Antibiotic susceptibility patterns of aerobic bacterial strains isolated from patients with burn wound infections

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Infection is still considered a serious threat to patients hospitalized in the burned unit. These patients are more susceptible to infection than healthy people for different reasons. For example, systemic immunosuppression, invasive medical procedures and prolonged hospital stay have been reported to influence the risk of infection.[1]

As a result of indiscriminate use of antibiotics, bacterial pathogens have shifted away from easily treatable bacteria towards the emergence of multidrug-resistant bacteria that are important problems for hospitalized patients.[2]

Determining the diversity in bacteria isolated from wound infection and the local antibiotic susceptibility patterns can guide the appropriate use of antibiotics in each hospital. The purpose of the current study was to ascertain the antibiotic susceptibility patterns of the most common aerobic bacterial isolates from burn wound infection in a referral hospital of Isfahan, Iran, over a one-year period.

This cross-sectional study was conducted between March 2013 and April 2014 at a referral burn hospital in Isfahan province, Iran. The hospital is the only referral center in the province, serving about 5 million people. A total number of 250 wound swabs collected from burn patients admitted to the hospital were evaluated. Patients were included in the study if they had been admitted for at least 48 hours and had no sign of infection or colonization at the time of hospitalization. This study was approved by the Ethics Committee of the Isfahan University of Medical Sciences.

Sterile swabs were used for sample collection from the wounds of burn patients whom, based on clinical signs, we suspected had a wound infection.[3] The obtained specimen was immediately inoculated onto blood agar, MacConkey agar, chocolate agar, and cetrimide agar (Himedia, Mumbai, India). Inoculated cultures were incubated aerobically at 37°C. Isolation and identification of bacteria were performed using standard procedures and conventional biochemical tests, as described previously.[4] Only one sample per patient was recruited for the study. Ultimately, identified bacteria were stored at -20°C on Brain-heart infusion (BHI) broth (Himedia) containing 20% (v/v) glycerol.

Ceftazidime (CAZ, 30 µg), imipenem (IMP, 10 µg), meropenem (MEM, 10 µg), ciprofloxacin (CIP, 5 µg), aztreonam (ATM, 30 µg), polymyxin B (PB, 300 units), gentamicin (GM, 10 µg), vancomycin (30 µg), piperacillin (PIP, 100 µg), ceftriaxone (CRO, 30 µg), and amikacin (AMK, 30 µg) purchased from MAST, Merseyside, UK, were used, according to CLSI (Clinical Laboratory Standard Institute) recommendations and the disk diffusion method was applied to determine antibiotic susceptibility.[5] *Staphylococcus aureus* ATCC 25923 and *P. aeruginosa* ATCC 27853 were used as control strains.

SPSS software version 13 (SPSS Inc., Chicago, IL, USA) was used for data analysis. Comparison was made using Chi-square and Fisher exact tests. A p value <0.05 was considered significant.

In total, 250 swabs taken from wound infections were analyzed. The specimens of 78 (31%) patients yielded bacterial growth. From these, 40 (51.3%) patients were female and 38 (48.7%) were male (P = 0.06). Out of the 78

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Table. Antibiotic susceptibility patterns of bacteria isolated from burn wound infection

Antibiotics	Microorganisms						
	P. aeruginosa	*S. aureus*	*A. baumannii*	*Klebsiella* spp.	*E. coli*	*Serratia* spp.	Total
Amikacin	30 (79.0%)	11 (64.7%)	2 (22.2%)	2 (25%)	1 (33.3%)	2 (66.6%)	48 (61.5%)
Gentamicin	29 (76.3%)	8 (47%)	2 (22.2%)	2 (25%)	1 (33.3%)	1 (33.3%)	43 (55.1%)
Imipenem	6 (15.7%)	11 (64.7%)	1 (1.1%)	1 (12.5%)	2 (66.6%)	1 (33.3%)	22 (28.2%)
Meropenem	5 (13.1%)	10 (58.8%)	1 (1.1%)	1 (12.5%)	2 (66.6%)	1 (33.3%)	20 (25.6%)
Ceftazidime	4 (10.5%)	5 (29.4%)	0 (0%)	0 (0%)	0 (0%)	1 (33.3%)	10 (12.8%)
Ciprofloxacin	9 (23.6%)	5 (29.4%)	1 (1.1%)	1 (12.5%)	1 (33.3%)	2 (66.6%)	19 (24.3%)
Aztreonam	10 (26.3%)	ND	4 (44.4%)	2 (25%)	2 (66.6%)	2 (66.6%)	20 (32.7%)
Piperacillin	11 (28.9%)	ND	1 (1.1%)	0 (0%)	1 (33.3%)	1 (33.3%)	14 (22.9%)
Polymyxin B	38 (100%)	ND	ND	ND	ND	ND	38 (100%)
Vancomycin	ND	17 (100%)	ND	ND	ND	ND	17 (100%)
Ceftriaxone	ND	6 (35%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	6 (15%)
Total	38 (48.7%)	17 (21.8%)	9 (11.5%)	8 (10.3%)	3 (3.8%)	3 (3.8%)	78 (100%)

