

# Microbiological Profile of Infections in a Tertiary Care Burns Unit

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## ABSTRACT

**Background:** The burden of infections among burns patients is higher in healthcare settings due to partial or complete loss of skin as a physical barrier among these patients. We intend to present microbiological profile of patients admitted to a tertiary care hospital in South India.

**Aim:** To describe microbiological profile of infections and antimicrobial susceptibility pattern of clinical isolates from burns patients in our tertiary care hospital.

**Materials and methods:** This retrospective analysis was done on consecutive patients admitted with burns over a period of three years at Apollo Specialty Hospitals, a tertiary care facility in Vanagaram, Chennai. Data analysis included clinical isolates from blood, urine, tissue, pus and tracheal aspirate. Types of bloodstream infections, urosepsis and antibiogram are described.

**Results:** Among 219 clinical isolates from various samples, 75% were gram-negative, 19% gram-positive and 6% were yeast like fungi. Among bloodstream infections, 32% were polymicrobial. Urosepsis was observed in 39% patients. Wound infections with sepsis was seen in 39% patients. Gram-negative isolates showed better susceptibility to amikacin, carbapenems, beta lactam – beta lactamase inhibitor combinations. Gram-positive isolates had better susceptibility to macrolides, doxycycline, glycopeptides.

**Conclusion:** The high prevalence of gram-negative, polymicrobial infections and multidrug resistant bacteria noted in our patients and the sensitivity patterns would help with appropriate decision on initial antibiotic therapy. However escalation and de-escalation of antibiotics should be planned based on culture reports.

**Keywords:** Antibiogram, bloodstream infection, burn wound infection, burns infection, polymicrobial infection

*Indian Journal of Critical Care Medicine* (2019); 10.5005/jp-journals-10071-23234

## INTRODUCTION

Infections are one of the most common complication encountered in patients hospitalized with severe burns. Mortality due to infections is alarming as most of them are caused by multidrug resistant bugs harbored in the hospital environment.<sup>1</sup> It is therefore mandatory to study the etiology of various infections, antibiotic susceptibility pattern of microorganisms isolated from clinical samples. Antibiotic policy of burns units should be based on local antibiogram in order to specifically target common organisms isolated from these patients.

## MATERIALS AND METHODS

This retrospective analysis was carried out by analyzing data collected over a period of three years (2014 to 2017) from all burns patients admitted to our tertiary care hospital in Chennai, Tamil Nadu, India. Clinical details and microbial profile were collected and documented.

Microbial profile analyzed included the following types of microorganisms and common organisms isolated from various clinical samples, types of bloodstream infections in burns and mortality rate in bloodstream infections, urosepsis and wound infections predisposing to sepsis, antibiogram of gram-negative bacilli, multidrug resistant gram-negative bacilli and gram-positive cocci. Difference in pattern of organisms isolated within and more than 48 hours of admission among direct admissions and patients referred from other hospitals were also analyzed.

All samples collected from burns patients were transported immediately and processed in the microbiology laboratory.

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**How to cite this article:** Ebenezer R, Princess I, Vadala R, Kumar S, Ramakrishnan N, Krishnan G. Microbiological Profile of Infections in a Tertiary Care Burns Unit. *Indian J Crit Care Med* 2019;23(9):405–410.

**Source of support:** Nil

**Conflict of interest:** None

Processing of clinical samples were done based on the department's Standard Operating Protocol. Significant clinical isolates were included based on colony morphology on blood agar, MacConkey agar, chocolate agar. Standard biochemical tests were performed for identification of these isolates. Nonfermenting gram-negative bacilli were identified using Vitek-2 compact system. Antimicrobial susceptibility testing was performed using Kirby Bauer disk diffusion method and Minimum Inhibitory Concentration for second line drugs were performed using E strips. All data were collected and documented in Microsoft Excel software for analysis.

