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Original Article

Methicillin-resistant *Staphylococcus aureus*-prevalence and Antimicrobial Sensitivity Pattern among Burn Patients in a Tertiary Care Hospital in Vindhya Region

Aishwarya Kharre[1], Vishnu Kumar Patel[2], Varsha Shukla[3], Rachna Gupta[4], Ashish Singh[3], Juhi Bisen[1]

[1]3rd Year Post Graduate, Department of Surgery, Shyam Shah Medical College and Associated Sanjay Gandhi Memorial Hospital, Rewa, Madhya Pradesh, India, [2]Associate Professor, Department of Surgery, Shyam Shah Medical College and Associated Sanjay Gandhi Memorial Hospital, Rewa, Madhya Pradesh, India, [3]Senior Resident, Department of Surgery, Shyam Shah Medical College and Associated Sanjay Gandhi Memorial Hospital, Rewa, Madhya Pradesh, India, [4]Professor and Head, Department of Surgery, Shyam Shah Medical College and Associated Sanjay Gandhi Memorial Hospital, Rewa, Madhya Pradesh, India

Abstract

Background: Methicillin-resistant *Staphylococcus aureus* (MRSA) is a well-recognized public health problem throughout the world. The evolution of new genetically distinct community-acquired and livestock-acquired MRSA and extended resistance to other non-*β*-lactams including vancomycin has only amplified the crisis. This paper presents data on the prevalence of MRSA and resistance pattern to other antibiotics on the selected specimen from burn patients.

Materials and Methods: This is a prospective study conducted in the burn unit of Shyam Shah Medical College and Sanjay Gandhi Memorial Hospital, Rewa (M.P.), from June 2018 to May 2019, where all patients with flame and scald burns were included in the study who had up to a second degree or partial-thickness burns.

Results: A total of 558 patients were admitted in the burn unit throu`ghout the year, the age ranged from 2 months to 85 years. About 56.10% were females and 43.90% were males. *Pseudomonas aeruginosa* (37.5%) was the most common isolate followed by *S. aureus* (18.75%). The prevalence of MRSA was 57.14% but all the MRSA isolates showed 100% sensitivity to vancomycin and linezolid closely followed by piperacillin and tazobactam combination. The prevalence of methicillin resistance overall among *S. aureus* and *Staphylococcus epidermidis* was found to be 51.72%.

Conclusion: MRSA is prevalent among the burn wounds but is 100% sensitive to vancomycin and linezolid. To ensure early and appropriate therapy, routine microbiological surveillance and a regular update of their antimicrobial susceptibility pattern could help in the prevention of development of multidrug resistance.

Key words: Antimicrobial sensitivity, Burn, Methicillin-resistant *Staphylococcus aureus*

INTRODUCTION

All over the world, it is estimated that approximately 25 lakh people in each continent sustain burns of which 100,000 are hospitalized and there are around 12,000 deaths per year due to thermal injuries. The exact number of burns is difficult to determine in India. Judicious extrapolation suggests that we have 7–8 lakh admissions due to burns and the projected figures suggest an annual mortality rate of 1–1.4 lakhs.

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Burns are the fourth most common and devastating forms of trauma, following traffic accidents, falls. and violence. The extensively burn or severely injured patient is at increased risk of burn infection as well as of injury to other organs as a result of various degrees of impairment of host defense mechanism. The survival rate for burn patients has improved substantially in the past few decades

Corresponding Author: Vishnu Kumar Patel, Department of Surgery, Shyam Shah Medical College and Associated Sanjay Gandhi Memorial Hospital, Rewa, Madhya Pradesh, India.

due to advances in modern medical care in specialized burn centers. Burn-related deaths depending on the extent of injury have been halved within the past 40 years.

Burn wound surface provides a favorable niche for microbial colonization and proliferation, while the avascularity of the eschar causes impaired migration of host immune cells, restricts delivery of systematically administered antimicrobial agents, and releases toxic substances that impair host immune response. The organisms responsible for infections in patients who suffer from burn injuries may be endogenous or exogenous which can change over time in the individual patient.

