Susceptibility Profile of Clinical Isolates of *Pseudomonas aeruginosa* to Recommended Antipseudomonal Antibiotics in Ibadan, Nigeria

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Abstract

Background: *Clinical isolates of Pseudomonas aeruginosa have been shown to demonstrate high resistance to various classes of antibiotics because of its unique nature.The increasing rate of resistance development among Pseudomonas aeruginosa strains, which also vary with geographical locations, has led to the recommendation of some classes of antibiotics for the treatment of pseudomonal infections. This study was therefore designed to determine the susceptibility of clinical isolates of P.aeruginosa in this environment to the various recommended classes of antibiotics.*

Materials and Methods: *P.aeruginosa strains were isolated and identified from various clinical specimens brought to the Medical Microbiology Laboratory of University College Hospital, Ibadan, Nigeria, between April and December 2009. These were subjected to antimicrobial susceptibility testing using the various classes of recommended antipseudomonal antibiotics.*

Results: *The strains of P.aeruginosa tested demonstrated high susceptibility rates to most of the recommended antipseudomonal antibiotics with the exception of gentamycin and ceftriaxone. Their susceptibility rates to the antibiotics were as follows: 75.9% to ciprofloxacin, 71.4% to pefloxacin and 60.9% to ofloxacin. Susceptibility rates to cefepime, meropenem, piperacillin, amikacin, ceftriaxone and gentamycin were 85.1%, 80.1%, 83.9%, 65.5%, 36.8% and 6.9% respectively.*

Conclusions: *Development of antibiotic resistance has been attributed to irrational and inappropriate use of antibiotics. Therefore, in order to sustain the high susceptibility demonstrated by P.aeruginosa to the tested antibiotics in this study, public health policy on appropriate prescribing and use of antibiotics must be instituted and effected in this environment.*

Keywords: *Pseudomonas aeruginosa, Susceptibility, Recommended Antipseudomonal Antibiotics*

Introduction

Pseudomonas aeruginosa strains, apart from being widely distributed in nature, are also highly prevalent in the hospital environment.[1] They have been implicated in various nosocomial infections and these include surgical site infections, severe burns, urinary tract infections and nosocomial pneumonia especially in immunocompromised patients.[2] Nosocomial infections caused by this organism

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are often associated with high morbidity and mortality because the strains of this causative microorganism are virulent and have a limited susceptibility to antimicrobials.[3] Despite therapy, the mortality due to nosocomial pseudomonas pneumonia is approximately 70%.[4]

In the United States, the overall prevalence in hospitals was approximately 4 per 1000 discharged and is the 4th cause of nosocomial infection, accounting for 10% of all nosocomial infections. In Nigeria, it is one of the leading Gram-negative bacteria isolated from clinical specimens in hospital–based studies.

Multiple antibiotic resistance in bacterial populations is a pervasive and growing clinical problem, which is recognized as a threat to public health. *P.aeruginosa* has demonstrated resistance to multiple antibiotics, thereby jeopardizing the selection of appropriate treatment.Furthermore, antibiotic resistance of *P. aeruginosa* isolates, which may be acquired during treatment, varies with geographical location and hospital environment. Regular antimicrobial susceptibility surveillance is therefore necessary for monitoring resistance patterns in various geographical locations.

A study conducted by Viren A Javiya in 2008 recommended the use of semi-synthetic penicillin like ticarcillin, piperacillin or 3rd–generation cephalosporins like cefoperazone, cefotaxime and ceftriaxone along with beta-lactamase inhibitors (clavulanate or sulbactam) against *P.aeruginosa* infections and to reserve amikacin for the treatment of severe nosocomial infections.[9]

This study was therefore conducted to determine the susceptibility pattern of clinical isolates of *P.aeruginosa* in our environment to some of the recommended classes of antibiotics. These include cefepime, a fourth generation cephalosporin and some carbapenems.

Materials and Methods

This is a laboratory-based study conducted over a period of 9 months (April-December 2009) in the diagnostic Medical Microbiology Laboratory of University College Hospital, Ibadan, Oyo State, Nigeria. This hospital is a major referral centre for other secondary and tertiary hospitals in the South Western Nigeria. It is a 800-bed facility with subspecialities in surgery, internal medicine, paediatrics, obstetrics and gynaecology, and laboratory medicine.

Pseudomonas aeruginosa strains were isolated and identified from various clinical specimens by standard bacteriological methods, which included colonial morphology, non-lactose fermentation, positive oxidase reaction, pyocyanin production, and Gram reaction (Gram-negative bacilli)[10]. The clinical specimens were wound swabs, tracheal aspirate, ear swabs, catheter tips, stool, sputum, urine and pus.

