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Epidemiological and bacteriological profile of sepsis in burns patients: A report from tertiary care hospital, India

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ABSTRACT

Background: Burns are one of the most prevalent and mortifying forms of trauma. Patients burn with significant thermal injury require immediate intensive care unit (ICU) care to minimize morbidity and mortality. Burns patients are generally more predisposed to sepsis because of two main reasons, i.e., burn wound infection and catheter-related bloodstream infection (CRBSI). Due to extensive skin barrier disruption and an alteration in the cellular and humoral immune responses burn wounds has a much higher incidence of sepsis as compared to other forms of trauma. **Aims and Objectives:** The present study was undertaken to study the bacteriological profile and sources of sepsis in burns patients and their antimicrobial susceptibility pattern. **Materials and Methods:** It is a prospective observational study conducted in the Department of Burns, Plastic and Maxillofacial Surgery, ICU and Department of Microbiology of a tertiary care hospital, Uttar Pradesh, India, between January 2020 and June 2022. Adult patients with 30–70% of total body surface area burns with central venous catheter (CVC) inserted during ICU admission were enrolled in the study. The presence of clinical sepsis in the burn patients was evaluated using the American Burn Association Sepsis criteria. For all patients with suspected clinical sepsis, paired blood cultures were collected simultaneously; one from the CVC and another from a peripheral site and were sent for bacteriological culture. Blood culture samples were processed as per standard procedures. CRBSI was defined if the same organism was isolated in paired blood cultures. Burn wound biopsy was sent for quantitative culture and 10^5 organisms/g of tissue were considered significant. **Results:** In the present study, the overall incidence of clinical sepsis was 28.4% (39/137), out of which 48.7% of cases were found to be due to CRBSI and the most common organism involved was *Klebsiella* spp. (42.1%), 33.3% of cases were due to burn wound sepsis and the most common organism involved was *Pseudomonas* spp. (61.5%); and 18.0% of cases were those in which no known source could be found. Possible explanations for these cases could be sepsis without bacteremia due to endotoxins and Gram-negative endotoxemia. **Conclusion:** To find out microorganisms causing burn wound infection by culture and provide suitable antibiotics according to their antibiotic sensitivity patterns helping us in managing these infection and decreasing overall morbidity and mortality in burn patients.

Key words: Sepsis; Antibiotics; Wounds; Epidemiology; Bacteria

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INTRODUCTION

Burns are one of the most prevalent and mortifying forms of trauma. Patients with significant thermal injury require immediate intensive care unit (ICU) care to minimize morbidity and mortality. As per 2021 statistics, WHO estimates 1,80,000 deaths every year across the world due to burn injury, with majority in Southeast Asia comprising

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low- and middle-income nations. In India, Out of 7 million burn injuries 2.4 lakhs people suffer from disability, and 1.4 lakhs people die every year.[1] Nearly 95% of global burn deaths and disabilities are estimated to occur in low and middle income countries of the world. Burns are extremely common and are major health problems in developing country like India.

There is a significant variation in the epidemiology of burns as it depends on the culture, industrialization, and level of civilization. Major causes of burn injuries in females are due to home appliances such as chulha and chimney while electric burns at the workplace are common in males.[2,3] The burn injury can be prevented by spreading awareness, education programs, and safety measures.[1,4] According to a study by Yadav et al., neurogenic shock and sepsis are the most common reason for death in burn patients.[5] A retrospective cohort study performed by Rech et al., highlights the outcome in burn patients with sepsis. The study indicates that patients without sepsis had a higher mortality rate as compared to patients with sepsis, contrary to expectation.[6] With a massive inflammatory response the skin is exposed to pathogens but loses its primary infection barrier function, leading to immunological suppression. This condition put the patient at risk of attaining several other infectious complications like sepsis.[7] De Macedo et al., performed a prospective study that suggests 19.4% of total patients treated at the burn unit have developed sepsis.[8] A study recommends frequent antibiotic resistance examination to select appropriate antibiotic.[9] Hence, understanding the sepsis etiology in burn patients will help in early diagnosis and prompt treatment.

