Contents lists available at ScienceDirect

Asian Pacific Journal of Tropical Medicine

journal homepage:www.elsevier.com/locate/apjtm

Document heading

Multidrug resistant *Psudomonas aeruginos*a infections complicating surgical wounds and the potential challenges in managing post-operative wound infections: University of Calabar Teaching Hospital experience

Jombo GT[1*], Akpan S[2], Epoke J[2], Denen Akaa P[3], Odey F[4]

[1]*Department of Medical Microbiology and Parasitology, College of Health Sciences, Benue State University, PMB 102119 Makurdi, Nigeria*
[2]*Department of Medical Microbiology and Parasitology, College of Medical Sciences, University of Calabar, PMB 1115 Calabar, Nigeria*
[3]*Department of Surgery, College of Health Sciences, Benue state University, Makurdi, PMB 102119 Makurdi, Nigeria*
[4]*Department of Paediatrics, College of Medical Sciences, University of Calabar, PMB 1115 Calabar, Nigeria*

ARTICLE INFO

Article history:
Received 12 May 2010
Received in revised form 27 May 2010
Accepted 6 June 2010
Available online 20 June 2010

Keywords:
Pseudomonas aeruginosa
Surgical site infections
Antibiotic susceptibility

ABSTRACT

Objective: To ascertain the antimicrobial susceptibility profile of *Pseudomonas aeruginosa (P. aeruginosa)* recovered from surgical site infections (SSIs). **Methods:** The study was retrospective in nature and was compiled for a period of five years (1st February, 2004–31st January, 2009). Data were generated from the culture of post-operative wound swab specimens by the microbiology laboratory of University of Calabar Teaching Hospital. Relevant information from the patients' records was compiled, such as age, gender, type of surgical procedure, microorganisms recovered and their antibiotic sensitivity patterns. Obtained data was analysed by using Epi Info 6 statistical software. **Results:** Of the 4 533 wound swab specimens processed, 673 were culture positive and *P. aeruginosa* was recovered from 13.1% of the culture positive specimens with its rate of recovery decreasing with age progression ($P< 0.05$) but with no gender difference ($P> 0.05$). Most of the *P. aeruginosa* isolates were from general surgery wards and least from orthopaedic wards. Ofloxacin, ceftriaxone and augmentin were the most active antibiotics while ampicillin, tetracycline and co-trimoxazole were the least active antibiotics, with no antibiotic having a 100% activity against the organism. **Conclusions:** In view of the high resistance displayed by *P. aeruginosa* recovered from SSIs, adequate antiseptic procedures should be entrenched to avoid colonization of surgical wounds by this microorganism as well as others with similar sensitivity profile. Ofloxacin, ceftriaxone and augmentin may be considered for prevention of *P.aeruginosa* infection.

1. Introduction

The advent of antimicrobial chemotherapy and antisepsis appear to have given rise to a major side effect "resistance", of which Joseph Lister (1827–1912) and his co-travellers, perhaps, least anticipated at the outset[1-3]. The susceptibility patterns of bacteria vary among organisms and species as well as the class of antimicrobial used[4-6]. This scenario has contributed to the challenges, most often physicians and other health professional encounter in the management of life threatening bacterial infections[7-9].

In the midst of growing widespread resistance by micro-organisms, management of post-operative surgical infections have continued to pose a serious challenge to health personnel saddled with such responsibilities world over[10-12]. *Pseudomonas aeruginosa (P. aeruginosa)* has been listed in several instances among the most notorious of bacteria complicating surgical site infections (SSIs)[13,14]. This is in view of its wide spread resistance against most of the antimicrobials readily available for management of its infections. In Cairo, Egypt, all the isolates of *P. aeruginosa* were found to be resistant to ampicillin, cloxacillin and co-trimoxazole[15]; and in Ilorin Nigeria, the susceptibility pattern of *P. aeruginosa* to cloxacillin, erythromycin, azithromycin and ceftazidime ranged from <50-90% of the 92 isolates recovered[16]. Of the 92 isolates of *P. aeruginosa* recovered in Zaria, 19.6% were resistant to three or more drugs tested, the commonest combination being ceftazi dime+perfloxacin+ofloxacin[17]. Also from South Africa, 100%, 75%, 30% and 10% of the isolates of *P. aeruginosa* were sensitive to colistin, gentamicin, streptomycin, and tetracycline respectively[18].

