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Bacterial Profile and AntibioGram of Vascular Catheter isolates in a Super Speciality Hospital

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Abstract

Large number of vascular catheters (central line, arterial line, peripheral venous catheters) are inserted into patients which serve as a source of nosocomial infections, resulting in septicemia associated with substantial mortality and morbidity. Aim is to study the risk factors, bacteriological profile and antimicrobial susceptibility pattern of bacterial isolates from vascular catheter segments and tips. Total 69 vascular tips and 69 blood culture from the same patients were analyzed for culture and sensitivity by standard microbiological procedure and the associated risk factors were identified. Out of 69 vascular tips, 31 (44.92 %) showed significant growth. Forty two percent were gram negative bacilli, 51.61% gram positive cocci and 6.45 % showed growth of *Candida species*. *Staphylococcus aureus* and *Klebsiella pneumoniae* were the most frequently isolated organisms. Only 5 blood culture samples were positive. Most effective antibiotic for *Staphylococcus aureus* was Cotrimoxazole and Gentamicin (7/12, 58.33%). Most susceptible antibiotic for Enterobacterales was Tigecycline (7/9, 77.77%). *Staphylococcus aureus* remains the most common organism isolated from vascular tip. Prolonged ICU (intensive care units) stay and longer duration of catheterization are most common risk factors leading to increased colonization and morbidity in cases of vascular catheter infections. Regular surveillance of vascular catheter associated infections is required for better patient care outcomes. Strict adherence to infection control protocols need to be there while insertion and removal of catheter.

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Introduction

Intravenous access in the Intensive Care Unit (ICU) setting is routine for the administration of fluids, blood products, drugs, parenteral nutrition and hemodynamic monitoring. Such interventions put the patients at risk for iatrogenic infections, especially bloodstream infections originating from colonization of the device. The infections associated with catheters occur either due to microbial colonization of the intracutaneous or

intravascular portion of the device or due to contamination of the catheter hub or infusate administered through the catheter. Vascular catheter associated bacteremia or candidemia is associated with an increased mortality and longer hospital stay (Harsha *et al.*). Catheter associated blood stream infection is defined as the presence of bacteremia arising from an intravenous catheter (Brun-Buisson *et al.*, 1987). Gram-positive cocci are responsible for at least two-thirds of the infections followed by Gram-negative bacilli, which

are responsible for a higher proportion of catheter related infections (CRIs) in intensive care unit (ICU) than in non-ICU patients. (Chopdekar *et al.*) Several risk factors of CRBSI has been identified and were broadly classified into patient related factors, catheter related factors, or medical staff related factors. The medical staff can manage their related factors by the strict use of antiseptic techniques and close adherence to the guidelines recommended by the Centre for Disease Control and prevention (CDC). Therefore, to improve the safety of patients we planned to conduct this study in our superspeciality care government hospital determining the incidence, risk factors, microbiological profile and antimicrobial susceptibility of the vascular catheter tip isolates.

Materials and Methods

This study was done in Department of Microbiology, Govind Ballabh Pant Institute of Post graduate Medical Education and Research (GIPMER) over the period of six months from June 2019 to December 2019 after taking institutional ethical clearance. A total of 69 vascular catheter tips were received in microbiology laboratory over the study period and were included in the study.

Collection of vascular catheter segment and tip: At the time of catheter removal, the site was examined for the presence of swelling, erythema, lymphangitis, increased warmth, tenderness and palpable venous thrombosis. Any antimicrobial ointment or blood present on the skin around the catheter was first removed with an alcohol pledget. The catheter was withdrawn with sterile forceps, the externalized portion being directed upward and away from the skin surface. After removal, the wound was milked in an attempt to express purulence. For 5.7 cm catheters, the entire length, beginning several millimeters inside the former skin-surface-catheter interface, was aseptically amputated and cultured. With longer catheters (20.3 cm and 60.9 cm in length) two 5 cm to 7 cm segments were cultured: a proximal one beginning several millimeters inside the former skin catheter interface, and the tip. Catheter segments were transported to the laboratory in a sterile tube.(Maki *et al.*)

Extra luminal Maki's roll plate method was used for processing of catheter tip. Using sterile forceps, the catheter tip was removed from transport tube and laid on 5% sheep blood agar (HiMedia, Mumbai, India). The tip was rolled back and forth across the entire surface of agar plate using sterile forceps and exerting slight

downward pressure and incubated aerobically at 37°C.(Slobbe *et al.*),(Winn *et al.*)

Agar plates were examined at 24 hours, 48 hours and 72 hours. Significant growth was defined as ≥ 15 colony forming unit. Significant colonies were further processed. Organisms were identified according to colony morphology, gram staining and biochemical tests. Antibiotic sensitivity test were done by Kirby Bauer disk diffusion technique as recommended by Clinical Laboratory Standards Institute (CLSI 2019).