The common pathogens isolated from burn wounds are *Staphylococcus aureus*, *Pseudomonas aeruginosa*, *Streptococcus pyogenes*, *Acinetobacter baumannii,* and various coliform bacilli. Microorganism is transmitted to the burn wound surfaces of admitted patients by the hands of medical personnel, by fomites, and from patient's skin surface and nose and during intervention.

S. aureus is frequently isolated pathogen in both community and hospital practices. *S. aureus* is normal flora in nasal vestibule and other skin sites, especially anus and armpits of the human population. As burn patients have lost their primary barrier and exposed to microorganism invasion continually and chronically, *S. aureus* becomes one of the greatest causes of nosocomial infection in burn patients.

The cases of antibiotic resistance have increased and resistant species such as methicillin-resistant *S. aureus* (MRSA) provide additional challenges in the form of virulence factors. MRSA has attracted more and more attention in recent years, especially in burn centers. Multimodal infection control concept is required to limit the spread of infection with multidrug-resistant organism including MRSA in a burn unit. Where patients colonized or infected with MRSA appear to be the main reservoir, transfer of these patients to other units or temporary closure of the unit, accompanied by intensive cleaning are very effective measures to stop transmission events.

The presence of drug-resistant bacteria in the hospital environment and in patients is a great threat for public health and because of the ever-increasing number of resistant strains with time, updated information on prevalence of local major pathogens and their sensitivity patterns is very helpful for health personnel responsible in the management of patients and monitoring the emergence of resistant bacteria in any given region.

MATERIALS AND METHODS

This prospective analysis was conducted in the Burn Unit of Shyam Shah Medical College and Sanjay Gandhi Memorial Hospital, Rewa (M.P.). The epidemiological analysis is based on data collected from 558 burn patients hospitalized between June 2018 and May 2019. Data collected included age, sex, percent total body surface area burnt, residence, season of injury, mechanism of injury, and outcome. The clinical samples were taken for microbiological tests from burn wound at different time intervals during the patients' stay in hospital. Culture and sensitivity tests were undertaken at the center's microbiology laboratory.

Microbiological Assessment

Bacterial isolation and identification

For isolation, all the samples were inoculated on a selective and differential medium (mannitol salt agar), enriched medium (blood agar) and incubated at 37°C for 24 h, and colonies of mannitol fermenter and beta-hemolysis of staphylococci were submitted to identification tests according to Bergey's manual of determinative bacteriology.

Antibiotic sensitivity test (Kirby-Bauer method)

Inoculums from the tested bacterium were prepared depending on Kirby-Bauer antibiotic testing. The bacterial suspensions were prepared from fresh single colonies and adjusted by comparison with 2 McFarland turbidity standard (6 × 108 cells/ml) tubes. Sterile cotton swab was dipped into the inoculum and then swabbed evenly across the surface of a Mueller-Hinton agar plate, after that within 15 min of inoculation, the antimicrobial-containing discs are applied to the agar with a forceps pressed firmly to ensure contact with the agar and then plate inverted and incubated at 37°C for 18 h. Inhibition zones were expressed in (mm) as the diameters of clear zones around the discs (CLSI, 2007) [Tables 1 and 2].

Data Entry and Analysis

The quantitative data were analyzed using descriptive statistics summarized and displayed on graphs and charts.

RESULTS

Demographic Profile of Burn Patients

In the study conducted among 558 patients admitted in burns unit, 56.10% patients were female and 43.90% of the affected population was males. The youngest patient in the study was 2 months old and the oldest was 85 years old [Figure 1].

Cause and Source of Burn

The cause of burn in 62.54% (349) patients was flames due to any cause, scalds due to hot liquids in 29.75% (166) and

electric burn in 7.71% (43) patients [Table 3]. In our study group, the majority of patients were afflicted with burns because of scalds due to hot liquids (29.75%) followed by burns due to kerosene oil (24.19%). The least common source was burning due to stove accounting for 6.82% of cases [Figure 2].

