**Original Article**

OPEN ACCESS

# Susceptibility Profiles of Isolated Bacteria from Pneumonia Patients in Medical ICU

**Rifat Yasmin[1], Huma Hussain[2], Hina Hussain[3], Muhammad Asif Naseer[4], Tazaeen Hina Kazmi[5], Syeda Turab Fatima Abidi[6]**

[1,6]Associate Professor, POF Hospital, Wah Medical College, NUMS, Wah Cantt
[2]Assistant Professor, POF Hospital, Wah Medical College, NUMS, Wah Cantt
[3]Medical Specialist, Fellow Critical Care Medicine, Pak Emirates Military Hospital (PEMH), Rawalpindi
[4]Associate Professor, HOD Emergency Medicine, Combined Military Hospital (CMH), Lahore
[5]Assistant Professor, POF Hospital, Wah Medical College, NUMS, Wah Cantt

Author`s Contribution

*[1]Provided concept/research design, data collection, and takes the responsibility, [2,3]Statistical analysis and manuscript writing. [4]Critical revision of the manuscript for important intellectual content. [5]Edit of manuscript and project management, [6]edit of manuscript and project management.*

*Funding Source: None*
*Conflict of Interest: None*

*Received: November 14, 2023*
*Accepted: May 23, 2024*

***Address of Correspondent***
*Dr. Rifat Yasmin*
*Associate Professor*
*POF Hospital, Wah Medical College, NUMS, Wah Cantt*
*rifatomer7@gmail.com*

**ABSTRACT**

**Objective:** To determine the susceptibility profiles of isolated bacteria from pneumonia patients in medical ICU.

**Methodology:** This cross-section observational study was conducted in the Medical ICU of Pakistan Ordinance Factories (POF) Hospital, Wah Cantt, Pakistan, between February and July 2023. The study included 100 patients aged ≥ 18 years, presented with severe symptoms of lower respiratory tract and exhibited bacterial growth. The patients' samples were collected from sputum, blood, tracheal secretions, bronchoalveolar lavage, and sent to hospital laboratory for sensitivity and culture analysis. Following overnight incubation, the agar plates were examined for bacterial growth and colonial morphology.

**Results:** Among 100 patients, 48% were female and 52% male. The mean age of the patients was 58.6±14.5 years. 75% of patients were discharged from ICU, while 25% died. Sputum specimens were collected from 60% of patients, blood specimens from 21% of patients, tracheal secretions from 10% of patients, and bronchoalveolar lavage from 9% of patients. 30% tested positive for Klebsiella pneumoniae, and Acinetobacter baumannii. Pseudomonas aeruginosa was detected in 20% of patients, while E. coli was found in 7% of patients. Among gram-positive bacteria, 6% of patients tested positive for Staphylococcus aureus, 3% for MRCONS, 2% for MRSA, and 2% for coagulase-negative staphylococcal organisms.

**Conclusion:** Significant levels of antibiotic resistance observed in isolates of gram-negative and gram-positive bacteria. The presence of increased resistance to multiple antibiotics indicates a high incidence of multidrug-resistant gram-positive and gram-negative organisms.

**Keywords:** Antibiosis; Bacteria; Pneumonia; Microbial sensitivity tests.

*Cite this article as: Yasmin R, Hussain H, Hussain H, Naseer MA, Kazmi TH, Abidi STF. Susceptibility Profiles of Isolated Bacteria from Pneumonia Patients in Medical ICU. Ann Pak Inst Med Sci. 2024; 20(3):337-341. doi. 10.48036/apims.v20i3.1126*

## Introduction

Modern medical treatments have evolved significantly over the years, particularly with the advent of antibiotics. This evolution has led to improved healthcare, higher patient survival rates, and effective management of illnesses that were once potentially and often fatal.[1] ICU patients with severe illnesses often encounter multidrug-resistant bacteria, leading to limited therapeutic options that effectively cover the spectrum of ICU pathogens.[2] Identifying the pathogen and its antibiotic pattern of sensitivity has essential for selecting appropriate antibiotics.[3] The emergence of bacteria resistant to multiple antibiotics has been increasingly observed over the past two decades, coinciding with the advancement of broad-spectrum and extended-spectrum antibiotics.[4]