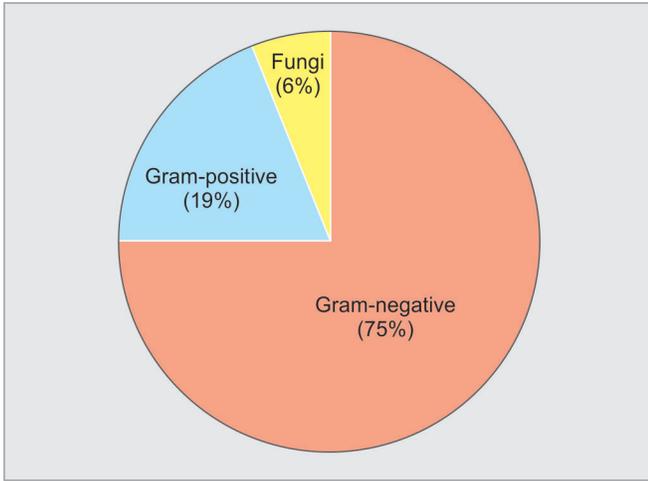


Fig. 1: Distribution of organisms isolated from burns patients (n = 219)

**RESULTS**

Among 94 burns patients admitted over a period of three years, 219 clinically significant microorganisms were isolated. Distribution of the types of organisms is illustrated in Figure 1. 75% isolates were gram-negative bacilli, among which 59% were multidrug resistant. Remaining 25% isolates were constituted by gram-positive cocci (19%) and yeast like fungi (6%). Filamentous fungi were not isolated from any patient.

Organisms isolated from blood were predominantly gram-negative bacilli (73%) followed by gram-positive cocci (24%) and yeast like fungi (3%). The pattern was different among urine isolates where gram-negative bacilli were still predominant but to a lesser extent (52%), followed by yeast like fungi (38%) and then gram-positive cocci (10%). Of note, yeast like fungi were not isolated from

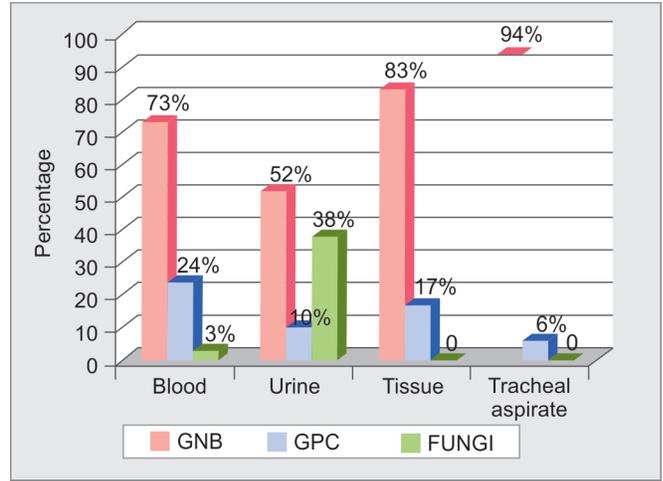


Fig. 2: Distribution of organisms isolated from various samples of burns patients (n = 219)

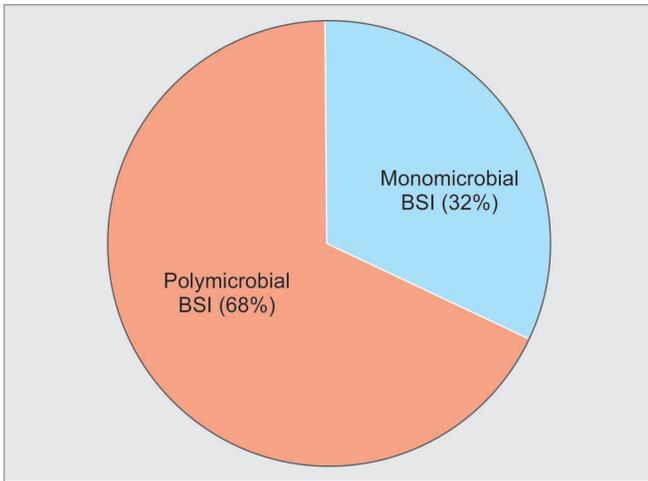
tracheal aspirates and tissue/pus isolates. Percentage distribution of types of organisms among various samples is illustrated in Figure 2.

Among gram-negative organisms, the most common were *Pseudomonas*, *Klebsiella* and *Acinetobacter*. *Enterococcus* was the common gram-positive isolate and *Candida* species being the most common yeast like fungi. A detailed distribution of organisms isolated from various clinical samples is elicited in Table 1.

A 72.5% with severe burns developed sepsis. Polymicrobial bloodstream infections were seen in 68% and monomicrobial infections in 32% patients (Fig. 3). Among polymicrobial bloodstream infections, combinations of gram-positive cocci with a gram-negative bacilli was seen in 56%, combinations of more than one gram-negative organism was seen in 38%, and 6% patients had a combination of gram-positive cocci, gram-negative bacilli and yeast like fungi.

