COMPARISON OF ANTIBIOTIC RESISTANCE OF ACINETOBACTER AND PSEUDOMONAS AERUGINOSA STRAINS ISOLATED FROM INTENSIVE CARE UNITS WITH OTHER CLINICS

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ABSTRACT

Introduction: Acinetobacter and Pseudomonas strains lead to serious and nosocomial infections in intensive care units (ICUs) and the other clinics. Resistance of these bacteria against to antibiotics, in particular is emerging as a very significant in intensive care units. The factors which affect the increase in resistance to antimicrobial drugs are the high probability of encountering antimicrobial resistant microorganisms and empiric antimicrobial treatment.

Materials and methods: The bacterial culture results of clinical specimens sent to Microbiology Laboratory of Mustafa Kemal University Hospital in five year period were examined retrospectively. Antimicrobial susceptibility of the bacteria of genus Acinetobacter and Pseudomonas aeruginosa isolated from these specimens were analyzed. The antibiotic resistance of P. aeruginosa and Acinetobacter strains isolated from ICUs and those isolated from other clinics was compared.

Results: In five-year period, 772 P. aeruginosa and 971 Acinetobacter spp. were isolated from the specimens. Twenty-three percent of P. aeruginosa strains and 49.3% of Acinetobacter spp. were isolated from the patients in intensive care units. 628 (64.7%) of Acinetobacter and 92 (11.9%) of P. aeruginosa strains were found to be Multidrug Resistant (MDR). The ratios of multidrug-resistance in Acinetobacter strains isolated from the patients in ICUs were found to be higher than those in P. aeruginosa strains isolated from the patients in intensive care units. MDR ratio of these bacteria isolated in ICUs was higher than that isolated in the other clinics.

Conclusion: Acinetobacter strains isolated from the patients in ICUs were determined to be more resistant than those isolated from the patients in other clinics while Pseudomonas strains isolated from the other clinics, were more resistant than those isolated from the patients hospitalized in ICUs. The ratio of MDR bacteria was higher in ICUs than that in other clinics.

Key words: Acinetobacter, Pseudomonas aeruginosa, intensive care unit, Multidrug resistance.

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Introduction

Acinetobacter and Pseudomonas strains cause serious nosocomial infections¹. The situations where suppression of the immune system such as neutropenia, hypogammaglobulinemia, complement deficiency predispose to Pseudomonas and Acinetobacter infections. Degradation of the integrity of the skin and mucous membranes, presence of intravenous or urinary catheter, usage of the endotracheal tube facilitate the development of infections with these bacteria². In addition, they are able to adapt to different environmental conditions, lack of nutrition requirements and easy to acquire resistance to antibiotics contributes to their pathogenicity²,³. They can cause septicemia, pneumonia and urinary tract infections in the hospitalized patients. Infection by these pathogens is complicated by antimicrobial resistance⁴. A large number of antibiotic-resistant strains emerge as a result of mutations; they are naturally resistant to many antibiotics⁵. Nosocomial infections with these multi-drug resistant (MDR) bacteria are a problem particularly in ICUs where the patients have an increased circulation and the usage of broad-spectrum antibiotics is high. Particularly in ICUs in hospitals Acinetobacter and Pseudomonas are opportunistic pathogens that can cause outbreaks⁵.
The probability of encountering such a pathogen is more higher in the ICU than in other clinics\(^6\).

In this study, it’s aimed to compare the antimicrobial resistance rates of *Pseudomonas* and *Acinetobacter* strains isolated from the patients hospitalized in ICUs with the antimicrobial resistance rates of them isolated from the other clinics.

**Material and method**

**Setting**

The study was performed in a newly founded university hospital in eastern mediterranean region of Turkey with 550 beds with four ICUs and 60 intensive care beds serving to a population of 1,500,000.

**Data**

The bacterial culture results of clinical specimens sent to Microbiology Laboratory of Mustafa Kemal University Hospital between January 2008 and December 2012 were analyzed retrospectively.