Staphylococcus aureus is a frequently encountered organism and is also found in anterior nares and normal

skin flora, thus serving as a primary origin of contamination in respiratory tract infection.[5] Identifying coagulase in staphylococci is the basis for organisms' identification. Organisms are categorized as either coagulase-positive or coagulase-negative staphylococci based on the presence or absence of coagulase. Staphylococcus aureus is coagulase-positive organism, while Staphylococcus epidermidis is coagulase-negative gram-positive organism. Coagulase-negative Staphylococcus is primarily found on implanted devices, particularly in patients of advanced age or with compromised immune systems.[6]

β-Lactam, including carbapenem, monobactam, cephalosporin, and penicillin account for 60% of all antibiotics utilized. The primary cause for the heightened utilization of these medications is their high degree of safety and broad spectrum of bacteria activity, which leads to high efficacy. The extensive use of these antibiotics has led to a significant setback due to the emergence of resistance.[7] Since the early 2000s, Methicillin-Resistant Staphylococcus Aureus (MRSA) has been recognized as the initial multi-drug resistant organism. However, in recently, gram-negative bacteria are documented to exhibit multi-drug resistance.[8] Isolate organisms have demonstrated resistance to extended-spectrum beta-lactamases (ESBL), carbapenems, and even colistin. Carbapenems have demonstrated effectiveness against nosocomial infections and community-acquired diseases that are resistant to other antibiotics.[9]

The study objective was to determine the susceptibility profiles of isolated bacteria from pneumonia patients in medical ICU. This information aims to guide effective antibiotic selection and treatment strategies for these patients.

# Methodology

This cross-section observational study was conducted after obtaining approval from the ethics committee at the Medical ICU of Pakistan Ordinance Factories (POF) Hospital, Wah Cantt, Pakistan from February to July 2023. 100 patients in total, of both genders, aged ≥ 18 years, who presented severe symptoms of the lower respiratory tract and exhibited bacterial proliferation, were included through consecutive sampling in the study. WHO calculator of sample size was used with the following parameters; a 95% confidence interval, a 5% significance level, and a 7% precision rate.[2] Patients with negative bacterial proliferation on culture reports and who had already received antibiotic treatment were excluded. Informed consent was obtained from each patient before they were included in the study.

The samples were collected from the patients' sputum, blood, tracheal secretions, bronchoalveolar lavage, and sent to hospital laboratory for sensitivity and culture analysis. A blood sample of 1-3 ml was collected for this purpose. The samples were placed onto appropriate culture media like chocolate, blood, and MacConkey agars, and then incubated for 24hrs at 35-37°C in aerobic conditions. Following incubation overnight, the agar plates were inspected for bacterial proliferation and colony morphology. Gram-negative rods were detected using oxidase test, catalase test, and Gram staining by assessing motility. Gram-negative Microbact 24E detection kits were utilized to confirm the isolates. For the identification of Gram-positive cocci, coagulase, the DNAase, and catalase tests were conducted.

Isolate bacterial suspension was adjusted to a turbidity equal to 0.5 standard of McFarland was inoculated onto agar of Mueller-Hinton. The susceptibility test of antimicrobe was conducted using altered disc of Kirby-Bauer diffusion method. The outcomes of susceptibility were interpreted as sensitive, intermediate, or resistant based on the guidelines of the Clinical Laboratory Standards Institute. The department of microbiology reported the culture results in 5 days.

The data was analyzed using SPSS v 23. The association between antibiotic sensitivity patterns and types of organisms was determined by chi square. The significant p-value was set at ≤ 0.05.

