Original Article

# Assessment of the pattern of antibiotic resistance among microorganisms isolated from the culture medium prepared from hospitalized patients: A retrospective study

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## Abstract

**Background:** Antibiotic resistance has become quite a challenge in the treatment of bacterial infections in the world. Therefore, the present study was conducted with the aim of investigating the pattern of antibiotic resistance among microorganisms isolated from the culture medium prepared from hospitalized patients. **Methods:** The type of study was cross-sectional descriptive. The antibiotic resistance pattern of positive samples collected from patients who got hospitalized in Shahid Faghihi hospital of Shiraz University of Medical Sciences between 2020 and 2021 using the disc diffusion method according to CLSI standards was measured. Then the data were entered into SPSS version 22 software and analyzed with appropriate statistical tests. **Results:** Of all positive samples, 69.7% were Gram-negative and the rest were Gram-positive. The most frequent Gram-negative bacteria were *Acinetobacter baumannii* (31.4%), *Escherichia coli* (25.3), and *Klebsiella pneumonia* (21.2%), and the most frequent Gram-positive bacteria were *Staphylococcus aureus* (79%), *Coagulase-negative staphylococci* (15.4%), and *Enterococcus* (3.6%). The resistance rate of *Acinetobacter baumannii, Klebsiella pneumonia*, and *Pseudomonas aeroginosa* against ciprofloxacin was 91.4%, 74.3%, and 52.3%; the resistance rate against gentamicin was 90.5%, 54.3%, and 43.9%; the resistance rate against Piperacillin-Tazobactam was 85.6%, 65%, and 43.1%; the resistance rate against imipenem was 97.1%, 57.9%, and 65.4%; and the resistance rate against colostin was 1.9%, 0%, and 3.4%, respectively. The resistance rate of *Staphylococcus aureus* against cefoxotin and vancomycin was 42.7% and 2.8%, respectively. **Conclusion:** Finally, we concluded from this study that microorganisms isolated from patients have developed resistance to many commonly used antibiotics.

**Keywords:** Drug resistance, Gram-negative bacteria, Gram-positive bacteria

## Introduction

Contacting hospital-acquired infections among hospitalized patients worldwide is a concerning issue which has attracted attention. Contacting hospital-acquired infections can significantly increase the length of hospitalization and treatment costs for patients.[1] Based on studies, between 4% and 10% of all hospitalized patients develop hospital-acquired infections.[2] Antibiotics play a fundamental role in treating bacterial diseases, which is why the emergence of bacterial resistance to antibiotics has become a global problem.[3,4] There is a concern that due to antibiotic resistance, the treatment of common infections may become more difficult and the duration of disease treatment may be longer.[5] If the available antibiotics lose their effectiveness due to the phenomenon of antibiotic resistance, the consequences

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and mortality caused by existing and emerging infectious diseases will significantly increase as a serious global threat.[6,7] Resistant bacterial infections cause 1.3 to 2 times more deaths compared to antibiotic-sensitive infections.[8] The highest rate of antibiotic resistance has been reported in areas that have had the highest level of antibiotic use.[9]

Currently, the widespread emergence of antibiotic resistance, especially in cases of multidrug resistance, has limited the selection of various antibiotics, even in the final stages of bacterial diseases.[10] Therefore, conducting studies to investigate the resistance patterns among microorganisms causing diseases in order to provide better treatment for patients and prevent the antibiotic resistance procedure in healthcare centers seems essential. So, our study was conducted with the purpose of investigating the pattern of antibiotic resistance among microorganisms isolated from the culture medium of hospitalized patients.

## Material and Methods

The type of study was cross-sectional descriptive and retrospective. The statistical population of this research was all the patients admitted to the departments of Shahid Faqihi Hospital of Shiraz University of Medical Sciences between the years 2021 and 2022, and all the patients for whom bacterial culture and antibiogram were performed for any reason during the mentioned time period were included in the study. From the total of 3511 initially eligible patients, 3042 patients were finally included in the study by taking into account the inclusion and exclusion criteria. The data collection tool was a researcher-made questionnaire. The data collection tool was a researcher-made questionnaire. This questionnaire included questions such as age, gender, location of sample collection, bacterial species found in each culture sample, whether the bacteria were Gram-positive or Gram-negative, the type of antibiotics tested, and their resistance and sensitivity. To measure the sensitivity or resistance of antibiotics, the disc diffusion method was used according to the standards of Clinical and Laboratory Standards Institute (CLSI).[11]

### Data analysis

All registered data were analyzed using SPSS software version 24 for Windows (SPSS, Chicago, IL). For descriptive statistics, the mean ± SD index was used for quantitative variables with normal distribution.

