ORIGINAL ARTICLE

A study on bacterial profile of burn wound infections

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ABSTRACT

Aim: This study was conducted to find out the bacterial aetiological agents of burn wound infections with antimicrobial testing of the bacterial isolates. **Materials and Methods**: This is a descriptive study of 203 patients with burn wound infections at Government Medical College, Thiruvananthapuram during the period January 2010 to April 2011. The specimens were cultured using aerobic microbiological techniques. Antimicrobial susceptibility testing to different agents was carried out using the disc diffusion method. **Results:** Cultures from burn wound revealed *Pseudomonas aeruginosa* as the most common organism followed by *Staphylococcus aureus, Escherichia coli, Acinetobacter baumannii* and *Klebsiella pneumoniae*. There was a high rate of multidrug-resistant organisms. However, all the staphylococci were susceptible to Vancomycin and the gram negatives were susceptible to Carbapenems. **Conclusion:** Collection of appropriate specimens for culture before starting of antibiotics helps in better management, along with isolation precautions. However close follow-up and repeat specimens are necessary for appropriate change in antibiotics. For empiric treatment Vancomycin and Imipenem appear to be a good combination in this hospital.

Key words: Antibiotic sensitivity, bacterial prevalence, burn wound infections

INTRODUCTION

Infections remain the leading cause of death among patients who are hospitalised for burns. The risk of burn wound infection is directly correlated to the extent of the burn and is related to the impaired resistance resulting from disruption of the skin's mechanical integrity and generalised immunosuppression. In India, majority of accidental burns are domestic in nature. Suicidal burns are more common among women. A large number of homicidal cases are also reported due to occurrence of dowry deaths.[1]

Very young children and the elderly have an increased risk of being burnt and have worse clinical outcomes than patients in other age groups.[2,3] Individuals with deliberate self-inflicted burn injuries and the disabled have been shown to have more severe injuries and longer hospital stays than those with accidental injuries.[4,5] Obese adults and those who have an underlying medical condition such as diabetes have also been shown to have higher morbidity and mortality. *Staphylococcus aureus* and *Pseudomonas aeruginosa* are the most common isolates in most burn units, followed by members of Enterobacteriaceae and gram-negative bacilli like *Acinetobacter baumannii*. Early diagnosis of the bacteria that cause the infections and their sensitivity pattern helps to institute appropriate antibacterial therapy and avoid further complications.

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MATERIALS AND METHODS

A descriptive study was carried out on 203 patients with burn wound infections during the period January 2010 to April 2011 at Government Medical College, Thiruvananthapuram, Kerala, India. A semi-structured questionnaire was prepared to record the medical history, examination details and investigation reports. Swabs were collected at the bedside from the burn wounds after cleaning the site with sterile normal saline on the third day and fifth postburn day. These specimens were immediately transported to the laboratory for further processing. Specimens were inoculated on Blood agar, MacConkey agar (Himedia Laboratories Pvt Ltd., Mumbai) and Salt agar (in-house). Antibiotic sensitivity testing was done according to Clinical and Laboratory Standards Institute (CLSI) guidelines.

RESULTS

Maximum number of patients was in the age group

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21-30 years (24.14%). Of the 155 adult cases, 132 (85.16%) were females and 23 (14.84%) were males. In contrast to adults, in children, the incidence of burns was more in males (56.25%). One hundred and twenty-eight (61.08%) cases were accidental, 75 (36.95%) were suicidal, 2 (0.98%) were homicidal and 2 (0.98%) were due to electrocution.

