ISSN: 2717-8161 REVIEW ARTICLE

New Trend Med Sci 2025; 6(1):22-25. https://dergipark.org.tr/tr/pub/ntms

Antibiotic Resistance in COPD Patients in the Intensive Care Unit: A Review of Recent Developments

Özgür Özmen[1,2*]

[1]School of Medicine, Department of Anesthesiology and Reanimation, Ataturk University, Erzurum, Türkiye
[2]Anethesiology Clinical Research Office, Atatürk University, Erzurum, Türkiye

Article History
Received 10 Dec 2024
Accepted 13 Jan 2025
Published Online 31 Jan 2025

[*]***Corresponding Author***
Özgür Özmen
School of Medicine
Department of Anesthesiology and Reanimation
Ataturk University, Erzurum, Türkiye
Phone: +90 5424002477
E-mail: dr.ozgurozmen@yahoo.com.tr

Doi:10.56766/ntms.1586539

Authors' ORCIDs
Özgür Özmen
https://orcid.org/0000-0003-2014-0468

Abstract: Chronic Obstructive Pulmonary Disease (COPD) is a major cause of morbidity and mortality globally, and it remains a leading contributor to hospital admissions, particularly in the elderly. In the past decade, COPD has been identified as one of the leading risk factors for infection-related complications, including pneumonia, bronchitis, and ventilator-associated pneumonia (VAP). Antibiotics are a cornerstone of therapy for COPD exacerbations caused by bacterial infections. However, inappropriate antibiotic use in this patient population has led to an increasing burden of antibiotic resistance. The overuse of broad-spectrum antibiotics is especially problematic in ICU settings, where empirical antibiotic treatment is often initiated without adequate microbiological testing. The relationship between COPD and antibiotic resistance is multifaceted. On the one hand, COPD patients are more likely to require antibiotics due to recurrent infections, leading to frequent antibiotic courses. On the other hand, the repeated exposure to antibiotics can promote the selection of resistant bacterial strains. The management of antibiotic resistance in COPD patients, particularly those in the ICU, is a complex and growing challenge. Strategies such as antibiotic stewardship programs, rapid microbiological diagnostics, and the use of narrow-spectrum antibiotics have been shown to reduce the emergence of resistant organisms and improve patient outcomes. However, the problem of antibiotic resistance in COPD patients remains significant, particularly in the context of multidrug-resistant pathogens. ©2025 NTMS.

Keywords: Intensive Care Unit; Chronic Obstructive Pulmonary Disease; Antibiotic Resistance.

1. Introduction

1. COPD and Infection Risk in Intensive Care

Chronic Obstructive Pulmonary Disease (COPD) is a major cause of morbidity and mortality globally, and it remains a leading contributor to hospital admissions, particularly in the elderly. COPD is characterized by persistent airflow limitation and an increased susceptibility to respiratory infections. Exacerbations of COPD are commonly triggered by bacterial or viral infections, leading to hospitalization and, in severe cases, the need for intensive care unit (ICU) admission [1]. The intensive care setting further complicates the management of these patients due to comorbidities, advanced age, and frequent mechanical ventilation needs.

In the past decade, COPD has been identified as one of the leading risk factors for infection-related complications, including pneumonia, bronchitis, and ventilator-associated pneumonia (VAP). Notably, patients with severe COPD often have compromised immune defenses, including impaired mucociliary clearance and altered airway microbiota, which predispose them to frequent infections. Furthermore,

Cite this article as: Özmen Ö. Antibiotic Resistance in Copd Patients in the Intensive Care Unit: A Review of Recent Developments. *New Trend Med Sci.* 2025; 6(1):22-25. Doi:10.56766/ntms.1586539.

the use of corticosteroids and other immunosuppressive treatments in COPD exacerbations may further increase the risk of opportunistic infections. This compromised state creates a vicious cycle, where infections exacerbate COPD and vice versa, leading to an increased need for hospitalization and prolonged ICU stays [2].