### Ethical issues

This study was approved by the Ethics Committee of Shiraz University of Medical Sciences, Shiraz, Iran, and registered with the protocol number "IR.SUMS.MED.REC.1400.118".

## Results

Out of all the studied samples, 1587 samples (52.2%) were related to male patients and 1455 samples (47.8%) were related to female patients. The average age of patients in this study was obtained as 19.45 ± 56.79 (standard deviation ± mean).

Out of all the cultured samples studied, 927 (30.5%) samples were from sputum, 856 (28.1%) samples were from blood, 613 (20.2%) samples were from skin lesions, 569 (18.7%) samples were from urine, 45 (1.5%) samples were from urinary catheter, 10 (0.3%) samples were from nasal mucus, 6 (0.2%) samples were from eyes, 4 samples were from umbilical cord (0.1%), 4 (0.1%) samples were from vagina, 3 (0.09%) samples were from throat, 2 (0.06%) samples were from central catheter, 2 (0.06%) were from spleen, and 1 (0.03%) sample was from pleural fluid.

Out of all the positive samples, 2120 (69.7%) isolates belonged to Gram-negative bacteria and 922 (30.3%) isolates belonged to Gram-positive bacteria.

Out of all the isolated Gram-negative bacteria, 666 (31.4%) were A. baumannii, 536 (25.3%) were E. coli, 450 (21.2%) were K. pneumonia, 273 (12.9%) were P. aeroginosa, 124 (5.8%) were Enterobacter, 54 (2.5%) were Alcaligenes, 12 (0.56%) were Proteus, 2 (0.09%) were Brucella, 1 (0.04%) was Citrobacter, 1 (0.04%) was Salmonella, and 1 (0.04%) was Flavobacterium.

Of all positive Gram isolates, 728 (79%) were S. aureus, 142 (15.4%) were CoNS, 33 (3.6%) were Enterococcus, 13 (1.4%) were S. viridans, and 6 (0.7%) were S. pneumoniae.

In this study, it was shown that A. baumannii is highly resistant to most available antibiotics, including imipenem (97.1%). The highest sensitivity of this bacteria was to the antibiotic colistin (98.1%).

Furthermore, the highest resistance of E. coli to antibiotics was observed against trimethoprim-sulfamethoxazole (80.9%) in this study. The highest antibiotic resistance of K. pneumoniae in this study was observed against ampicillin-sulbactam (82.9%). Regarding P. aeruginosa, the highest resistance was observed against cephalothin (100%). For Enterobacter, the highest resistance was observed against clindamycin (97.1%), and for Alcaligenes, the highest resistance was observed against ceftriaxone (83.3%). For Proteus, the highest resistance was observed against nitrofurantoin (100%) and ofloxacin (100%), and regarding both Brucella isolates, both of them were sensitive to ciprofloxacin. Also, just Citrobacter and Salmonella isolates studied were sensitive to ceftriaxone, imipenem, gentamicin, amikacin, cefepime, ciprofloxacin, and ampicillin-sulbactam. Furthermore, the investigation of the antibiotic resistance pattern of Flavobacterium isolate showed that it was resistant to trimethoprim-sulfamethoxazole, ceftriaxone, gentamicin, piperacillin-tazobactam, amikacin, and cefepime but sensitive to imipenem and ciprofloxacin. The results of the study regarding the resistance and sensitivity of Gram-negative bacteria to antibiotics are shown in Table 1.

Regarding Gram-positive bacteria, the study results showed that for S. aureus, the highest resistance was observed against Penicillin G (93.6%) and ampicillin (93.3%). For CoNS species, the highest resistance was observed against

