Original Article

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Prevalence of Multidrug-Resistant and Extensively Drug-Resistant *Proteus*, *Providencia* and *Morganella* Species in Burn Wound Infection

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Abstract

Background: The major challenge for a burn team is a nosocomial infection in burn patients, which is known to cause over 50% of deaths. The phenomenal evolution and increase of multidrug-resistance (MDR) of many bacterial pathogens is increasing and representing a growing public health problem in the world.

Subjects and Methods: A retrospective study was conducted among the patients admitted to the burn ward of our hospital, between January and December 2012. All the patients irrespective of age, sex, duration of hospital stay, percentage and degree of burn were included in our study. Wound swabs from 1294 patients hospitalized in burn ward were studied. The various isolates were analyzed for their antimicrobial susceptibility profile. Tribe *Proteeae* was further classified into MDR, extensively drug-resistant (XDR), and pandrug-resistant (PDR) on the basis of standardized international criteria.

Results: Out of 883 isolates from 1294 patients, 71 were found to be *Proteus* species (8%), 15 *Providencia* species (1.7%), while only 1 *Morganella* species (0.1%) was isolated during the study period. Among the *Proteus* spp., 55% (39/71) were found to be MDR while 39.4% (28/71) were XDR. MDR and XDR *Providencia* were found to be 53.3% (8/15) and 46.6% (7/15), respectively. While the only *Morganella* spp. isolated was found to be MDR. None of the isolates were found to be PDR.

Conclusions: Although survival rates for burn patients have improved substantially in the past few decades, nosocomial infections still remain a major challenge in burn care. Resistance to antimicrobials is an increasingly common problem, and its management is a subject of concern. The present study highlights the alarming levels of antimicrobial resistance among members of tribe *Proteeae*.

Key words: Burn wound infection, Extensively drug-resistant, Multidrug-resistant, Pandrug-resistant

INTRODUCTION

Despite significant advances in burn care, infection remains a major cause of morbidity and mortality in burn patients.[1] From time to time and from place to place, the invading microorganisms vary in their frequency and susceptibility to antibiotics. Therefore, it is desirable to conduct a periodic study to assess the infective agents of burn wounds so that preventive measures could be modified accordingly.

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The genus *Proteus* along with genus *Providencia* and *Morganella* belongs to the tribe *Proteeae* of the family Enterobacteriaceae. Although the tribe concept was ruled out in the recent Centers for Disease Control and Prevention (CDC) classification, the terminology continues to be used until date. The phenomenal evolution and increase of multidrug-resistance (MDR) of many bacterial pathogens, including tribe *Proteeae* is increasing and causing a growing public health problem in the world. Thus, a group of international experts came together through a joint initiative by the European Centre for Disease Prevention and Control and the CDC, to create a standardized international terminology to describe resistance profiles in bacteria often responsible

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for healthcare-associated infections and prone to MDR.[2] They classified the organisms into MDR, extensively drug-resistant (XDR), and pandrug-resistant (PDR) on the basis of its antimicrobial susceptibility profiles.[2]

This study seeks to determine the prevalence of tribe *Proteeae* in burn wound infections and their antibiotic resistance pattern.

MATERIALS AND METHODS

A retrospective study was carried out in the Department of Microbiology of a Tertiary Care Hospital in New Delhi, India. Wound swabs from 1294 patients hospitalized in the burn ward that came to our Microbiology Laboratory between January and December 2012 were analyzed. Various isolates and their antimicrobial susceptibility profile were studied. Antimicrobial resistance pattern of Tribe *Proteeae* was further divided into MDR, XDR, and TDR. In our Microbiology laboratory, wound swabs are inoculated on blood agar (Nutrient agar [HIMEDIA Catalogue Number-M001] plus 10% sterile sheep blood), MacConkey agar (HIMEDIA Catalogue Number-M081B), and brain heart infusion broth (HIMEDIA Catalogue Number-M1037). Plates and the broth are incubated at 37°C for 24 and 48 h, respectively. All bacterial isolates examined for colony characteristics, Gram-staining, motility and biochemical tests. Tribe *Proteeae* is identified on the basis of phenylpyruvic acid production, detected in the Phenylalanine deaminase test. Colonies which are non-lactose fermenting on MacConkey agar and show swarming on blood agar are isolated and identified by biochemical tests based on whether they are positive for phenylalanine deaminase production; H_2S gas production; and urease reactions. *Proteus vulgaris* produces indole which differentiated it from indole negative *Proteus mirabilis* and *Proteus penneri*. Similarly, identification of *Providencia* and *Morganella* spp. is done on the basis of biochemical tests. Antimicrobial susceptibility testing is done by modified Stokes disc diffusion method. A suspension of 0.5 McFarland standard prepared from colonies of the isolated organism and was inoculated along with control strains on Mueller-Hinton agar (MHA) plates (HIMEDIA Catalogue Number- M1084) with sterile cotton swabs. Antimicrobial discs applied on MHA and kept for overnight incubation. All Gram-negative bacilli tested for susceptibility to cephalexin (30 μg), ceftriaxone (30 μg) cefotaxime (30 μg), gentamicin (10 μg), amikacin (30 μg), ciprofloxacin (5 μg), amoxicillin-clavulanic acid (20/10 μg), imipenem (10 μg), meropenem (10 μg), piperacillin-tazobactam (100/10 μg), netilmicin (30 μg), polymyxin-B (300 units), colistin (10 μg) (HIMEDIA Laboratories Pvt. Ltd., Mumbai, India). *Escherichia coli* standard strain (NCTC 10418) used as a control.

