



# Frequency and Antibiotic Susceptibility of *Pseudomonas aeruginosa* and *Acinetobacter baumannii* Infections in Pediatrics Intensive Care Unit of Imam Ali Hospital, Karaj, Iran During 2017-2018

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## Abstract

**Background:** *Pseudomonas aeruginosa* and *Acinetobacter baumannii* are widely ubiquitous in nature. In addition, they are opportunistic pathogens for humans and the common cause of nosocomial infections.

**Objective:** Due to the increased antibiotic resistance in the treatment of nosocomial infections, this study aimed to evaluate the antibiotic susceptibility pattern of *P. aeruginosa* and *A. baumannii* in the pediatrics intensive care unit (PICU).

**Materials and Methods:** Totally, 280 clinical samples from PICU patients were evaluated in this study. The samples were examined for *P. aeruginosa* and *A. baumannii* using standard microbiological methods. Finally, the Epsilon test method was performed to investigate the antibiotic susceptibility pattern of these bacteria.

**Results:** The results revealed a total of 21 isolates (7.5%) of *P. aeruginosa* and 11 isolates (3.9%) of *A. baumannii*. *P. aeruginosa* isolates showed the highest susceptibility to colistin (85.7%) and gentamicin (66.7%) while *A. baumannii* isolates were more susceptible to colistin (100%), ceftazidime (54.5%), and amikacin (45.5%), respectively.

**Conclusion:** Due to the antibiotic susceptibility patterns of bacterial isolates in the recent study, colistin and gentamicin are recommended for the treatment of *P. aeruginosa* infections and colistin, ceftazidime, and amikacin are suggested for *A. baumannii* infections.

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## Background

Nosocomial infections are a common medical concern in developed and developing countries, which promotes the spread of infectious diseases in the community.<sup>1</sup> In recent years, the occurrence of hospital-acquired infections in patients and personnel has been reported as an important issue worldwide, which has been associated with morbidity and mortality despite the very careful care.<sup>2</sup> The incidence of infections was 0.2% to 5.7% in Iran during 2007-2008, of which 28.9%, 28%, 26.8%, and 4.8%-16% were urinary tract, respiratory, surgical, and blood infections, respectively.<sup>3</sup> *Pseudomonas aeruginosa* is a gram-negative, mobile, aerobic, and rod-shaped

bacterium that sometimes exists in a small number of the natural flora of the gastrointestinal tract and occasionally in the human skin,<sup>4</sup> causing infections in hospitalized patients and those with cystic fibrosis.<sup>5</sup> In addition, *Acinetobacter baumannii* is a Gram-negative, obligatory aerobic, and oxidase negative bacterium. This bacterium is saprophytic and detectable from the environment and hospitals. *Acinetobacter baumannii* strains are opportunistic pathogens that cause infections in the respiratory tract, urinary tract, and wounds and cause septicemia as well. Nosocomial infections caused by these bacteria are considered as a serious problem in hospitalized patients.<sup>6</sup> Previous research showed that

the antibiotic resistance of bacterial isolates varies even in different parts of a hospital.<sup>7</sup> When the suspicion of *P. aeruginosa* and *A. baumannii* infections occurs, empirical antibiotic therapy should be initiated, but definitive treatment is based on the results of antimicrobial susceptibility tests.<sup>8</sup> The antibiotic susceptibility pattern of *P. aeruginosa* and *A. baumannii* is geographically variable.<sup>9</sup> Due to the fact that there are no epidemiologic data on the resistance of pathogens such as *P. aeruginosa* and *A. baumannii* in Karaj hospitals, knowledge about the susceptibility pattern is very critical for initiating the experimental therapy. Accordingly, this study aimed to evaluate the susceptibility pattern of these bacteria isolated from the samples obtained from the pediatric intensive care unit (PICU) of Imam Ali hospital, Karaj, Iran (2017-2018).

## Materials and Methods

### Sample Collection, Bacterial Culture, the Identification of Isolates From the ICU Environment

This study investigated 280 clinical samples from the PICU that were referred to the laboratory of Imam Ali Hospital. The specimens were transported to the medical school for up to 24 hours using specific media (blood culture media and Stuart Ringertz Transport Media). The samples were then cultured in blood agar and MacConkey agar media and isolates were identified by standard biochemical tests.<sup>10</sup> Similarly, the major operation theatres of the hospital were surveyed as part of infection control procedures.