Blood cultures: blood culture sample was collected with aseptic precautions. 70% alcohol followed by 2% povidone iodine was used for surface disinfection at the site of collection. Adult and pediatric BACTEC blood culture bottles were inoculated with 10 ml and 3–5 ml of blood from adults and children, respectively. The bottles were then placed in BACTEC 9050 blood culture instrument (Becton Dickenson, USA) and incubated at 37°C. After BACTEC instrument flagged positive, the vials were subjected to Gram staining and further inoculation on sheep blood agar and MacConkey agar (HiMedia). The culture plates were then incubated aerobically at 37°C for 18–24 h. Identification and antimicrobial susceptibility testing were done by VITEK-2 compact automated system and Kirby–Bauer disc diffusion method on Mueller–Hinton agar as per the CLSI guidelines. Strains of *Staphylococcus aureus* (ATCC25923), *Escherichia coli* (ATCC25922), and *P. aeruginosa* (ATCC27853) were used for culture and susceptibility testing as controls. Samples which were flagged negative by the machine after 5 days of incubation were subcultured on sheep blood agar and MacConkey agar (HiMedia) and were reported sterile if no growth was observed after 24 hours of incubation.

Results and Discussion

In the present study a total number of 69 catheters obtained from the patients were examined and studied. Of the 69 catheters, 65 were venous catheter and 4 were central arterial catheters. Out of the 69 catheters studied and cultured, a total of 31 isolates were obtained which were having significant count of organisms. Among the 31 isolates, 27 isolates were obtained from the central venous catheters and 4 from arterial lines.

On the other hand, blood culture was positive only in 5 of the culture positive vascular catheters and were having the same organism isolated in tip culture. So, the prevalence of confirmed CRBSI was 16.12 % (5/31) and

rest all 26 isolates from suspected catheter associated infection were probably colonisers. No blood culture was positive in rest of vascular catheter culture negative patients.

Patients in thirties age group constituted major portion of the study group. Males constituted 48.38% while females formed 51.61% of the study group. Most common co-morbide condition associated with suspected catheter associated infection was heart ailments (48.38%). Average duration of catheterization was around 15-21 days (Table 1). The potential risk factors associated with suspected vascular catheter associated infections were; age group less than 45 (74.19%), post surgical cases (80.64%) presence of multilumen catheter (100%) and more than 10 days of catheterization (58.06%) (Table 2). Mostly all the catheters were removed as per a routine protocol followed in the hospital (Figure 1). Fever remained the most common systemic complication present in the patients suffering from catheter associated infections (Figure 2).

A total of 31 isolates were culture positive from the 69 catheter samples processed. *Staphylococcus aureus* (38.78%) and *Klebsiella pneumoniae* (16.12%) formed the most commonly isolated pathogens among Gram positive and Gram negative organisms respectively. *Enterococcus species* (4, 12.9%) was the third most common organism followed *Escherichia coli* formed the next most common isolate at 3 (9.6%). Among the non fermenting gram negative bacilli (NFGNB), *P. aeruginosa* (2) were the most common followed by *Acinetobacter baumannii* (1, 3.2%), *Burkholderia cepacia* (1, 3.2%) and others (1, 3.2%). Among the yeast, *Non Candida albicans* was isolated in 2 (6.4%) occasions while there was only one *Candida albicans* (3.2%) isolated. Most effective antibiotic for *Staphylococcus aureus* was Cotrimoxazole and Gentamicin (7/12, 58.33%) and most susceptible antibiotic for *E. fecalis* was Teicoplanin (4/4, 100%) (Table 3). Linezolid (2/12, 16.66%) and Ofloxacin (2/12, 16.66%) were least susceptible drug for *S.aureus* while High level Gentamicin (1/4, 25%) remained the least susceptible drug for *E. fecalis*. Most susceptible antibiotic for Enterobacterales was Tigecycline (7/9, 77.77%) (Table 4) while most susceptible antibiotic for non fermenters remained Meropenem and Cotrimoxazole. Cephalosporins, Ampicillin (0%) was the least susceptible for the Enterobacterales group. *Acinetobacter baumannii* was pan drug resistance and *Burkholderia cepacia* was susceptible only to Meropenem and Cotrimoxazole. Cephalosporins remained the least

susceptible group for drugs for Nonfermenter group as well (Table 4).