Apart from the physical examination, microbiological culture and infection biomarker detection can be helpful in diagnosing burn wound infection. Infection in burn patients can be controlled by wound care and use of antibiotics.[10] However, the initial use of antibiotics is prescribed without any microbiological results. Hence making it is vital to investigate the varying patterns of the microorganisms, antimicrobial resistance, and pathogen distribution for targeted drug treatment and dissipation of antibiotics.[11] Microbiological analysis will help to identify the causative microorganism and to choose effective and appropriate antimicrobial agents.

Burns patients are generally more predisposed to sepsis because of two main reasons, i.e., burn wound infection and catheter-related bloodstream infection (CRBSI). Due to extensive skin barrier disruption and an alteration in the cellular and humoral immune responses burn wounds has a much higher incidence of sepsis as compared to other forms of trauma. Patients with large surface area burns need long-term venous access because maintenance of peripheral intravenous lines can be impractical in these patients.[12] The burn patient appears to be especially susceptible to this complication with catheter infection rates reported ranging from 8% to 57%.[13] Burn wound infections are continuously varying in terms of microbial pathogenicity and antimicrobial sensitivity. A regular evaluation is required to ensure appropriate and prompt therapeutic treatment. Thus to maintain a good infection control in the burn unit a constant surveillance of microorganisms and the pattern of antibiotic susceptibility is required. This will ameliorate the overall infection pertaining to mortality and morbidity. Hence, the present study was undertaken to study the bacteriological profile and sources of sepsis in burns patients.

Aims and objectives

The present study was undertaken to

1. Study the bacteriological profile
2. Sources of sepsis in burns patients and their antimicrobial susceptibility pattern.

MATERIALS AND METHODS

It was a prospective observational study conducted in the Department of Burns, Plastic and Maxillofacial Surgery, ICU and Department of Microbiology of Rama Medical College Hospital and Research Centre, a tertiary care hospital in Northern India, Hapur Pilkhuwa, Uttar Pradesh region. The study was conducted between January 2020 and June 2022 after obtaining ethical clearance from the institute ethical committee. Adult patients of age between 18 and 60 years were included in the study. Adult patients with 30–70% of total body surface area (TBSA) burns with a central venous catheter (CVC) inserted during ICU admission were enrolled in the study. Patients with CVC inserted at any other hospital or who had evidence of sepsis at the time of admission were excluded from the study. Other exclusion criteria included comorbidities like hypertension, diabetes mellitus, cardiac disease or any other immune deficiency disorders.

The presence of clinical sepsis in the burn patients were evaluated using American Burn Association Sepsis criteria.[13] For all patients with suspected clinical sepsis, paired blood cultures were collected simultaneously; one from the CVC and another from a peripheral site and were sent for bacteriological culture. Blood culture samples were processed as per standard procedures.[14] CRBSI was defined if the same organism was isolated in paired blood cultures. A burn wound biopsy was sent for quantitative culture and 10^5 organisms/g of tissue were considered significant.[15] Patient's clinical features: Pulse rate, respiratory rate, and temperature were recorded along with their demographic

data. Blood samples were also sent for total leukocyte count, platelet count at the time of sending of other samples.

All data were entered into Microsoft Excel. Epidemiological data, frequency tables, and bivariate analysis were done by Chi-square test using SPSS statistics 17.0 software. Microbiological isolates listings and antibiotics susceptibility pattern analysis were done by using WHONET 5.6 software.

Inclusion criteria

Adult patients of age between 18 and 60 years were included in the study. Adult patients with 30–70% of TBSA burns with CVC inserted during ICU admission were enrolled in the study.

Exclusion criteria

Patients with CVC inserted at any other hospital or who had evidence of sepsis at the time of admission were excluded from the study. Other exclusion criteria included comorbidities like hypertension, diabetes mellitus, cardiac disease, or any other immune deficiency disorders.

