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CHARACTERISTICS AND ANTIMICROBIAL SUSCEPTIBILITY OF BACTERIA CAUSING PNEUMONIA IN PATIENTS WITH ACUTE EXACERBATION OF COPD AT THE DEPARTMENT OF RESPIRATORY MEDICINE, THONG NHAT HOSPITAL, IN 2025

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ABSTRACT: Chronic obstructive pulmonary disease (COPD) is common among older adults, while respiratory infection and antimicrobial resistance complicate the management of exacerbations. This study aimed to describe bacterial isolates and antimicrobial resistance in patients with pneumonia during COPD exacerbations at the Department of Respiratory Medicine, Thong Nhat Hospital. A retrospective cross-sectional study included 271 patients admitted to the department from January to December 2025. Variables included age, sex, sputum culture results, bacterial species, and antimicrobial susceptibility. The median age was 73 years (interquartile range, 16), and 243 patients (89.7%) were male. Among 197 patients with sputum cultures, 63 (32.0%) had positive cultures, yielding 75 isolates. Gram-negative bacilli accounted for 66/75 isolates (88.0%); Klebsiella pneumoniae and Pseudomonas aeruginosa each accounted for 17 isolates (22.7%). Acinetobacter baumannii showed 66.7% (6/9) resistance to imipenem and meropenem; Klebsiella aerogenes showed 85.7% (6/7) resistance to piperacillin/tazobactam, cefepime, and ciprofloxacin, and 71.4% (5/7) resistance to meropenem. K. pneumoniae remained 90.9% susceptible to meropenem and 81.8% susceptible to imipenem but only 9.1% susceptible to ciprofloxacin. Gram-negative bacilli predominated among positive cultures. Antibiotic selection should be guided by local microbiological data and adjusted according to susceptibility results, particularly in older patients.

Keywords: COPD; acute exacerbation of COPD; pneumonia; antimicrobial susceptibility; antimicrobial resistance; older adults.

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1. INTRODUCTION

COPD is one of the most common chronic respiratory diseases, particularly in older adults. According to GOLD 2025, the disease presents with persistent respiratory symptoms (dyspnea, chronic cough, sputum production) and persistent, often progressive, airflow obstruction caused by combined damage to the bronchi (inflammation) and the alveoli (emphysema) [1]. According to the definition of the Global Initiative for Chronic Obstructive Lung Disease (GOLD) (2025): "An exacerbation of COPD is an event characterized by dyspnea and/or cough and sputum that worsen over <14 days, which may be accompanied by tachypnea and/or tachycardia and is often associated with increased local or systemic inflammation caused by infection, pollution, or other insult to the airways"[1]. The Anthonisen criteria (1987) classify exacerbations by changes in dyspnea, sputum volume, and sputum purulence [2]. Although the definitions differ, all diagnostic frameworks require a worsening of symptoms from the patient's stable baseline together with a need to change the usual treatment regimen. In current clinical practice, the Anthonisen criteria remain important in the diagnosis of COPD exacerbations.

Respiratory infection is a common trigger of COPD exacerbations. The spectrum of pathogens may vary with disease severity, history of antibiotic use, hospitalization, and the epidemiological characteristics of each facility [3, 4]. In hospitalized patients, especially older adults with multiple comorbidities and impaired airway defense mechanisms, opportunistic Gram-negative bacteria may be present at a considerable rate. However, bacterial culture does not always identify the causative agent, and a positive result may reflect either infection or airway colonization.

Studies in Vietnam have shown that pathogen detection rates and bacterial distribution differ by testing method and study population. Culture usually has a lower detection rate than molecular techniques; Klebsiella pneumoniae, Pseudomonas aeruginosa, and Acinetobacter baumannii have been reported in hospitalized patients with COPD in Vietnam [5, 6]. At the same time, resistance to cephalosporins, fluoroquinolones, and carbapenems narrows treatment options. Microbiological data at each hospital therefore need to be updated to support rational antibiotic use.

This study aimed to describe the distribution of bacteria isolated by bacterial culture and to examine the antimicrobial resistance rates of common pathogens in patients with acute exacerbation of COPD and pneumonia treated at the Department of Respiratory Medicine, Thong Nhat Hospital, in 2025.

2. SUBJECTS AND METHODS

2.1. Study subjects

We reviewed the medical records of patients with acute exacerbation of COPD and pneumonia treated at the Department of Respiratory Medicine, Thong Nhat Hospital, in 2025. Patients admitted from 01/01/2025 to 31/12/2025 were eligible. Data were collected from 01/10/2025 to 31/01/2026.