**Table 1: Antibiotic resistance pattern of Gram-negative bacteria**

| Antibiotics | Gram-Negative Bacteria (*n* (%)) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *A.baumannii* | | | *E. coli* | | | *K.pneumonia* | | | *P.aeroginosa* | | |
| | **Res** | **Inter** | **Sen** | **Res** | **Inter** | **Sen** | **Res** | **Inter** | **Sen** | **Res** | **Inter** | **Sen** |
| Nitrofurantoin | 0 (0) | 0 (0) | 8 (100) | 57 (19) | 7 (2.3) | 236 (78.7) | 67 (67.7) | 5 (5.1) | 27 (27.3) | 35 (97.2) | 0 (0) | 1 (2.8) |
| Ofloxacin | 0 (0) | 1 (12.5) | 8 (100) | 204 (68.9) | 7 (2.4) | 85 (28.7) | 66 (68) | 2 (2.1) | 29 (29.9) | 13 (40.6) | 2 (6.3) | 17 (53.1) |
| Trimethoprim-sulfamethoxazole | 1 (0.7) | 12 (8.8) | 136 (100) | 114 (80.9) | 0 (0) | 27 (19.1) | 78 82.1) | 0 (0) | 17 (17.9) | 43 (95.6) | 0 (0) | 2 (4.4) |
| Ceftriaxone | 0 (0) | 14 (2.2) | 650 (100) | 363 (69) | 7 (1.3) | 156 (29.7) | 339 (76.9) | 5 (1.1) | 97 (22) | 249 (92.6) | 3 (1.1) | 17 (6.3) |
| Imipenem | 1 (0.2) | 18 (2.7) | 657 (100) | 77 (14.5) | 4 (0.8) | 451 (84.8) | 259 (57.9) | 4 (0.9) | 184 (41.2) | 178 (65.4) | 2 (0.7) | 92 (33.8) |
| Gentamicin | 1 (0.2) | 62 (9.4) | 662 (100) | 138 (26.1) | 0 (0) | 391 (73.9) | 239 (54.3) | 2 (0.5) | 199 (45.2) | 119 (43.9) | 3 (1.1) | 149 (55) |
| Piperacillin-tazobactam | 3 (2) | 19 (12.4) | 153 (100) | 16 (9.9) | 4 (2.5) | 142 (87.7) | 80 (65) | 0 (0) | 43 (35) | 22 (43.1) | 2 (3.9) | 27 (52.9) |
| Amikacin | 3 (0.5) | 54 (8.2) | 661 (100) | 28 (5.3) | 3 (0.6) | 498 (94.1) | 159 (35.5) | 5 (1.1) | 284 (63.4) | 107 (39.2) | 3 (1.1) | 163 (59.7) |
| Cefepime | 1 (0.2) | 16 (2.5) | 653 (100) | 146 (62.4) | 7 (3) | 81 (34.6) | 261 (75.7) | 4 (1.2) | 80 (23.2) | 163 (69.1) | 11 (4.7) | 62 (26.3) |
| Cephalotin | 0 (0) | 0 (0) | 9 (100) | 240 (78.7) | 0 (0) | 65 (21.3) | 83 (82.2) | 0 (0) | 18 (17.8) | 9 (100) | 0 (0) | 0 (0) |
| Ciprofloxacin | 2 (0.3) | 50 (8.3) | 606 (100) | 349 (72.4) | 13 (2.7) | 120 (24.9) | 303 (74.3) | 10 (2.5) | 95 (23.3) | 137 (52.3) | 11 (4.2) | 114 (43.5) |
| Ampicillin-sulbactam | 14 (2.3) | 60 (10) | 603 (100) | 113 (52.6) | 14 (6.5) | 88 (40.9) | 267 (82.9) | 2 (0.6) | 53 (16.5) | 217 (93.9) | 1 (0.4) | 13 (5.6) |
| Colistin | 0 (0) | 559 (98.1) | 570 (100) | | | | 0 (0) | 0 (0) | 1 (100) | 8 (3.4) | 0 (0) | 228 (96.6) |