RESULTS

A total of 137 patients were enrolled in this study. Majority of the patients were female (85/137, 62%). The age of the patients ranged from 18 to 60 years. Majority (122/137, 89%) of patients were in the age group of 18–40 years with a mean age of 29.1 years. Thermal burns (123/137, 89.8%) were the major category of burns. According to TBSA burns, patients were divided into groups that contained a comparable number of patients in each group with mean TBSA burns of 50.5%. The most common site for CVC insertion was the femoral vein (129/137, 94.2%). Demographic details of all patients are described in Table 1.

The bacteriological profile of CVC blood, peripheral blood, and burn wound cultures is described in Table 2. Gram-negative bacteria were the predominant pathogens isolated from all the clinical samples. *Klebsiella* spp. was the most common isolate from both CVC blood (53/123, 43.1%) and peripheral blood (45/96, 46.9%) whereas in burn wound cultures, *Pseudomonas* spp. was the predominant isolate (40/124, 32.3%).

Clinical sepsis was observed in total 39/137 (28.5%) patients. The most common cause for sepsis was CRBSI (19/39, 48.7%) followed by Burn wound sepsis (13/39, 33.3%). No cause could be identified in 7 (18.0%) cases. The microbiological profile of clinical sepsis cases is described in Table 3. *Klebsiella* spp. (8/19, 42.1%) was the predominant isolate from CRBSI while *Pseudomonas* spp. (8/13, 61.5%) in case of Burn wound sepsis.

Table 1: Socio-demographic and clinical data of burns patients included in the study

Variables	Frequency n (%)
Sex	
Male	52 (38.0)
Female	85 (62.0)
Age (years)	
Mean age	29.1
Range	18–60
Types of burns	
Thermal	123 (89.8)
Electric flash	11 (8.0)
Scald	03 (2.2)
%age TBSA burns	
Mean	50.5
Range	30–70
Site of CVC insertion	
Femoral	129 (94.2)
Subclavian	04 (2.9)
IJV	04 (2.9)

TBSA: Total body surface area, CVC: Central venous catheter, IJV: Internal jugular vein

As the percentage TBSA burn increased, the incidence of clinical sepsis also increased (P=0.0126). There was a very significant correlation between the post-burn days of sample collection and clinical sepsis incidence with 79.48% cases of sepsis occurring between the post-burn 5 and 9 days (P<0.0001). The correlation of sepsis with TBSA burn percentage and post-burn days of sample collection is described in Table 4. There was no significant correlation between age of patient and clinical sepsis (P=0.7268). There was a direct correlation of clinical sepsis with CVC blood culture positivity (P=0.017) and wound culture positivity (P=0.0008).

Antibiotic susceptibility of *Klebsiella* spp. and *Pseudomonas* spp. in CVC blood, peripheral blood, and burn wound samples are described in Figures 1 and 2 respectively. *Klebsiella* spp. Showed higher resistance to beta-lactam, third generation cephalosporin, aminoglycosides and fluroquinolones. Carbapenem resistance ranged from 55 to 77%. Among carbapenems, ertapenem was a less effective drug. Blood isolates were more resistant strains as compared to burn wound isolates. No resistance was observed for colistin and tigecycline. A similar picture was observed in *Pseudomonas* isolates also. However, Carbapenem resistance ranged from 22% to 75% and no resistance was observed for colistin.

DISCUSSION

Klebsiella spp. was the most common organism isolated from both CVC and peripheral blood cultures (43–47%). In a study conducted by Raz-Pasteur et al., *Klebsiella pneumoniae* was present in 36% of positive blood cultures.[16]

Table 2: Bacteriological profile of CVC blood, peripheral blood, and burn wound samples from burns patients