**Laboratory analyses**

The specimens were inoculated on the appropriate mediums and were incubated in 37 °C aerobically. Isolates were identified as *P. aeruginosa* based on colony morphology, odor, Gram staining, production of blue-green pigment on Mueller Hinton agar, reactions (k/k) on triple sugar iron agar slants, positive oxidase reaction. The species identification was confirmed with the Vitek 2 compact system (Biomerieux, France) as required. Isolates were suspected as Acinetobacter based on colony morphology on eosine methylene blue agar, Gram staining, negative oxidase reaction and identified by Vitek 2 compact system (Biomerieux, France). Antimicrobial susceptibility testing was performed by Vitek 2 compact system (Biomerieux, France). The bacteria which were determined to be resistant to at least three of these antibiotics; ceftazidime, ciprofloxacin, gentamicin and imipenem were identified as MDR bacteria.

**Statistics**

Data were analyzed using Statistical Package for Social Sciences. Comparison for categorical variables was calculated using chi-square or Fisher’s exact test. A p-value<0.05 was considered statistically significant.

**Results**

During the 5 years period, 772 *P. aeruginosa* and 971 *Acinetobacter* spp. were isolated from the specimens. More *Acinetobacter* strains were isolated than *Pseudomonas aeruginosa* strains in every year. Figure 1 shows *Pseudomonas aeruginosa* and *Acinetobacter* spp. strains by years.

![Figure 1: Pseudomonas aeruginosa and Acinetobacter spp. strains isolated by years.](image)

<table>
<thead>
<tr>
<th>The specimens</th>
<th>Pseudomonas</th>
<th>Acinetobacter</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>%</td>
<td>n</td>
</tr>
<tr>
<td>Wound</td>
<td>293</td>
<td>37.9</td>
<td>217</td>
</tr>
<tr>
<td>Urine</td>
<td>166</td>
<td>21.5</td>
<td>142</td>
</tr>
<tr>
<td>Sputum</td>
<td>155</td>
<td>20</td>
<td>227</td>
</tr>
<tr>
<td>Tracheal aspirate</td>
<td>60</td>
<td>7.8</td>
<td>158</td>
</tr>
<tr>
<td>Blood</td>
<td>35</td>
<td>4.6</td>
<td>169</td>
</tr>
<tr>
<td>Abcess</td>
<td>26</td>
<td>3.4</td>
<td>29</td>
</tr>
<tr>
<td>Bronchoalveolar lavage</td>
<td>24</td>
<td>3.1</td>
<td>3</td>
</tr>
<tr>
<td>Cerebrospinal fluid</td>
<td>6</td>
<td>0.8</td>
<td>5</td>
</tr>
<tr>
<td>Catheter</td>
<td>6</td>
<td>0.8</td>
<td>12</td>
</tr>
<tr>
<td>Peritoneal fluid</td>
<td>1</td>
<td>0.1</td>
<td>4</td>
</tr>
<tr>
<td>Pleural fluid</td>
<td>0</td>
<td>0</td>
<td>5</td>
</tr>
</tbody>
</table>

Table 1: The specimens which *Acinetobacter* and *Pseudomonas* were isolated from.

Among isolated *P. aeruginosa* strains, 293 (37.9%) were from wounds, 166 (21.5%) from urine, 155 (20%) from sputum, 60 (7.8%) tracheal aspirate, and 35 (4.6%) from blood. The specimens, from which *Acinetobacter* spp. strains were mostly isolated, were sputum (23.4%), wound (22.4%), blood (17.4%), tracheal aspirate (16.3%) and urine (14.6%). Thirty-one percent of *P. aeruginosa* and 40.5% of *Acinetobacter* strains were isolated from the lower respiratory tract samples (sputum, tra-
cheal aspirate, bronchoalveolar lavage, pleural fluid). Table 1 shows the the samples which the strains were isolated.

Twenty-three percent of *Pseudomonas aeruginosa* strains and 49.3% of *Acinetobacter* spp. were isolated from the patients in intensive care units. *Acinetobacter* strains were more frequent than *P. aeruginosa* strains in ICUs (p<0.001) (Table 2).

<table>
<thead>
<tr>
<th>The clinics (the specimens were sent from)</th>
<th><em>P. aeruginosa</em> N (%)</th>
<th><em>Acinetobacter</em> N (%)</th>
<th>Total N (%)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Other Clinics Than Intensive Care Units</td>
<td>594 (76.9)</td>
<td>492 (50.7)</td>
<td>1086 (62.3)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Intensive care units</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Surgical</td>
<td>95 (12.3)</td>
<td>238 (24.5)</td>
<td>333 (22.6)</td>
<td></td>
</tr>
<tr>
<td>Medical</td>
<td>83 (10.8)</td>
<td>241 (24.8)</td>
<td>324 (18.6)</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>772 (100)</td>
<td>971 (100)</td>
<td>1743 (100)</td>
<td></td>
</tr>
</tbody>
</table>

Table 2: The clinics which the specimens were sent from.

