²⁰, Hui et al²² and Lin et al²³ who found *K. pneumoniae*

Table III: Sensitivity pattern of isolated organisms

Organism	Azith		Moxi		Cipro		Ceftri		Cefur		Genta		Mero		Penici		Linez		Doxycycline		Amoxyclavu		Co-trimexaso		Levofloxacin			
	S	R	S	R	S	R	S	R	S	R	S	R	S	R	S	R	S	R	S	R	S	R	S	R	S	R		
Strep	6	1	6	1	4	3	7	0	5	2	7	0	7	0	0	7	7	0	5	2	4	3	4	3	4	3	6	1
Staph	4	5	7	2	7	2	8	1	1	8	9	0	9	0	0	9	9	0	7	2	5	4	5	4	8	1		
Kleb	12	4	3	13	12	4	16	0	4	12	16	0	16	0	0	16	0	16	2	14	1	15	3	13	15	1		
Psudo	0	3	0	3	0	3	0	3	0	3	3	0	3	0	0	3	0	3	0	3	0	3	0	3	0	3		

S= Sensitive; R=Resistant

Discussion

COPD is one of the leading causes of mortality and morbidity. It is a progressive illness with periods of remission and exacerbations. The impact of exacerbations is significant and patients’ symptoms and lung function may take several weeks to recover to the baseline values.^{16,17}

Data suggest that 50–70% of exacerbations are due to respiratory infections (including bacteria, atypical

as the predominant organism in their study. However, they also found other gram-negative organisms like *P. aeruginosa* and *Acinetobacter* spp. which were not found in our study as patients admitted in ICU were not studied. However, these results disagree with those of Fagon et al²⁴, who found that the most prevalent microorganism in COPD patients was *H. influenzae* (39%), followed by *S. pneumoniae* (16%) and *Moraxella catarrhalis* (7%). This disagreement may be due to the difference in environment, time of

the study, number of cases, and the method of sample collection, such as bronchoalveolar lavage and use of a protective brush. These results also disagree with those of Monsó et al¹¹ who found that the most prevalent microorganism was *H. influenzae* (58%) followed by *M. catarrhalis* and *S. pneumoniae* (each 10%).

In this study, we found that the most sensitive antibiotics were meropenem (35, 100%), and gentamicin (35, 100%) followed by ceftriaxone (32, 91%), levofloxacin and moxifloxacin (30, 85%) and azithromycin (23, 65%). Among orally administered drugs the sensitivity rate was 42% for doxycycline and linezolid, 34% for trimethoprim–sulfamethoxazole, 28% for amoxicillin–clavulanic acid, and cefuroxime, and 0% for penicillin.

Wilson et al²⁵ found that the rate of bacterial eradication after treatment with amoxicillin–clavulanic acid was 76.7% and 87.4% with azithromycin. These figures mismatch with our study in which the sensitivity rate was 28% for amoxicillin–clavulanic acid, and 65% for azithromycin. Our study is similar to that of Erkan et al²⁶ who noted the poor efficacy of penicillin and amoxicillin–clavulanic acid.

Klebsiella pneumoniae, *Staphylococcus aureus* and *Streptococcus pneumoniae* were the most common sputum pathogen in hospitalized patients with AECOPD. Meropenem and gentamicin followed by ceftriaxone and moxifloxacin were the most active antibacterial agents. Because of high price of meropenem and nephrotoxicity of gentamicin, ceftriaxone and moxifloxacin can be the drugs of choice in treating AECOPD in our setting.

Limitations

We could not find viruses due to unavailability of diagnostic tests and due to unavailability of serological tests we were unable to detect *Mycoplasma* and *Legionella*.

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