Since effective management of post-operative wound

*Corresponding author: Dr. Jombo GT, Department of Medical Microbiology and Parasitology, College of Health Sciences, Benue State University, PMB 102119 Makurdi, Nigeria.
E-mail: jombogodwin@yahoo.com

infections contributes to the overall success of a surgical procedure, proper knowledge of the antimicrobial profile of the most important complicating micro-organisms becomes necessary. Such information may be useful to surgeons probably in the pre-, intra- and post- operative antimicrobial prophylaxis of patients in order to achieve successful surgical outcomes.

2. Materials and methods

2.1. Study area

The study was carried out at University of Calabar Teaching Hospital (UCTH), which is situated in Calabar city, the capital of Cross Rivers State.

2.2. Procedure

The study was retrospective in nature; data generated from the antibiotic susceptibility pattern of bacteria recovered from post operative wound swab specimens were compiled for a period of five years (1st February, 2004-31st January, 2009). All the post-operative wound swab specimens processed and documented during the period under review were considered. Specimens were collected, transported, stored and processed using standard laboratory procedures[19]. Briefly, cotton wool tipped swab sticks were used to collect wound swab samples; microscopy was carried out on the specimens after gram staining, and then inoculated into appropriate culture media for incubation. Modified Kirby-Bauer's diffusion method was used to carry out susceptibility testing. Other relevant information concerning patients were obtained from their records[20].

2.3. Analysis of results

The results were analysed by using Epi Info 6, statistical software, P values < 0.05 were considered significant.

3. Results

During the period under review, 4 533 wound swab specimens were processed at UCTH Calabar Medical Microbiology laboratory; the lowest and highest number of specimens were aged≥80 and 60-69 years, 7(0.1%) and 1 013(22.3%) respectively. Forty seven percent (n=2 127) and 53.1% (n=2 406) were males and females respectively. Table 1 shows the age and gender distribution of patients with post-operative wound infections.

Micro-organisms were recovered from 673 (14.8%) of the specimens processed comprising *Staphylococcus aureus* 20.2% (n=136); Coagulase negative Staphylococcus 10.1% (n=68); *Escherichia coli* 19.0% (n=128); *Streptococcus pyogenes* 11.7% (n=79); *Klebsiella* spp. 10.0% (n=67); *Citrobacter/Enterobacter* 2.8% (n=19); *Proteus* spp. 7.3% (n=49); *Enterococcus* spp. 1.9% (n=13) and *P. aeruginosa* 13.1% (n=88).

Based on sources of specimens among the 88 isolates of *P. aeruginosa*, 14.8% (n=13); 2.2% (n= 2); 19.3% (n=17) and 16.0% (n=14) isolates of the organism were recovered from ENT, Ophthalmic, Maternity and Gynaecologic Wards, while 19.3% (n=17); 21.6% (n=19) and 6.8% (n=6) of the infections were from Orthopaedic, General Surgery, and Accidents & Emergency Wards respectively.

Analysis of rate of isolation of *P. aeruginosa* based on gender showed that 1.8% (39/2 127) and 2.0% (49/2 406) of the male and female gender were respectively infected with the organism. This difference was not statistically significant (P>0.05). Figure 1 showed the result of isolation of *P. aeruginosa* from post-operative wound infections based on gender of the subjects.

A review of the rate of isolation of *P. aeruginosa* based on age of the subjects showed a significantly low infection rates at the extremes of age (P<0.05). 0-9 years and >80 years had 0.0% and 1.1%, respectively, whereas, those aged 10-19 years and 40-49 years with 19.3% and 18.2% infection rates recorded respectively. Figure 1 showed the isolation of *P. aeruginosa* from post-operative wound infections based on age of subjects.