ND – not-determined. All data presented are n (%).

isolated bacteria, 17 (21.8%) were Gram-positive and 61 (78.2%) were Gram-negative (Table). Monomicrobial growth was seen for 75 (96%) of cases whereas 3 (4%) of patients had polymicrobial infection. *Pseudomonas aeruginosa* was the most prevalent isolated microorganisms (n=38; 48.7%), followed by *Staphylococcus aureus* (n=17; 21.8%), *Acinetobacter baumannii* (n=9; 11.5%), *Klebsiella* spp. (n=8; 10.3%), *E. coli* (n=3; 3.8%), and *Serratia* spp. (n=3; 3.8%). As shown in Table, *P. aeruginosa* displayed the highest susceptibility to polymyxin B (100%), followed by amikacin (79.0%) and gentamicin (76.3%). *S. aureus* isolates were mostly susceptible to vancomycin (100%), followed by amikacin (64.7%). The antibiotic resistance of isolated bacteria revealed that 58 (74%) were multidrug resistant. Irrespective of bacterial isolates, the highest susceptibility was recorded for amikacin (61.5%).

The skin functions as a barrier to the external environment and plays an important role in protecting the body from infections. Wound infection is one of the most important complications of burns, and has primary contribution to mortality, morbidity and cost of healthcare in burn patients. Infections can lead to the development of life-treating conditions such as septic shock and multi-organ failure.[6] Therefore, early recognition of wound infection, which is crucial to reduce hospitalization days, cost, mortality and morbidity, allows appropriate treatment to be applied.

This study showed the distribution of antibiotic resistance patterns of bacterial species isolated from patients with burn wound infection in a reference center in Iran. In the present study, we evaluated 250 swabs from burn patients whom we suspected had wound infections. Our results revealed that 31% out of 250 patients had positive culture. This number was lower than other reports from Saudi Arabia (65.74%)[7] and India (97.01%).[8] This difference in prevalence may be the result of different infection control practices and general hygiene in the investigated hospitals. In our study, Gram negative bacteria were more regularly involved in wound infection than Gram positive bacteria (P = 0.00). It is known that Gram positive microorganisms usually are isolated in the early stages of hospitalization, while in prolonged hospitalization Gram negative microorganisms predominate, as the results of nosocomial infection.[9]

P. aeruginosa (48.7%) and *S. aureus* (21.8%) were the most prevalent bacteria isolated in our study (Table). in another study carried out in the Tehran province, Iran, *P. aeruginosa* (57.3%) was found to be the main pathogen responsible for burn wound infection.[10] In fact, it seems that *S.*

aureus and *P. aeruginosa* produce different virulence factors and display innate resistance against different drugs, and are known to be major causes of wound infection in hospitalized patients. The limitation of the present study is that other specimens (such as tissue biopsy) were not collected, and incubation in anaerobic atmosphere was not performed.

The *P. aeruginosa* isolates in this study were highly non-susceptible to ceftazidime (89.95%) and imipenem (84.3%). These isolates were mostly susceptible to amikacin (79.0%) (Table).

It is well documented that *P. aeruginosa* possesses different antibiotic resistance mechanisms that can be divided into two categories, intrinsic and acquired resistance. These mechanisms, such as low permeability of outer membrane protein and overexpression of efflux pumps, as well as antibiotic modifying enzymes are responsible for failure in antibiotic therapy.[11]

All isolated *P. aeruginosa* and *S. aureus* strains were susceptible to polymyxin B and vancomycin, respectively. These antibiotics had the widest coverage against *P. aeruginosa* and *S. aureus* and seem to be appropriate for empirical treatment of complicated cases.

Based on the present study we can conclude that in our hospital Gram-negative bacteria, especially non-fermentative Gram-negative bacilli, were involved in burn wound infection more frequently than Gram-positive bacteria. Amikacin and gentamicin were the most effective antibiotics.

Authors' contributions statement: HV and FB contributed to study design. HV performed data interpretation and wrote the manuscript. FB and HV performed the laboratory procedures. All authors read and approved the final manuscript.

Conflicts of interest: All authors – none to declare.

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