PREVALENCE OF MULTI-DRUG RESISTANT (MDR) 
PSEUDOMONAS AERUGINOSA ISOLATES IN SURGICAL UNITS OF 
AHMADU BELLO UNIVERSITY TEACHING HOSPITAL, ZARIA, 
NIGERIA: AN INDICATION FOR EFFECTIVE CONTROL 
MEASURES

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Abstract

Background: Multiple antibiotic resistance in bacteria populations is currently one of the greatest challenges to 
the effective management of infections. Constant bacteriological monitoring of pathogens in the hospital in 
general and specialized units is necessary to provide accurate data on the prevalence and antibiotic resistance 
pattern of specific pathogens.

Method: All clinical samples from the surgical units of ABUTH, Zaria over a 24-month period were processed 
and 
Pseudomonas aeruginosa 
isolates characterized and identified using standard microbiological procedures. 
The antibiotic susceptibility of isolates and a standard strain to ceftazidime, amikacin, gentamicin, imipenem, 
ciprofloxacin and perfloxacin was determined by the disk diffusion method.

Results: A total of 1,452 clinical specimens were processed and 878 pathogenic bacteria isolated within the 
study period. There were 92 
Pseudomonas aeruginosa 
isolates, giving a prevalence level of 10.5%. Most of the 
isolates were from urine (51.1%) and wounds (41.3%). A total of 18/92 (19.6%) of the isolates were resistant to 
three or more of the antibiotics tested, with the most prevalent resistance pattern being 
ceftazidime+gentamicin+perfloxacin+ofloxacin (27.8%).

Conclusion: There is need for instituting an antimicrobial resistance surveillance system that provides clinicians 
with up-to-date data on the prevalence and resistance pattern of commonly encountered pathogens like 
Pseudomonas aeruginosa.

Key words: Psuedomonas aeruginosa, drug resistance, surgical units

Introduction

The Pseudomonads are a diverse bacterial group of 
established and emergent pathogens. 
Members of 
the genus are major agents of nosocomial and 
community acquired infections, being widely 
distributed in the hospital environment where they are 
particularly difficult to eradicate. 
However, despite 
abundant opportunities for spread, 
Pseudomonas aeruginosa 
rarely causes community acquired 
infections in immunocompetent patients.

Pseudomonas aeruginosa, although not an 
obligate parasite, is the species amongst the 
Pseudomonads most commonly associated with 
human diseases. There has been a lot of recent 
advances in medicine, such as, the advent of more 
elaborate surgery and intensive care, the use of broad 
spectrum antibiotics and immunosuppressive drugs, 
the availability of invasive procedures or 
instrumentations and the increase in the number of 
immunocompromised patients (e.g. oncology patients 
on cytotoxic therapy / radiotherapy, patients with 
organ transplants and even patients with AIDS). A 
direct consequence of this is that there is a rise in 
patients with impaired immune defences 
thereby 
leading to an increase in nosocomial infections 
especially by Gram-negative organisms such as 
Pseudomonas. Such organisms may be found in the 
patient’s own flora, or in damp environmental sites or 
hospital equipments and medicaments. They exhibit 
natural resistance to many antibiotics and antisepsics 
in which they may survive for long periods, and may 
even multiply in the presence of minimal nutrients 
and have the ability to colonize traumatised skin.

In recent years, drug resistant bacteria have given 
rise to several serious outbreaks of infections with 
many deaths. 
Pseudomonas aeruginosa 
is known to 
cause a wide spectrum of diseases. It can infect
almost any external site or organ, and therefore can be isolated from various body fluids such as sputum, urine, wounds, eye or ear swabs and from blood.  

Constant bacteriological monitoring of the pathogens isolated from clinical specimens from patients in special units is necessary to draw attention of clinicians and infection control specialists to their current antibiotic susceptibility pattern and how often specific pathogens are isolated. This will form the bedrock of appropriate surveillance studies in such settings that will lead to developing, implementing and monitoring the impact of interventions such as the evidence-based, mutually agreed guidelines for the empirical antimicrobial therapy of common pathogens, effective infection control and public health guidelines.

Materials and Methods

Isolation, characterisation and identification

All clinical samples received from the surgical unit of ABUTH, Zaria, Nigeria between October 1999 and September 2001 were processed using standard microbiological procedures. 

