Letter to the Editor

Pseudomonas aeruginosa infection in burn patients in Sulaimaniyah, Iraq: risk factors and antibiotic resistance rates

Nasih Othman[1], Muhammed Babakir-Mina[1], Chia Kamil Noori[2], Parihan Yahya Rashid[2]

[1]*Biomedical Research Unit, Sulaimani Polytechnic University, Sulaimaniyah, Iraq*
[2]*Burns and Plastic Surgery Hospital, Sulaimaniyah, Iraq*

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Dear Editor,

Colonization of pathogens in burn wounds and their systemic invasion may cause severe complications and death. The two most common pathogens responsible for burn wound infections are *Staphylococcus aureus* and *Pseudomonas aeruginosa* [1-5]. Burn wards have been reported to harbor multi-drug resistant strains of *P. aeruginosa* which can colonize burn wounds and lead to infection [6]. This pathogen has been reported as the most common source of burn wound infection in the United States [7]. *P. aeruginosa* is also the most common isolate reported among burn patients in Iraqi Kurdistan [8]. This high prevalence of infection and the fact that the pathogen is resistant to many commonly used antibiotics makes a strong case for monitoring this infection in burn wards. Therefore, the current study investigated the risk factors for infection with this pathogen and the antibiotic resistance rates in order to provide evidence for prevention and treatment.

We reviewed the medical records of 985 patients admitted to the Sulaimani Burns and Plastic Surgery Hospital (the Burn Centre) in Iraqi Kurdistan between January 2009 and November 2012. All collected specimens were inoculated on MacConkey agar and Cetrimide agar and incubated at 37°C for 24 hours. Subsequently, colorless colonies (non-lactose fermenter) on both MacConkey and Cetrimide agars were subjected to further identification according to Bergey's manual of determinative bacteriology [9]. Final confirmation was made using the analytical profile index (API 20E system) (BioMerieux SA, Lyon, France). All isolates were tested against eight antibiotic discs using the Kirby–Bauer method.

Culture and sensitivity tests were undertaken for a total of 985 patients (males 43%, females 57%). The age ranged from under one to 85 years of age (median 17, IQR 4, 26). The majority of burns were caused by flames (63%) and the mean total body surface area burnt (TBSA) was 25% (SD 15.7%). Out of 985 patients, a total of 266 patients (27%) yielded at least one positive result for *P. aeruginosa*. Characteristics of these 266 patients were compared with those of the rest of the patients.

Factors which were significant at $p \leq 0.20$ (age, sex, TBSA, mechanism of injury, season and province of residence) were included in the multiple logistic model. No significant interactions or multicollinearity were observed. The Hosmer-Lemeshow test for goodness of fit for the multivariable model was not significant ($\chi^2 = 8.9$, 8 df, $p = 0.4$). The logistic model explained 23% of the variability in Pseudomonas infection. Adjusted odds ratios are shown in table 1. Female gender, greater burn size, flame burns, winter season and residence in other provinces were significant factors for infection. Females were more at risk of infection than males by almost two fold (OR 1.86, 95% CI [1.22-2.85]). Compared to patients with TBSA less than 25%, patients with burn size greater than 50% had over six-fold odds of infection (OR 6.57, 95% CI [3.45-12.47]). Compared to scalds, flame injuries had an almost three-fold odds of infection (OR 2.9, 95% CI [1.79-4.70]).

Table 1. Adjusted odds ratios and 95% confidence intervals (CI] for factors significantly associated with *Pseudomonas aeruginosa* infection

Risk factor	Odds ratio (95% CI)	Wald test	
		z	P Value
Sex			
Male	Reference group	2.9	0.004
Female	1.86 (1.22-2.85)		
Burn size (%TBSA burnt)			
0-25%	Reference group		
25.1-50%	4.16 (2.67-6.47)	6.3	<0.001
Over 50%	6.57 (3.45-12.47)	5.8	<0.001
Cause of burn			
Scald	Reference group		
Flame	2.90 (1.79-4.70)	4.4	<0.001
Other*	5.19 (1.93-13.94)	3.3	0.001
Residence			
Sulaimaniyah city	Reference group		
Outside city	1.49 (0.95-2.35)	1.7	0.09
Other provinces	2.77 (1.37.5.60)	2.8	0.005
Season			
Summer	Reference group		
Autumn	1.58 (0.84-2.98)	1.42	0.15
Winter	3.9 (2.20-6.86)	4.74	<0.001
Spring	1.71 (1.0-2.96)	2.0	0.05

Log likelihood= -301.1, LR test χ^2=181.3, 10 df , P<0.001; *includes contact, chemical and electrical burns

Table 2. Antibiotic resistance of *P. aeruginosa* in all specimens and in all individual patients (in order of increasing resistance)

	Specimens (n=878)*		Patients (n=266)*	
	Resistant	Sensitive	Resistant	Sensitive
	Number (%)	Number (%)	Number (%)	Number (%)
Imipenem	283 (32.2)	596 (67.8)	75 (28.2)	191 (71.8)
Meropenem	310 (36.9)	530 (63.1)	80 (31.0)	178 (69.0))
Amikacin	503 (57.3)	375 (42.7)	128 (48.1)	138 (51.9)
Ciprofloxacin	538 (61.3)	340 (38.7)	153 (57.5)	113(42.5)
Cefepime	544 (62.5)	327 (37.5)	146 (55.1)	119 (44.9)
Ceftazidime	644 (73.6)	231 (26.4)	184 (69.2)	82 (30.8)
Tobramycin	669 (76.2)	209 (23.8)	181 (68.1)	85 (31.9)
Gentamicin	277 (85.3)	39 (14.7)	777 (88.5)	101 (11.5)

** There are some missing values in some categories*

Patients coming from other provinces had almost three-fold odds of infection compared to patients from Sulaimaniyah city (OR 2.77, 95% CI [1.37-5.60]). Winter was the worst season for burn infection with *P. aeruginosa* with infection four times as likely as compared to summer (OR 3.9, 95% CI [2.2-6.86]).