| Antibiotics | Gram-Negative Bacteria (*n* (%)) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *Enterobacter* | | | *Alcaligenes* | | | *Proteus* | | | *Brucella* | | |
| | **Res** | **Inter** | **Sen** | **Res** | **Inter** | **Sen** | **Res** | **Inter** | **Sen** | **Res** | **Sen** | **Int** |
| Nitrofurantoin | 12 (27.3) | 2 (4.5) | 30 (68.2) | | | | 2 (100) | 0 (0) | 0 (0) | 1 (100) | 0 (0) | |
| Ofloxacin | 32 (76.2) | 1 (2.4) | 9 (21.4) | | | | 2 (100) | 0 (0) | 0 (0) | 0 (0) | 1 (100) | |
| Trimethoprim-sulfamethoxazole | 23 (79.3) | 0 (0) | 6 (20.7) | 12 (80) | 0 (0) | 3 (20) | 2 (100) | 0 (0) | 0 (0) | 1 (50) | 1 (50) | |
| Ceftriaxone | 54 (60.7) | 0 (0) | 35 (39.3) | 45 (83.3) | 0 (0) | 9 (16.7) | 5 (41.7) | 0 (0) | 7 (58.3) | 0 (0) | 1 (100) | |
| Imipenem | 31 (34.8) | 0 (0) | 58 (65.2) | 8 (14.8) | 1 (1.9) | 45 (83.3) | 4 (33.3) | 0 (0) | 8 (66.7) | 1 (50) | 1 (50) | |
| Gentamicin | 32 (36) | 0 (0) | 57 (64) | 36 (66.7) | 0 (0) | 18 (33.3) | 2 (16.7) | 0 (0) | 10 (83.3) | 1 (100) | 0 (0) | |
| Piperacillin-tazobactam | 10 (31.3) | 0 (0) | 22 (68.8) | 0 (0) | 0 (0) | 19 (100) | 0 (0) | 0 (0) | 3 (100) | | | |
| Amikacin | 41 (42.3) | 0 (0) | 56 (57.7) | 36 (39.2) | 0 (0) | 18 (33.3) | 2 (16.7) | 0 (0) | 10 (83.3) | 0 (0) | 1 (100) | |
| Cefepime | 34 (94.4) | 0 (0) | 2 (5.6) | 42 (77.8) | 6 (11.1) | 6 (11.1) | 163 (69.1) | 11 (4.7) | 62 (26.3) | 0 (0) | 1 (100) | |
| Cephalotin | 33 (97.1) | 0 (0) | 1 (2.9) | 12 (80) | 0 (0) | 3 (20) | 2 (100) | 0 (0) | 0 (0) | 1 (100) | 0 (0) | |
| Ciprofloxacin | 22 (33.8) | 0 (0) | 43 (66.2) | 25 (50) | 6 (12) | 19 (38) | 4 (36.4) | 1 (9.1) | 6 (54.5) | 0 (0) | 2 (100) | |
| Ampicillin-sulbactam | 12 (26.1) | 1 (2.2) | 33 (71.7) | 34 (69.4) | 3 (6.1) | 12 (24.5) | 3 (33.3) | 0 (0) | 6 (66.7) | 0 (0) | 1 (100) | |
| Colistin | | | | 6 (66.7) | 0 (0) | 3 (33.3) | | | | | | |

Penicillin G (100%), ampicillin (100%), and amoxicillin (100%). For Enterococcus, the highest resistance was observed against trimethoprim-sulfamethoxazole (100%). For Streptococcus viridans (S. viridans), the highest resistance was observed against ofloxacin (100%), ceftriaxone (100%), imipenem (100%), and gentamicin (100%). In the case of pneumonia (S. pneumonia), the study showed the highest resistance against erythromycin (66.7%) and clindamycin (66.7%) and regarding Streptococcus pneumonia (S. pneumonia), the highest resistance was observed against erythromycin (66.7%) and clindamycin (66.7%) [Table 2].

## Discussion

In this study, among the Gram-negative bacteria, the highest number of isolated bacteria belonged to A. baumannii. This result contradicts the findings obtained in Europe and America, where in a study conducted between 2000 and 2002, the highest isolate isolated from patients was the E. coli bacteria.[12]

Pseudomonas aeruginosa and Acinetobacter baumannii species are common nonfermenting Gram-negative bacteria that cause hospital-acquired infections and are therefore of particular concern.[13] In this study, both these bacteria showed low levels of resistance to colistin. In this study, A. baumannii species showed 100% resistance to nitrofurantoin and cephalotin antibiotics. In this study, the resistance level of this bacterium against ciprofloxacin was found to be 91%. In the study by Hadadi *et al.*[14] in Tehran, the resistance level of A. baumannii to ciprofloxacin was reported to be 21%, which is much lower than the result obtained from our study. The concerning issue in this study was the 97.1% resistance of this bacteria to imipenem. Karimzadeh *et al.*[15] reported a similar result regarding the resistance of this bacterium to imipenem in Shiraz, with a range of 75% to 100% resistance, from 2013 to 2015. In a study conducted by Jafari Nodoushan *et al.*[16] at Zeynabieh Hospital in Shiraz, the resistance level of this bacterium to imipenem was reported as 10.1%. The study conducted in China by Ruoming Tan *et al.*[17] reported a 44.4% resistance rate of A. baumannii to this antibiotic for patients who required ICU admission for less than 48 hours. In a study conducted by Karlowsky *et al.*[18] in the United States, a resistance rate of less than 10% was reported. This significant difference in A. baumannii resistance to carbapenem in our study center compared to other centers is likely due to the high use of imipenem in this center compared to others and requires serious attention and further investigation.