Inclusion criteria were: patients aged 18 years or older with a diagnosis of COPD according to GOLD 2025; an exacerbation according to Anthonisen [2]; and clinical and/or radiological pneumonia. Pneumonia was defined by the clinical, laboratory, and radiological criteria of the Guidelines for the diagnosis and treatment of community-acquired pneumonia in adults (Decision No. 4815/QĐ-BYT, 2020) [7].

For the microbiological analysis, only patients with valid bacterial culture results were included in the analysis of bacterial characteristics and antimicrobial susceptibility. Microbiological testing included sputum, blood, or bronchial lavage cultures. A sputum specimen was considered acceptable when at least 25 neutrophils and fewer than 10 squamous epithelial cells were seen per low-power field (×100), according to the Murray-Washington criteria [7]. Older adults in this study were defined as people aged 65 years or older; this definition was used only for description and was not a selection criterion.

Exclusion criteria were: tuberculosis under treatment; hospital-acquired pneumonia; ventilator-associated pneumonia; severe immunodeficiency; records missing key information; and death within the first 24 hours before a specimen was obtained.

2.2. Methods

This was an observational, descriptive cross-sectional study with retrospective data collection from electronic medical records. All records meeting the criteria during the study period were included (total sampling).

During the study period, 271 patients were admitted with a diagnosis of acute exacerbation of COPD and pneumonia that met the clinical criteria and were included in the initial study population to describe general characteristics of age and sex. Of these, 197 patients with valid bacterial culture results were used for the analysis of microbiological characteristics and antimicrobial susceptibility. The remaining 74 patients had no valid bacterial culture result in their medical records or no complete microbiological result was recorded; they were therefore not included in the analysis of culture positivity, distribution of isolated bacteria, and antimicrobial resistance rates. Thus, analyses of bacteriological characteristics and antimicrobial susceptibility were performed only in the 197 patients with culture results, whereas the 271 patients were used to describe the baseline characteristics of the study population.

Data were obtained from electronic medical records, microbiology reports, and the antimicrobial susceptibility management system. Microbiological specimens, including sputum, blood, or bronchoalveolar lavage fluid, were collected and cultured according to the routine procedures of the Department of Microbiology, Thong Nhat Hospital. Bacterial isolates were identified with the automated Vitek 2 system. Antimicrobial susceptibility testing was performed automatically on the Vitek 2 system, based on the minimum inhibitory concentration (MIC) of each antibiotic. Susceptibility results were interpreted according to CLSI M100, 34th edition, 2024, and classified uniformly as S (susceptible), I (intermediate), or R (resistant). In this study, microbiological and susceptibility data were collected retrospectively from microbiology test reports and the antimicrobial susceptibility management system of Thong Nhat Hospital. Variables included age, sex, bacterial culture, Gram group, bacterial species, and classification as susceptible (S), intermediate (I), or resistant (R).

The resistance rate was the number of resistant isolates divided by the number of isolates tested with each drug; denominators could differ.

2.3. Data analysis

After collection, data were checked, cleaned, and coded before entry into SPSS version 26.0 for analysis. Qualitative variables such as sex, culture results, bacterial group, bacterial species, and susceptibility results were presented as frequencies and percentages. Quantitative variables such as age were tested for distribution; because they were not normally distributed, they were presented as median and interquartile range, together with minimum–maximum values. Age was compared between the two sexes using the Mann–Whitney U test. The antimicrobial resistance rate was calculated as the number of resistant isolates over the total number of isolates tested with each antibiotic and presented as n/N (%); antibiotics with small denominators were interpreted with caution. Statistical significance was set at $p < 0.05$.

2.4. Research ethics

The ethical aspects and safety of the study were approved by the Biomedical Research Ethics Committee of Nguyen Tat Thanh University, certificate No. 144/GCN-NTT dated 19 November 2025.

3. RESULTS

3.1. Age and sex of the study population

Table 1. Age and sex of the study population

Sex	Patients, n (%)	Median age (IQR)	Min - max
Male	243 (89.7)	72 (16)	41 - 97
Female	28 (10.3)	79 (15)	61 - 93
Total	271 (100.0)	73 (16)	41 - 97

Note: Age was compared between men and women using the Mann–Whitney U test: $U = 2154.5$; $Z = -3.178$; $p = 0.001$.