The COVID-19 pandemic further exacerbated this issue by increasing the incidence of co-infections in critically ill COPD patients, particularly in those requiring mechanical ventilation. Studies have shown that these patients often receive broad-spectrum antibiotics as empirical treatment, which significantly contributes to the rise of antibiotic resistance [1,3].

2. Antibiotic Use and Antibiotic Resistance in COPD Patients

Antibiotics are a cornerstone of therapy for COPD exacerbations caused by bacterial infections. However, inappropriate antibiotic use in this patient population has led to an increasing burden of antibiotic resistance. Recent studies highlight that a significant proportion of antibiotics prescribed in COPD exacerbations are either unnecessary or poorly targeted. A study by found that ICU patients with COPD are frequently prescribed broad-spectrum antibiotics before microbiological confirmation of infection, which leads to increased pressure on bacterial populations to develop resistance mechanisms [1,4].

The overuse of broad-spectrum antibiotics is especially problematic in ICU settings, where empirical antibiotic treatment is often initiated without adequate microbiological testing. This practice increases the risk of multi-drug resistant (MDR) infections, particularly from pathogens like *Pseudomonas aeruginosa, Acinetobacter baumannii, and Klebsiella pneumoniae*, which are notorious for their resistance to multiple classes of antibiotics [4]. Notably, these pathogens are commonly associated with hospital-acquired infections, including VAP and catheter-related bloodstream infections, which are common in mechanically ventilated COPD patients.

A study conducted in Nseir et al. demonstrated a significant increase in the prevalence of MDR pathogens in ICU patients with COPD, correlating antibiotic overuse with poorer outcomes, including longer ICU stays and higher mortality rates. The authors also highlighted that despite the growing body of evidence pointing to the overuse of antibiotics, there remains a gap in the implementation of effective antibiotic stewardship programs (ASPs) in many healthcare settings, particularly in developing countries [5].

The emergence of extensively drug-resistant (XDR) organisms has further complicated the management of infections in COPD patients. These organisms are resistant to almost all available antibiotics, leaving clinicians with few therapeutic options. A recent study by Ullah et al. reported that the number of XDR infections in ICU patients with COPD has increased over the past five years, leading to an urgent need for new antibiotic classes and innovative therapeutic strategies [6].

3. The Impact of COPD on Antibiotic Resistance

COPD patients, particularly those with severe or very severe forms of the disease, are at an elevated risk of developing infections due to several factors inherent to the disease. The chronic inflammation associated with COPD results in structural changes to the airways, such as goblet cell hyperplasia and mucus plugging, which impair the natural defense mechanisms of the respiratory tract. Additionally, the frequent use of corticosteroids, which are commonly prescribed to manage COPD exacerbations, further suppresses the immune response, making patients more susceptible to both bacterial and viral infections[2-4].

The relationship between COPD and antibiotic resistance is multifaceted. On the one hand, COPD patients are more likely to require antibiotics due to recurrent infections, leading to frequent antibiotic courses. On the other hand, the repeated exposure to antibiotics can promote the selection of resistant bacterial strains. This is particularly concerning in the ICU, where patients are often treated with broad-spectrum antibiotics empirically while awaiting culture results. As a result, bacterial populations are increasingly exposed to antibiotic pressure, leading to the development of resistance over time [3,4].

A study by Günay et al. examined the impact of frequent hospital admissions on the development of antibiotic resistance in COPD patients [7]. The study found that patients who experienced multiple hospitalizations for COPD exacerbations over a two-year period had a significantly higher rate of colonization with resistant pathogens compared to those with fewer hospital admissions. This highlights the importance of carefully managing antibiotic use in hospitalized COPD patients to prevent the development of resistance.

