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SHORT COMMUNICATION

Prevalence, antibiogram profile and cross transmission of *Pseudomonas aeruginosa* in a tertiary burn unit

Emmanuel Maundy Ikpeme, Kingsley Hovana Enyi-Idoh*, Joseph Fuh Nfongeh, Lawrence Bassey Etim and Felix Chinedu Akubuenyi

Department of Biological Sciences, Cross River University of Technology, Calabar, Cross River State, Nigeria.
E.mail: kingenyi@gmail.com

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ABSTRACT

Aims: *Pseudomonas aeruginosa* is an opportunistic pathogen that still develops life threatening infections in patients with immunological system defects like burns. The major problem with this organism is the ability to persist during infections due to its high rate of resistance to many drugs. This study was designed to evaluate the prevalence and drug susceptibility profile of *Pseudomonas aeruginosa* in patients admitted to a burn unit in a tertiary health facility.
Methodology and Result: From 80 selected patients, appropriate clinical specimens from burn sites were collected and processed for the isolation and identification of *Pseudomonas aeruginosa..* Also, 78 surveillance samples from various environmental sites and hands impressions of nursing staff in the burn unit were cultured for the isolation of *Pseudomonas aeruginosa.* Drug susceptibility profile showed high resistance for *ceftazidime* (40.7%) *ciprofloxacin* (13.1%) and *piperacillin* (34.6%); furthermore, low resistance for some antibiotics like imipenem (17.5%) pipereracillin/tazobactam (12.3%) and *aztreonam* (16%) were obtained. In addition, 8 multiresistant *Pseudomonas aeruginosa* (MRPA) isolates were recovered from clinical specimens and from environmental samples.
Conclusion, significance and impact of study: Evidence of high prevalence of clinical and environmental MRPA reported in this study provides the rationale for strict enforcement of infection prevention protocol to minimize cross transmission of bacterial pathogens in hospital burn units and consequent disease burden arising from MRPA.

Keywords: Nosocomial infection, drug susceptibility, cross transmission

INTRODUCTION

Infection in the burn unit has been under intense study over the past few decades (Gikas *et al*., 2000; Pruitt *et al*., 1998). Immunucompromised or critically ill patients are at high risk of getting the hospital acquired infections.
Bacterial infections following severe burn injuries can be most simplistically attributed to extensive breaches in the skin barrier. The fact that *Pseudomonas aeruginosa* occurs so commonly in the environment makes it extremely likely that an individual suffering severe burns will be challenged with this micro-organism before the burns can heal (Erol *et al.*, 2004). Since this bacterium is naturally resistant to many drugs and is able to get resistance to all effective antimicrobials, the infection with this organism is particularly problematic condition for patients.

Burn units are known to harbour multidrug resistant (MDR) P*seudomonas aeruginosa* that can serve as source of infection (Rossolini *et al*., 2005). Apart from the inanimate hospital environment,bacterial flora is also carried into a hospital by the patient and can be an important source of infection for the same individuals after burn injuries. The worst scenario occurs when such strain cross contaminate other burn victims and can persist throughout several course of antibiotic treatment. In an outbreak of *P. aeruginosa* in a hospital, including a medical/surgical unit, a stepdown and a transplant unit, more environmental strains of the bacteria was recovered from sink drains and faucet heads than from equipment such as respiratory equipment, intravenous monitors, dispensing machines, ice machines, fluid dispensers and scissor hooks. (Hota *et al*., 2009).

In another study that reviewed a 6-year antibiotic susceptibility record to assess the prevalence of MDR isolates at a US Army burn center, *Acinetobacter baumannii* (22%) was found to be most prevalent organism recovered, followed by *Pseudomonas aeruginosa* (20%) (Keen *et al*., 2010). *P. aeruginosa*, was also found to be resistant to all 4 classes of antibiotics tested in the study, including colistin.

***Corresponding author**

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Antibiotic susceptibility test is therefore imperative as it guides the selection of an effective regimen of the treatment of *Pseudomonas aeruginosa* infections. Data from antibiograms are most useful when initiating empiric therapy or when tracking antimicrobial resistance over time within a hospital or health care system (Agnihotri *et al*., 2004). Accordingly our work sought to determine the profile of drug susceptibility and colonization routes of *Pseudomonas aeruginosa* isolated from burn injuries with a view to making informed decisions on the choice of effective clinical management of the disease burden.

