Journal of Medical Bacteriology

Prevalence of Multi-Drug Resistant Bacteria Isolated from Patients Admitted to the Intensive Care Unit in Tehran, Iran: a Five-Year Prospective Study- 2019-2023

Ali Ahmadi [1], Soghra Khani [2], Abas Ali Imani Fooladi [1]*

1 *Molecular Biology Research Center, Biomedicine Technologies Institute, Baqiyatallah University of Medical Sciences, Tehran, Iran.*

2 *Department of Biochemistry, Pasteur institute of Iran, Tehran, Iran.*

ARTICLE INFO

Article type:
Original Article

Article history:

Received	16	Sep	2025
Revised	14	Oct	2025
Accepted	20	Nov	2025
Published	12	Dec	2025

Keywords:
Bacterial infections, Drug resistance, Intensive care unit, Nosocomial infections.

*Corresponding Authors: Abas Ali Imani Fooladi, Applied Microbiology Research Center, Biomedicine Technologies Institute, Baqiyatallah University of Medical Sciences, Tehran, Iran. *Tel*: +98-21-88055925, *E-mail:* imanofouladi.a@gmail.com.

ABSTRACT

Background: The study aims to identify bacterial agents and study the prevalence of pathogenic bacteria isolated from patients admitted to the Intensive Care Unit, as well as recognize factors affecting nosocomial infection that can lead to control and treatment of these infections.

Methods: This study was conducted in the Intensive Care Unit of Baqiyatallah Hospital in Tehran. Totally 738 samples were obtained from patients with a bacterial infection were included in this study. Patient information, including age, gender, type of clinical sample, susceptibility testing, year of hospitalization in to the Intensive Care Unit, and the prevalence of isolated bacteria, was analyzed.

Results: The findings of this study revealed that *Acinetobacter*, *Pseudomonas aeruginosa*, and *Staphylococcus aureus* had the highest and *Escherichia coli*, *Enterobacter*, and Streptococci had the lowest prevalence in the to the Intensive Care Unit isolates. Gram-negative bacteria were responsible for most nosocomial infections in the Intensive Care Unit. The rate of nosocomial infections in the Intensive Care Unit had a constant incidence in the recorded years. The rate of nosocomial infections was higher in the male patients than female, with a higher average year of age. Also, the results showed that most isolates were multiple drug resistant.

Conclusion: The high rate of nosocomial infections in to the Intensive Care Unit belonged to respiratory infections. Factors such as intubation and elderly age are associated with the type of infection. Bacterial isolates had a high level of resistance to most antibiotics. Therefore, periodic antibacterial sensitivity assessment could help optimize empirical antibiotic therapy against to the Intensive Care Unit acquired infections.

- ***Please cite this paper as:*** Ahmadi A, Khani S, Imani Fooladi AA. Prevalence of Multi-Drug Resistant Bacteria Isolated from Patients Admitted to the Intensive Care Unit in Tehran, Iran: a Five-Year Prospective Study- 2019-2023. *J Med Bacteriol.* 2025; **13** (4): pp.67-74. DOI: 10.18502/jmb.v13i4.20525

Introduction

According to World Health Organization, the rate of Nosocomial infections (NIs) is between 5.7%-19.1% in low- and middle-income countries and 3.5%-12% in 3.5% to 12% in developed countries (1]. Although less than 10% of total hospitalized patients are admitted to the Intensive Care Unit (ICUs), between 20% to 45% of all nosocomial infections occur in the ICU (2, 3). Since patients admitted to ICUs suffer most often from severe underlying diseases, they are more susceptible to NIs caused by ICU- resident opportunistic bacterial pathogens. On the other hand, the prevalence of MDR pathogens such as Extended-spectrum beta-lactamases produced Acinetobacter, and Pseudomonas in the ICUs and their antibiotic resistance patterns are significantly higher than that of other sections of hospitals (in which there are various resistance reports) (4-6). They are often resistant to most clinically used antibiotics and cause higher treatment failure rates. Therefore, they must pay more attention to the types of ICU resident pathogens and their resistance rates to help physicians to make better therapeutic decisions (7-9). According to the reports, although the overall rate of NIs in Iran is estimated at 15-20 %, there are a few reports on their microbial diversity and resistance rates, the age, gender, and clinical source of the patients, year and ward of isolation, and the frequency of poly bacterial patterns. Considering the importance of microbial resistance in the intensive care unit, it seems necessary to investigate the common causative agents and their microbial resistance. In this study, we aimed to evaluate, in a trendy manner, the prevalence of ICU pathogens, NI and antibiotic resistance patterns in ICU-isolated nosocomial pathogens at Baqiyatallah Hospital in Iran.