Of the 271 patients, 89.7% were male. The median age of the whole sample was 73 years, with an interquartile range of 16 and a range of 41–97 years. Women had a median age of 79 years, higher than that of

men (72 years) (Mann–Whitney U=2154.5; Z=−3.178; p=0.001) [Table 1].

3.2. Bacterial culture and identification

Table 2. Bacterial culture results

Results	n	Rate (%)
Positive, Gram-positive only	6	3.0
Positive, Gram-negative only	54	27.5
Positive, mixed Gram-negative and Gram-positive	3	1.5
Negative	134	68.0
Total	197	100.0

Of the 197 bacterial cultures, 63 were positive (32.0%), including 54 with Gram-negative bacteria only, 6 with Gram-positive bacteria only, and 3 with both groups. There were 134 negative cultures (68.0%) [Table 2].

Table 3. Bacterial pathogens isolated

Pathogen	Isolates	Rate (%)**
Gram-negative bacilli	66	88.0
Klebsiella pneumoniae	17	22.7
Pseudomonas aeruginosa	17	22.7
Acinetobacter baumannii	9	12.0
Klebsiella aerogenes	8	10.7
Escherichia coli	5	6.7
Other Gram-negative bacteria*	10	13.3
Gram-positive cocci	9	12.0
Staphylococcus haemolyticus	3	4.0
Staphylococcus capitis	2	2.7
Streptococcus mitis	2	2.7
Staphylococcus aureus	1	1.3
Streptococcus pneumoniae	1	1.3
Total	75	100.0

*,**Note: Other Gram-negative bacteria included Achromobacter xylosoxidans (2), Stenotrophomonas maltophilia (2), Alcaligenes faecalis (1), Citrobacter werkmanii (1), Enterobacter cloacae (1), Pandoraea spp. (1), Proteus mirabilis (1), and Serratia marcescens (1). Percentages for each species were calculated over the total of 75 isolates.

The 63 positive cultures yielded 75 bacterial isolates. Gram-negative bacteria accounted for 66/75 isolates (88.0%), and Gram-positive bacteria for 9/75 isolates (12.0%). K. pneumoniae and P. aeruginosa were the two most common species, with 17 isolates each (22.7%), followed by A. baumannii with 9 isolates (12.0%) and Klebsiella aerogenes with 8 isolates (10.7%) [Table 3].

3.3. Antimicrobial resistance rates

Table 4. Resistance rates of the five common Gram-negative bacilli

Antibiotic	K. pneumoniae, n/N (%)*	A. baumannii, n/N (%)	P. aeruginosa, n/N (%)	K. aerogenes, n/N (%)	E. coli, n/N
Piperacillin/ tazobactam	3/11 (27.3)	6/9 (66.7)	4/9 (44.4)	6/7 (85.7)	0/5
Cefepime	3/10 (30.0)	4/9 (44.4)	1/9 (11.1)	6/7 (85.7)	2/5
Ceftazidime	2/8 (25.0)	6/8 (75.0)	1/9 (11.1)	3/4	0/5
Ciprofloxacin	5/11 (45.5)	6/8 (75.0)	4/9 (44.4)	6/7 (85.7)	3/5
Levofloxacin	1/1	5/8 (62.5)	4/8 (50.0)	1/1	Not tested
Imipenem	2/11 (18.2)	6/9 (66.7)	2/9 (22.2)	1/5	0/5
Meropenem	1/11 (9.1)	6/9 (66.7)	1/9 (11.1)	5/7 (71.4)	0/5

*Note: n is the number of isolates resistant to an antibiotic; N is the total number of cases tested with that antibiotic. For antibiotics with a denominator ≤ 5 (especially levofloxacin), percentages are only descriptive at the isolate level and do not support epidemiological interpretation; results should be read as n/N.

For K. pneumoniae, the highest susceptibility rates were observed with meropenem (90.9%) and imipenem (81.8%). Susceptibility rates to piperacillin/tazobactam, cefepime, and ceftazidime were 72.7%, 70.0%, and 75.0%, respectively. Only 9.1% were susceptible to ciprofloxacin, whereas 45.5% were intermediate and 45.5% were resistant.

A. baumannii was resistant in 6/8 isolates tested (75.0%) to ceftazidime and ciprofloxacin, and in 6/9 (66.7%) to pip/tazo, imipenem, and meropenem. P. aeruginosa had a resistance rate of 11.1% to cefepime, ceftazidime, and meropenem. K. aerogenes was resistant in 6/7 (85.7%) to pip/tazo, cefepime, and ciprofloxacin, and in 5/7 (71.4%) to meropenem. E. coli showed no resistance to piperacillin/tazobactam, ceftazidime, imipenem, or meropenem in the 5 isolates tested; because the denominator was small, no conclusion can be drawn about the true resistance rate [Table 4].