All the isolates of *P. aeruginosa* were resistant to ampicillin and tetracycline while a sensitivity of 0.7%, 58%, 52%, 37%, 32%, and 63% was recorded against co-trimoxazole, colistin, gentamicin, streptomycin, erythromycin and augmentin. The sensitivity of the organism to Ofloxacin and ceftriaxone was 98% and 96% respectively. Figure 2 showed the antimicrobial susceptibility pattern of *P. aeruginosa* recovered from post-operative wound infections.

Table 1
Age and gender distribution of patients with post-operative wound infections [n(%)].

Age (Years)	Male	Female	Total
0-9	59 (1.3)	86 (1.9)	145 (3.2)
10-19	452 (10.0)	333 (7.3)	785 (17.3)
20-29	202 (4.5)	401 (8.8)	603 (13.3)
30-39	379 (8.4)	198 (4.4)	577 (12.8)
40-49	411 (9.1)	277 (6.1)	688 (15.2)
50-59	319 (7.0)	172 (3.8)	491 (10.8)
60-69	258 (5.7)	755 (16.7)	1 013 (22.3)
70-79	41 (0.9)	164 (3.6)	205 (4.5)
80 & Above	2 (0.0)	5 (0.1)	7 (0.1)
Unclassified	4 (0.1)	15 (0.3)	19 (0.4)
Total	2 127(47.0)	2 406(53.0)	4 533(100.0)

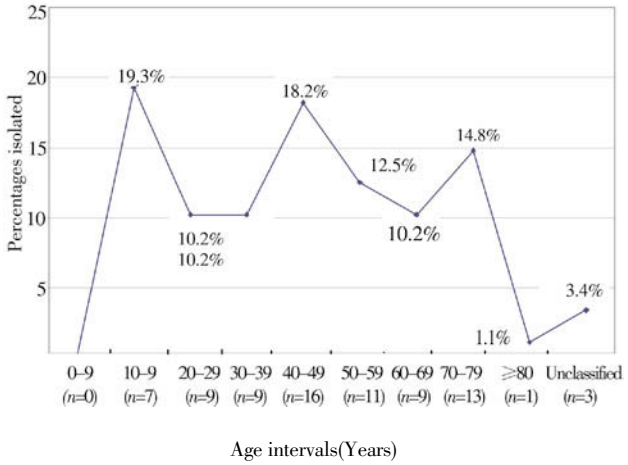

Figure 1. Isolation of *P. aeruginosa* from post-operative wound infections based on age of subjects.

X^2 (Mantel-Haenszel)= 10.47, *OR*= 0.00, *P*= 0.001.

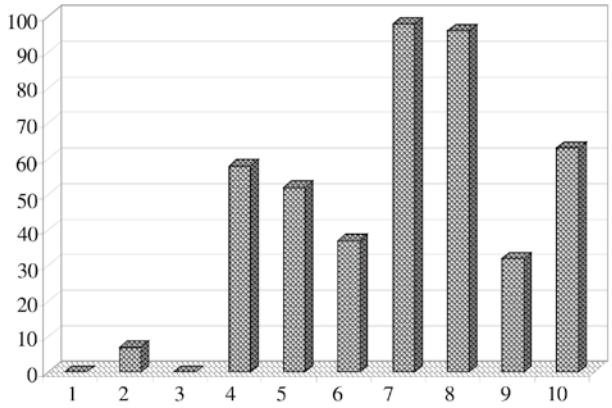

Figure 2. Antimicrobial susceptibility pattern of *P. aeruginosa* recovered from post-operative wound infections.

4. Discussion

P. aeruginosa was found to account for 13.1% (*n*=88) of the 673 wound swab specimens from suspected post-operative wound infections, majority of the isolates being from general surgical ward with significantly higher rates in the younger age groups compared to the older (*P*<0.05); but without gender difference (*P*<0.05). The higher rate of *P. aeruginosa* infection in children compared to adults may be attributed to the differential in integrity in innate immunity being supposedly the lower in the children compared to adults[21,22]. This probably inadvertently complements the inherent virulent factors of the organism usually associated with its disease perpetuation and pathogenesis[23,24].