Materials and Methods

Patients and clinical samples

This study was done in Baqiyatallah hospital ICUs in Tehran and assessed the prevalence of nosocomial infections and pattern of antibiotic resistance in all patients admitted to the hospital ICUs between 2019 and 2023. The protocol of this study was approved by the ethics committee of the Baqiyatallah University. According to the standard definition, nosocomial infection is an infection that involves patients at least 48 hours after hospitalization (10). For ICU patients, clinical samples were regularly obtained, including associate, bronchial aspirate, tracheal aspirate, pleural fluid, blood, CSF, and wound. The patients whose collected samples yielded the growth of organisms were then identified. The following variable, such as age, sex, time of admission, ward, and site of infection were investigated. Procedures performed according to the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2000. Informed consent was obtained from all patients for being included in the research.

Bacterial isolation and identification

All collected samples were inoculated on the various microbiological media and incubated at 37ºC for 24-48 hours. The identification of the isolates was performed by colony characteristics and biochemical tests.

Antibacterial susceptibility testing

Antibacterial susceptibility testing was performed by Kirby-Bauer disk diffusion of the Muller Hinton Agar medium according to CLSI guidelines (11).

Statistical analysis

Data have been analyzed by SPSS version 17. Data were presented in number and percentage of each variant using tables and charts.

Results

During the study period, from 738 hospitalized patients in the ICUs, a total of 914 non-duplicated pathogenic bacteria were isolated. Overall, the prevalence of pathogenic bacteria was slightly higher among males (52%) than females. The prevalence had a stable rate among males and females during the study period and the average age of the patients was 53 years old. More than 50% of the patients were over 50 years old. Most of the NI patients in ICUs were elderly males. The rate of nosocomial infections in the ICUs had a constant incidence in the recorded years. The respiratory system was the most common site of nosocomial infections, the bronchoalveolar lavage was the most frequent sample, and the blood was the least (Table 1).

Table 2 reveals the prevalence of bacteria responsible for nosocomial infections. *Acinetobacter* spp (50%) and *P. aeroginosa* (18.9%) had the highest frequency rates, followed by *S. aureus* (9.8%), *Enterococcus* (6.8%), *Klebsiella pneumoniae* (4.6%) and *Enterobacter* (4.1%). The relationship between the isolates and different samples was investigated. According to the results presented in Table 2, the distribution of isolates varies among different samples. Because of the complexity, multiple pathogens were also isolated from some ICU patients. Among the total cases of nosocomial infections, 63.4% were poly microbial, and 36.5% were monobacterial (Table 3). The results showed that although Gram-negative bacteria were predominant only for polybacterial cases, Streptococci ssp. was most frequent (77.7%). The most common bacteria found in poly bacterial infections were included *Acinetobacter, P. aeruginosa*, and *S. aureus*. Also, the most abundant strain isolated each year is *Acinetobacter*, followed by *P. aeruginosa*.

The most predominant polybacterial rate was seen for Ascites (53.3%), followed by pleural fluid (44.4%), wound (36.6%) and bronchoalveolar fluid (33.9%) specimens. The Ascite and bronchial samples were found to have most poly bacterial infections rates. The rate of NI of the total ICU admissions in the ICU patients was 25%. The results showed that most of the isolates were Multiple drug resistant, and the resistance pattern is seen for each year in tables 4. The average rates of antibiotic resistance during 2019-2023 were 80, 93, 117, 139, and 192, respectively. Based on the obtained findings of this study, a trend of decreasing antibiotic susceptibility was shown in isolated strains during the five years.