In this study, the highest resistance of E. coli was against trimethoprim-sulfamethoxazole (80.9%) and the lowest resistance was against amikacin (5.3%). It also showed high resistance against ciprofloxacin (72.4%), which is commonly used in empirical treatment of urinary tract infections. In a study conducted by Karimzadeh *et al.*,[15] the resistance rate of this bacterium to trimethoprim-sulfamethoxazole was reported to be between 62.5% and 73.9%, and that to ciprofloxacin between 66.7% and 69.5%. Also, in this study, the level of E. coli resistance to amikacin was found to be 27.5%. Hadadi *et al.*[14] in Tehran also reported a 72% resistance rate of this bacterium to ciprofloxacin and a 12% resistance rate to imipenem. With these explanations, it seems better to use amikacin for empirical treatment of E. coli infections in our healthcare centers.

In this study, the highest resistance of S. aureus was observed against penicillins such as Penicillin G (93.6%), ampicillin (93.3%), and amoxicillin (91.5%), while the lowest resistance was observed against vancomycin (2.8%). The prevalence of MRSA in this study was also found to be 49.3%. A study conducted by Karimzadeh *et al.*[19] reported a prevalence of vancomycin-resistant S. aureus of 6.67% in Namazi Hospital in Shiraz between 2013 and 2015. The study conducted by Azimi *et al.*[20] in Tehran showed that the highest level of resistance among S. aureus isolates was against oxacillin (67.2%) from the penicillin family, and the lowest level of resistance was against vancomycin (1.5%). The study conducted by Gurung *et al.*[21] in Nepal showed that out of all the S. aureus isolates studied, 75% were of the MRSA type. In this study, all S. aureus isolates were resistant to penicillin, and 65.4% of the isolates were resistant to ampicillin. All isolates of S. aureus in this study were sensitive to vancomycin. A study conducted by Mendem *et al.*[22] in India showed that 45% of all S. aureus isolates were of the MRSA type. In this study, the highest level of resistance was observed against penicillin (97.64%). The resistance rate against vancomycin in this study was reported to be 10.84%. Most severe infections caused by S. aureus occur in a hospital setting, and this bacterium, especially the MRSA type, has developed high resistance to many oral antibiotics that are available.[23] Especially the emergence of vancomycin-resistant isolates, which for many years have been the antibiotic of choice for treating infections caused by S. aureus, is very concerning.[24] It seems that adhering to health protocols related to reducing the transmission of this bacterium to patients is very important in preventing severe infections.

In this study, S. pneumoniae showed the highest resistance to erythromycin (66.7%), clindamycin (66.7%), and Penicillin G (40%). Additionally, all isolates of S. pneumoniae were susceptible to amikacin, vancomycin, cefazolin, rifampin, cephalotin, and ciprofloxacin. In the study by Beheshti *et al.* in Tehran,[25] the resistance pattern of S. pneumoniae was reported as trimethoprim-sulfamethoxazole (86%), erythromycin (73%), tetracycline (66%), clindamycin (43%), penicillin (16%), chloramphenicol (14%), and levofloxacin (2%). Another study in Tehran conducted by Habibian *et al.*[26] showed that 12% of S. pneumoniae isolates were resistant to penicillin. Additionally, in this study, it was reported that 8% of isolates were resistant to vancomycin. In Wang *et al.*'s[27] study in China, the highest resistance of S. pneumoniae was observed against clindamycin (95.8%), erythromycin (95.2%), and trimethoprim-sulfamethoxazole (93.6%), while the lowest resistance was observed against ceftriaxone (8.2%). In this study, a resistance rate of 86.9% was reported against penicillin. The study also showed a high rate of resistance to macrolides. Also, a high percentage of S. pneumoniae isolates was found to be resistant to penicillin.