### Determination of Antibiotic Susceptibility by Epsilon test

According to the Clinical and Laboratory Standards Institute (2017) guidelines, species identification and antimicrobial susceptibility testing were confirmed using the Epsilon test (E-test) method based on the following antibiotics. Ceftazidime, cefepime, ceftriaxone, imipenem, meropenem, piperacillin, piperacillin-tazobactam, ciprofloxacin, levofloxacin, cotrimoxazole, gentamicin, amikacin, and colistin were used to determine the antibiotic susceptibility of *P. aeruginosa* and *A. baumannii*. For susceptibility testing, *Escherichia coli* ATCC 25922 and *P. aeruginosa* ATCC 27853 were used as the control.

## Results

### Bacterial Culture

Totally, 280 samples were obtained from patients who were admitted to the PICU, including 95 blood samples and 185 respiratory and sputum secretions. Further, 21 and 11 positive cultures were related to *P. aeruginosa* and *A. baumannii*, respectively.

### Antibiotic Susceptibility Results of *Pseudomonas aeruginosa*

The results of antibiotic susceptibility testing on *P. aeruginosa* showed that 10 isolates (47.6%) were sensitive to imipenem, meropenem, piperacillin, piperacillin-tazobactam, and ciprofloxacin and 11 of them (52.4%) to levofloxacin and cotrimoxazole. Furthermore, 12 isolates (57.1%) were sensitive to ceftriaxone, ceftazidime, and cefepime and 13 isolates (61.9%) were susceptible to amikacin. Moreover, the highest sensitivity was observed to colistin and gentamicin in 18 (85.7%) and 14 (66.7%) isolates, respectively (Table 1).

### Antibiotic Susceptibility Results of *Acinetobacter baumannii*

Based on the results of antibiotic susceptibility tests on *A. baumannii*, all isolates were resistant to cefepime, ceftriaxone, ciprofloxacin, piperacillin, and piperacillin-tazobactam while 100% susceptibility was observed to colistin. Additionally, 5 isolates (45.5%) were susceptible to levofloxacin, cotrimoxazole, gentamicin, and amikacin, and 2 of them (18.2%) were sensitive to imipenem and only 1 isolate (9.1%) represented sensitivity to meropenem. Eventually, 6 isolates (54.5%) were susceptible to ceftazidime and 1 isolate (9.1%) was sensitive to ampicillin-sulbactam (Table 1).

## Discussion

*Pseudomonas aeruginosa* has been commonly reported as a pathogen which is usually resistant to antibiotics.<sup>11, 12</sup> Recently, resistance to beta-lactam antibiotics has been increased in *P. aeruginosa* in some areas. Bacteria have several mechanisms of resistance to carbapenems

**Table 1.** Antibiotic Susceptibility of *Acinetobacter Baumannii*

Antibiotic Susceptibility of <i>P. aeruginosa/A. baumannii</i> (%)		
Antibiotic	Sensitive	Resistant
IPM	47.6/18.2	52.4/81.8
MEM	47.6/9.1	52.4/90.9
PIP	47.6/0.0	52.4/100
TZP	47.6/0.0	52.4/100
CIP	47.6/0.0	52.4/100
LVX	52.4/45.5	47.6/54.5
TMP/SMX	52.4/45.0	47.6/55.0
CAZ	57.1/54.5	42.9/45.5
CRO	57.1/0.0	42.9/100
CPE	57.1/8.5	42.9/91.5
AMK	61.9/45.5	38.1/55.5
CST	85.7/100	14.3/0.0
GEN	66.7/45.5	33.3/54.5

Note. IPM: imipenem; MEM: meropenem; PIP: piperacillin; TZP: tazobactam; CIP: ciprofloxacin; LVX: levofloxacin; TMP/SMX: Trimethoprim/sulfamethoxazole; CAZ: ceftazidime; CRO: ceftriaxone; CPE: carbapenemase; AMK: amikacin; CST: colistin; GEN: gentamicin.