The drugs with the highest activity against *P. aeruginosa* during the study period were Ofloxacin (98%), ceftriaxone (96%) and augmentin (63%), and those with the lowest activity were ampicillin (0%), tetracycline (0%) and co-trimoxazole (7%) among the isolates tested. The fact that no antibiotic was able to record a 100% activity against all the *P. aeruginosa* isolates tested shows the high profile multiple resistance, the organism has attained in present day medicine[25,26]. This could pose a serious threat in the management of wound infections especially in health centres in the rural and semi-urban communities in the country where facilities to clearly show its antimicrobial susceptibility profile on its isolation may be lacking. The sensitivity pattern similar to this present one was also reported in Taipei, Taiwan[18] and Chennai, India[16] where activities of most quinolones were found to be almost 100% against *P. aeruginosa*, although the organism accounted for over 20% of the bacterial isolates recovered from SSIs. Also Vyhnanek et al in Czech republic[27] similarly reported that none of the drugs tested in the study centre had 100% activity against *P. aeruginosa* including the newly introduced tygecycline of which the organism was 100% resistant. Contrary to findings in the present study however, the organism along with other Gram negative bacilli recovered from emergency departments of major hospitals in Beijing, China had sensitivity patterns similar to that of the nosocomial isolates and the resistance pattern generally appeared to be on the decline[28]. This feat achieved in Beijing was attributed largely to improvement in regulation and control of retail, prescription and intake of antibiotics which is a good example for the present global war against antimicrobial resistance[24-27].

It is therefore emphasized that adequate pre-, intra-, and post-operative precautions need to be taken seriously in the preparation as well as in the handling of surgical patients so as to prevent colonization of this highly multiply resistant bacteria and other bacteria that may share similar resistant traits[29,30]. In addition, the institution of a functional infection control committee with a competent surveillance machinery and provision of a competent and elaborate antibiotic policy is strongly advocated for hospitals and clinics in the country[23,31]. This would, to a large extent, impact positively both on the incidences of post-operative wound infections as well as the rate of emergence of antimicrobial resistance by streamlining the mode of prescription, sale as well as intake of these drugs[8,9]. This position has also been well corroborated by Licker et al in Romania[32], Juan et al in Spain[33], and Huang et al in Shanghai China[34].

In conclusion, this study has also re-affirmed the strains of *P. aeruginosa*, which are multiply resistant, are among the most common isolates from post operative wound infections. Proper management of patients before, during and after surgery will help to prevent the challenge of confronting these multiply resistant microbes such as *P. aeruginosa*, and also general control of infection in the hospital environment. Furthermore, Ofloxacin, ceftriaxonr and augmentin may be considered on isolation of the micro-organism.

Conflict of interest statement

We declare that we have no conflict of interest.

References

[1]Drago L, De Vechi E, Nicola L, Colombo A, Guerra A, Gismondo MR. Activity of levofloxacin and ciprofloxacin with cefepime, ceftazidime, imipenem, piperacillin-tazobactam and amikacin against different *Pseudomonas aeruginosa* phenotypes and *Acinetobacter* spp. *Chemotherapy* 2004; **50:** 202-10.

[2]Andes DR, Craig WA. Cephalosporins. In: Mandell GL, Bennet JE, Dolin R. *Mandell, Douglas and Bennett's principles and practice of infectious diseases*. 6th ed. Philadelphia: Churchill Livingstone; 2005, p. 294-311.

[3]Talbot GH, Bradley J, Edwards JE, Jr, Gilbert D, Scheld M, Bartlett JG. Bad bugs need drugs: An update on the Development pipeline from the antimicrobial availability Task Force of the Infectious Diseases Society of America. *Clin Infect Dis* 2006; **42**: 657-68.

[4]Gladstone P, Rajendran P, Brahmadathan KN. Incidence of carbapenem resistant non fermenting gram negative bacilli from patients with respiratory infections in Intensive Care Units. *Indian J Med Microbiol* 2005; **23**: 189-91.