Pseudomonas aeruginosa isolates were characterised and identified using a combination of colonial morphology, Gram stain characteristics, motility test, oxidative- fermentation test, catalase, citrate and oxidase tests and pyocyanin production.

Antibiotic susceptibility testing

The antibiotic susceptibility pattern of the Pseudomonas aeruginosa isolates was determined using the disk diffusion method according to the modified Kirby-Bauer technique. All the clinical isolates and a standard strain Pseudomonas aeruginosa ATCC 27853 were tested for their sensitivity to the following antibiotics: ceftazidime 30µg, amikacin 30µg, gentamicin 10µg, imipenem 10µg, ciprofloxacin 5µg (all from 54932 BioMeriéux SA Marcy L’Etoile, France); ofloxacin 5µg (B39892 Oxoid Unipath Ltd, Basingstoke, England); perfloxacin 10µg (152 Pasteur Biological Laboratory, India).

Results

A total of 1,452 clinical specimens were received from the surgical units of ABUTH, Zaria between October 1999 and September 2001, with 878 pathogenic bacteria isolated. There were 92 isolates of Pseudomonas aeruginosa, giving a prevalence level of 10.5%. Table 1 shows the relative distribution of the Pseudomonas aeruginosa isolated in various clinical specimens. Most of the isolates were from urine 47 of 92 [51.1%] and wounds 38 of 92 [41.3%]. Only one isolate each was obtained from blood and sputum.

Table 2 shows the antibiotic susceptibility pattern of the Pseudomonas aeruginosa isolates based on the source of the isolates. A total of 31 of 47(66%) of the isolates from urine and 26 of 35(74.3%) from wound were sensitive to gentamicin. Greater than 80% of the isolates from wound were sensitive to Imipenem, Amikacin, Ciprofloxacin and Cefazidime while more than 70% of the isolates from urine were sensitive to the same drugs. Isolates were considered multi-resistant if they showed resistance to three or more of the tested antibiotics. A total of 28 of 92(19.6%) were multi-resistant and they were isolated from urine, 9 of 47(19.1%); wound, 7 of 38(18.9%) and catheter tip, 2 of 3(66.7%).

Table 1: Distribution of pseudomonas aeruginosa from various clinical specimens

<table>
<thead>
<tr>
<th>Source/Site</th>
<th>No of isolates</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urine</td>
<td>47</td>
<td>51.1</td>
</tr>
<tr>
<td>Wounds</td>
<td>38</td>
<td>41.3</td>
</tr>
<tr>
<td>Catheter tip</td>
<td>3</td>
<td>3.3</td>
</tr>
<tr>
<td>Ear swabs</td>
<td>2</td>
<td>2.1</td>
</tr>
<tr>
<td>Blood</td>
<td>1</td>
<td>1.1</td>
</tr>
<tr>
<td>Sputum</td>
<td>1</td>
<td>1.1</td>
</tr>
<tr>
<td>Total</td>
<td>92</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Table 2: Antibiotic susceptibility pattern of pseudomonas aeruginosa isolates based on site of specimen

<table>
<thead>
<tr>
<th>Source/Site</th>
<th>IPM</th>
<th>CIP</th>
<th>AN</th>
<th>CAZ</th>
<th>GN</th>
<th>PEF</th>
<th>OFX</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urine [47]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>1</td>
<td>4</td>
<td>4</td>
<td>5</td>
<td>2</td>
<td>3</td>
<td>7</td>
</tr>
<tr>
<td>6</td>
<td>3</td>
<td>6</td>
<td></td>
<td>6</td>
<td>1</td>
<td>7</td>
<td>9</td>
</tr>
<tr>
<td>Wound [38]</td>
<td>3</td>
<td>3</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>5</td>
<td>4</td>
<td>6</td>
<td></td>
<td>1</td>
<td>6</td>
<td>0</td>
<td>8</td>
</tr>
<tr>
<td>Catheter tip [3]</td>
<td>2</td>
<td>2</td>
<td>-</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>2</td>
</tr>
<tr>
<td>Ear swab [2]</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>-</td>
<td>2</td>
<td>-</td>
</tr>
<tr>
<td>Blood [1]</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>Sputum [1]</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>1</td>
<td>-</td>
</tr>
</tbody>
</table>

