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Original Research Article

A clinical study of patients with central venous catheter associated bloodstream infections in a tertiary care hospital

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ABSTRACT

Background: Central venous access puts the patients at risk of iatrogenic complications and is associated with bloodstream infections. *Staphylococcus aureus*, *Staphylococcus epidermidis*, *Staphylococcus saprophyticus* and *Methicillin Resistant Staphylococcus aureus* (MRSA) are responsible for at least two-thirds of the infections followed by *Klebsiella pneumoniae*, *Escherichia coli*, *Pseudomonas aeruginosa*, *Enterococcus spp* and *Acinetobacter spp*. Due to the scarcity of Central Venous Catheter associated Blood Stream Infections (CVC-BSI) data, this study was taken up in our tertiary care hospital.

Aims: This study is aimed to study the profile of organisms causing CVC-BSI, assess their antimicrobial susceptibility, the clinical course and outcome.

Methods: All subjects whose central venous catheter samples (n=84) were sent for culture and sensitivity during the study period were included in this prospective observational study. The study was done in the Department of Microbiology from July 2019 to December 2019. The catheter tips were streaked onto blood agar plate using Roll plate technique. After biochemical identification of the organisms, antimicrobial susceptibility testing was performed by modified Kirby-Bauer disc diffusion method as per the Clinical Laboratory Standard Institute (CLSI) guidelines.

Results: Growth of pathogens was seen in 64.3% (n=54). The common organisms were *Coagulase Negative Staphylococcus aureus* (CONS) in 27.78% (n=15), *Enterococcus spp*, *Klebsiella pneumoniae* in 14.8% each (n=8) and *Acinetobacter spp* in 11.1% (n=6). Resistance was seen with amoxicillin + clavulanic acid, cefepime, ciprofloxacin and cefoperazone. The organisms were sensitive to levofloxacin, tetracycline and vancomycin.

Conclusion: Aseptic precautions taken by the healthcare personnel will bring down the infections and curb the spread of multi-drug resistant hospital acquired infections.

Keywords: Central venous catheter, Bacteriological profile, Antimicrobial drug resistance

INTRODUCTION

Central Line Associated Blood Stream Infections (CLABSI) is defined as clinical signs of infection, such as culture growth of the same bacteria from blood taken from a central line catheter or catheter tip and peripheral vein in a patient who did not have a source of infection other than the catheter.¹ CLABSI is also defined as development of blood stream infection within 48 hours of insertion of

central line with laboratory-confirmed blood stream infections (BSI) (not related to an infection at another site).² BSIs due to central venous catheterization are one of the major device-associated infections in the intensive care unit (ICU). It can be a source of sepsis, bacteraemia, multi organ failure and even death.³ Central venous catheters are used for delivery of medication and parenteral nutrition, hemodynamic monitoring and for collection of blood samples.⁴ CLABSI results from bacterial colonisation of the catheters and may lead to

significant clinical problem.⁵ It increases hospital cost and length of stay. The incidence of CLABSI varies between ICUs due to differences in type of catheters used, insertion and utilization techniques and frequency of catheter manipulations.⁶ *Coagulase-negative Staphylococci* (CoNS), and *Staphylococcus aureus* are the common causes of catheter related blood stream infections.^{7,8} *Acinetobacter baumannii* has recently emerged as a leading cause of nosocomial bloodstream infections in the intensive care unit (ICU) and associated with high mortality.^{9,10} Knowledge about the prevalence of catheter related infections and the profile of the organisms would help in infection control. The objective of this study was to study the profile of pathogens causing Central Venous Catheter associated Blood Stream Infections (CVC-BSI) in a tertiary care hospital in South India and also assess their antimicrobial susceptibility pattern, clinical course and outcome.