[5]Maillard JY. Bacterial resistance to biocides in the healthcare environment: should it be of genuine concern? *J Hosp Infect* 2007; **65**(Suppl 2): 60-72.

[6]Timurkaynak F, Can F, Azap OK, Demirbilek M, Arslan H,

Karaman SO. In Vitro activities of non-traditional antimicrobials alone or in combination against multidrug-resistant strains of *Pseudomonas aeruginosa* and *Acinetobacter baumanii* isolated from intensive care units. *Int J Antimicrob Agents* 2006; **27**(3): 224-8.

[7]Masterton RG, Kuti JL, Turner PJ, Nicolau DP. The OPTIMA programme: utilizing MYSTIC (2002) to predict critical pharmacodynamic target attainment against nosocomial pathogens in Europe. *J Antimicrob Chemother* 2005; **55**(1): 71-7.

[8]Jombo GTA, Jonah P, Ayeni JA. Multidrug resistant *Pseudomonas aeruginosa* in contemporary medical practice: Findings from urinary isolates at a Nigerian University Teaching Hoapital. *Nig J Physiological Sci* 2008; **23**(1&2): 105-9.

[9]Jombo GTA, Okwori EE, Peters EJ, Umana AN. Multi-drug resistant *Pseudomonas aeruginosa* from ear discharges and potential challenges in treatment of ear infections: Findings from Makurdi, North central Nigeria. *Mary Slessor J Med* 2008; **8**(2): 10-6.

[10]Erlandsson M, Gill H, Nordlinder D, Giske CG, Jonas D, Nilsson LE, et al. Antibiotic susceptibility patterns and clones of *Pseudomonas aeruginosa* in Swedish ICUs. *Scand J Infect Dis* 2008; **40**(6-7): 487-94.

[11]Tan L, Sun X, Zhu X, Zhang Z, Li J, Shu Q. Epidemiology of nosocomial pneumonia in infants after cardiac surgery. *Chest* 2004; **125**(2): 410-17.

[12]Batura D, Rao GG, Nielson PB. Prevalence of antimicrobial resistance in intestinal flora of patients undergoing prostatic biopsy: implications for prophylaxis and treatment of infections after biopsy. *BUJ Int* 2010; PMD 20346055 [Epud Ahead of Print].

[13]Ezechi OC, Edet A, Akinlade H, Gab-Okafor CV, Herbertson E. Incidence and risk factors for caesarean wound infection in Lagos, Nigeria. *BMC Res Notes* 2009; 2: 186e. Available at: http//www.biomedcentral.com/1756-0500/2/186.

[14]Thanni LO, Aigoro NO. Surgical site infection complicating internal fixation of fractures: incidence and risk factors. *J Natl Med Assoc* 2004; **96**: 1070-72.

[15]Tsering DC, Das S, Adhiakari L, Pal R, Singh TS. Extended-spectrum beta-lactamase detection in gram negative bacilli of nosocomial origin. *J Glob Infect Dis* 2009; **1**(2): 87-92.

[16]Wirth FW, Picoli SU, Cantarelli VV, Goncalves AL, Brust FR. Santos LM, et al. Metallo-beta-lactamase-producing *Pseudomonas aeruginosa* in two hospitals from southern Brazil. *Braz J Infect Dis* 2009; **13**(3): 170-72.

[17]Achudume AC, Olawale JT. Occurrence of antibiotic resistant bacteria in waste site of Ede, south west Nigeria. *J Environ Biol* 2009; **30**(2): 187-9.

[18]Chen WY, Jang TN, Huang CH, Hsueh PR. *In Vitro* susceptibilities of aerobic and facultative anaerobic gram-negative bacilli isolated from patients with intra-abdominal infections at a medical centre in Taiwan: results of the study for monitoring antimicrobial resistance trends (SMART) 2002-2006. *J Microbiol Immunol Infect* 2009; **42**(4): 317-23.

[19]Clinical and Laboratory Standards Institute. *Performance standards for antimicrobial susceptibility testing. CLSI Document M100-S16*. 16th ed. Wayne, PA, USA: CLSI; 2006.