Table 1: Distribution of cases according to monomicrobial isolates

Isolate	Third day		Fifth day	
	Number	Percentage	Number	Percentage
P. aeruginosa	76	47.20	62	42.76
S. aureus	54	33.54	40	27.59
MRSA	11	6.83	34	23.45
E. coli	8	4.97	2	1.38
A. baumannii	8	4.96	4	2.76
K. pneumoniae	4	2.48	3	2.07

Table 2: Distribution of cases according to polymicrobial isolates

Isolate	Third day		Fifth day	
	Number	Percentage	Number	Percentage
P. aeruginosa + *S. aureus*	7	87.5	25	50
P. aeruginosa + *E. coli*	0	0	6	12
P. aeruginosa + MRSA	0	0	6	12
P. aeruginosa + *K. pneumoniae*	0	0	1	2
P. aeruginosa + *A. baumannii*	0	0	4	8
S. aureus + *A. baumannii*	0	0	4	8
S. aureus + *E. coli*	1	12.5	3	6
MRSA + *E. coli*	0	0	1	2

Microbial profile

On the third postburn day, the number of monomicrobial isolates was 161 (79.31%) and it reduced to 145 (71.42%) on the fifth postburn day. But the polymicrobial infections that were 8 (3.94%) in number on the third day increased to 50 (24.63%) on the fifth day.

Table 1 shows that the isolates of *P. aeruginosa*, *S. aureus*, *E. coli*, *K. pneumoniae* and *A. baumannii* were more on the third postburn day compared to fifth postburn day. But Methicillin-resistant *S. aureus* (MRSA) increased from 11 (6.83%) on the third postburn day to 34 (23.45%) on the fifth postburn day.

Table 2 shows that the number of polymicrobial isolates was less on the third postburn day compared to that on the fifth postburn day. The most common combination was *P. aeruginosa* and *S. aureus*.

Among the isolates of *P. aeruginosa*, 9 (11.34%) were sensitive to Gentamicin, 55 (72.36%) to Ciprofloxacin, 67 (88.15%) to Ceftazidime, 24 (31.57%) to Amikacin and 76 (100%) were sensitive to Piperacillin–Tazobactam and Imipenem on the third post burn day. But on the fifth day, the resistance increased [Tables 3 and 4].

Among the total of 65 isolates of *S. aureus*, 11 (16.92%) were resistant to Cefoxitin and identified as MRSA. Of the 54 (83.07%) isolates of Methicillin-sensitive *S. aureus* (MSSA), all were sensitive to Cefoxitin, Amikacin, Vancomycin, Rifampicin, Linezolid and Clindamycin on the third and fifth days. Of the MRSA isolates, all were sensitive to Vancomycin, Rifampicin, Clindamycin and Linezolid on the third and fifth postburn days [Tables 5 and 6].

Table 3: Antibiotic sensitivity pattern of gram-negative isolates on third postburn day

Antimicrobial agent	*P. aeruginosa* (total no. 76)		*E. coli* (total no. 8)		*K. pneumoniae* (total no. 4)		*A. baumannii* (total no. 8)	
	Number sensitive	Percentage	Number sensitive	Percentage	Number sensitive	Percentage	Number sensitive	Percentage
Ampicillin (10 µg)	NT		0	0	0	0	1	12.5
Gentamicin (10 µg)	9	11.34	0	0	1	25	3	37.5
First-generation Cephalosporins (30 µg)	NT		7	87.5	2	50	5	62.5
Ciprofloxacin (5 µg)	55	72.36	5	67.5	2	50	3	37.5
Third-generation Cephalosporins (30 µg)	67	88.15	7	87.5	3	75	6	75
Amikacin (30 µg)	24	31.57	7	87.5	3	75	8	100
Cefoperazone–Sulbactam (75-30 µg)	NT		8	100	4	100	8	100
Piperacillin–Tazobactam (100-10µg)	76	100	NT		NT		NT	
Aztreonam (30 µg)	NT		4	50	3	75	2	25
Imipenem (10 µg)	76	100	8	100	4	100	8	100

Of the third-generation Cephalosporins, Ceftazidime was used for testing *P. aeruginosa* and Ceftriaxone was used for testing *E. coli, K. pneumoniae*, and *A. baumannii* J Burn Care Rehabil.Medicina (Kaunas)

Table 4: Antibiotic sensitivity pattern of gram-negative isolates on the fifth postburn day