METHODS

This study was a prospective, observational clinical study conducted in the Department of Microbiology at Kempegowda Institute of Medical Sciences and Research Centre, Bangalore. The study was conducted between July 2019 and December 2019 after approval by the Institutional Ethics Committee (IEC). The study was registered with Clinical trial registry- India (CTRI). All the subjects (n=84) whose central venous catheter samples were sent for culture sensitivity during the above-mentioned study period were the participants for this study (Non-probability sampling: convenience sampling). Central venous catheter samples of 84 study subjects were examined for eligibility. Samples of 54 subjects were confirmed to be eligible, included in the study, completed follow-up and analysed. Data regarding the age, gender, reason for hospitalization, use of empirical antimicrobials, source of the central venous catheter samples, the organisms cultured, and their sensitivity and resistance patterns were noted. The subjects were followed up during their course in the hospital.

Inclusion criteria included subjects with Central venous catheters (CVCs) in situ for >3 days of insertion and sterile blood culture immediately after catheterization and subjects whose CVC tip samples when processed showed significant growth of one or more organisms.

Subjects who got CVC inserted outside our hospital were excluded from the study.

CVC tips collected from the patients were streaked onto blood agar plate using the Roll plate technique. Growth of >25 colonies was considered as significant growth. If needed, sub-cultures were done. Gram positive and gram negative organisms were identified. After biochemical identification of the organisms, antimicrobial susceptibility testing was performed on Muller Hinton agar plates by modified Kirby-Bauer disc diffusion

method as per the Clinical Laboratory Standard Institute (CLSI) guidelines.

The data collected were analysed and the results were depicted in the form of percentages, graphs or bar charts.

RESULTS

A total of 84 central venous catheter samples that were sent for culture sensitivity during the study period were analysed.

The length of stay in the hospital ranged from 3 days to 15 days.

Table 1: Demographic profile.

Variables	N (%)	
Age (years)*#	Infants (1 month to 1 year)	1 (1)
	Adolescents (11 to 19 years)	1 (1)
	Adults (up to 60 years)	56 (67)
	Elderly (> 60 years)	26 (31)
Gender	Male	56 (67)
	Female	28 (33)

*Age of the subjects ranged from 4 months to 85 years

Mean age 596 ± 213.5 months

Table 2: Case distribution.

	N (%)	
Distribution of the cases	Culture positive	54 (64.3)
	No growth	30 (35.7)
Source of the cases	Emergency medicine ICU	33 (39)
	Orthopedics ICU	21 (25)
	General surgery ICU	14 (17)
	General Medicine ICU	13 (15)
	Respiratory medicine ICU	2 (2.4)
	Pediatrics ICU	1 (1.2)
Source of the specimen	Site of the central venous catheter	Internal Jugular Vein
	Single / multiple lumen catheter	Single lumen catheter
Catheter in-situ (no. of days)	2	11 (13.1)
	3	17 (20.24)
	4	12 (14.29)
	5	12 (14.29)
	6	14 (16.67)
	7	9 (10.71)
	8	8 (9.52)
9	1 (1.19)	

The reasons for hospitalization in the emergency medicine ICU was Organophosphorus poisoning (n=5), Chronic kidney disease (CKD) (n=6), fulminant hepatic failure (n=1), left lower lobe pneumonia (n=4), sepsis (n=4), congestive cardiac failure (n=5), cerebrovascular accident (n=2), road traffic accident with head injury (n=3) and ischemic heart disease (n=3). The patients were admitted

to the orthopaedics ICU (n=21) following post traumatic fractures.

Hospitalization to the general surgery ICU was for acute pancreatitis (n=5), explorative laparotomy (n=4), necrotising fasciitis (n=2) and gangrenous appendicitis (n=3). Admission to the general medicine ICU was due to CKD (n=9) and sepsis (n=4).

Table 3: Profile of culture positive pathogens causing central venous catheter associated blood stream infection.