4. DISCUSSION

The study yielded two notable findings. First, patients hospitalized for acute exacerbation of COPD with pneumonia were mainly older adults (median age 73 years) and men (89.7%), in line with the epidemiological profile of COPD in Vietnam. Second, Gram-negative bacilli accounted for 88.0% of isolates, and some species had high resistance rates to antibiotic classes commonly used empirically. K. pneumoniae and P. aeruginosa were the two most frequently isolated species.

The median age of 73 years indicates that the results mainly reflect COPD treatment practice in older adults. This group often has reduced respiratory reserve, multiple comorbidities, and repeated exposure to healthcare facilities or antibiotics. However, the study did not fully collect these factors, so causal relationships could not be determined. Men accounted for 89.7%, but pack-year data were not available to assess the role of smoking.

The culture positivity rate of 32.0% was lower than the 43.7% obtained by culture in the study by Van LK and Van PH [5]. Dao et al. reported a higher detection rate in a prospective study with a broader range of tests [6]. The difference may be due to patient selection criteria, specimen quality, antibiotic use before sampling, and laboratory techniques; the present study did not have sufficient data to analyze these factors.

Gram-negative bacteria accounted for 88.0%, mainly K. pneumoniae and P. aeruginosa, consistent with some reports in hospitalized patients with COPD in Vietnam [5, 6]. COPD with pneumonia may be associated with worse outcomes [8], while P. aeruginosa can persist in the airways of patients with COPD [9]. The proportion of Gram-negative bacteria in our study was higher than the 79.71% reported in Kien Giang and close to the 90% reported in COPD patients with the frequent exacerbator phenotype in Long An [10, 11]. This difference indicates that local microbiological data should be built and updated for each facility rather than extrapolated from multicenter studies. However, a single bacterial culture cannot reliably distinguish infection from colonization.

A. baumannii and K. aerogenes had high resistance rates to many of the drugs tested. A. baumannii was 66.7% (6/9) resistant to both imipenem and meropenem; K. aerogenes was 71.4% (5/7) resistant to meropenem. Multidrug resistance could not be concluded because the denominators were small (6 to 9 isolates tested with each drug).

K. pneumoniae remained 90.9% susceptible to meropenem and 81.8% susceptible to imipenem, but only 9.1% susceptible to ciprofloxacin. P. aeruginosa was 11.1% resistant to cefepime, ceftazidime, and meropenem among the nine isolates tested, compared with 44.4% to ciprofloxacin. These results support surveillance within the department but are not sufficient to establish a stand-alone treatment protocol. Carbapenems should not be regarded as a routine choice on the basis of a descriptive study alone; treatment also depends on severity, risk of drug resistance, organ function, and susceptibility results. In older adults, attention should be paid to dose adjustment for renal function, drug interactions, and adverse effects.

This study has limitations: it was retrospective and single-center; only 197/271 patients had bacterial cultures, and the positivity rate was low (32%); data on antibiotic use before sampling were insufficient; bacterial culture may reflect coloni-

zation; some drug–species pairs had only 1 to 5 isolates tested (levofloxacin, ceftazidime, and imipenem for K. aerogenes, and the entire susceptibility panel for E. coli), so the corresponding rates are not reliable enough for epidemiological interpretation; and the panel of drugs tested was not uniform. In addition, because the retrospective data did not fully record sputum volume and character for each patient, we could not classify exacerbation severity according to Anthonisen types I, II, and III, and therefore could not assess the relationship between exacerbation severity and culture results or antimicrobial resistance phenotypes.

5. CONCLUSION

Among 271 patients with acute exacerbation of COPD and pneumonia, the median age was 73 years and men accounted for 89.7%. Of the 197 bacterial cultures, 63 were positive, yielding 75 isolates; Gram-negative bacilli accounted for 88.0%. K. pneumoniae and P. aeruginosa were the two most common species. A. baumannii and K. aerogenes had high resistance rates to some beta-lactams, fluoroquinolones, and carbapenems; K. pneumoniae remained relatively susceptible to carbapenems but showed markedly reduced susceptibility to ciprofloxacin. The results emphasize the role of bacterial culture, susceptibility testing, and local microbiological data in selecting and adjusting antibiotics for hospitalized patients, especially older adults.

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