Discussion

This study presents a profile of pathogenic bacterial strains isolated from patients in the ICUs of one hospital over five years. Our research aimed at determining the prevalence rate of different bacterial isolates, the frequent resistance patterns, and evaluating polybacterial infections. According to WHO, the rate of NI in developed, and developing countries is 5-15 and >25%, respectively. In addition, the prevalence of NI caused by MDR bacteria is 1-5% (12). In this study, the rate of NI in ICUs was 25% without any remarkable change during the five years. Consistent with studies by Shehabi et al., Amini et al., and Jean et al., *Pseudomonas*, *Acinetobacter*, and *S. aureus* were the most prevalent bacteria causing NIs in this study. (13-15). Unlike our study, in another study in ShahreKord, *Klebsiella* and coagulase-negative Staphylococci were more prevalent in ICU patients (16).

Table 1. Frequency (%) of clinical specimens in ICU wards during 2019-2023.

Year / Specimen	2019	2020	2021	2022	2023	Total
Ascite	1(0.10)	0	5(0.54)	6(0.66)	3(0.32)	15(1.6)
BAL	134(14.6)	96(10.50)	129(14.1)	30(3.3)	24(2.6)	413(45.2)
Pleural fluid	2(0.22)	0	5(0.54)	0	2(0.22)	9(0.98)
Bronchial	16(1.7)	5(0.54)	5(0.54)	1(0.10)	0	27(2.9)
Trachea	45(4.9)	13(1.43)	44(4.8)	96(10.50)	137(14.98)	335(36.6)
Blood	2(0.22)	0	3(0.32)	0	0	5(0.54)
wound	17(1.8)	9(0.98)	32(3.51)	18(1.98)	25(2.74)	101(11)
CSF	3(0.32)	0	3(0.32)	1(0.10)	2(0.22)	9(0.98)
Total	220(24.07)	123(13.4)	226(24.7)	152(16.6)	193(21.1)	914(100)

Table 2. Frequency (%) of isolates according to the specimen types.

Specimen / Bacteria isolated	Ascites	BAL	Pleural fluid	Bronchial	Trachea	Blood	Wound	CSF
Acinetobacter	0	221(24.1)	4(0.4)	12(1.3)	182(19.9)	1(0.1)	30(3.28)	9(0.98)
S. aureus	0	52(5.68)	1(0.1)	2(0.22)	27(2.95)	1(0.1)	7(0.77)	0
Klebsiella	0	8(0.87)	0	1(0.1)	23(2.5)	0	10(1.1)	0
P. aeruginosa	2(0.22)	89(9.73)	1(0.1)	8(0.87)	65(7.1)	0	13(1.4)	0
Streptococcus	4(0.44)	7(0.77)	1(0.1)	0	9(0.98)	0	15(1.6)	0
Enterococcus	8(0.87)	15(1.6)	2(0.2)	2(0.22)	18(1.97)	2(0.22)	16(1.7)	0
E. coli	0	3(0.3)	0	0	1(0.10)	0	4(0.44)	0
Enterobacter	1(0.10)	18(1.9)	0	2(0.22)	10(1.09)	1(0.1)	6(0.66)	9(0.98)

Table 3. Poly bacterial pattern frequency (%) according to the year.

Year / Bacterial pattern	2019	2020	2021	Total	2022	2023	Total
One bacterial	129(14.1%)	77(8.4%)	149(16.3%)	580(63.4%)	97(10.6%)	128(14%)	580(63.4%)
Two bacterial	82(8.9%)	34(3.7%)	74(8.09%)	280(30.6%)	40(4.38%)	50(5.5%)	280(30.6%)
Three bacterial	9(0.98%)	12(1.3%)	3(0.32%)	54(5.9%)	15(1.62%)	15(1.6%)	54(5.9%)

Table 4. Resistance Rate (%) of bacterial isolates.