Relation of Socioeconomic Status with Infection

It was evident in our study that most of the patients with positive cultures belonged to the lower class (90.48%), indicating the correlation and significance of hygiene with the rate of infection [Figure 3].

Prevalence of MRSA

The wound swabs were taken from 112 patients who satisfied the inclusion criteria, 25% were culture negative. The prevalence for *S. aureus* and coagulase-negative *Staphylococcus* was found to be 18.75% (21) and 6.25% (7), respectively. Among the patients in whom *S. aureus* was isolated, the disc diffusion method using cefoxitin discs was used to detect MRSA. The prevalence of MRSA was found to be 57.14% (12) and prevalence of methicillin resistance was found to be 42.8% (3) in patients with *Staphylococcus epidermidis*. The overall prevalence of methicillin resistance was 51.72% (15) [Table 4].

Antimicrobial Sensitivity of MRSA

All the MRSA isolates showed 100% sensitivity to vancomycin and linezolid closely followed by piperacillin and tazobactam combination with 95.24% and 85.71% sensitivity to *S. aureus* and coagulase-negative *Staphylococcus*, respectively [Table 5].

DISCUSSION

Bacterial infections of the burn wound still remain a major cause of morbidity and mortality in thermally injured patients. The burned patient is prey for a wide variety of microorganisms, as burn presents an extensive surface with a large mass of dead tissue and free exudation of serum which is favorable for bacterial growth. The burn site initially becomes colonized with microorganisms which if uncontrolled progresses to invasion and gives rise to bacteremia and sepsis, which is a major cause of mortality in burn patients. Although the diagnosis of burn wound infections can be made clinically, additional microbiological evidence is needed for instillation of proper therapy.

In studies conducted on burn patients in Rewa, by Lal *et al.* in 2012, Jain *et al.* in 2015, and Singh *et al.* in 2018, the incidence in females was 82.2%, 59.3% and 60%, respectively, which is very well in correlation with our present study.

In contrast, Agnihotri *et al.*, Lari *et al.*, and Ekrami and Kalantar reported that the incidence was higher in males in