**Table 2: Antibiotic resistance pattern of Gram-positive bacteria**

| Antibiotics | Gram-Positive Bacteria (*n* (%)) | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *S.aureus* | | | *CoNS* | | | *Enterococcus* | | | *S.viridans* | | | *S.pneumonia* | | |
| | Res | Inter | Sen | Res | Inter | Sen | Res | Inter | Sen | Res | Inter | Sen | Res | Inter | Sen |
| Nitrofurantoin | 5 (71.4) | 0 (0) | 2 (28.6) | | | | 20 (100) | 0 (0) | 0 (0) | 2 (66.7) | | 1 (33.3) | 1 (100) | 1 (100) | 0 (0) |
| Ofloxacin | 20 (50) | 0 (0) | 20 (50) | 5 (71.4) | | 2 (28.6) | 1 (5) | 0 (0) | 19 (95) | 3 (100) | | 0 (0) | 5 (100) | 3 (60) | 0 (0) |
| Trimethoprim-sulfamethoxazol | 5 (71.4) | 0 (0) | 2 (28.6) | | | | 0 (0) | 0 (0) | 3 (100) | 3 (100) | | 0 (0) | 6 (100) | 2 (33.3) | 0 (0) |
| Ceftriaxon | 2 (22.2) | 0 (0) | 7 (77.8) | | | | 2 (9.5) | 0 (0) | 19 (90.5) | 3 (100) | | 0 (0) | 6 (100) | 4 (66.7) | 0 (0) |
| Imipenem | 6 (75) | 0 (0) | 2 (25) | | | | 5 (23.8) | 0 (0) | 16 (76.2) | 3 (100) | | 0 (0) | 6 (100) | 2 (33.3) | 0 (0) |
| Gentamicin | 4 (50) | 0 (0) | 4 (50) | | | | 8 (38.1) | 1 (4.8) | 12 (57.1) | 3 (60) | | 2 (40) | 6 (100) | 6 (100) | 0 (0) |
| Piperacillin-tazobactam | 7 (87.5) | 0 (0) | 1 (12.5) | | | | 2 (66.7) | 0 (0) | 1 (33.3) | 5 (71.4) | | 2 (28.6) | 1 (100) | 1 (100) | 0 (0) |
| Amikacin | 6 (42.9) | 0 (0) | 8 (57.1) | | | | 3 (14.3) | 0 (0) | 18 (85.7) | 7 (77.8) | | 2 (22.2) | 5 (100) | 3 (60) | 0 (0) |
| Penicillin G | 3 (6.4) | 0 (0) | 44 (93.6) | 18 (100) | | 18 (100) | 4 (33.3) | 0 (0) | 8 (66.7) | 2 (33.3) | | 4 (66.7) | 6 (100) | 2 (33.3) | 0 (0) |
| Erythromycin | 23 (14.6) | 0 (0) | 135 (85.4) | 42 (85.7) | | 7 (14.3) | 1 (9.1) | 0 (0) | 10 (90.9) | 6 (66.7) | | 3 (33.3) | 6 (100) | 4 (66.7) | 0 (0) |
| Amoxicillin | 4 (8.5) | 0 (0) | 43 (91.5) | 15 (100) | | 0 (0) | 7 (58.3) | 0 (0) | 5 (41.7) | 4 (30.8) | | 9 (69.2) | 6 (100) | 2 (33.3) | 0 (0) |
| Clindamycin | 214 (30.1) | 4 (0.6) | 492 (69.3) | 114 (81.4) | | 26 (18.6) | 1 (7.7) | 0 (0) | 12 (92.3) | 1 (33.3) | | 2 (66.7) | 6 (100) | 6 (100) | 0 (0) |
| Vancomycin | 703 (97.2) | 0 (0) | 20 (2.8) | 1 (0.7) | | 139 (99.3) | 10 (31.3) | 0 (0) | 22 (68.8) | 1 (33.3) | | 2 (66.7) | 1 (100) | 1 (100) | 0 (0) |
| Cefoxitin | 390 (57.3) | 0 (0) | 291 (42.7) | 75 (57.3) | | 56 (42.7) | 1 (50) | 0 (0) | 1 (50) | 5 (50) | | 5 (50) | 5 (100) | 3 (60) | 0 (0) |
| Cefepime | 3 (37.5) | 0 (0) | 5 (62.5) | | | | 3 (23.1) | 0 (0) | 10 (76.9) | 4 (40) | | 6 (60) | 6 (100) | 6 (100) | 0 (0) |
| Cefazolin | 499 (69.8) | 0 (0) | 216 (30.2) | 55 (39) | | 86 (61) | 4 (30.8) | 0 (0) | 9 (69.2) | 6 (54.5) | | 5 (45.5) | 5 (100) | 5 (100) | 0 (0) |
| Rifampin | 582 (80.9) | 0 (0) | 137 (19.1) | 31 (21.8) | | 111 (78.2) | 4 (13.3) | 0 (0) | 26 (86.7) | 7 (63.6) | | 1 (9.1) | 6 (100) | 6 (100) | 0 (0) |
| Cephalotin | 505 (70.6) | 0 (0) | 210 (29.4) | 49 (34.8) | | 92 (65.2) | 6 (20) | 0 (0) | 24 (80) | 7 (58.3) | | 5 (41.7) | 4 (100) | 4 (100) | 0 (0) |
| Ciprofloxacin | 40 (35.4) | 1 (0.9) | 72 (63.7) | 21 (65.6) | | 11 (34.4) | 13 (41.9) | 0 (0) | 18 (58.1) | 2 (66.7) | | 1 (33.3) | 6 (100) | 4 (66.7) | 0 (0) |
| Ampicillin | 5 (71.4) | 0 (0) | 2 (28.6) | 17 (100) | | 0 (0) | 20 (100) | 0 (0) | 0 (0) | 3 (100) | | 0 (0) | 6 (100) | 6 (100) | 0 (0) |