Culture positive organisms (n=54)	N (%)
<i>Coagulase-negative staphylococci</i>	15 (27.78)
<i>Klebsiella spp</i> *	10 (18.5)
<i>Enterococcus spp</i> #	8 (14.8)
<i>Acinetobacter spp</i> #	6 (11.1)
<i>Pseudomonas aeruginosa</i>	4 (7.4)
<i>Escherichia coli</i>	3 (5.56)
<i>Enterobacter spp</i> #	2 (3.7)
<i>Methicillin resistant Staphylococcus aureus</i>	2 (3.7)
<i>Candida tropicalis</i>	2 (3.7)
<i>Staphylococcus aureus</i>	1 (1.9)
<i>Non fermenting gram negative bacilli</i>	1 (1.9)

**Klebsiella pneumoniae*: n=8, *Klebsiella oxytoca*: n=2; #Speciation was not conducted.

Table 4: Culture positive pathogens and resistance pattern.

Organisms	Resistance shown to antimicrobial agents
<i>Coagulase-negative staphylococci (CoNS) (n=15)</i>	β-lactam antibiotics* (n=9)
	Macrolides# (n=3)
	Fluoroquinolones† (n=3)
<i>Klebsiella spp (n=10)</i>	β-lactam antibiotics* (n=3)
	Fluoroquinolones† (n=2)
	Aminoglycoside‡ (n=3)
	Carbapenams§ (n=2)
<i>Enterococcus spp (n=8)</i>	β-lactam antibiotics* (n=3)
	Aminoglycoside‡ (n=3)
	Macrolides# (n=2)
<i>Acinetobacter spp (n=6)</i>	β-lactam antibiotics* (n=3)
	Aminoglycoside‡ (n=3)
<i>Pseudomonas aeruginosa (n=4)</i>	β-lactam antibiotics* (n=2)
	Aminoglycoside‡ (n=2)
<i>Escherichia coli (n=3)</i>	β-lactam antibiotics* (n=2)
	Fluoroquinolones† (n=1)
<i>Enterobacter spp (n=2)</i>	β-lactam antibiotics* (n=2)
<i>Methicillin resistant Staphylococcus aureus (MRSA) (n=2)</i>	β-lactam antibiotics* and methicillin (n=2)
<i>Staphylococcus aureus (n=1)</i>	β-lactam antibiotics* (n=1)
<i>Non fermenting Gram negative bacilli (NFGNB) (n=1)</i>	β-lactam antibiotics* (n=1)

*Amoxicillin, ampicillin, cefoperazone, cefepime, cefoxitin, cefuroxime, ceftriaxone, cefexime, ceftazidime, piperacillin + tazobactam; # Erythromycin; † Ciprofloxacin, levofloxacin; ‡ Gentamicin, amikacin; §Meropenam, imipenem.

Table 5: Culture positive isolates and sensitivity pattern.

Organisms	Sensitive AMAs
<i>Coagulase-negative staphylococci (CoNS) (n=15)</i>	Vancomycin (n=8)
	Clindamycin (n=4)
	Gentamicin (n=3)
<i>Klebsiella spp (n=10)</i>	Clindamycin (n=6)
	Vancomycin (n=4)

Continued.

Organisms	Sensitive AMAs
<i>Enterococcus spp</i> (n=8)	Vancomycin (n=3) Levofloxacin (n=5)
<i>Acinetobacter spp</i> (n=6)	Meropenem (n=4) Ciprofloxacin (n=2)
<i>Pseudomonas aeruginosa</i> (n=4)	Levofloxacin (n=2) Meropenem (n=2)
<i>Escherichia coli</i> (n=3)	Meropenem (n=1) Gentamicin (n=2)
<i>Enterobacter spp</i> (n=2)	Imipenam, Meropenem (n=2)
<i>Methicillin resistant Staphylococcus aureus (MRSA)</i> (n=2)	Meropenem (n=2)
<i>Staphylococcus aureus</i> (n=1)	Gentamicin, levofloxacin (n=1)
<i>Non fermenting Gram negative bacilli (NFGNB)</i> (n=1)	Meropenem (n=1)

Table 6: Use of empirical antimicrobials.