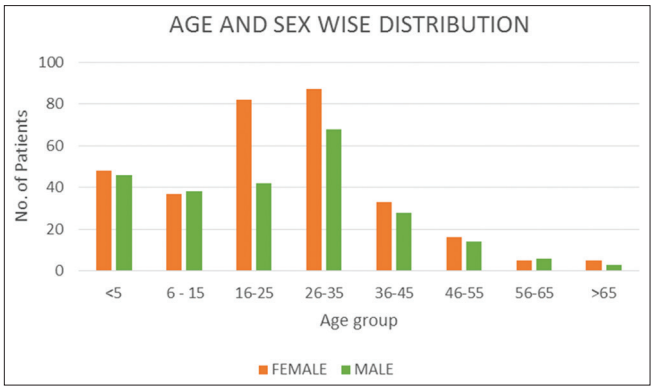

Figure 1: Age and sex wise distribution

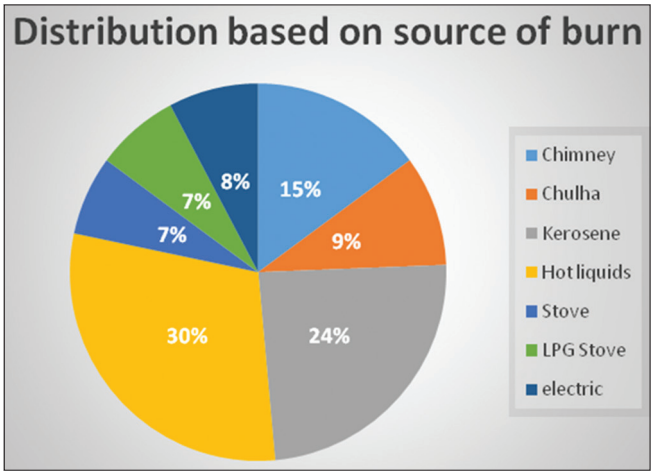

Figure 2: Distribution based on source of burn

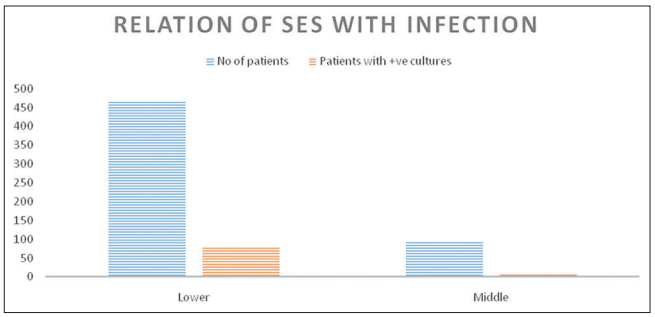

Figure 3: Relation of Socioeconomic status with infection

their studies. High incidence of burns in females is probably due to occupational hazards of working in the kitchen as the kitchen is the most common place to receive a burn. In the Indian rural setting, women are more predisposed especially due to the old methods used such as chulha and chimney which are more susceptible to catch and cause fire. Social evil such as dowry and domestic violence is a major culprit for intentional burn deaths.

According to most studies, flame burns are the most common type of burn injuries. In the present study as well, flame burns were the commonest type of burns

Table 1: Antibiotic discs used for Gram-positive organisms

Antibiotic	Abbreviation	Strength	Antibiotic	Abbreviation	Strength
Penicillin	P	10 units	Gentamycin	GEN	10 µg
Cefoxitin	CX	30 µg	Cotrimoxazole	COT	1.25
Erythromycin	E	15 µg	Amikacin	AK	30 µg
Clindamycin	CD	2 µg	Ciprofloxacin	CIP	5 µg
Linezolid	LZ	30 µg	Piperacillin+Tazobactam	PIT	100/10 µg
Vancomycin	VA	30 µg	Ceftriaxone	CTR	30 µg

Table 2: Antibiotic discs used for Gram-negative organisms

Antibiotic	Abbreviation	Strength	Antibiotic	Abbreviation	Strength
Cefuroxime	CXM	30 µg	Meropenem	MP	10 µg
Amikacin	AK	30 µg	Ceftazidime	CAZ	30 µg
Ceftriaxone	CTR	30 µg			
Cotrimoxazole	COT	1.25			
Gentamicin	GEN	10 µg			
Ciprofloxacin	CIP	5 µg			
Piperacillin+Tazobactam	PIT	30 µg			

Table 3: Cause of burn

S. No.	Cause of burn	Number of patients	Percentage
1	Flame	349	62.54
2	Scald	166	29.75
3	Electric	43	7.71
	Total	558	100

Table 4: Prevalence of methicillin-resistant *Staphylococcus aureus*

S. No.	Organism	Methicillin resistance	Percentage
1	*Staphylococcus aureus* (21)	12	57.14
2	*Staphylococcus epidermidis* (7)	3	42.8

accounting for 62.54% of all the cases. It was followed by burns due to scalds seen in 29.75% of the cases. This is consistent with the study by Delgado *et al.* (2002) in which they reported scalding as the most common cause of burns in children under 5 years. Most of the scalds injuries (47.62%) were seen in children below 12 years of age. Scalds have been unanimously found to be the predominant form of burns among children. As the age increases, frequency of scalds decreases and flame burns increase in number.

In our study, 18.75% of the swabs sent for culture were positive for *S. aureus*. *Staphylococcus* was the predominant cause of burn wound infection in the pre-antibiotic era and remains an important pathogen at present. However, Srinivasan *et al.* stated that the percentage incidence of staphylococci is on the decline from 2002 to 2005.