**Table 1:** Concordance of clinical isolates from various samples of burns patients (n = 219)

Type of organism	Tissue/Pus/ Wound			
	Blood	swab	Urine	Tracheal aspirate
Gram-negative bacilli				
• <i>Pseudomonas</i> species	23	19	1	6
• <i>Klebsiella</i> species	22	18	6	2
• <i>Acinetobacter</i> species	13	9	1	7
• <i>Proteus mirabilis</i>	2	7	1	–
• NFGNB	6	1	1	–
• Others ( <i>E.coli</i> , <i>Enterobacter</i> , <i>Citrobacter</i> )	10	3	5	1
Total gram-negatives : 164	76	57	15	16
Gram positive cocci				
• <i>Enterococcus</i> species	14	6	3	–
• MRCoNS	7	2	–	1
• MRSA	2	1	–	–
• <i>Streptococcus</i> species	2	1	–	–
• MSSA	–	2	–	–
Total gram-positives : 41	25	12	3	1
Fungi				
• <i>Candida</i> species	3	–	9	–
• <i>Trichosporon</i>	–	–	2	–
Total Fungi : 14	3	–	11	–
Total isolates : 219	104	69	29	17



**Fig. 3:** Distribution of type of bloodstream infections in burns patients

A mortality rate of 59% was observed in patients with polymicrobial bloodstream infections. A lesser mortality rate of 41% was seen in patients with monomicrobial bloodstream infections.

Urosepsis was seen in 39% patients, the most common organism causing the same being *Klebsiella* species. Wound infection

related sepsis was seen in another 39% of burns patients, the most common organism being *Pseudomonas* species.

The profile of infections was different based on whether it was early (48 hours after admission) or later. It was also noted that the isolates were different among patients referred from outside hospitals in comparison with those directly admitted to our facility (Table 2).

Antibiogram of isolates showed that less than 50% of gram-negative isolates were susceptible to gentamicin (40%), cefotaxime (42%), ceftazidime (44%), ciprofloxacin (33%), and cefepime (39%). More than 50% of gram-negatives were susceptible to amikacin (53%), cefoperazone-sulbactam (56%), piperacillin-tazobactam (54%), imipenem (59%), meropenem (60%) and ertapenem (80%) (Fig. 4).

Susceptibility to fosfomycin, colistin and polymyxin B was seen in 96%, 100% and 100% isolates, respectively (Fig. 5).

Considerably lower rate of resistance was seen among gram-positive clinical isolates. Less than 50% of gram-positive organisms were susceptible to penicillin (25%) and clindamycin (43%). All other antibiotics showed good percentage of action against gram-positive cocci (Fig. 6).

## DISCUSSION

Mortality rate due to infections is high among adult and pediatric burns patients in India and other developed countries.<sup>2,3</sup> Organisms

**Table 2:** Distribution of isolates based on time and place of admission

≤48 hours of admission	
Direct admission	Referred from other hospitals
Gram-negative bacilli:	Gram-negative bacilli:
<ul style="list-style-type: none"> <li>• <i>Pseudomonas aeruginosa</i> (25%)</li> <li>• <i>Acinetobacter baumannii</i> (25%)</li> <li>• <i>Klebsiella pneumoniae</i> (25%)</li> <li>• <i>Enterococcus</i> species (25%)</li> </ul>	<ul style="list-style-type: none"> <li>• <i>Klebsiella</i> species (25.6%)</li> <li>• <i>Pseudomonas</i> species (18.6%)</li> <li>• <i>Acinetobacter baumannii</i> (14%)</li> <li>• NFGNB (4.6%)</li> <li>• <i>Proteus mirabilis</i> (4.5%)</li> <li>• <i>Citrobacter diversus</i> (2.3%)</li> <li>• <i>Escherichia coli</i> (2.3%)</li> </ul>
	Gram-positive cocci:
	<ul style="list-style-type: none"> <li>• <i>Enterococcus</i> species (11.6%)</li> <li>• <i>Streptococcus</i> species (4.5%)</li> <li>• MRCoNS (2.3%)</li> <li>• MRSA (2.3%)</li> <li>• MSSA (2.3%)</li> <li>• <i>Candida</i> species (4.5%)</li> </ul>
>48 hours of admission	
Direct admission	Referred from other hospitals
Gram-negative bacilli:	Gram-negative bacilli:
<ul style="list-style-type: none"> <li>• <i>Pseudomonas</i> species (26.4%)</li> <li>• <i>Acinetobacter baumannii</i> (13.2%)</li> <li>• <i>Klebsiella</i> species (13.2%)</li> <li>• <i>Proteus mirabilis</i> (5.7%)</li> <li>• <i>Escherichia coli</i> (5.7%)</li> <li>• NFGNB (3.8%)</li> <li>• <i>Enterobacter</i> species (1.9%)</li> </ul>	<ul style="list-style-type: none"> <li>• <i>Klebsiella</i> species (24.8%)</li> <li>• <i>Pseudomonas</i> species (21.4%)</li> <li>• <i>Acinetobacter</i> species (13.7%)</li> <li>• <i>Enterobacter</i> species (5.1%)</li> <li>• <i>Proteus mirabilis</i> (4.3%)</li> <li>• <i>Citrobacter diversus</i> (3.4%)</li> <li>• NFGNB (3.4%)</li> <li>• <i>Escherichia coli</i> (2.6%)</li> </ul>
Gram-positive cocci:	Gram positive cocci:
<ul style="list-style-type: none"> <li>• <i>Enterococcus</i> species (13.2%)</li> <li>• MRCoNS (3.8%)</li> <li>• MRSA (3.8%)</li> </ul>	<ul style="list-style-type: none"> <li>• <i>Enterococcus</i> species (8.5%)</li> <li>• MRCoNS (6%)</li> <li>• <i>Streptococcus</i> species (0.9%)</li> <li>• MSSA (0.9%)</li> </ul>
<i>Candida</i> species (9.4%)	<i>Candida</i> species (3.4%)
	<i>Trichosporon</i> species (1.7%)