[20]Forbes BA, Sahm DF, Weissfeld AS. *Bailey and Scott's diagnostic microbiology*. 12th ed. Missouri: Mosby Elsevier; 2007, p. 251-3.

[21]Haas JP, Evans AM, Preston KE, Larson EL. Risk factors for surgical site infection after cardiac surgery. The role of endogenous flora. *Heart Lung* 2005; **34**: 108-14.

[22]Oguntibeju OO, Nwobu RAU. Occurrence of *Pseudomonas aeruginosa* in post-operative wound infection. *Pak J Med Sci* 2004; **20**(3): 187-91.

[23]Olayinka AT, Onile BA, Olayinka BO. Prevalence of multidrug resistance (MDR) *Pseudomonas aeruginosa* isolates in surgical units of Ahmadu Bello University teaching hospital, Zaria, Nigeria: An indication for effective control measures. *Ann Afr Med* 2004; **3**(1): 13-6.

[24]Jombo GTA, Ayilara AO, Bello K, Gadzama GB, Mbaawuaga EM. Microbial isolates from surgical sites infection at a Federal Medical Centre in North Eastern Nigeria. *Mary Slessor J Med* 2006; **6**(2): 59-66.

[25]Tomozawa T, Sugihara C, Kakuta M, Sugihara K, Koga T. In Viteo postantibiotic effects of tomopenem (CS-023) against *Staphylococcus aureus* and *Pseudomonas aeruginosa*. *J Med Microbiol* 2010; **59**(4): 438-41.

[26]Miriagou V, Camagila G, Edelstein M, Galani I, Giske CG, Gniadkowski M, et al. Acquired carbapenemases in Gram negative bacterial pathogens: detection and surveillance issues. *Clin Microbiol Infect* 2010; **16**(2): 112-22.

[27]Vyhnanet F, Adamkova V, Duchac V, Teplan V Jr, Jirasek T. Antimicrobial treatment of nosocomial intra-abdominal infections-new treatment options with tygcycline. *Rozhl Chir* 2009; **88**(9): 503-7.

[28]Zhang ZQ, Qlan YY, Liu G, Li TS, Meng QY. Vicissitude of antibiotic sensitivity of Gram negative bacilli in patients with infection in emergency departments in Beijing during 2005 to 2007. *Zhongguo Wei Zhong Ji Jiu Yi Xue* 2009; **21**(12): 738-41.

[29]Srinivas N, Jetter P, Ueberbacher BJ, Werneburg M, Zerbe K, Steinmann J, et al. Peptidomimetic antibiotics target outer-membrane biogenesis in *Pseudomonas aeruginosa*. *Science* 2010; **327**(5968): 1010-13.

[30]Allou N, Kermarrec N, Muller C, Thabut G, Philip I, Lucet JC, Montravers P. Risk factors and prognosis of post operative pneumonia due to *Pseudomonas aeruginosa* following cardiac surgery. *J Antimicrob Chemother* 2010; **65**(4): 806-7.

[31]Mela EK, Drintzias EG, Christofidou MK, Filos KS, Anastassion ED, Gartaganis SP. Ocular surface bacterial colonization in sedative care unit patients. *Anaesth Intensive Care* 2010; **38**(1): 190-3.

[32]Licker M, Bafdiafoiu L, Negru C, Barnzeu C, Zugravu R, Horhat F, Moldovan R. Bacterial multi-resistance emergence in South-Western Romania. *Bacteriol Virusol Parazitol Epidemiol* 2009; **54**(2): 79-86.

[33]Juan C, Zamorano L, Mena A, Alberti S, Perez JL, Oliver A. Metallo-beta-lactamase-producing *Pseudomonas putidi* as a reservoir of multidrug resistance elements that can be transferred to successful *Pseudomonas aeruginosa* clones. *J Antimicrob Chemother* 2010; **65**(3): 474-8.

[34]Huang J, Tang YQ, Sun JY. Intravenous colistin sulphate: a rarely used form of polymyxin E for the treatment of severe multidrug-resistant Gram negative bacterial infections. *Scand J Infect Dis* 2010; **42**(4): 260-65.