In our study, coagulase-negative staphylococci (*S. epidermidis*) were recovered at a frequency of 6.25%. This finding is similar to a study by Mama *et al.* (2014) in which they reported a 14.5% coagulase-negative staphylococci isolated from wounds. Coagulase-negative staphylococci being a normal skin flora and common contaminant of wound most often may be isolated (Mama *et al.*, 2014).

Among the patients in whom *S. aureus* was isolated, tests were applied to detect MRSA. The prevalence was found to be 57.14% in patients with *S. aureus* infection and 42.8% in patients with *S. epidermidis*. The overall prevalence of MRSA was 51.72%.

According to an Indian study, the prevalence of infections caused by MRSA has increased from 12% in 1992–80.03% in 1999. The prevalence of MRSA infection in the study by Naqvi *et al.* was 24.6%. It is less than that reported by Mokaddas and Sanyal, 1996, i.e., 74.6% and other studies conducted in Guru Teg Bahadur Hospital in New Delhi, from 1997 to 2002 (Singh *et al.*, 2003). Muscat, Oman, the prevalence of MRSA was about 95% during 1995–1996 (Prasanna and Thomas, 1999). In another study, all isolates of *S. aureus* were resistant to methicillin at Gulhane Military Medical Academy Istanbul Turkey (Oraloncul *et al.*, 2002). The authors of this study suggested many factors that may account for an increased incidence of MRSA colonization and infection. These factors included the use of broad-spectrum antibiotics, average length of hospital stay, and poor hospital infection control practices. A similar picture is also reflected in the present study.

The antimicrobial sensitivity testing was done by Kirby Bauer's disc diffusion method. Methicillin resistance was

Table 5: Antibiotic sensitivity pattern of staphylococci

Organism	P	E	CD	LZ	VA	CIP	PIT	COT	AK	GEN
Staphylococcus aureus										
n (%)	3 (14.29)	13 (61.90)	16 (76.19)	21 (100)	21 (100)	10 (47.62)	20 (95.24)	12 (57.14)	11 (52.38)	NT
Staphylococcus epidermidis										
n (%)	2 (28.57)	3 (42.86)	5 (71.43)	7 (100)	7 (100)	3 (42.86)	6 (85.71)	3 (42.86)	4 (57.14)	NT

GEN: Gentamicin, AK: Amikacin, COT: Cotrimoxazole, PIT: Piperacillin+Tazobactam, CIP: Ciprofloxacin, VA: Vancomycin, LZ: Linezolid, CD: Clindamycin, E: Erythromycin, P: Penicillin

tested using cefoxitin (30 μg) disc and it was found that 57.14% of the *S. aureus* isolates and 42.8% of the coagulase-negative *Staphylococcus* isolates were methicillin-resistant but all the MRSA isolates showed 100% sensitivity to vancomycin and linezolid closely followed by piperacillin and tazobactam combination.

This is in accordance with other studies on MRSA in burn patients by Rajput *et al.* and Oncul *et al.* They both reported a 40% incidence of MRSA. About 33.3% of the CONS isolates were methicillin-resistant. This finding is similar to that by Altoparlak *et al.* who reported 20.9% isolates of CONS to be methicillin-resistant.

The resulting antibiograms give some cause for concern because the predominant bacterial isolates were relatively resistant to the commonly available, more economical antimicrobials.

CONCLUSION

The present study has given us the knowledge regarding incidence of bacterial colonization of burn wounds in our hospital and specifically about the prevalence of MRSA.

In conclusion, to ensure early and appropriate therapy, routine microbiological surveillance and a regular update of their antimicrobial susceptibility pattern could help in the prevention of development of multidrug resistance. Among other precautions, personal hygiene of the patients and handwashing practice among health-care providers is to be emphasized and practiced routinely.

To prevent antibiotic resistance, there should be an Institutional Infection Control Committee that can monitor and provide guidelines for the rational use of antibiotics. Our results may be helpful in providing useful information regarding the pattern of burn wound microbial colonization, the dominant flora and antimicrobial resistance in our burn unit and thus will help in the formulation of effective guidelines for therapy, thus improving overall infection-related morbidity and mortality.

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