No. of culture positive	Gram-negative bacteria						Gram-positive bacteria		
	Klebsiella	*Acinetobacter*	*Pseudomonas*	*Proteus*	*Escherichia coli*	*Enterobacter*	*Staphylococcus aureus*	CONS	*Enterococcus*
CVC blood (n=123, 89.8%)	53 (43.1%)	20 (16.3%)	12 (9.7%)	6 (4.9%)	4 (3.2%)	8 (6.5%)	6 (4.9%)	5 (4.1%)	9 (7.3%)
Peripheral blood (n=96, 70.1%)	45 (46.9%)	9 (9.4%)	14 (14.6%)	11 (11.5%)	4 (4.2%)	5 (5.2%)	2 (2.1%)	2 (2.1%)	4 (4.2%)
Burn wound (n=124, 90.5%)	22 (17.7%)	37 (29.8%)	40 (32.3%)	6 (4.8%)	2 (1.6%)	-	17 (13.7%)	-	-

CONS: Coagulase-negative *Staphylococcus* spp.

All the *Klebsiella* spp. in the present study were sensitive to colistin and tigecycline. Carbapenem resistance ranged from 6 to 50%.

Pseudomonas spp. was the most common isolate from burn wound culture (32.3%). In a retrospective study of 5 years by Singh et al., (2003) in burns unit in Delhi, a similar finding was observed. The incidence of antimicrobial resistance had also markedly increased over the past years.[17] In a retrospective study done from burns unit in Chennai, India, Ramakrishnan et al., (2005) found the incidence of *Pseudomonas* spp. to be 41% out of a total of 535 samples that were sent.[18] They found the organism to be highly sensitive to carbapenems followed by amino-glycosides and quinolones. In the present study, carbapenem resistance was observed in 9/40 (22%) *Pseudomonas* isolates, but only 4/40 (10%) showed susceptibility toward netilmicin. No resistance was observed for colistin.

In the present study, the overall incidence of clinical sepsis was 28.4% (39/137), out of which 48.7% of cases were found to be due to CRBSI and the most common organism involved was *Klebsiella* spp. (42.1%), 33.3% of cases were due to burn wound sepsis and the most common organism involved was *Pseudomonas* spp. (61.5%); and 18.0% of cases were those in which no known source could be found. Possible explanations for these cases could be sepsis without bacteremia due to endotoxins and Gram-negative endotoxemia, organ system failure, and respiratory failure all of which were not examined in the study. This finding is slightly less as compared to another study by Kumar et al., where CRBSI was found in 52.0% of clinical sepsis cases. This can be explained by the fact that their study comprised non-burnt patients who otherwise had no other significant source of infection.[14]

Gram-negative bacilli are the predominant pathogen in 84.2% (16/19) of CRBSI cases. In a cohort study done by Braun et al., (2014) in a tertiary care center in Israel, there was a linear shift toward a predominance of Gram-negative bacilli throughout the study period (P for trend <0.001). In 1996, 68% (68/100) CRBSIs were caused by Gram-positive cocci, while in 2012, 77.8% (28/26) were caused by Gram-negative bacilli.[19]

In this study, it has tried to correlate the incidence of clinical sepsis with various possible sources of infection that a burnt patient is exposed to. It is already a well-known fact that as the time duration increases in the post-burn period, the chances of the culture of samples taken from various sites (wound and blood) becoming positive for bacterial growth increases. A significant increase in the incidence of clinical sepsis was observed during the 5–9 days post burn period and then a decrease after 10 days post burn. Possible

Table 3: Bacteriological profile of sepsis cases

No. of patients with clinical sepsis (n=39)	*Klebsiella* spp.	*Pseudomonas* spp.	Other gram negatives	Gram positives
CRBSI (n=19, 48.7%)	8 (42.1)	4 (21.0)	4 (21.0)	3 (15.8)
Burn wound sepsis (n=13, 33.3%)	5 (38.5)	8 (61.5)	-	-

Figures in parenthesis are percentages

Table 4: Correlation of clinical sepsis with TBSA burns percentage and post-burn days of sample collection