Antimicrobial agent	*Pseudomonas aeruginosa* (total no. 62)		*E. coli* (total no. 2)		*K. pneumoniae* (total no. 3)		*A. baumannii* (total no. 4)	
	Number sensitive	Percentage	Number sensitive	Percentage	Number sensitive	Percentage	Number sensitive	Percentage
Ampicillin (10 µg)	NT		0	0	0	0	0	0
Gentamicin (10 µg)	2	3.22	0	0	0	0	0	0
First-generation Cephalosporins (30 µg)	NT	0	0	0	0	0	0	0
Ciprofloxacin (5 µg)	13	20.96	0	0	0	0	0	0
Third-generation Cephalosporins (30 µg)	27	43.54	0	0	0	0	0	0
Amikacin (30 µg)	8	1.90	0	0	0	0	0	0
Cefoperazone–Sulbactam (75-30 µg)	NT		2	100	3	100	4	100
Piperacillin–Tazobactam (100-10 µg)	51	82.25	NT		NT		NT	
Aztreonam (30 µg)	NT		1	50	1	33.3	2	50
Imipenem (10 µg)	62	100	2	100	3	100	4	100

Table 5: Antibiotic sensitivity pattern of the gram-positive isolates on the third postburn day

Antimicrobial agent	MSSA (total no. 54)		MRSA (total no. 11)	
	Number sensitive	Percentage	Number sensitive	Percentage
Penicillin (10 IU)	4	7.40	0	0
Gentamicin (10 µg)	10	18.51	0	0
First-generation Cephalosporins (30 µg)	50	92.59	0	0
Erythromycin (15 µg)	46	85.18	0	0
Cefoxitin (30 µg)	54	100	0	0
Amikacin (30 µg)	54	100	6	54.54
Vancomycin (30 µg)	54	100	11	100
Rifampicin (5 µg)	54	100	11	100
Clindamycin (2 µg)	54	100	11	100
Linezolid (30 µg)	54	100	11	100

Table 6: Antibiotic sensitivity pattern of gram-positive isolates on the fifth postburn day

Antimicrobial agent	MSSA (total no. 40)		MRSA (total no. 34)	
	Number sensitive	Percentage	Number sensitive	Percentage
Penicillin (10 IU)	2	5	0	0
Gentamicin (10 µg)	7	17.5	0	0
First-generation Cephalosporins (30 µg)	32	80	0	0
Erythromycin (15 µg)	36	90	0	0
Cefoxitin (30 µg)	40	100	0	0
Amikacin (30 µg)	40	100	15	44.11
Vancomycin (30 µg)	40	100	34	100
Rifampicin (5 µg)	40	100	34	100
Clindamycin (2 µg)	40	100	34	100
Linezolid (30 µg)	40	100	34	100

Of the 203 cases, 113 (55.7%) survived and 90 (44.3%) died.

DISCUSSION

This study was carried out to know the prevalence of different bacterial aetiological agents of burn wound infections with their antimicrobial susceptibility.

In the present study, monomicrobial infection occurred in 161 (79.32%) cases on the third day and 145 (71.42%) cases on the fifth day. Polymicrobial infection occurred in 8 (3.94%) cases on the third day and 50 (24.64%) cases on the fifth day. Thirty-four (16.74%) of the swabs were sterile on the third day and 8 (3.94%) were sterile on the fifth day. This may be due to prior intake of antibiotics or due to anaerobic infections.

Among the monomicrobial infections, *P. aeruginosa* was the most common organism obtained. In contrast to our study, studies conducted by Frame *et al*.[6] and Bagdonas *et al*.[7] showed that *S. aureus* was the most common isolate in patients with burn wound infections. However, another study conducted by Rajput *et al*. also showed that *P. aeruginosa* (55%) was the most common isolate in burn wound infections, followed by *S. aureus* (19.29%).[8]

Among the polymicrobial infections, the combination of *P. aeruginosa* and *S. aureus* was the commonest (50%). This is in accordance with the study conducted by Nagoba *et al*.[9]