Permutation test.
| Total | 8 | 5 | - | 8 | - | 9 | 8 | 6 | 4 | 7 | 9 | 1 | 5 | 1 | 2 | 3 | 3 | 1 | 1 | 4 | 3 |
|       | 7 | 3 | 2 | 2 | 1 | 9 | 3 | 0 | 8 | 7 | 7 | 6 | 0 | 6 |

Imp = Imipenem; Cip = Ciprofloxacin; An = Amikacin; Caz = Ceftazidime; Gn = Gentamicin; Pef = Perfloxacin; Ofx = Ofloxacin; S = Sensitive; R = Resistant; I = Intermediate
Discussion

In this study, 92 isolates of \textit{P. aeruginosa} from clinical samples received from the surgical unit of the Ahmadu Bello University Teaching Hospital, Zaria, were studied. This number represents 10.5\% (92/878) of various bacterial pathogens isolated from this unit between October 1999 and September 2001. In two similar studies, the percentage prevalence was higher (14.4\% and 17.5\%). However these studies though also hospital based covered all specimens from all clinical units within the respective hospitals and so the study population and number of specimens studied were larger. 13,14

Most isolates in this study were obtained from urine samples, accounting for 51.1\% of the total. This is not surprising considering the fact that most patients going in for major surgery tend to get catheterised. Also the study included patients from the urology unit, some of who had been on catheter for a considerable period of time. Unfortunately, it could not be determined which of the urine samples were catheter specimens, post catheterisation specimens or mid-stream urine samples.

It has however been shown in other studies that the use of indwelling catheters create an inherent risk for infection. 15 Catheter associated UTIs (CAUTIs) comprise perhaps the largest institutional reservoir of nosocomial antibiotic resistant pathogens and the most important of which are multiple drug resistance enterobacteriaceae such as \textit{Klebsiella}, \textit{Proteus}, \textit{P. aeruginosa} etc. 16,17 CAUTI is also the second most common cause of nosocomial blood stream infection. 18

Microorganisms are commonly attached to indwelling medical devices such as urinary catheters to form biofilms made up of extracellular polymers. Bacteria that commonly contaminate urinary catheters and develop biofilms are \textit{Staphylococcus epidermidis}, \textit{Enterococcus faecalis}, \textit{Escherichia coli}, \textit{Proteus mirabilis}, \textit{P. aeruginosa} and \textit{Klebsiella pneumoniae}. 19 The longer the urinary catheter remains in place, the greater the tendency for these organisms to develop biofilms and result in UTI. For example, it was discovered that 10 – 50\% of patients undergoing short-term catheterisation (i.e. \( \leq 7 \) days) become infected, while virtually all patients undergoing long-term catheterisation (\( \geq 28 \) days) become infected. 19

Also in a study done in Benin, \textit{P. aeruginosa} accounted for 16.95\% of CAUTI. 20

In this study, 41.3\% of the isolates were obtained from wounds however the nature of the wounds was not defined. Tissues taken from non-device related chronic infections have shown the presence of biofilms bacteria surrounded by an exopolysaccharide matrix. 21 \textit{P. aeruginosa} has also increasingly been isolated in surgical wound infections. 22

The incidence of wound infection however varies from surgeon to surgeon, from hospital to hospital, from one surgical procedure to another and most importantly from one patient to another. 23 Also hospital patients receiving broad-spectrum antibiotics as prophylaxis are frequently colonized by \textit{P. aeruginosa} in the lower intestinal tract. 9,22

Blood and sputum accounted for 1.1\% each of the \textit{Pseudomonas aeruginosa} isolates obtained in this study; this may be due to the low number of blood and sputum samples sent in from the surgical unit during the study period. However \textit{P. aeruginosa} is said to be responsible for pneumonia and septicaemia with attributable deaths reaching 30\% in immunocompromised patients. 24 – 26 The possibility of aspiration Pseudomonal pneumonia cannot be ruled out in post-surgical patients especially if immunocompromised.

The prevalence of antimicrobial pathogens often varies dramatically between communities, hospitals in the same community, and among different patient populations in the same hospital. 25 Faced with these variations, the physician in clinical practice has the responsibility of making clinical judgements about likely pathogen(s) involved in the infection process. To effectively and correctly make such judgements, they should have access to up-to-date data on the prevalence and antimicrobial resistance pattern of commonly encountered pathogens in their practice setting. It is therefore important to institute a system for the surveillance of antimicrobial resistance that will involve the collection and collation of both clinical and microbiological data. 8

References

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