MATERIALS AND METHODS

The University of Calabar Teaching Hospital (UCTH) is one of the many referral centres in South-South Nigeria, for patients with severe burn injuries. Patients were hospitalized in the burn unit following different types of burn injuries; gasoline (n = 15), oil (n=18), boiling water (n= 44), flame (n=6) acid (n=3). The age range of patients was classified as follows: under 15 (n=46), 15 to 40 (n=20), above 40 (n=14).There were altogether 49 male and 31 female patients. Clinical samples included burn wounds swabs; environmental samples (78) were water from faucets, swabs from sinks, floors, door handles, dressing trolleys, hand impressions of staff, antiseptics and other areas with potentials for cross contamination though out the burn unit.

Samples were collected and processed on a weekly basis for a period of 3 months, June to August, 2009 after due ethical considerations. Altogether 158 samples (Clinical and environmental) were obtained. Samples were cultured on Mueller–Hinton agar at 37 °C for 34 hours by the disk diffusion method described by Kirby-Bauer (Bauer *et al*., 1966). *Pseudomonas aeruginosa* isolates were identified to specie level using standard laboratory procedures (Kiska, *et al.*, 2003).

Drug susceptibility tests were done for all isolates by Bauer–Kirby agar diffusion method for the following antimicrobial agents amikacin (30 µg), aztreonam (10 µg) cefotaxime (10 µg) ceftazidime (10 µg) ceftizoxime (10 µg) ciprofloxacin (5 µg) gentamicin (10 µg) imipenem (10 µg) Kanamycin (30 µg) meropenem (10 µg) piperacillin (100 µg) piperacillin/tazobactam (100/10 µg) polymyixin β (300 units) (Mast diagnostics, Merseyside, UK). CLSI breakpoints were used to determine susceptibility (CLSI, 2006). Quality control was carried out using standard strain of *Pseudomonas aeruginosa (ATCC 12278)*. Multi-drug resistant (MDR) *Pseudomonas aeruginosa* isolates were those resistant to ceftazidime and at least 3 of the following antibiotics, amikacin, aztreonam, ciprofloxacin, gentamicin, imipenem, piperacillin and aminoglycoside.

RESULTS

Out of a total number of 86 patients admitted in the Burn Unit (BU), 80 with serious burn injuries (90%) were included in this study; 46 (60%) were under 15, 20 (25%) between 15 and 40 yr while 14 (17.5%) were above 40; 49 (61.3%) were male 31 (38.8%) were female. The median length of burn unit stay was 29 days.

During the course of the surveillance study, environmental samples (78) revealed that 13 were positive for *Pseudomonas aeruginosa.* Of these 8 (61.5%) isolates came from hand impression cultures of nursing staff, 2 (15.4%) from air and the rest 3 (23%) from fomites. Altogether 68 of *Pseudomonas aeruginosa* isolates were obtained from clinical specimens; 31 (45.6%), 20 (29.9%) and 17 (27.9%) were isolated from under 15 yrs, 15-40 yrs, above 40 yrs in that order. In general terms, 44 (64.7%) and 24 (35.3%) isolates were obtained from male and female patients respectively.

Among all positive isolates (81), 33 (40.7%) were resistant (<16 mm) to ceftazidime, 26 (32%) amikacin, 20 (24.7%) gentamicin 13 (16%) aztreonam. Polymyxin B was uniformly sensitive against all isolates (>20 mm). Eleven (13.6%) multi-drugs resistant (MDR) *Pseudomonas aeruginosa* isolates, were recovered from clinical specimens while 5 (6.2%) were recovered from environment and hand impressions. The results of prevalence and drug susceptibility tests are shown in Tables 1, 2 and 3.

Table 1: Prevalence of *Pseudomonas aeruginosa* in clinical and surveillance samples.

Clinical/Surveillance sites	Swabs taken	*Pseudomonas aeruginosa* isolated (%)
Burn Injuries	80	68 (85.0)
Hand impression Culture	26	8 (30.8)
Sinks	10	0
Floors	5	0
Walls	12	1 (8.3)
Door handles	10	2 (20.0)
Tap water	5	0
Air culture	10	2 (20.0)
TOTAL	**158**	**81 (51.3)**

Table 2: In vitro susceptibility of *Pseudomonas aeruginosa* isolates to commonly used antimicrobial agents.