Organism	Empirical antimicrobials (n=64)	Indication for use of the AMA
<i>Acinetobacter spp</i> (n=5)	Faropenam (n=1)	Chronic Kidney Disease
	Gentamicin (n=1)	CKD with suspected UTI
	Meropenam (n=1)	Dengue fever
	Imipenam (n=1)	Bicondylar fracture shaft of right tibia
	Cefoperazone + sulbactam* (n=1)	Cerebrovascular accident with right hemiplegia
<i>Candida tropicalis</i> (n=2)	Clindamycin (n=1)	Necrotising fasciitis of left thigh
	Meropenam (n=1)	CKD with urosepsis
<i>Coagulase-negative staphylococci (CoNS)</i> (n=18)	Meropenam (n=8)	Pneumonia (n=1), acute pancreatitis (n=1), CKD (n=6)
	Piperacillin + tazobactam* (n=3)	Fulminant hepatic failure (n=1), Organophosphorous poisoning (n=1), Acute kidney injury (n=1)
	Ceftriaxone (n=2)	Chronic kidney disease (n=2)
	Cefoperazone + sulbactam* (n=4)	Acute kidney injury (n=4)
	Linezolid (n=1)	Chronic kidney disease (n=1)
<i>Escherichia coli</i> (n=3)	Piperacillin + tazobactam* (n=1)	OP poisoning (n=1)
	Metronidazole (n=1)	Gangrenous appendicitis (n=1)
	Cefoperazone + sulbactam* (n=1)	Post traumatic fracture of right femur (n=1)
<i>Enterobacter spp</i> (n=1)	Cefotaxime (n=1)	RTA with head injury (n=1)
<i>Enterococcus spp</i> (n=9)	Meropenam (n=6)	Sepsis (n=5), diffuse cerebral contusion (n=1)
	Piperacillin + tazobactam* (n=2)	RTA with head injury (n=2)
	Linezolid (n=1)	Snakebite (n=1)
<i>Klebsiella spp</i> (n=12)	Piperacillin + tazobactam* (n=3)	RTA (n=1), acute subarachnoid haemorrhage (n=1), post explorative laparotomy (n=1)
	Meropenam (n=6)	Sepsis with CKD (n=5), encephalitis (n=1)
	Cefpodoxime (n=1)	Acute intestinal obstruction (n=1)
	Linezolid (n=1)	Acute intestinal obstruction (n=1)
	Polymixin (n=1)	Diabetic foot with ulcer (n=1)
<i>Pseudomonas aeruginosa</i> (n=8)	Piperacillin + tazobactam* (n=7)	Cortical venous thrombosis (n=1), CKD with suspected UTI (n=6)
	Ceftriaxone (n=1)	Post traumatic fracture of right clavicle (n=1)
<i>Staphylococcus aureus</i> (n=6)	Piperacillin + tazobactam* (n=3)	Sepsis (n=3)
	Meropenam (n=3)	Acute respiratory distress syndrome (n=3)

*Fixed Dose Combinations (FDCs).

DISCUSSION

Central line associated bloodstream infection is a serious and one of the most common causes of hospital acquired infections worldwide. Central line associated blood stream

infection may result from health care interventions and constitutes an important cause of morbidity and mortality among ICU patients. Formation of bacterial colonization in the catheter may be due to poor hygiene, occlusive

dressing, moisture around the site of exit, nasal colonization and poor hand hygiene.

This study was aimed at finding out the profile of organisms causing contamination of the CVCs in hospitalized patients and also their antimicrobial resistance and sensitivity patterns.