The isolate was considered as MDR when non-susceptible to at least 1 agent in more than 3 antimicrobial categories/groups and XDR if bacterial isolate remains susceptible to only one or two antimicrobial categories. Isolate non-susceptible to all agents in all antimicrobial categories was considered as PDR.[2]

RESULTS

A total of 1294 pus swab specimens, from patients admitted to the burn ward, were received in our Microbiology laboratory between January and December 2012. The age range of the admitted patients was between 8 months and 55 years, and male to female ratio was 2:1. Out of 883 isolates obtained, 71 were found to be *Proteus* species (8%), 15 *Providencia* species (1.7%) while 1 was *Morganella* species (0.1%). Other isolates included *Pseudomonas* spp., *Klebsiella* spp., *Staphylococcus aureus* (56.7% methicillin-resistant *S. aureus* and 43.3% methicillin-susceptible *S. aureus*), *E. coli*, *Acinetobacter* spp., and *Citrobacter* spp. (Figure 1). The antimicrobial resistance profile of *Ptoteus*,

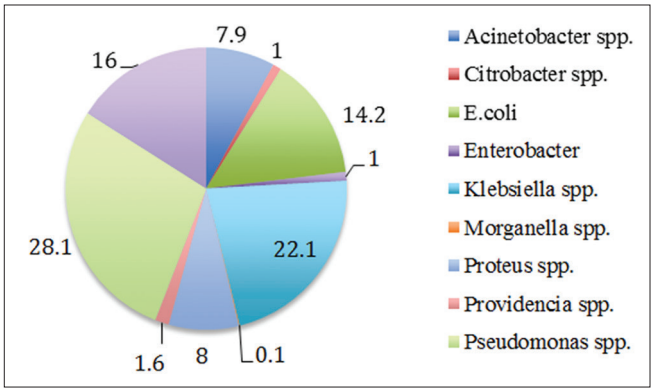

Figure 1: Percentage of different bacterial isolates from burn patients

Table 1: Percentage resistance of *Proteus*, *Providencia*, and *Morganella* isolates from burn patients

Antimicrobial (%)	Percentage of resistant isolates (%)		
	Proteus	*Providencia*	*Morganella*
Cephalexin	87.3	93	100
Ceftriaxone	45	80	0
Cefotaxime	71.8	80	100
Amoxicillin-clavulanic acid	94.3	100	0
Ciprofloxacin	86	86.7	0
Gentamycin	88.7	93	0
Amikacin	84.5	86.7	0
Imipenem	4.2	6.7	100
Meropenem	5.6	4.2	0
Piperacillin-tazobactam	9.8	4.2	0
Netilmycin	59	80	100
Polymyxin-B	59	26.7	100
Colistin	59	26.7	100

Providencia, and *Morganella* spp. is given in Table 1. Among the *Proteus* spp., 55% (39/71) were found to be MDR while 39.4% (28/71) were XDR. MDR and XDR *Providencia* were found to be 53.3% (8/15) and 46.6% (7/15), respectively. The *Morganella* isolate was found to be resistant to more than 3 classes of antimicrobial agents and thus classified as MDR.

DISCUSSION

A total of 1294 pus swab specimens, from patients admitted to the burn ward, were received in our Microbiology laboratory during a period of 1-year. Thus, compared to other studies, we employed a fairly large sample size, which is beneficial for accurate interpretation of results.[3,4] In our study, the patient age ranged from 8 months to 55 years and male to female ratio was 2:1. This is similar to another Indian study conducted among burn patients.[3] Similar results were also obtained in another study which reported male to female ratio of 1.45:1.[5]

Although survival rates for burn patients have improved substantially in the past few decades due to advances in modern medical care in specialized burn centers, still, nosocomial infections represent a major challenge for a burn team in burn patients, which are known to cause over 50% of burn deaths.[6-8] In our study, the most frequent isolates was found to be *Pseudomonas* spp. followed by *Klebsiella* spp. this is similar to several other studies among burn patients.[4,9-11] In our study, the prevalence of *Proteus* spp. was found to be 8% which was in contrast to 2.3% found in another study conducted in Chandigarh.[12] The variations may be due to differences in local conditions, prevention protocols, topical and systemic treatment of burn wounds as well as study lengths.[13]

In our study, we found very high-level of resistance, where 55% *Proteus* spp. were found to be MDR and 39.4% XDR while 53.3% and 46.6% of *Providencia* spp. were found MDR and XDR, respectively. The only *Morganella* spp. isolated was also identified to be MDR. However, none of the isolates were found to be PDR and most of the isolates were susceptible to piperacillin-tazobactam, imipenem, and meropenem which are the only options left for the treatment of these infections. Similar high-level resistance has been reported in other studies as well.[14] This high-level resistance could be due to continuous usage of broad-spectrum antimicrobials and nonadherence to hospital antibiotic policy. This could also be explained by the fact that our institution being a tertiary care referral institute, thus most patients would have been already harboring the resistant organisms.

CONCLUSION

Burns provide a suitable site for bacterial multiplication and infection, mainly because of the larger area involved and longer duration of patient stay in the hospital. To ensure early and appropriate therapy in burn patients, a frequent evaluation of the wound is necessary; all burn institutions should follow a strict antibiotic policy. Therefore, a continuous surveillance of microorganisms and a regular update of their antibiotic resistance pattern are essential to maintaining good infection control programs in the burn unit.

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