# Results

The study included 100 patients in the medical ICU diagnosed with pneumonia. The patient's mean age was 58.6±14.5 years, with 48% being female and 52% male. 75% of patients were discharged from the ICU, while the remaining 25% died. Sputum specimens were collected from 60% of patients, blood specimens from 21% of patients, tracheal secretions from 10% of patients, and bronchoalveolar lavage from 9% of patients. Community-acquired pneumonia and nosocomial pneumonia cases each accounted for 30%, 28% were classified as ventilator-associated pneumonia, and the remaining 12% were aspiration pneumonia. 30% tested positive for Klebsiella pneumoniae, and 30% tested positive for Acinetobacter baumannii. Pseudomonas aeruginosa was detected in 20% of patients, while E. coli was found in 7% of patients. Among gram-positive bacteria, 6% of patients tested positive for Staphylococcus aureus, 3% for MRCONS, 2%

for MRSA, and 2% for coagulase-negative staphylococcal organisms (Table I).

**Table I: All patient's characteristics. (n=100)**

| Variables | | N | % |
|---|---|---|---|
| Age (years) | Mean ± SD | 58.6±14.5 | |
| Gender | Male | 52 | 52.0 |
| | Female | 48 | 48.0 |
| Mortality | Discharged | 75 | 75.0 |
| | Died | 25 | 25.0 |
| Specimen type | Sputum | 60 | 60.0 |
| | Blood | 21 | 21.0 |
| | Tracheal secretion | 10 | 10.0 |
| | Bronchoalveolar lavage | 9 | 9.0 |
| Pneumonia diagnosis | Community-acquired | 30 | 30.0 |
| | Nosocomial | 30 | 30.0 |
| | Ventilator-associated | 28 | 28.0 |
| | Aspiration | 12 | 12.0 |
| Isolated organism | E. coli | 7 | 7.0 |
| | Klebsiella | 30 | 30.0 |
| | Pseudomonas aeruginosa | 20 | 20.0 |
| | Acinetobacter baumannii | 30 | 30.0 |
| | MRSA | 2 | 2.0 |
| | Coagulase -ve Staph. | 2 | 2.0 |
| | Gram +ve S. aureus | 6 | 6.0 |
| | MRCONS | 3 | 3.0 |

**Table II: Antibiotic sensitivity and resistance of gram -ve organisms.**

| Antibiotic | N | Sensitivity | Resistance |
|---|---|---|---|
| Amikacin | 80 | 30 | 50 |
| Ampicillin | 35 | 5 | 30 |
| Cefoperzone/Sulbactam | 80 | 30 | 50 |
| Cefoperazone | 80 | 25 | 55 |
| Cefotaxime | 80 | 14 | 66 |
| Ceftazidime | 80 | 20 | 60 |
| Ceftriaxone | 80 | 5 | 75 |
| Ciprofloxacin | 80 | 10 | 70 |
| Co-amoxiclav | 70 | 7 | 63 |
| Colistin | 80 | 25 | 55 |
| Cotrimoxazole | 65 | 4 | 61 |
| Gentamicin | 80 | 10 | 70 |
| Imipenem | 80 | 30 | 50 |
| Levofloxacin | 80 | 8 | 72 |
| Meropenem | 80 | 35 | 45 |
| Moxifloxacin | 80 | 30 | 50 |
| Piperacillin/Tazobactam | 80 | 30 | 50 |
| Tetracycline | 70 | 4 | 66 |

**Table III: Antibiotic sensitivity and resistance of gram +ve organisms.**

| Antibiotic | N | Sensitivity | Resistance |
|---|---|---|---|
| Azithromycin | 20 | 6 | 14 |
| Clindamycin | 20 | 5 | 15 |
| Erythromycin | 20 | 3 | 17 |
| Linezolid | 20 | 5 | 15 |
| Penicillin | 20 | 4 | 14 |
| Teicoplanin | 20 | 5 | 15 |
| Vancomycin | 20 | 6 | 14 |

Ampicillin sensitivity was observed in 5/35 patients, cotrimoxazole in 5/70 patients, and co-amoxiclav in 7/70 patients. Ciprofloxacin and gentamicin sensitivity was found equally in 10/80, and amikacin in 30/80 patients. The sensitivity of Cefotaxime was observed in 14/80, ceftriaxone in 5/80, piperacillin/tazobactam and cefoperazone/sulbactam was equally found in 30/80 patients. Similarly, high sensitivity was observed with imipenem (30/80) and meropenem (35/80). Whereas, low sensitivity was found for tetracycline (4/70), ceftazidime (20/80), cefoperazone (25/80), and levofloxacin (8/80).