All the isolates identified as *Pseudomonas aeruginosa* were subjected to antimicrobial susceptibility tests according to the recommendation of the Clinical and Laboratory Standards Institute (CLSI) for disc diffusion tests.[11] The isolates were tested against the following antibiotics: ciprofloxacin(30ug), cefepime(30ug),ceftriaxone(30ug), meropenem (10ug), amikacin(30ug), piperacillin(30ug),pefloxacin(30ug), ofloxacin(10ug) and gentamycin (10ug).

The biographic information of the patients included in this study, which were age and sex,were obtained and recorded.

The diameters of zones of inhibition around the colonies of *Pseudomonas aeruginosa* were measured with calibrated meter rule and interpreted as susceptible or resistant in accordance with CLSI guidelines.[11]

Results

A total of one hundred and seventy-four strains of *P.aeruginosa* were recovered from various clinical specimens during the period of study.

Table1.
Frequency of isolation of *Pseudomonas aeruginosa* from clinical specimens

Clinical specimens	Frequency of isolation	
	Number	Percentage (%)
Sputum	10	5.8
Pus	6	3.5
Ear swabs	64	36.8
Catheter tips	12	6.9
Stool	6	3.5
Wound swabs	56	32.2
Urine	16	9.2
Tracheal aspirates	4	2.3
Total	174	100.0

A breakdown of the frequency of isolation of *P.aeruginosa* strains from these clinical specimens revealed that there were 56 (32.2%) from wound swabs, 4(2.3%) from tracheal aspirate, 64 (36.8%) from ear swabs, 12(6.9%) from catheter tips, 6(3.5%) from stool,10(5.8%) from sputum, 16(9.2%) from urine and 6(3.5%) from pus (Table1).The patients from whose specimens these strains were isolated

Table 2.
Gender distribution of patients with *Pseudomonas aeruginosa* infections

Sex	Number	Percentage (%)
Male	108	62
Female	66	38
Total	174	100.0

consisted of 108 (62%) males and 66 (38%) females (Table 2). The age range of these patients were between 4 months and 65 years. High susceptibility rates were demonstrated towards the recommended antipseudomonal antibiotics with the exception of gentamycin which demonstrated a rather low susceptibility. Among the 174 isolates of *P.aeruginosa,* 132 (75.9%), 124 (71.4%) and 106 (60.9%) were susceptible to ciprofloxacin, pefloxacin and ofloxacin respectively. 148 (85.1%) were

Table 3.

Antibiotic susceptibility pattern of clinical isolates of *Pseudomonas aeruginosa*

Antibiotics	Antibiotic susceptibility pattern	
	Susceptible No (%)	Resistant No (%)
Ciprofloxacin	132 (75.9)	42 (24.1)
Pefloxacin	124 (71.4)	50 (28.6)
Ofloxacin	106 (60.9)	68 (39.1)
Cefepime	148 (85.1)	26 (14.9)
Ceftriaxone	64 (36.8)	110 (63.2)
Gentamycin	12 (6.9)	162 (93.1)
Amikacin	114 (65.5)	60 (34.5)
Meropenem	140 (80.1)	34 (19.9)
Piperacillin	146 (83.9)	28 (16.1)

susceptible to cefepime, a 4th generation cephalosporin, 140 (80.1%) to meropenem, 146 (83.9%) to piperacillin, 114 (65.5%) to amikacin, 64 (36.8%) to ceftriaxone and 12 (6.9%) to gentamycin (Table 3). The highest susceptibility 148 (85.1%) was demonstrated towards cefepime, while the lowest was found in gentamycin 12 (6.9%), an aminoglycoside. The susceptibility pattern of *P.aeruginosa* in the various clinical specimens is shown in Table 4.

Table 4.
Antibiotic susceptibility pattern of *P.aeruginosa* isolates from clinical specimens.