	DC[1]	E[2]	CAZ[3]	C[4]	TE[5]	D[6]	AT[7]	CZ[8]	CRO[9]	AMX[10]	P[11]	SXT[12]	V[13]	AK[14]	IMP[15]	TZP[16]	CP[17]	MRO[18]	GM[19]
Acinetobacter	70	70	70	70	70	70	70	70	70	70	70	69	70	68	69	70	70	69	69
P. aeruginosa	70	70	70	70	70	70	70	70	70	70	70	70	68	67	68	66	68	70	70
S. aureus	70	70	70	70	70	70	70	70	70	70	70	53	10	66	68	62	70	70	70
Klebsiella	70	70	70	70	70	70	70	70	70	70	70	70	70	70	60	70	65	65	70
Enterococcus	70	70	70	70	70	70	70	70	70	70	70	70	55	70	70	55	70	70	70
Enterobacter	70	70	70	70	70	70	70	70	70	70	70	70	64	70	64	64	70	66	70
Streptococcus	70	70	70	70	70	70	70	70	70	70	65	70	50	70	70	60	70	70	70
E. coli	70	70	70	70	70	70	70	70	70	70	70	70	70	53	53	30	70	70	70

Although *E. coli* is an important NI pathogen in ICU, the prevalence of *E. coli* in this study was low, possibly because there were no urine samples in our research and the fact that *E. coli* are especially important for urinary tract infections.

Other studies have reported different prevalence rates for *P. aeruginosa* (36% in India; 33% in Brazil), *Klebsiella* (20% in India; 12% in Brazil), and *Acinetobacter* (17% in Brazil) (17-20). Polybacterial infections are more challenging to treat and impose heavier costs on the healthcare system and patients (21). We found a high rate of polybacterial infections in our study. The most prevalent bacteria, including *Acinetobacter* and *Pseudomonas*, were MDR as being resistant to different classes of antibiotics. As other studies have implied, *Acinetobacter*, *P. aeruginosa*, *Enterobacter*, *Klebsiella*, and *E. coli* were the most prevalent Gram-negatives, and *S. aureus*, Streptococci, and Enterococci were the most common Gram-positive bacteria isolated from poly bacterial infections (22). Similar studies have shown that polybacterial infections predominantly involve Gram-negative bacilli rather than Gram-positive or anaerobic bacteria (23-26). In this study, most pathogens were isolated from BAL, trachea, and wound specimens. Instead, plural aspirate, sputum, and ascites were less frequent. In a study by Harbarth and colleagues, surgical wound infections were the most common nosocomial infections (30%), followed by urinary tract infections, pneumonia, and bloodstream infection (27). In a study by Poor and colleagues, the highest incidence of nosocomial infections belonged mainly to urinary tract infections and hospital pneumonia (28). In our study, the incidence of nosocomial infections was higher at extreme ages, similar to two other domestic studies in Tehran (29) and Sanandaj (30). Also, similar to other studies, most MDR in this study was seen in patients older than 50 years old (31). Continuous monitoring of antibiotic resistance in bacteria is a routine surveillance program in many countries (32). In a study between 2002 upto 2007 in the US,

out of 29723 Gram-negative bacteria, 6644 MDRs were isolated (33). Also, a study of ICU patients in China indicated a high rate of antibiotic resistance in Gram-negative bacteria. They did not find a significant relationship between sex and the rate of nosocomial infections in ICU patients (34). In the present study, there was no relationship between sex and MDR infections. Antimicrobial administration in ICUs is ten times higher than other wards of the hospital (35-37), demonstrating a major reason for such a high level of resistance in ICUs. Our results indicated that there was no constant or certain time trend in the resistance rate of the ICU bacteria in our hospital from 2019 to 2024.

Conclusion

In conclusion, the etiology of ICU infections is polymicrobial, and MDR Gram-negative bacteria are the most predominant isolates of ICU patients. There was not a constant time trend in the resistance rate of the bacteria during five years. The rate of NI in the present study was almost the same as in other developing countries.

Acknowledgements

The authors would like to thank dear colleagues in the microbiology laboratory of the Baqiyatallah University of Medical Sciences for their laboratory work supports.

Funding Information

The authors received no financial support for the research, authorship, and/or publication of this article.

Ethics approval and consent to participate

Not needed.

Conflict of interest

All of authors declare that they have no conflict of interest.