The high sensitivity was found for moxifloxacin in 30/80 and colistin in 25/80 patients. For gram-positive organisms, sensitivity was recorded as follow: penicillin in 2/20, erythromycin in 3/20, clindamycin in 5/20, vancomycin in 6/20 patients, linezolid in 5/20, azithromycin in 6/20, and teicoplanin in 5/20 patients (Table II & III).

The frequency of antibiotic sensitivity for gram-positive organisms indicated that Staphylococcus aureus was sensitive to all tested antibiotics, including azithromycin, clindamycin, erythromycin, linezolid, penicillin, teicoplanin, tigecycline, and vancomycin (Table 5). MRSA demonstrated high resistance to azithromycin and penicillin, but demonstrated moderate sensitivity to clindamycin, erythromycin, linezolid, teicoplanin, and vancomycin (43%). CONS (coagulase-negative Staphylococcus) exhibited high resistance to erythromycin, linezolid, penicillin, and teicoplanin (100%). Whereas, azithromycin demonstrated enhanced sensitivity (100%). MRCONS were high resistant to azithromycin (86%), clindamycin (100%), and erythromycin (100%). Drugs such as penicillin demonstrated a 50% sensitivity, while linezolid, teicoplanin, and vancomycin each showed a sensitivity of 33%.

# Discussion

In this study, 30% patients each tested positive for Klebsiella pneumoniae and Acinetobacter baumannii, followed by Pseudomonas aeruginosa in 20% patients, and 7% patients tested positive for E. coli. A study conducted in Islamabad, Pakistan reported that the most common organism among gram-negative patients was E. coli (15%), followed by Pseudomonas aeruginosa (13%) and Klebsiella pneumoniae (10%). However, MRSA was the most prevalent among gram-positive patients (6%). Pseudomonas showed sensitivity to colistin (93%), while Klebsiella pneumoniae demonstrated sensitivity to

**Table IV: Frequency of antibiotic sensitivity and resistance of gram -ve organisms.**

| Antibiotic | Klebsiella (R/S) | E. coli (R/S) | Pseudomonas aeruginosa (R/S) | Acinetobacter baumannii (R/S) | p-value |
|---|---|---|---|---|---|
| Amikacin | 18/8 | 4/3 | 13/7 | 15/5 | .019 |
| Ampicillin | - | 6/0 | - | - | .032 |
| Cefoperzone/Sulbactam | 22/14 | 6/0 | 16/4 | 13/7 | .153 |
| Cefoperazone | 25/10 | 6/0 | 12/8 | 12/7 | .243 |
| Cefotaxime | 30/3 | 4/3 | 13/5 | 19/3 | .092 |
| Ceftazidime | 28/7 | 5/2 | 12/8 | 15/3 | .295 |
| Ceftriaxone | 30/3 | 5/1 | 20/0 | 15/1 | .181 |
| Ciprofloxacin | 30/5 | 6/0 | 20/2 | 14/3 | .578 |
| Co-amoxiclav | 28/4 | 7/0 | - | - | .751 |
| Colistin | 25/9 | 5/2 | 15/4 | 10/10 | .722 |
| Cotrimoxazole | 30/2 | 6/0 | - | 25/3 | .742 |
| Gentamicin | 31/4 | 4/1 | 18/3 | 17/2 | .079 |
| Imipenem | 20/10 | 5/2 | 15/6 | 10/12 | .797 |
| Levofloxacin | 32/2 | 6/0 | 14/4 | 20/2 | .243 |
| Meropenem | 20/14 | 6/0 | 15/6 | 14/5 | .176 |
| Moxifloxacin | 25/12 | 4/3 | 15/5 | 6/10 | .678 |
| Piperacillin/Tazobactam | 25/10 | 5/2 | 7/13 | 13/5 | .001 |
| Tetracycline | 30/3 | 6/0 | - | 30/1 | .798 |