## Conclusion

Finally, we concluded from this study that resistance has been developed to many common and used antibiotics. It seems that in the exposure of infections caused by Gram-negative bacteria, the experimental use of cephalosporins and fluoroquinolones is no longer suitable for our medical centers, especially in the exposure of the Enterobacteriaceae family.

Overall, it seems that vancomycin is the most appropriate treatment for injuries caused by Gram-negative opportunistic bacilli (except for Enterococcus).

## Recommendation

According to the obtained results, it is suggested that while conducting continuous studies in the field of finding the pattern of antibiotic resistance in all medical centers in order to improve the monitoring protocols of antibiotic use, experimental treatment of infections should be avoided as much as possible; Because, contrary to expectations, many common antibiotics used against isolates isolated from patients are ineffective and only cause antibiotic resistance.

## Limitations

One of the limitations of this study was the low diversity of tested antibiotics in each antibiotic category and the lack of uniformity of tested antibiotics for each bacterial species, which should be taken into consideration in future research.

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## Conflicts of interest

There are no conflicts of interest

## References

1. Mehta Y, Jaggi N, Rosenthal VD, Kavathekar M, Sakle A, Munshi N, *et al.* Device-associated infection rates in 20 cities of India, data summary for 2004-2013: Findings of the International Nosocomial Infection Control Consortium. Infect Control Hosp Epidemiol 2016;37:172-81.
2. Spencer R, Perry C. Winning ways. J Hosp Infect 2004;58:245-6.
3. Dunne EF, Fey PD, Kludt P, Reporter R, Mostashari F, Shillam P, *et al.* Emergence of domestically acquired

ceftriaxone-resistant *Salmonella* infections associated with AmpC beta-lactamase. JAMA 2000;284:3151-6.