Antibiotics (µg)	Number[a] (%) of positive *Pseudomonas aeruginosa* isolates		
	Sensitive	Intermediate	Resistant
Amikacin (30)	40 (49%)	14(17.3%)	26(32.1%)
Aztreonam (10)	54 (55.7%)	14(17.3%)	13 (16%)
Ceftazidime (10)	29 (35.8%)	19(23.5%)	33 (40.7%)
Ciprofloxacin (5)	35 (43.2%)	20 (24.7%)	26 (37.1%)
Gentamicin (10)	49 (60.5%)	12 (14.8%)	20 (24.7%)
Imipenem (10)	63 (77.8%)	14 (17.3%)	14 (17.5%)
Meropenem (10)	51 (63.0%)	10 (12.3%)	21(25.9%)
Piperacillin (100)	30 (37.0%)	22 (27.2%)	28 (34.6%)
Piperacullin/ tazobactam (100/10)	67 (82.7%)	4 (4.9%)	10 (12.3%)
Polymixynβ (300units)	70 (84.4%)	11 (13.6%)	0

[a]N = 81

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Table 3: Antibiotic Resistance Patterns of *Pseudomonas aeruginosa* isolates.

Antibiotics (µg)	Clinical isolates n = 68, R%	Hand culture isolates n = 8, R%	Environmental isolates n = 5, R%
Amikacin (30)	36	41	20
Aztreonam (10)	50	49	36
Ceftazidime (10)	49	35	32
Ciprofloxacin (5)	40	41	22
Gentamicin (10)	38	28	30
Imipenem (10)	20	16	12
Meropenem (10)	36	11	18
Piperacillin (100)	45	26	25
Piperacullin/ tazobactam (100/10)	16	12	15
Polymixyn β (300units)	0	0	0

DISCUSSION

Pseudomonas aeruginosa isolated from burn injuries have significant effect on the mortality and morbidity in hospitalized burn patients particularly in a developing country such as ours. Here, we evaluated the colonization route (cross transmission mode) and drug susceptibility pattern of *Pseudomonas aeruginosa* in a tertiary burn unit. In our study, more male, (73%) and child (57%) patients were admitted into the burn unit. The reason may be a combination of factors such as male dominant activity, child restiveness and poor safety consciousness in our society.

When compared to other studies in community based hospitals (Gikas *et al.,* 2002; Lari *et al.*, 2000), nosocomial infections of burn injuries carried by *Pseudomonas aeruginosa* were higher with a prevalence of 51.3% in the present study. These differences are partly due to the fact that our facility is largely a referral centre with intensive support therapies and hence more vulnerable to developing nosocomial *Pseudomonas aeruginosa* infections.

It also appears a greater tendency towards increased susceptibility (82%) was evident in combination therapeutic antibacterial regimen, particularly where synergy exist (Harris *et al.,* 1999; Rossolini *et al.*, 2005). Cross acquisition seems to play an important role in the epidemiology of nosocomial colonization of infection with *Pseudomonas aeruginosa.* Understanding the route of colonization is crucial to the development of effective preventive measures against infection. Our findings of 15.4% positive environmental isolates highlight the need for further attention to disinfection of inanimate hospital environment and control of contacts between staff and patients. Moreover use of some antimicrobial agents must be restricted due to existence of high resistance to them.

The revelation that 40.7% of isolates were multi-drug resistant is not only significant but also instructive. Multi-drug resistant *Pseudomonas aeruginosa* is quite problematic in patients with burn injuries and may illustrate the importance of selective pressure of antibiotics. In a study of urinary MDR *P. aeruginosa* isolates in Jos, Nigeria, all the 100% isolates of *P. aeruginosa* were resistant to penicillin, cloxacillin, tetracycline, nitrofurantoin and nalidixic acid while 67% were sensitive to augmentin, 92% to ofloxacin, 92% to ciprofloxacin and 86% to cefuroxime (Jombo *et al*., 2008). The resistance pattern of *P. aeruginosa* from urine against antibiotics was extremely high. Such a scenario will heighten the presence and transmission of *P. Aeruginosa* from conveniences as well.

To overcome inappropriate treatment of burn patients infected with *Pseudomonas, aeruginosa* periodic antibacterial susceptibility surveys for bacterial isolates in burn units are recommended.

CONCLUSION

Pseudomonas aeruginosa is an opportunistic pathogen with an innate ability to persist during infections due to its high rate of resistance to many drugs including *ceftazidime, ciprofloxacin, piperacillin, imipenem*, *pipereracillin/tazobactam* and *aztreonam*. These antibiotics are top of the range first line therapy candidates for bacteria – associated infections. Evidence of high prevalence of clinical and environmental MRPA reported in this study and their apparent resistant patterns observed provides the rationale for strict enforcement of infection prevention protocol to minimize cross transmission of bacterial pathogens in hospital burn units and consequent disease burden arising from MRPA.

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