**Table V: Frequency of antibiotic sensitivity and resistance of gram +ve organisms.**

| Antibiotic | S. aureus (R/S) | MRSA (R/S) | CONS (R/S) | MRCONS (R/S) | p-value |
|---|---|---|---|---|---|
| Azithromycin | 1/0 | 6/2 | 1/2 | 6/2 | .053 |
| Clindamycin | 1/0 | 4/3 | 3/1 | 7/1 | .644 |
| Erythromycin | 1/0 | 4/3 | 5/0 | 7/0 | .191 |
| Linezolid | 1/0 | 4/3 | 4/0 | 6/2 | .452 |
| Penicillin | 1/0 | 7/0 | 4/0 | 4/4 | .120 |
| Teicoplanin | 1/0 | 4/3 | 4/0 | 6/2 | .452 |
| Vancomycin | 1/0 | 4/3 | 3/1 | 6/2 | .785 |

tigecycline (100%) and minocycline (84%). The ICU had an overall mortality rate of 31%.[10] In this study, the ICU had mortality rate of 25%.

Ghazal et al reported that the most common organism was E. coli (47%), followed by Pseudomonas aeruginosa (17%) and Acinetobacter baumannii (13%).[11] In this study, the sensitivity of Klebsiella pneumoniae was demonstrated as follows: amikacin (52%), meropenem (46%), cefoperazone-sulbactam (40%), imipenem (37%), moxifloxacin (34%), colistin (31%), cefoperazone (28%), and piperacillin-tazobactam (28%). Bhat et al demonstrated that Klebsiella pneumoniae positive patients, 53% were resistant to meropenem and imipenem. Similarly, for Proteus mirabilis positive patients, 50% resistance was found against meropenem and imipenem.[12]

CONS (coagulase-negative Staphylococcus) was found to be high resistant to erythromycin, linezolid, penicillin, and teicoplanin (100%), in this study. Azithromycin demonstrated enhanced sensitivity (100%). MRCONS exhibited high resistance to azithromycin (86%), clindamycin (100%), and erythromycin (100%). Drugs such as penicillin demonstrated a 50% sensitivity, while linezolid, teicoplanin, and vancomycin each showed a sensitivity of 33%. A study conducted in Egypt on CONS revealed that amikacin, ciprofloxacin, and vancomycin were effective against CONS. CONS exhibited high resistance to commonly utilized first-line antimicrobe agents.[13] Tehseen et al demonstrating that gram-negative bacteria were sensitive to vancomycin, while gram-positive bacteria were sensitive to amikacin.[14] Li et al studied the sensitivity of organisms to meropenem and found that gram-negative were frequently resistance (54%) to meropenem, while gram-positive organisms showed lower resistance (39%) to meropenem.[15] A study conducted in Egypt found that Klebsiella pneumoniae was frequent isolated organism in gram-negative bacteria (41%), followed by Acinetobacter baumannii (19%), Pseudomonas aeruginosa (17%), E. coli (15%), Enterobacter aerogenes (5%), and Proteus mirabilis (2%). The sensitivity antibiotics indicated carbapenem resistant was up to 36%, and colistin showed a sensitivity of 87%.[16]

# Conclusion

Significant levels of antibiotic resistance observed in isolates of gram-negative and gram-positive bacteria. The

presence of increased resistance to multiple antibiotics indicates a high incidence of multidrug-resistant gram-positive and gram-negative organisms. Therefore, accurate identification of the organism is recommended to ensure the administration of empirical drugs that are mainly effective against the isolated organism, especially in severe cases.