References

1. Jima SA, Gerete TB, Hailu FB, et al. Prevalence and associated factors of nosocomial infection among children admitted at Jimma Medical Center, Southwest Ethiopia: a retrospective study. *Front Pediatr* 2025; **13**:1485334.
2. Janbakhsh A, Naghipour A, Mohseni Afshar Z, et al. The prevalence of nosocomial infections in Imam Reza Hospital of Kermanshah, Iran, during 2019–2020. *J Kermanshah Univ Med Sci* 2023; **27**:e138126.
3. Taj A, Shamim A, Khanday SB, et al. Prevalence of common nosocomial organisms in surgical intensive care unit in North India: A hospital-based study. *Int J Crit Illn Inj Sci* 2018; **8**(2):78-82.
4. Golli AL, Cristea OM, Zlatian O, et al. Prevalence of multidrug-resistant pathogens causing bloodstream infections in an intensive care unit. *Infect Drug Resist* 2022:5981-92.
5. Zlatian O, Balasoiu A, Balasoiu M, et al. Antimicrobial resistance in bacterial pathogens among hospitalised patients with severe invasive infections. *Exp Ther Med* 2018; **16**(6):4499-510.
6. Martins APS, da Mata CPSM, Dos Santos UR, et al. Association between multidrug-resistant bacteria and outcomes in intensive care unit patients: a non-interventional study. *F Pub H* 2024; **11**:1297350.
7. Unal S, Garcia-Rodriguez JA. Activity of meropenem and comparators against *Pseudomonas aeruginosa* and *Acinetobacter* spp. isolated in the MYSTIC Program, 2002-2004. *Diagn Microbiol Infect Dis* 2005; **53**(4):265-71.
8. Hashemian M, Kazemian H, Kaviar VH, et al. Nosocomial infections and antimicrobial susceptibility patterns among patients admitted to intensive care unit of Imam Khomeini hospital in Ilam, Iran. *Mol Biol Rep* 2023; **50**(7): 5565-74.
9. Khan JZ, Ismail M, Ullah R, et al. Increased

burden of MDR bacterial infections; reflection from an antibiogram of ICUs of a tertiary care hospital. *J Infect Dev Ctries* 2023; **17**(07):994-8.
10. Kulvatunyou N, Boonbarwornrattanakul A, Soonthornkit Y, et al. Incidence of ventilator-associated pneumonia (VAP) after the institution of an educational program on VAP prevention. *J Med Assoc Thai* 2007; **90**(1):89-95.
11. Wayne P. Clinical and Laboratory Standards Institute (CLSI) performance standards for antimicrobial disk diffusion susceptibility tests 19th ed. approved standard. CLSI document M100-S19 2009; **29**.
12. Lim C, Takahashi E, Hongsuwan M, et al. Epidemiology and burden of multidrug-resistant bacterial infection in a developing country. *Elife* 2016; **5**:1-18.
13. Obeidat N, Jawdat F, Al-Bakri AG, et al. Major biologic characteristics of Acinetobacter baumannii isolates from hospital environmental and patients' respiratory tract sources. *Am J Infect Control* 2014; **42**(4):401-4.
14. Amini M, Javanmard A, Davati A, et al. Bacterial colonization in tracheal tubes of ICU patients. *Iran J Pathology* 2009; **4**(3):123-7.
15. Vincent JL. Nosocomial infections in adult intensive-care units. *Lancet* 2003; **361**(9374):2068-77.
16. Habibian R. Changes of trend of antibiotic susceptibility in isolated bacteria from culture of ICU patients of Shahrekord Ayatollah Kashanani Hospital, IR Iran. *JSUMS* 2012; 14.
17. Shojaei S, Rahimi T, Amini M, et al. Survey of Nosocomial Infections in Patients Admitted to Nekoei Hospital of Qom City in 2012, Iran. *Qom Uni Med Sci J* 2015; **9**:64-73.
18. Orrett FA. Nosocomial infections in an intensive care unit in a private hospital. *West Indian Med J* 2002; **51**(1):21-4.
19. Mendes C, Oplustil C, Sakagami E, et al. Antimicrobial susceptibility in intensive care units: MYSTIC Program Brazil 2002. *Braz J Infect Dis* 2005; **9**(1):44-51.
20. Malani PN. Mandell, Douglas. Bennett's principles and practice of infectious diseases. *JAMA* 2010; **304**(18):2067-71.
21. Seth AK, Geringer MR, Hong SJ, et al. Comparative analysis of single-species and polybacterial wound biofilms using a quantitative, in vivo, rabbit ear model. *PLosOne* 2012; **7**(8):e42897.
22. Rhoads DD, Cox SB, Rees EJ, et al. Clinical identification of bacteria in human chronic wound infections: culturing vs. 16S ribosomal DNA sequencing. *BMC Infect Dis* 2012; **12**:321.
23. Mama M, Abdissa A, Sewunet T. Antimicrobial susceptibility pattern of bacterial isolates from wound infection and their sensitivity to alternative topical agents at Jimma University Specialized Hospital, South-West Ethiopia. *Ann Clin Microbiol Antimicrob* 2014; **13**:14.
24. Rolston KV, Bodey GP, Safdar A. Polymicrobial infection in patients with cancer: an underappreciated and underreported entity. *Clin Infect Dis* 2007; **45**(2):228-33.
25. Choopani A, Rafati H. Prevalence of *Staphylococcus aureus* strains isolated from wound infection and drug sensitivity pattern, Tehran-Iran (2006-07). *J Gorgan Uni Med Sci* 2012; **14**(3):135-40.
26. Thanni LO, Osinupebi OA, Deji-Agboola M. Prevalence of bacterial pathogens in infected wounds in a tertiary hospital, 1995-2001: any change in trend? *J Natl Med Assoc* 2003; **95**(12):1189-95.
27. Harbarth S, Ruef C, Francioli P, et al. Nosocomial infections in Swiss university hospitals: a multi-centre survey and review of the published experience. Swiss-Noso Network. *Schweiz Med Wochenschr* 1999; **129**(42):1521-8.
28. Larypoor M, Frsad S. Evaluation of nosocomial infections in one of hospitals of Qom, 2008. *IJMM* 2011; **5**(3):7-17.
29. Mohammadimehr M, Feizabadi MM, Bahadori O, et al. Study of prevalence of gram-negative bacteria caused nosocomial infections in ICU in Besat hospital in Tehran and detection of their antibiotic resistance pattern-year 2007. *IJMM* 2009; **3**(2):47-54.