628 (64.7%) of *Acinetobacter* and 92 (11.9%) of *P. Aeruginosa* strains were found to be MDR. The rates of MDR *Acinetobacter* strains in ICUs were found to be higher than *Pseudomonas* strains (p<0.001) (Table 3).

<table>
<thead>
<tr>
<th>Clinics</th>
<th><em>P. aeruginosa</em> N (%)</th>
<th><em>Acinetobacter</em> N (%)</th>
<th>Total N (%)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not MDR**</td>
<td>544 (31.2)</td>
<td>274 (15.7)</td>
<td>1086 (62.3)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>MDR**</td>
<td>50 (2.9)</td>
<td>218 (12.5)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ICUs*</td>
<td>136 (7.8)</td>
<td>410 (23.5)</td>
<td>657 (37.7)</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>680 (39)</td>
<td>343 (19.7)</td>
<td>1023 (58)</td>
<td></td>
</tr>
</tbody>
</table>

Table 3: MDR rates of *P. aeruginosa* and *Acinetobacter* strains in ICUs and the other clinics.

*ICUs: intensive care units
**MDR: multidrug resistant

Multidrug resistance in *Acinetobacter* strains increased through the years. Figure 2 shows the rates of MDR *Acinetobacter* and *Pseudomonas* strains according to the years.

*Acinetobacter* strains isolated from the patients hospitalized in ICUs were determined to be more resistant than those isolated from the patients in other clinics (p<0.05). The antibiotics to which *Acinetobacter* strains isolated from the patients hospitalized in ICUs were the most resistant were ceftriaxone (52%), ceftazidime (50%), levofloxacin (49%), ceferim (48%), meropenem (45%), imipenem (45%), piperacillin/tazobactam (45%), trimethoprim/sulfamethoxazole (42%), and gentamicin (39%) (Figure 3).

![Figure 2: The rates of MDR *Acinetobacter* and *Pseudomonas* strains by years.](image2)

![Figure 3: The resistance rates of *Acinetobacter* strains isolated from the patients in intensive care units and the other clinics.](image3)

![Figure 4: The resistance rates of *P. aeruginosa* strains isolated from the patients in intensive care units and the other clinics.](image4)

When the antimicrobial resistance rates of all *Acinetobacter* and *P. aeruginosa* strains isolated in five-year period were examined, the strains isolated from ICUs were found to be more resistant to ceftriaxone, ceftazidime, ceferim, imipenem, meropenem, gentamicin and levofloxacin than the other antibiotics (p<0.001).
Discussion

A. baumannii and P. aeruginosa can cause serious infections and have been reported in many geographic regions. Infections due to these bacteria seems to be increasing worldwide, especially as cause of ventilator-associated pneumonia (VAP) in patients hospitalized in ICUs\(^{(9)}\).

Acinetobacter and Pseudomonas are bacteria that are most frequently isolated in Europe and USA. As with P aeruginosa, A baumannii infections have occurred in ICUs in USA\(^{(9)}\). The strains responsible for these outbreaks tend to be resistant to multiple agents, including carbapenems. Pseudomonas aeruginosa is the third most frequently bacterium isolated from ICUs and the clinics other than ICUs in Europe and USA\(^{(9)}\). P. aeruginosa is the third and the second most frequently bacterium isolated from ICUs in USA and Europe respectively\(^{(9)}\). It’s isolated more frequent than the other clinics. Acinetobacter is seventh most frequently bacterium isolated from ICUs in USA and Europe. Also Acinetobacter is isolated from the patients hospitalized in ICUs more frequent than the other clinics\(^{(9)}\). P. aeruginosa and Acinetobacter also lead to infections in high-risk patients in burn units. Yali et al.\(^{(10)}\) reported that while P. aeruginosa was the second most frequently isolated bacterium from the common burn ward, P. aeruginosa and Acinetobacter species were the most frequently isolated from the burn intensive care units.

They determined the antibiotic resistance rates in burn intensive care unit was more than the antibiotic resistance in common burn ward in their study. Also in the study about nosocomial infection characteristics in a burn intensive care unit, P. aeruginosa and Acinetobacter species were reported to be the most frequently isolated bacteria\(^{(11)}\).