Sepsis and TBSA burns percentage		Sepsis and post burn days	
No. of patients with TBSA burns percentage	No. of patients with sepsis	No. of patients/ Post-burn day	No. of patients with sepsis
30–40% (n=44)	8 (18.2)	<5 days (n=48)	2 (4.2)
41–50% (n=35)	8 (22.8)	5–9 days (n=71)	31 (43.7)
51–60% (n=26)	13 (50.0)	≥10 days (n=18)	6 (33.3)
61–70% (n=32)	10 (31.2)		

Figures in parenthesis are percentages, TBSA: Total body surface area

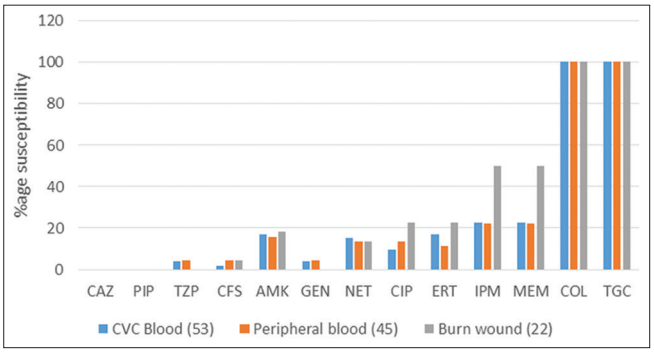

Figure 1: Percentage susceptibility of *Klebsiella* spp. in different clinical samples

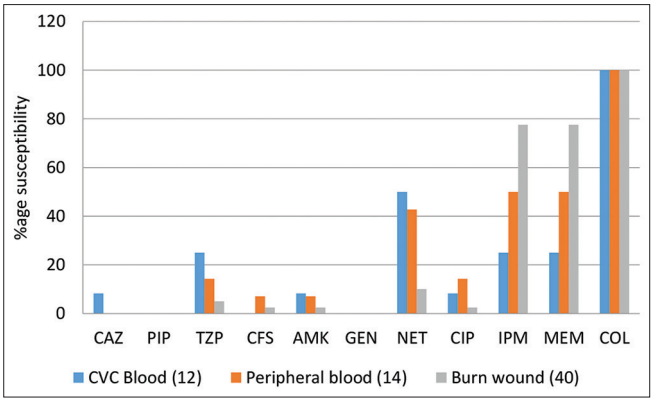

Figure 2: Percentage susceptibility of *Pseudomonas* spp. in different clinical samples

reasons could be the use of higher antibiotics, nutritional improvements, separation of eschar and thereby, drainage of sub-eschar abscesses during this time.

In general, it is assumed that as the number of culture positivity increases, the chances of sepsis also increases. In this study, a similar correlation was found to be statistically significant (P=0.017).

In the present study, a statistically significant correlation between the CVC blood culture positivity with sepsis (P=0.029) was found. When the culture positivity of CVC blood and peripheral blood were compared in combination, a significant correlation was observed between both the blood culture positivity with clinical sepsis as compared with either one of them being positive alone (P=0.017). Sadowski et al., (1988) also studied the value of culturing central-line catheter tips in burn patients. The results of this study demonstrated that routine culturing of catheter tips offers no useful information for the diagnosis of bacteremia and that a positive catheter tip culture should not be used as a criterion to treat patients for bacteremia.[20]

Limitations of the study

Sample size is small for this study. So further studies on large sample size need to be done to reach general conclusion.

CONCLUSION

Klebsiella spp. was the most common organism isolated from both CVC and peripheral blood cultures. All the *Klebsiella* spp. in the present study were sensitive to colistin and tigecycline. *Pseudomonas* spp. was the most common isolate from burn wound culture. *Klebsiella* spp. showed higher resistance to beta-lactam, beta-lactam beta-lactamase inhibitor combinations, third-generation cephalosporin, aminoglycosides, and fluoroquinolones. Carbapenem resistance was variable.

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Authors' Contributions:
SM- Collection of data and interpreted the results; **JKA-** Concept and design of the study and collection of data; **DA-** Prepared first draft of manuscript and finalize the manuscript; **YM-** Critically review the article.

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