Furthermore, the use of mechanical ventilation in COPD patients has been linked to an increased risk of acquiring hospital-associated infections, including VAP, which is particularly challenging to treat due to the involvement of resistant organisms. Ventilated COPD patients are often exposed to a range of antibiotics during their ICU stay, leading to a greater likelihood of developing resistance. Studies have shown that the duration of mechanical ventilation is directly correlated with the risk of acquiring multidrug-resistant pathogens [7,8].

4. Strategies to Mitigate the Burden of Antibiotic Resistance

To address the growing challenge of antibiotic resistance in COPD patients, especially those in the ICU, several strategies have been proposed and implemented. Antibiotic Stewardship Programs (ASPs) have gained widespread recognition as an essential tool in reducing inappropriate antibiotic use. The main

objective of ASPs is to ensure the appropriate selection, dosage, and duration of antibiotic therapy, thereby minimizing the emergence of resistant organisms. Suzuki et al. demonstrated that the implementation of an ASP in ICU settings resulted in a significant reduction in the use of broad-spectrum antibiotics and a corresponding decline in the prevalence of resistant pathogens [9]. This study further emphasized the need for ongoing education and training of healthcare staff on the principles of antimicrobial stewardship to achieve sustainable improvements in antibiotic prescribing practices [9].

One of the key elements of effective antibiotic stewardship is the use of rapid microbiological diagnostics, which allows for more targeted therapy. Recent advancements in molecular diagnostics, such as polymerase chain reaction (PCR)-based tests, enable clinicians to quickly identify the causative pathogen and its resistance profile. This approach has been particularly beneficial in ICU settings, where time is of the essence in selecting the appropriate antibiotic therapy[10]. Rapid identification of pathogens such as Methicillin-resistant Staphylococcus aureus (MRSA) and Pseudomonas aeruginosa has led to faster de-escalation of antibiotic therapy and improved patient outcomes.

Additionally, the use of narrow-spectrum antibiotics is a critical component of antibiotic stewardship. Studies have consistently shown that the use of broad-spectrum antibiotics should be reserved for cases where the causative pathogen is unknown or when the patient is critically ill. As soon as microbiological results are available, therapy should be narrowed to target the specific pathogen, which helps minimize the risk of resistance. A 2020 meta-analysis found that the use of narrow-spectrum antibiotics in ICU patients with COPD was associated with lower rates of MDR infections and reduced hospital stays [11].

5. Emerging Directions and Future Research

The fight against antibiotic resistance requires ongoing research and the development of new therapeutic approaches. The emergence of multidrug-resistant (MDR) and extensively drug-resistant (XDR) pathogens highlights the urgent need for novel antibiotics. Recent advancements in drug development have focused on the creation of new antibiotic classes, including beta-lactamase inhibitors and cephalosporin combinations, which have shown promising results in treating resistant pathogens [2-5].

Furthermore, immunomodulatory treatments for COPD patients are being explored as a potential way to enhance the host's ability to fight infections and reduce the need for frequent antibiotic use. Research into agents that can modulate the immune system, such as interleukin inhibitors and toll-like receptor agonists, has shown promise in reducing the frequency of exacerbations and infections in COPD patients. These therapies may provide an adjunct to antibiotics in the management of respiratory infections, particularly in patients with severe COPD who are at high risk of recurrent infections[12].

In addition to pharmacological interventions, non-pharmacological strategies such as vaccination and pulmonary rehabilitation may play a key role in reducing the incidence of infections in COPD patients. The use of vaccines against pneumococcal infections and influenza has been shown to reduce the frequency of COPD exacerbations, thereby potentially reducing the need for antibiotics [13].

2. Conclusion

The management of antibiotic resistance in COPD patients, particularly those in the ICU, is a complex and growing challenge. Strategies such as antibiotic stewardship programs, rapid microbiological diagnostics, and the use of narrow-spectrum antibiotics have been shown to reduce the emergence of resistant organisms and improve patient outcomes. However, the problem of antibiotic resistance in COPD patients remains significant, particularly in the context of multidrug-resistant pathogens.