# References


1. Hutchings MI, Truman AW, Wilkinson B. Antibiotics: past, present and future. Curr Opin Microbiol. 2019;51(10):72-80. https://doi.org/10.1016/j.mib.2019.10.008
2. Giamarellou H, Karaiskos I. Current and potential therapeutic options for infections caused by difficult-to-treat and pandrug resistant gram-negative bacteria in critically ill patients. Antibiotics. 2022;11(8):1009. https://doi.org/10.3390/antibiotics11081009
3. Gajic I, Kabic J, Kekic D, Jovicevic M, Milenkovic M, Mitic Culafic D, et al. Antimicrobial susceptibility testing: a comprehensive review of currently used methods. Antibiotics. 2022;11(4):427. https://doi.org/10.3390/antibiotics11040427
4. Cook MA, Wright GD. The past, present, and future of antibiotics. Sci Transl Med. 2022;14(657):eabo7793. https://doi.org/10.1126/scitranslmed.abo7793
5. Pal M, Kerorsa GB, Marami LM, Kandi V. Epidemiology, pathogenicity, animal infections, antibiotic resistance, public health significance, and economic impact of staphylococcus aureus: a comprehensive review. Am J Public Health Res. 2020;8(1):14-21.
6. Fernandes Queiroga Moraes G, Cordeiro LV, de Andrade Júnior FP. Main laboratory methods used for the isolation and identification of Staphylococcus spp. Rev Colomb Cienc Quim-Farm. 2021;50(1):5-28. https://doi.org/10.15446/rcciquifa.v50n1.95444
7. Lima LM, da Silva BN, Barbosa G, Barreiro EJ. β-lactam antibiotics: An overview from a medicinal chemistry perspective. Eur J Med Chem. 2020;208(12):112829. https://doi.org/10.1016/j.ejmech.2020.112829
8. Alfeky AA, Tawfick MM, Ashour MS, El-Moghazy AN. High prevalence of multi-drug resistant methicillin-resistant Staphylococcus aureus in tertiary Egyptian Hospitals. J Infect Dev Ctries. 2022;16(05):795-806. https://doi.org/10.3855/jidc.15833
9. Elmonir W, Abd El-Aziz NK, Tartor YH, Moustafa SM, Abo Remela EM, Eissa R, et al. Emergence of colistin and carbapenem resistance in extended-spectrum β-lactamase producing Klebsiella pneumoniae isolated from chickens and humans in Egypt. Biology. 2021;10(5):373. https://doi.org/10.3390/biology10050373
10. Qadeer A, Akhtar A, Ain QU, Saadat S, Mansoor S, Assad S, et al. Antibiogram of medical intensive care unit at tertiary care hospital setting of Pakistan. Cureus. 2016;8(9):e809. https://doi.org/10.7759/cureus.809
11. Ghazal L, Qureshi AH, Iqbal N. Antibiotic Susceptibility Pattern of Gram Negative Bacilli Isolated from Different Clinical Specimens in a Tertiary Care Hospital. J Islamabad Med Dent Coll. 2018;7(2):112-117.
12. Bhat V, Gupta S, Kelkar R, Biswas S, Khattry N, Moiyadi A, et al. Bacteriological profile and antibiotic susceptibility patterns of clinical isolates in a tertiary care cancer center. Indian J Med Paediatr Oncol. 2016;37(01):20-24. https://doi.org/10.4103/0971-5851.177010
13. Shehab El-Din EM, El-Sokkary MM, Bassiouny MR, Hassan R. Epidemiology of neonatal sepsis and implicated pathogens: a study from Egypt. BioMed Res Int. 2015;2015(1):509484. https://doi.org/10.1155/2015/509484
14. Tehseen T, Hussain A, Ghazal L. Bacterial Isolate of Neonatal Sepsis and their Susceptibility Pattern in POF Hospital Wah Cantt. Infect Dis J Pak. 2018;27(3):70-73.
15. Li JY, Chen SQ, Yan YY, Hu YY, Wei J, Wu QP, et al. Identification and antimicrobial resistance of pathogens in neonatal septicemia in China-A meta-analysis. Int J Infect Dis. 2018;71(7):89-93. https://doi.org/10.1016/j.ijid.2018.04.794
16. Makharita RR, El-Kholy I, Hetta HF, Abdelaziz MH, Hagagy FI, Ahmed AA, et al. Antibiogram and genetic characterization of carbapenem-resistant gram-negative pathogens incriminated in healthcare-associated infections. Infect Drug Resist. 2020;13(2020):3991-4002. https://doi.org/10.2147/IDR.S276975