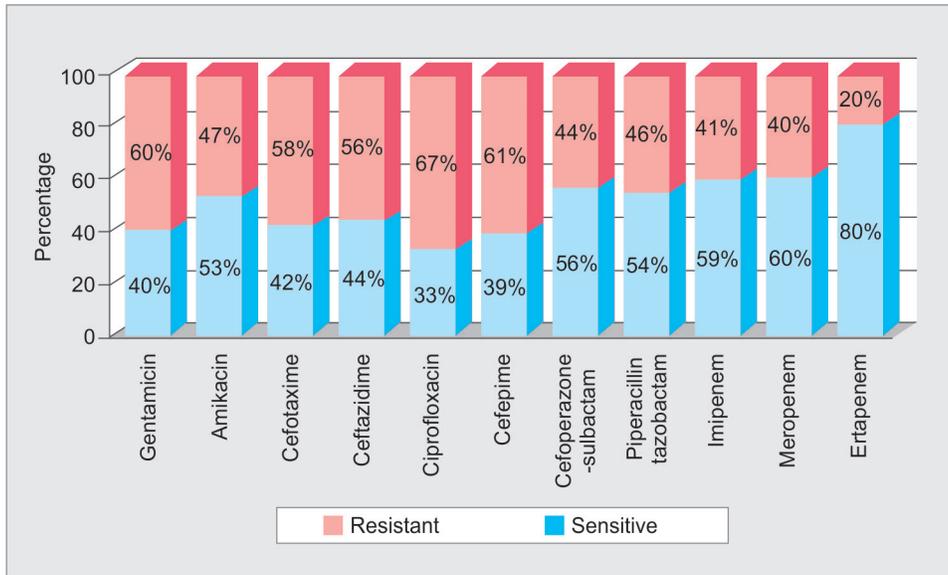


Fig. 4: Percentage of sensitivity and resistance of gram-negative isolates from burns patients (n = 164)