that include the absence of OprD purine, the high expression of secretion pumps, reduced permeability, and the production of beta-lactams such as metallo-beta-lactamases.<sup>13-15</sup> In addition, the long-term hospitalization of patients, catheterization, and the use of broad-spectrum antibiotics are the important factors which cause the high rates of infection in this unit.<sup>16</sup> In the study of Aminzadeh and Kashi, 249 Gram-negative isolates were determined which had the highest resistance to ceftazidime (68%) while the least resistance to imipenem (6.5%) among *Enterobacter* isolates.<sup>17</sup> In another study, Mohammadzadeh et al investigated the antibiotic susceptibility of imipenem resistant *P. aeruginosa* isolates in the hospitals of Tehran. The results showed 57.8%, 36.8%, 84.2%, 47.3%, and 94.7% resistance to ciprofloxacin, gentamicin, piperacillin-tazobactam, aztreonam, along with cefepime and cefotaxime, respectively, of which 31.2% of isolates were multi-drug resistant.<sup>18</sup> Further, Moniri et al identified 32 isolates of *Enterobacter* and *P. aeruginosa* from ICU. Among *P. aeruginosa* isolates, the highest resistance was found to amikacin and ampicillin-sulbactam while the highest resistance was reported to ceftazidime among *Enterobacter* spp. Isolates.<sup>19</sup> Similarly, Peymani et al investigated the multi-drug resistance (MDR) isolates of *Enterobacter* spp. and *P. aeruginosa* from patients admitted to the ICUs of the hospitals of Tehran and Qazvin and found that the most antibiotic resistance was related to cefpodoxime and cefotaxime among *P. aeruginosa* isolates. The results of this study showed a significant increase in MDR *P. aeruginosa*.<sup>20</sup> In the present study, the highest resistance was detected to imipenem, meropenem, piperacillin-tazobactam, and ciprofloxacin, and the highest sensitivity was observed to gentamicin and colistin, respectively. *A. baumannii* is an expanding opportunistic pathogen that colonizes different host groups, especially those in the ICU. This bacterium causes urinary tract and wound infections, meningitis, endocarditis, peritonitis, skin infections, and soft tissue. Moreover, several factors may predispose patients to *Acinetobacter* infections, including long-term hospitalization, immunodeficiency, surgical procedures, long-term exposure to colonized patients, burns, and age, as well as the use of a broad-spectrum antibacterial agent and the presence of invasive devices.<sup>21, 22</sup> In recent years, the increased use of antibiotics has led to the emergence of resistant strains.<sup>23</sup> The antimicrobial resistance of *A. baumannii* is due to innate and inherent mechanisms that include enzymatic changes, mutations in the target genes, changes in the permeability of the outer membrane, and the increase of the expression of the pumps.<sup>24</sup> The treatment of infections caused by this bacterium typically involves the use of beta-lactams and fluoroquinolones, which in recent years, has led to the emergence of resistant isolates by increasing the use of these antibiotics.<sup>23</sup> In a study conducted by Mohebi et al in Karaj hospitals, *Acinetobacter* isolates from various clinical samples were

resistant to cefotaxime and cefepime (100%), piperacillin (96%), ciprofloxacin (92%), aztreonam (83%), and gentamicin (75%). In this study, the most isolates were related to patients who were admitted to ICU.<sup>25</sup> In the present study, the sensitivity of *A. baumannii* to fluoroquinolones such as ciprofloxacin and beta-lactam antibiotics were low. The results demonstrated that all isolates were susceptible to ciprofloxacin and only 1 isolate (9.1%) was resistant to ampicillin-sulbactam. Colistin is the most effective therapeutic agent against *A. baumannii*. This antibiotic is also called “polymyxin E” and is a cationic polypeptide<sup>26</sup>. MDR in *Acinetobacter* spp. is a global concern. In a study by Kholatabadi et al in the hospitals of Kashan, MDR was reported to be 66%.<sup>27</sup> *Acinetobacter baumannii* has become one of the most successful pathogens in modern healthcare because of its amazing ability to acquire antimicrobial resistance and several strains of *A. baumannii* are highly resistant to most clinically available antibiotics.<sup>28</sup>

## Conclusion

Due to the high antibiotic resistance of *P. aeruginosa*, the use of colistin and gentamicin antibiotics as experimental antibiotics is recommended for the treatment of suspected cases of *P. aeruginosa*. Furthermore, the use of antibodies such as colistin, ceftazidime, or amikacin as experimental antibiotics is suggested for the treatment of suspected cases considering the high antibiotic resistance of *A. baumannii*. Finally, periodical studies for identifying drug resistance and knowledge about appropriate empirical treatment will be highly effective.

## Availability of Data and Materials

All generated or analyzed data are included in this published article.

## Conflict of Interest Disclosures

The authors declare that they have no competing interests.

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## Ethics Approval

This study was approved by the Regional Scientific Ethics Committee of Alborz University of Medical Sciences (Project number: IR.ABZUMS.REC.1396,143,144).

## Authors' Contributions

PCH, SSE, and PCH interpreted patients' data and samples. In addition, RA, KP, and MQ interpreted sample isolation and analysis. Further, RA, SN, and OS were the major contributors in writing the manuscript. Finally, all authors read and approved the final manuscript.

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**Informed Consent**

Written informed consent was obtained from the patient's parents for the publication of this article. A copy of the written consent is available for review by the Editor-in-Chief of this journal.

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