4. Kollef MH, Fraser VJ. Antibiotic resistance in the intensive care unit. Ann Intern Med 2001;134:298-314.
5. Butler CC, Hillier S, Roberts Z, Dunstan F, Howard A, Palmer S. Antibiotic-resistant infections in primary care are symptomatic for longer and increase workload: Outcomes for patients with *E. coli* UTIs. Br J Gen Pract 2006;56:686-92.
6. Alós JI, Serrano MG, Gómez-Garcés JL, Perianes J. Antibiotic resistance of *E. coli* from community-acquired urinary tract infections in relation to demographic and clinical data. Clin Microbiol Infect 2005;11:199-203.
7. Arason VA, Kristinsson KG, Sigurdsson JA, Stefánsdóttir G, Mölstad S, Gudmundsson S. Do antimicrobials increase the carriage rate of penicillin resistant pneumococci in children? Cross sectional prevalence study. BMJ 1996;313:387-91.
8. Cosgrove SE, Carmeli Y. The impact of antimicrobial resistance on health and economic outcomes. Clin Infect Dis 2003;36:1433-7.
9. Goossens H, Ferech M, Vander Stichele R, Elseviers M. Outpatient antibiotic use in Europe and association with resistance: A cross-national database study. Lancet 2005;365:579-87.
10. Ho J, Tambyah PA, Paterson DL. Multiresistant gram-negative infections: A global perspective. Curr Opin Infect Dis 2010;23:546-53.
11. Humphries RM, Ambler J, Mitchell SL, Castanheira M, Dingle T, Hindler JA, *et al.* CLSI methods development and standardization working group best practices for evaluation of antimicrobial susceptibility tests. J Clin Microbiol 2018;56:e01934-17. Erratum in: J Clin Microbiol 2023;61:e0073923. doi: 10.1128/jcm.00739-23.
12. Jones ME, Draghi DC, Thornsberry C, Karlowsky JA, Sahm DF, Wenzel RP. Emerging resistance among bacterial pathogens in the intensive care unit--a European and North American Surveillance study (2000-2002). Ann Clin Microbiol Antimicrob 2004;3:1-11.
13. Manikal VM, Landman D, Saurina G, Oydna E, Lal H, Quale J. Endemic carbapenem-resistant *A.baumannii* species in Brooklyn, New York: Citywide prevalence, interinstitutional spread, and relation to antibiotic usage. Clin Infect Dis 2000;31:101-6.
14. Hadadi A, Rasoulinejad M, Maleki Z, Yonesian M, Shirani A, Kourorian Z. Antimicrobial resistance pattern of Gram-negative bacilli of nosocomial origin at 2 university hospitals in Iran. Diagn Microbiol Infect Dis 2008;60:301-5.
15. Karimzadeh I, Sadeghimanesh N, Mirzaee M, Sagheb MM. Evaluating the resistance pattern of gram-negative bacteria during three years at the nephrology ward of a referral hospital in southwest of Iran. J Nephropathol 2017;6:210-9.
16. Jafarinodoushan M, Motamedifar M, Navidomidifar, Rahmanian M. Investigation of antibiotic resistance pattern of non-fermenting gram-negative bacteria isolated from patients in a referral hospital, Shiraz, Southwest Iran. PJMHS 2020;14:1006-10.
17. Tan R, Liu J, Li M, Huang J, Sun J, Qu H. Epidemiology and antimicrobial resistance among commonly encountered bacteria associated with infections and colonization in intensive care units in a university-affiliated hospital in Shanghai. J Microbiol Immunol Infect 2014;47:87-94.
18. Karlowsky JA, Draghi DC, Jones ME, Thornsberry C, Friedland IR, Sahm DF. Surveillance for antimicrobial susceptibility among clinical isolates of *P.aeroginosa*aeruginosa and *A.baumannii* from hospitalized patients in the United States, 1998 to 2001. Antimicrob Agents Chemother 2003;47:1681-8.
19. Karimzadeh I, Mirzaee M, Sadeghimanesh N, Sagheb MM. Antimicrobial resistance pattern of Gram-positive bacteria during three consecutive years at the nephrology ward of a tertiary referral hospital in Shiraz, Southwest Iran. J Res Pharm Pract 2016;5:238-47.
20. Azimi T, Maham S, Fallah F, Azimi L, Gholinejad Z. Evaluating the antimicrobial resistance patterns among major bacterial pathogens isolated from clinical specimens taken from patients in Mofid Children's Hospital, Tehran, Iran: 2013-2018. Infect Drug Resist 2019;12:2089-102.
21. Gurung RR, Maharjan P, Chhetri GG. Antibiotic resistance pattern of *S.aureus* with reference to MRSA isolates from pediatric patients. Future Sci OA 2020;6:FSO464. doi: 10.2144/fsoa-2019-0122.
22. Mendem SK, Alasthimannahalli Gangadhara T, Shivannavar CT, Gaddad SM. Antibiotic resistance patterns of *S.aureus:* A multi center study from India. Microb Pathog 2016;98:167-70.
23. Craft KM, Nguyen JM, Berg LJ, Townsend SD. Methicillin-resistant *Staphylococcus aureus* (MRSA): Antibiotic-resistance and the biofilm phenotype. Medchemcomm 2019;10:1231-41.
24. Pletz MW, Burkhardt O, Welte T. Nosocomial methicillin-resistant *S.aureus* (MRSA) pneumonia: Linezolid or vancomycin?-Comparison of pharmacology and clinical efficacy Eur J Med Res 2010;15:507-13.
25. Beheshti M, Jabalameli F, Feizabadi MM, Hahsemi FB, Beigverdi R, Emaneini M. Molecular characterization, antibiotic resistance pattern and capsular types of invasive *S.pneumonia*e isolated from clinical samples in Tehran, Iran. BMC Microbiol 2020;20:e167.
26. Habibian S, Mehrabi-Tavana A, Ahmadi Z, Izadi M, Jonaidi N, Darakhshanpoure J, *et al.* Serotype distribution and antibiotics susceptibility pattern of *S.pneumonia* in Iran. Iran Red Crescent Med J 2013;15:e8053.
27. Wang C-Y, Chen Y-H, Fang C, Zhou M-M, Xu H-M, Jing C-M, *et al.* Antibiotic resistance profiles and multidrug resistance patterns of *S.pneumonia*e in pediatrics: A multicenter retrospective study in mainland China. Medicine 2019;98:e15942..