In our study Acinetobacter strains were isolated more than Pseudomonas aeruginosa strains in the five-year period. About a half (49.3%) of Acinetobacter strains and 23% of Pseudomonas strains were isolated from intensive care units.

P. aeruginosa and Acinetobacter species were also the most frequently isolated from the ICUs in Iran, Southern Europe and Turkey in Erdem et al.’s study\(^{(12)}\). And in another study from Turkey Inan et al.\(^{(13)}\) reported that the most isolated bacteria in their study about device-associated infections in ICUs as Acinetobacter spp. (35.3%) and P. aeruginosa (20.6%). Acinetobacter spp. was isolated %16.1 and %40.6 in respectively 2004 and 2010.

In a study performed in China in between 1996 and 2001, P. aeruginosa and Acinetobacter species were found to be the most and the fourth most frequently isolated bacteria respectively\(^{(14)}\).

Nosocomial Pseudomonas and Acinetobacter spp., are often resistant to a wide range antibiotics. Aminoglycosides cephalosporins, penicillins are the antibiotics to which Acinetobacter spp. is naturally resistant. Also Pseudomonas displays intrinsic resistance to most antibiotics. Pseudomonas and Acinetobacter spp particularly cause opportunistic infections in critically ill patients. Some of them have been found to be resistant to all antibiotics\(^{(15)}\).

In another study from China P. aeruginosa, Acinetobacter baumannii were the most common strains among the isolates and multiresistant A. baumannii and P. aeruginosa shown high resistance to almost all antibiotics in ICU\(^{(16)}\). MDR rates in Acinetobacter species and P. aeruginosa were found 64.7% and 11.9% respectively in our study. Thus the rates in Acinetobacter species were determined more than P. aeruginosa.

In the study which was performed in intensive unit of trauma centre by Sharma et al\(^{(17)}\) Acinetobacter and Pseudomonas species were reported to be the most frequently isolated bacteria. And they reported that 27% of the gram negative bacteria were resistant to all drugs. Cortesa et al.\(^{(18)}\) investigated the prevelans of microorganisms isolated from the patients with bacteraemia in ICUs in their study. And they found that Acinetobacter baumannii was the fifth (4%) most frequently isolated bacteria and P. aeruginosa (3.8%) was the the sixth most frequently isolated bacteria. The carbapenem resistance rate in A. baumannii was 10.5% in 2001. And it was reported to be increased to 49.5% in 2008. During this period antimicrobial resistance in P. aeruginosa was increased from 15% to 30% in their study.

In the study included the surveillance data of Argentina, Acinetobacter species were more resistant among Gram negative bacilli isolated from adult intensive care patients\(^{(19)}\). Medell et al.\(^{(20)}\) reported that most frequently isolated were A. baumannii and P. aeruginosa in their study about nosocomial VAP in ICUs. High percentages of resistance to antibiotics were reported in this study. Resende et al.\(^{(21)}\) also reported that the most commonly found bacteria were P. aeruginosa, Acinetobacter spp. in VAP in their study. They found that 54.5% of multiresistant bacteria associated with VAP. In another study performed in our
hospital before, we found 86% of *P. aeruginosa* strains isolated from patients with lower respiratory tract infection in intensive care unit were determined to carry one and more resistance genes⁵.  

*P. aeruginosa* and *Acinetobacter* species isolated from ICUs are more resistant to the antibiotics than those isolated from the clinics other than ICUs⁶. In our study *Acinetobacter* species isolated from ICUs were found to be more resistant to the antibiotics than those isolated from the clinics other than intensive care units. Conversely *Pseudomonas* species isolated from the other clinics were found to be more resistant than those isolated from ICUs.  

Different factors including the higher frequency of *Acinetobacter* strains in intensive care units, frequent use of antibiotics that might affect these bacteria and frequent use of effective antibiotics to *Acinetobacters* empirically when an infection is suspected might be the reasons of this situation. The higher resistance rates of *P. aeruginosa* strains in clinics other than intensive care might be due to overuse of antipseudomonal agents because of higher frequency of these bacteria in these clinics and patient to patient transmission of bacteria and resistance.

References


5) Paterson DL. The Epidemiological Profile of Infections with Multidrug-Resistant *Pseudomonas aeruginosa* and *Acinetobacter Species* Clin Infect Dis 2006; 43: S43-8.


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