30. Lavakhamseh H, Shakib P, Rouhi S, et al. A survey on the prevalence and antibiotic sensitivity of nosocomial infections in the besat hospital, Sanandaj, Iran. *J Nos Infec* 2014; **1**(2):1-8.
31. Zolldann D, Haefner H, Poetter C, et al. Assessment of a selective surveillance method for detecting nosocomial infections in patients in the intensive care department. *Am J Infect Control* 2003; **31**(5):261-5.
32. Sahm DF, Brown NP, Draghi DC, et al. Tracking resistance among bacterial respiratory tract pathogens: summary of findings of the TRUST Surveillance Initiative, 2001-2005. *Postgraduate medicine* 2008; **120**(1):8-15.
33. Hoban DJ, Bouchillon SK, Hawser SP, et al. Trends in the frequency of multiple drug-resistant Enterobacteriaceae and their susceptibility to ertapenem, imipenem, and other antimicrobial agents: data from the Study for Monitoring Antimicrobial Resistance Trends 2002 to 2007. *Diagn Microbiol Infect Dis* 2010; **66**(1):78-86.
34. Meng X, Dong M, Wang DI, et al. Antimicrobial susceptibility patterns of clinical isolates of gram-negative bacteria obtained from intensive care units in a tertiary hospital in Beijing, China. *J Chemother* 2011; **23**(4):207-10.
35. Bergmans DC, Bonten MJ, Gaillard CA, et al. Indications for antibiotic use in ICU patients: a one-year prospective surveillance. *J Antimicrob Chemother* 1997; **39**(4):527-35.
36. Emmerson M. Antibiotic usage and prescribing policies in the intensive care unit. *Intensive Care Med* 2000; **26**(1):S26-30.
37. Ebrahimzadeh MA, Shokrzadeh M, Ramezani A. Utilization pattern of antibiotics in different wards of specialized Sari Emam University Hospital in Iran. *Pak J Biol Sci* 2008; **11**(2): 275-9.