Antibiotic sensitivity pattern

P. aeruginosa (76 on the third day and 62 on the fifth day)

In the present study, among the isolates of *P. aeruginosa*, 100% were sensitive to Piperacillin–Tazobactam and Imipenem on the third day. But on the fifth day, 51 (82.25%) cases were sensitive to Piperacillin–Tazobactam and 100% cases were sensitive to Imipenem. A study by Agnihotri *et al.* showed Piperacillin–Tazobactam was the most effective drug against *P. aeruginosa*.[10] Sixty-seven (88.15%%) cases were sensitive to Ceftazidime on the third day, but on

the fifth day, only 27 (43.54%) cases were sensitive. A study conducted by Revathy *et al.* also showed that *Pseudomonas* was highly susceptible to Ceftazidime (83%).[11] In the present study, 9 (11.34%) cases were sensitive to Gentamicin and 24 (31.57%) cases were sensitive to Amikacin on the third day. But on the fifth day, only 2 (3.22%) cases were sensitive to Gentamicin and 8 (12.90%) cases were sensitive to Amikacin. This is quite alarming as aminoglycosides are the mainstay of treating *Pseudomonas* sepsis. This finding is similar to the study finding of Branski *et al*.[12]

S. aureus (54 on the third day and 40 on the fifth day)

In the present study, all the MSSA (54 on the third day and 40 on the fifth day) were sensitive to Amikacin, Vancomycin, Rifampicin, Clindamycin and Linezolid. This finding is similar to the study findings of Sarma *et al*.[13] and Rajput *et al*.[8] A high degree of Penicillin resistance was noted in our study. Only 4 (7.40%) isolates were sensitive to Penicillin on the third day and 2 (5%) were sensitive on the fifth day.

In the present study, all 11 (100%) MRSA isolates were sensitive to Vancomycin, Rifampicin, Clindamycin and Linezolid on the third day. But on the fifth day, there were 34 MRSA isolates, all of which were sensitive to the above drugs. This finding is similar to the study findings of Shehab *et al*.[14] and Revathy *et al*.[11]

All the isolates of *E. coli* (8 on the third day and 2 on the fifth day) and *K. pneumoniae* (4 on the third day and 3 on the fifth day) were extended-spectrum beta-lactamase (ESBL) producers by double disc method.

S. aureus was the most common isolate in children, followed by *P. aeruginosa*. In accordance with our study, a study conducted by Imran *et al*.[15] reported that the most frequent organism isolated from burn wound infections in children was *S. aureus*, followed by *P. aeruginosa*.

A high percentage of multidrug-resistant (MDR) isolates is probably due to empirical use of broad-spectrum antibiotics and nonadherence to hospital antibiotic policy. Once MDR strains become established in the hospital environment, they can persist for months. Therefore, careful microbiological surveillance and *in vitro* testing before the start of antibiotic therapy and strict antibiotic policy may be of great help in prevention and treatment of MDR isolates in burn units and, thus, reduction of overall infection-related morbidity and mortality. The overcrowding in burns ward is an important cause of cross-infection and must be avoided in order to control a hospital-acquired infection.

Proposed antibiotic regimens:

1. A combination of Cloxacillin and Amikacin is proposed as the best regimen in early-onset burn wound infection (within 3 days), due to the low prevalence of MRSA here.
2. However, late-onset (after 5 days) infections may be treated with Linezolid as MRSA appeared in late-onset infections.
3. Infections with ESBL producing gram-negative bacteria may be treated with Piperacillin–Tazobactam or Cefoperazone–Sulbactam after proper susceptibility tests.

Prevalence of MRSA is likely to influence the empirical management of burn wound infections. The prevalence of MDR organisms is to be considered as a warning sign for the emerging spread of antibiotic resistance and the need for urgent implementation of strict antibiotic policy and infection control measures. For the development of an antibiotic policy, good communication must exist between the surgeon and the microbiologist and such studies help in promoting this interaction.

CONCLUSION

Following guidelines are proposed based on this study for the management of burn wound infections:

1. Collection of appropriate specimens for culture before starting of antibiotics.
2. Empirical antimicrobial therapy can be started based on the susceptibility data extrapolated from the present study, given above. However, in life-threatening infections, Vancomycin and Imipenem combination can be given.
3. Close follow-up of the patients, repeat culture and changes in antibiotics as and when necessary according to the antibiotic susceptibility pattern.
4. Strict aseptic precautions and source isolation should be implemented in case of infection with MDR organisms to prevent cross-transmission.

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