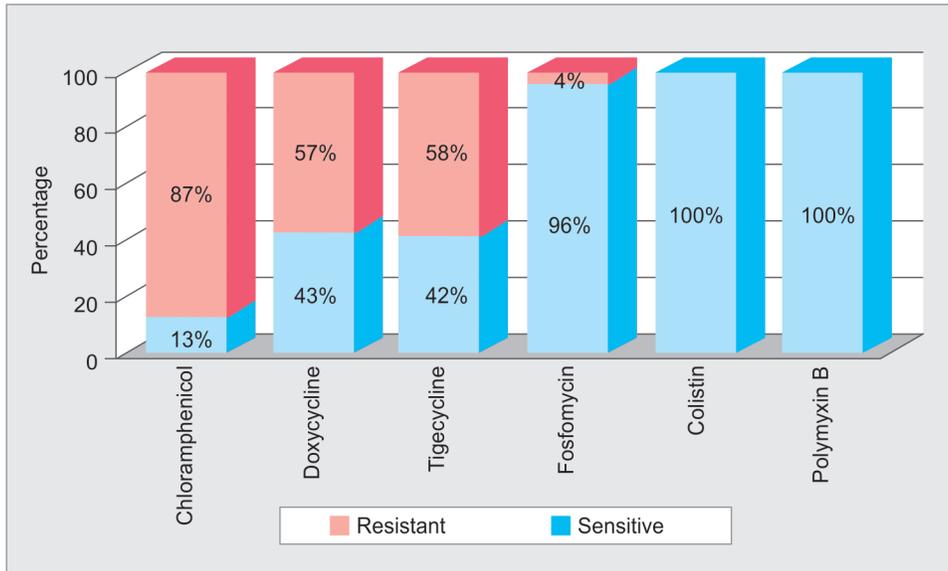


Fig. 5: Percentage of sensitivity and resistance to second-line drugs of MDR gram-negative isolates from burns patients

causing infections in burns patients gain their access through colonization of the host as primary barrier to the organisms is lost.<sup>4</sup> Therefore, microorganisms present in the hospital environment, patient's own resident flora or a combination of both become the usual causative factors of infection.<sup>1</sup> Organism profile and their susceptibility to antibiotics vary between every hospital and geographic location. For this reason, we carried out this study among burns patients to analyze types of organisms and their antibiogram.

Gram-negative infections were predominant among burns patients, being consistent with data from a large meta analysis published in 2014.<sup>5</sup> Among gram-negatives, *Pseudomonas* species and *Klebsiella* species top the list of causative pathogens. Similar kind of preponderance to these organisms were observed in two studies from Maharashtra<sup>6,7</sup> and one from Karnataka.<sup>8</sup> From our study as well as the literature reviewed by us, it is proven that

gram-negative infections due to *Pseudomonas*, *Klebsiella* and *Acinetobacter* are common among burns patients.

On the other hand, incidence of gram-positive infections among our burn patients was 19%, being much lower than other studies from central India (26%)<sup>9</sup> and China (31.3%).<sup>10</sup> gram-positive organisms were common in bloodstream infections, out of which 99% were associated with polymicrobial bloodstream infections. *Enterococcus* species was the most common gram-positive organism isolated (11% incidence). We did not encounter vancomycin resistant enterococci from any clinical sample. One contrasting finding in our study was the very negligible percentage of *Staphylococcus aureus* (MSSA and MRSA) infections. This finding was contrary to various studies from India and Iran.<sup>6,8,11</sup> Other gram-positives such as MRSA and coagulase negative staphylococci were isolated from a meager number of clinical samples. Studies so far have reported contradicting findings with high incidence of MRSA, MSSA from

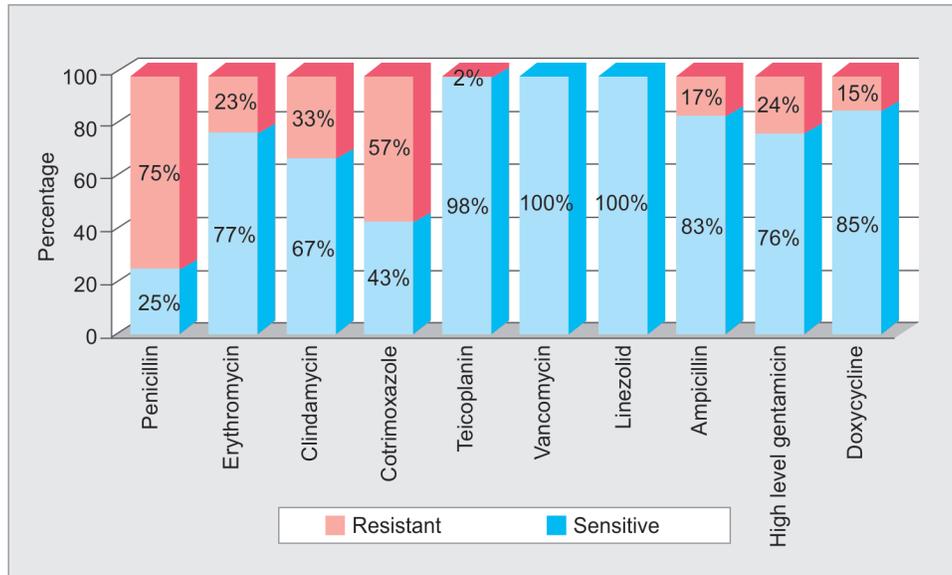


Fig. 6: Percentage of sensitivity and resistance of Gram-positive isolates from burns patients

burns patients. The same studies have not reported enterococcal infections from burns patients.<sup>12,13</sup> Among drug resistant pathogens in burns patients, MRSA is not therefore a major threat in our center (1.4% incidence).