Future research into novel antibiotics, immunomodulatory therapies, and non-pharmacological interventions will be critical in addressing this issue. In the meantime, clinicians must continue to prioritize appropriate antibiotic use, ensure effective infection control measures, and remain vigilant in the face of emerging resistance.

Limitations of the Study

Limitation of our study; antibiotic resistance could be evaluated in the intensive care spectrum rather than in a single disease group.

Acknowledgement

None.

Conflict of Interests

The author declare that they have no conflict of interest.

Financial Support

No financial support was received for this study.

Author Contributions

Conception and Design of the study, Collection and/or Processing and Literature review, Writing Original Manuscript, Analysis and/or interpretation and final version and is responsible for final approval of the submitted manuscript; ÖÖ.

Ethical Approval

None.

Data sharing statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Consent to participate

None.

Informed Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

References

1. Hanania NA. Chronic obstructive pulmonary disease (COPD) is a major cause of morbidity and mortality worldwide. *Respir Med*. 2012;106(2):S1-2.
2. MacLeod M, Papi A, Contoli M, et al. Chronic obstructive pulmonary disease exacerbation fundamentals: Diagnosis, treatment, prevention and disease impact. *Respirology*. 2021;26(6):532-51.
3. Bajire SK, Shastry RP. Synergistic effects of COVID-19 and Pseudomonas aeruginosa in chronic obstructive pulmonary disease: a polymicrobial perspective. *Mol Cell Biochem.* 2024;479(3):591-601.
4. Herath SC, Normansell R, Maisey S, Poole P. Prophylactic antibiotic therapy for chronic obstructive pulmonary disease (COPD). *Cochrane Database Syst Rev.* 2018 30;10(10):CD009764.
5. Nseir S, Di Pompeo C, Cavestri B, et al. Multiple-drug-resistant bacteria in patients with severe acute exacerbation of chronic obstructive pulmonary disease: Prevalence, risk factors, and outcome. *Crit Care Med.* 2006;34(12):2959-66.
6. Kaleem Ullah M, Malamardi S, Siddaiah JB, et al. Trends in the Bacterial Prevalence and Antibiotic Resistance Patterns in the Acute Exacerbation of Chronic Obstructive Pulmonary Disease in Hospitalized Patients in South India. Antibiotics (Basel). 2022;11(11):1577.
7. Abdelsalam Elshenawy R, Umaru N, Aslanpour Z. Shorter and Longer Antibiotic Durations for Respiratory Infections: To Fight Antimicrobial Resistance-A Retrospective Cross-Sectional Study in a Secondary Care Setting in the UK. Pharmaceuticals (Basel). 2024;17(3):339.
8. van der Bie S, Haaksma ME, Vermin B, et al. A Systematic Review of the Pulmonary Microbiome in Patients with Acute Exacerbation COPD Requiring ICU Admission. *J Clin Med.* 2024;13(2):472.
9. Suzuki A, Yamaguchi F, Maeda M, et al. Antimicrobial Stewardship Program for Patients in the Hematological Department Receiving Carbapenem Therapy: A Single-Center and Interrupted Time Series Analysis. *Antibiotics (Basel).* 2023;12(2):302.
10. Li YJ, Pan CZ, Fang CQ, Zhao ZX, Chen HL, Guo PH, Zhao ZW. Pneumonia caused by extensive drug-resistant Acinetobacter baumannii among hospitalized patients: genetic relationships, risk factors and mortality. *BMC Infect Dis.* 2017;17(1):371.
11. Papazian L, Klompas M, Luyt CE. Ventilator-associated pneumonia in adults: a narrative review. Intensive Care Med. 2020;46(5):888-906.
12. Tavares LP, Galvão I, Ferrero MR. Novel Immunomodulatory Therapies for Respiratory Pathologies. *Comprehensive Pharmacol.* 2022:554–94.
13. Joean O, Welte T. Vaccination and modern management of chronic obstructive pulmonary disease - a narrative review. Expert Rev Respir Med. 2022;16(6):605-14.