The study included 878 positive specimens for *P. aeruginosa* from 266 patients. Number of positive samples per patient ranged from 1 to 22 samples with a mean of 3.2 (SD = 3.1) specimens per patient. The majority of the specimens were taken from the lower limbs (43%) followed by the trunk (23%) and the upper limbs (17%).

Antibiotic sensitivity tests were undertaken for cefepime, ciprofloxacin, imipenem, meropenem, ceftazidime, amikacin, gentamicin and tobramycin. Table 2 shows number and percentage of cultures resistant and sensitive to each of these antibiotics by number of patients and specimens. The most effective antibiotic was imipenem with 32% resistance followed by meropenem (37%) in all specimens. Gentamicin was the least effective antibiotic with 86% resistance.

Table 3 shows antibiotic resistance in relation to sex, age and site of infection. Females showed significantly more resistance to some antibiotics including ciprofloxacin, ceftazidime, amikacin and tobramycin. In relation to age, there were only significant differences in percentage of resistance to cefepime and tobramycin. In relation to the site of infection, urine specimens showed the highest resistance to all antibiotics. The site of infection was significantly associated with resistance in case of cefepime, imipenem, meropenem, amikacin and tobramycin.

P. aeruginosa accounted for 27% of isolates from burn patients in the present study. This is similar to the 28% reported by a previous study from the same city [8]. A higher prevalence has been reported by studies elsewhere, such as 57% in Iran [10], 55% in India [11] and 51% in Palestine [12]. This may be due the type inclusion criteria for the microorganisms accounted for and cultured. Risk factors for infection with *P. aeruginosa* were: female gender, greater burn size, flame burns, winter season and residence in other provinces. Burn size and depth are generally known to increase the risk of colonization and infection. Residence in other provinces was associated with a three-fold increase in odds of infection, probably due to longer delay between injury and hospitalization, increasing the likelihood of colonization as reported by Pirnay *et al* [13]. Burn size over 50% was associated with over six-fold increase in odds of

Table 3. Percentage *of P aeruginosa* specimens resistant to antibiotics according to sex, age and site of infection

	Imipenem	Meropenem	Amikacin	Ciprofloxacin	Cefepime	Ceftazidime	Tobramycin	Gentamicin
Sex								
Male	28.5*	31.8*	51.8†	54.3†	58.7*	68.2†	69.0†	86.1*
Female	33.7	38.9	59.4	64.0	63.9	75.7	79.0	89.4
Age/years								
0-5	28.6*	38.6*	52.4*	66.1*	56.9†	73.7*	68.6†	84.8*
6-14	33.3	28.7	54.0	56.3	47.1	63.2	67.8	85.1
15-59	33.3	38.3	59.0	60.7	65.8	74.9	79.2	89.5
Over 59	16.7	23.5	61.1	77.8	61.1	83.3	66.7	88.9
Site of infection								
Head & neck	25.0†	23.6†	51.7†	56.7*	53.3†	75.0*	65.0†	83.3*
Upper limb	29.0	25.3	52.0	60.5	56.6	68.4	71.7	90.1
Trunk	31.2	39.0	56.9	58.9	63.0	77.4	78.2	88.6
Lower limb	31.3	36.9	57.6	60.7	63.3	72.1	77.1	87.8
Blood	41.7	52.6	66.1	72.8	66.1	76.3	81.4	93.2
Urine	80.0	95.0	90.0	85.0	100.0	95.0	95.0	95.0

† P values are equal to or smaller than 0.05 i.e. the difference between groups is significant; * P values are bigger than 0.05 i.e. the difference between groups is not significant

infection which is consistent with studies from Turkey [14] and India [15]. A greater burn size means a greater area of unprotected body surface and a greater chance of colonization. Flame injuries are usually deeper and cause more destruction to the surrounding structures which may facilitate colonization of microorganisms. Association between burn depth and a higher risks of infection has been reported in the literature [15].

In our study imipenem was the most effective antibiotic with 32% resistance. Other studies have reported variable rates of imipenem resistance such as 4% in Pakistan [16], 37% in Tunisia [17], 43% in Libya [18] and 76% in Iran [19]. The second most effective antibiotic was meropenem with 37% resistance. Other studies have reported resistance to meropenem as 1% in Pakistan [16], 20% in Iran [19], and 64% in Libya [18]. Resistance to all other tested antibiotics was over 50%. Resistance rates were generally higher in older patients except in the case of imipenem and meropenem. This may be due to more exposure of the older generation to broad-spectrum antibiotics during their lifetime and the development of cross-resistance. Bacteria recovered from urine and blood specimens showed the highest rates of resistance probably due to higher virulence; the most virulent bacteria are those that overcome the body defenses and gain access to the blood stream and hence show more resistance to antibiotics.

Antibiotic susceptibility of *P. aeruginosa* has changed due to the emergence of multidrug-resistant strains. Therefore it is of vital importance to regularly monitor nosocomial infections in burn units and undertake culture and sensitivity tests to select the most effective antibiotics for treatment.

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Corresponding author
Dr Nasih Othman
Biomedical Research Unit
Sulaimani Polytechnic University
Sulaimaniyah, Iraq
Phone: + 964(0)7701451633
Email: nasihothman@yahoo.com

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