According to a review on fungal infections in burns patients, standard guidelines have been placed for diagnosis of invasive fungal infections.<sup>14</sup> Using these standards, a significant colony count for urine isolates and isolation of *Candida* species in more than one clinical sample were taken into consideration before making a diagnosis. Among our patients, 14 patients had yeast like fungi in blood and/or urine cultures. All patients with invasive candidiasis succumbed to infection (100% mortality). The duration of stay of patients with candiduria and invasive candidiasis was longer than those without these conditions (mean length of stay: 24.8 days). Fungal burn wound infections and infections due to molds such as *Aspergillus* and *Zygomycetes* were not encountered in our study. Good environmental conditions and air quality play a pivotal role in containing mold infections among patients and we were able to achieve the same in our unit. Large scale studies from France and Australia have also shown a low incidence of noncandidal fungal infections in burns patients.<sup>15,16</sup>

*Trichosporon* species causing infections among burns patients have been reported by very few authors and literature search did not reveal reports from India.<sup>17,18</sup> Two of our patients had *Trichosporon* species infection, both isolated from urine as these infections start as colonization of urinary catheters. *Trichosporon* can thus be considered as an emerging pathogen among burns patients. They have better susceptibility to echinocandins but variable susceptibility to amphotericin B and fluconazole.<sup>19</sup> Invasive infection with *Trichosporon* species may be fatal, therefore isolation from urine cannot be ignored as a colonizer.

Urosepsis among burns patients is a gray zone as this has not been an area of research among these group of patients. Among our patients with sepsis, 10 patients had same organisms isolated from urine and blood (39% incidence). Growth in urine culture can thus be used to predict or anticipate similar organisms in blood in

case of development of sepsis. Another interesting finding was that there were no gram-positive organisms causing urosepsis.

Similarly, only gram-negative organisms were isolated from wound infections as well as blood of 13 patients. No gram-positive organisms were associated with wound infection predisposing to sepsis. It may therefore be postulated that gram-negative organisms in burns patients get disseminated from their primary infective foci and gram-positive organisms do not get disseminated.

Antibiograms of burn centers should be exclusive and empirical treatment algorithms must be based on an updated yearly antibiogram data.<sup>20</sup> Based on this study, we would incorporate data from this antibiogram for our future use. An updated antibiogram is emphasized due to change in trends of microorganisms and their susceptibility to various antibiotics. The most common example would be the rise in multi drug resistant gram-negative isolates from 2014 to 2017 in our center as well as other centers.<sup>21</sup> Keeping this in mind, literature search revealed antibiograms of isolates isolated only from burn wounds. Whereas, our study includes a comprehensive antibiogram of all clinical samples (wound, blood, urine, tissue, respiratory samples). We have compared this with two studies published in 2004 from Uttar Pradesh and in 2014 from Chennai.<sup>20,21</sup> This comparison showed that our gram-negative clinical isolates had better susceptibility to gentamicin, cefotaxime, ciprofloxacin than other studies. Few antibiotics like carbapenems, cefoperazone sulbactam could not be compared due to unavailability of data from studies in and outside India. However, in our study, 80% of isolates were susceptible to ertapenem. Ertapenem has low risk of development of resistance when compared to other carbapenems. Better susceptibility was noted among gram-positive isolates from our patients to ampicillin, doxycycline, erythromycin and penicillin when compared to other studies.<sup>20,21</sup>

Large scale studies on microbial profile and susceptibility pattern of burns isolates are required in future. This would provide an insight on predominant resistance patterns and thus help clinicians to make targeted empiric antibiotic therapy for burns patients.

## CONCLUSION

Studies published so far have mainly concentrated only on burn wound infections and few on sepsis among burns patients. Our study provides comprehensive microbial profile and their antibiogram from all samples of burns patients which could help guide empiric choice of antibiotics based on suspected source. Efforts will be made to include this susceptibility pattern in our antibiotic policy for future use in these group of patients. This would also be a stepping stone to formulate separate yearly antibiogram in our hospital which serves as a tertiary care referral center for burns.

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