In this study, 84 patients who had CVCs were studied. Clinical findings have shown that the prolonged usage of medical devices like venous catheters increase the risk of infection in the hospitalized patients in the ICU. Also, duration of hospitalization and duration of catheterization are two major determinants contributing to the incidence of these infections.¹¹

According to the study results from the CVC samples, 64.3% cases (n=54) had at least one kind of bacteria or fungus that grew in the culture media. Sharif et al in a study at the medical university of Kashan-Iran, showed that out of the 100 samples that were cultured, 29% cases had at least one kind of microorganism that grew in the culture media, which is less than the prevalence of infection in this study. In this study, the most common organism grown was *Coagulase negative staphylococcus* (CONS) which is similar to Sharif's study.¹²

Similar results were also shown by a study done in Gonder, Ethiopia, 24.2% by Ali and Kebede et al in 2008.¹³ Studies from India by Arora et al 2007 (20.02%) and Sharma et al 2002 (33.9%) also showed comparable results.^{14,15} Slight variation may be due to many factors like geographical locations, patient type, timing and number of blood cultures or difference in blood culture system.¹³⁻¹⁵

In a study done in Brazil by Grothe et al out of the 156 inpatients, 94 catheter samples were culture positive (60%). Also in this study, patients whose catheters were put in the jugular vein, suffered from the CVC infection more than the patients who had their catheters put into the subclavian vein.¹⁶ In our study, the catheter was inserted in the internal jugular vein in all the patients, and only single lumen catheters were used.

Higher level of contamination is related to longer duration of hospitalization. Thus, care of the catheter, in the patients who are hospitalized in the ICU, is important. All these factors can reduce the incidence of CVC related infection.

Coagulase negative staphylococci (43%, n=6) was the commonest organism isolated in a study by Arti Ninama et al. Second most common organism was *Klebsiella pneumoniae* (29%, n=4) followed by *Pseudomonas aeruginosa* (21%, n=3) and *Candida albicans* (7%, n=1).¹⁷ These findings are similar to our study. Colonization of the catheter tip by *staphylococcal* infection is due to migration of skin organisms at the insertion site and gram-negative aerobes is because of infusate contamination and handling by health care personnel.

CoNS and *Enterococcus spp* isolates showed higher level of resistance to beta-lactam antibiotics than *Staphylococcus aureus*. However, all the three were sensitive to vancomycin which is similar to other studies.^{18,19} Most of the gram-negative bacteria were resistant to beta-lactam antibiotics. Among gram-negative bacterial isolates, *Acinetobacter spp* and *Klebsiella spp* were dominant species. This is similar to a study done by Manmeet Kaur Gill et al.²⁰

Presence of diabetes was found to be a significant comorbid condition in our study which was same as the study by Jia et al.²¹ *CoNS* was a major isolate from the patients in our study. Similarly, Rodrigo et al observed that most common isolate as *CoNS* accounting for 54%.²² *CoNS* was sensitive to vancomycin, teicoplanin and linezolid.

The resistance and sensitivity patterns of gram-negative isolates were similar to a study by Mansur et al.²³

According to study by McGee and Gould, large percentage of CLABSIs can be minimized by proper application and use of full barrier precautions, aseptic skin preparation, the avoidance of femoral catheters, appropriate hand hygiene, use of antiseptic or antibiotic impregnated catheters, the removal of unnecessary catheters as early as possible and comprehensive educational programs for staff.²⁴

CONCLUSION

The long duration of catheterization and colonization play an important role in development of the central line blood stream infection along with various other factors which causes septicemia and multi organ failure. Prolonged hospital stay of patients with catheterization leads to overburdening of the cost of treatment which can be minimized by using catheter lock solutions and application of local antibiotics. Even the deaths and co-morbid conditions can be reduced by regular surveillance of appropriate infection control practices. Culture results and sensitivity will also help to treat specific organism.

The antimicrobial sensitivity patterns of the common isolates provide guidelines for the physician in critical care medicine to start appropriate empirical antibiotic therapy depending upon the clinical scenario. This can be cost-effective and can also prevent indiscriminate use of antibiotics.

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