Antibiotics	Clinical Specimens							
	Wound swabs (56) No (%)	Ear swabs (64) No (%)	Urine (16) No(%)	Pus (6) No(%)	Catheter Tips (12) No(%)	Sputum (10) No(%)	Tracheal aspirate (4) No (%)	Stool (6) No(%)
Ciprofloxacin	32(57.1)	60(93.8)	8(50.0)	2(33.3)	6(50.0)	8(80.0)	0(0.0)	0(0.0)
Cefepime	52(92.9)	60(93.8)	8(50.0)	4(66.3)	10(83.3)	8(80.0)	0(0.0)	0(0.0)
Ceftriaxone	8 (14.3)	30(46.9)	12(75.0)	2(33.3)	2(16.7)	6(60.0)	0(0.0)	4(66.7)
Amikacin	36(64.3)	38(59.4)	12(75.0)	6(100.0)	4(33.3)	8(80.0)	4(100.0)	4(66.7)
Meropenem	48(85.7)	52(81.3)	14(87.5)	6(100.0)	4(33.3)	8(80.0)	0(0.0)	2(33.3)
Pefloxacin	28(50.0)	48(75.0)	6(37.5)	2(33.3)	4(33.3)	4(40.0)	0(0.0)	0(0.0)
Piperacillin	40(71.4)	48(75.0)	10(62.5)	4(66.3)	4(33.3)	2(20.0)	2(50.0)	2(33.3)
Ofloxacin	24(42.9)	52(81.3)	6(37.5)	2(33.3)	4(33.3)	6(60.0)	0(0.0)	0(0.0)
Gentamycin	8(14.3)	16(2.5)	2(12.5)	0(0.0)	2(16.7)	6(60.0)	0(0.0)	0(0.0)

Discussion

Pseudomonas aeruginosa, as an opportunistic pathogen, can cause life-threatening diseases. It is usually the main cause of mortality in cases of polymicrobial bacteraemia.[12] It has also been implicated as a leading cause of nosocomial infections especially among critically ill admitted in intensive care unit and in immuno compromised patients.

In the breakdown of frequency of isolation of *P. aeruginosa* strains from clinical specimens in this study, majority of the strains were isolated from ear swabs (36.8%), followed by wound swabs (32.2%), urine (9.2%) and catheter tips (6.9%). This is contrary to the study conducted by Javiya et al in 2008 where majority of the *P.aeruginosa* strains were isolated from urine specimens followed by pus and sputum.[9]

The unique feature of *P.aeruginosa* has been its resistance to a variety of antibiotics which is primarily attributed to low permeability of the cell wall, production of inducible

cephalosporinase, active efflux and poor affinity for the target DNA gyrase.[13] Infections caused by *P.aeruginosa* are found to be particularly problematic because the organism is inherently resistant to many drug classes and is able to acquire resistance to all effective antimicrobial drugs.[14] In the present study, there was a clear tendency towards good susceptibility for most of the groups of antibiotics recommended for use against *P.aeruginosa. Pseudomonas aeruginosa* was most susceptible to cefepime, a 4th generation cephalosporin, and, this is consistent with reports from other groups of workers.[15-17]

However, susceptibility to another cephaslosporin of the 3rd generation, ceftriaxone, was rather poor. This finding is similar to the one reported by Yetkin *et al* in 2006, where the percentage of resistance to cephalosporins was in the range of 27% to 88%.[18] Our study has also recorded good susceptibilities to the quinolones, ciprofloxacin (75.9%), pefloxacin (71.4%) and ofloxacin (60.9%) which is contrary to high resistance rates reported by some other workers.[19-20]

Earlier studies have also shown meropenem to be the most effective antibiotic against *P.aeruginosa* but more recent studies have demonstrated the evolution of meropenem-resistant strains of *P.aeruginosa*.[21] However, the present study has demonstrated good activity of meropenem (80.1%) against *P.aeruginosa*. The activity of amikacin (65.5%) against *P.aeruginosa* was quite good in this study but poor in gentamycin (6.9%). The effectiveness demonstrated by amikacin against *P.aeruginosa* is corroborated by reports from other groups of workers.[18] In addition, the resistance pattern to gentamycin demonstrated in this study was also similar to the one reported by Muller–Premru and Gubina in 2000.[22] Piperacillin (83.9%) also showed high susceptibility against *P.aeruginosa*.

Studies conducted recently have focussed on decreased susceptibility of *P.aeruginosa* to currently used antipseudomonal agents which include beta-lactams, aminoglycosides and fluoroquinolones. The carbapenems, imipenem and meropenem have been demonstrated to be active against multidrug-resistant strains of *P.aeruginosa* but there have been reports of resistance to these antibiotics which has constituted a growing therapeutic problem.

The difference in susceptibility or resistance pattern demonstrated in different geographic locations may be attributable to factors like exposure to antibiotics, studied population, and type of clinical specimen examined (Table 4).

Conclusion

Since development of resistance to antibiotics has been attributed to inappropriate use or abuse of antibiotics in infectious diseases, and in order to sustain the high susceptibility demonstrated by *Pseudomonas aeruginosa* to the tested antibiotics in this study, rational use of antimicrobials must be a priority. Moreover, a public health policy on appropriate prescribing and use of antibiotics must be instituted and effected. The practice of promoting the use of antibiotics for prophylaxis in clinical settings where they are unnecessary should be discouraged. Furthermore, the concept of reserving antibiotics to minimize the misuse of available antimicrobials must be adopted and strictly adhered to.

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