The rate of nosocomial infections is alarming, due to the increasing use of invasive procedures which are performed in the ICU routinely. The therapeutic interventions which are associated with infectious complications include indwelling catheters, sophisticated life support, intravenous fluid therapy and use of broad spectrum antibiotics leading to a spectrum of multi-drug resistant pathogens, which contributed to the evolution of the problem of nosocomial infections. Vascular catheters are one of most commonly inserted catheters routinely used for intravenous (IV) antibiotic treatment and/or other medications, chemotherapy, long-term IV feeding and blood transfusions. Vascular access spares patients the stress of repeated needle sticks and provides a painless way to draw blood or deliver medication. However, any vascular catheter (central/ peripheral) placed imposes risks such as damage to the blood vessel, bruising or bleeding at the puncture site and infections. There is a high rate of CVC insertion and mortality associated with blood stream infections (BSIs).

Patients in thirties age group constituted major portion of the study group. However, in previous studies conducted by Vardhan *et al.*, and Kaur *et al.*, no particular age incidence with regard to catheter infection was seen. (Harsha *et al.*,) (Chopdekar *et al.*,)

Males constituted 48.38% while females formed 51.61% of the study group. This is in concordance with the studies done by Inamdar *et al.*, which reported that gender is a risk factor for occurrence of CRBSI as their study reported there was statistically significant difference between males and females, and female's gender was a risk factor for CRBSI occurrence (Inamdar *et al.*,).

Most common co-morbid conditions associated with suspected catheter infections were heart ailments (48.38%). However, other studies have shown surgical patients with sepsis to be the most commonly infected individuals. (Chopdekar *et al.*,)

Average duration of catheterization was around 15-21 days (Table 1). The potential risk factors associated with suspected vascular catheter infections were; age group less than 45 (74.19%), post surgical cases (80.64%) presence of multilumen catheter (100%) and more than 10 days of catheterization (58.06%) (Table 2). Mostly all the catheters were removed as per a routine protocol

followed in the hospital (Figure 1). Fever (19.35%) remained the most common systemic complication present in the patients suffering from suspected catheter associated infections (Figure 2). Significant risk factors were presence of local signs of inflammation at the site of catheterisation (20%) and prolonged duration of CVCs(18%). Hence, local signs of inflammation (erythema, tenderness and frank oozing) around the catheter insertion site can be used as a marker of catheter being a possible source of BSI and should warrant its removal. The ICU stay was significantly prolonged in CVC cases concluding that longer duration of catheterisation and ICU treatment might have contributed to the occurrence of CVC. Parameswaran *et al.*, in their study also showed significant difference in mean hospital stay and local signs of inflammation between cases and controls. (Parameswaran *et al.*,)

Blood culture was positive only in 5 of the culture positive vascular catheters. All five positive blood cultures were having the same organism isolated in tip culture. This can be explained by the fact that all the patients from whom the blood catheter samples were collected were on antibiotics prior to sampling. This explains the negativity of blood culture (Table 5).

The central venous catheter associated blood stream infection criteria states that a positive simultaneous blood cultures from CVC and peripheral vein yielding the same organism in the presence of either significant catheter-tip colonisation with $\geq 10^3$ CFU of the same organism isolated from the blood cultures, or simultaneous quantitative blood cultures (QBCs) in which the number of CFUs isolated from the blood drawn through the CVC was at least 5-fold greater than the number isolated from blood drawn percutaneously (Raad *et al.*,).

So, as per the criteria only 5 patients developed confirmed central venous catheter associated blood stream infections. All of these patients were females and were having co morbid conditions such as hypertension and carcinomas as the associated risk factors. All these organisms isolated were from the Enterobacterales and were only sensitive to Tigecycline and Colistin. After treatment with Tigecycline and Colistin, all patients recovered.

The prevalence of CRBSI was 7.24 % (5/31) in our study. Other studies showed prevalence ranging from 18.3% to 78%. (Sapkota *et al.*,) This lower prevalence

found could be due to the fact that this study took place when Covid 19 era when all the healthcare professional followed strict infection control practices.

A total of 31 isolates were culture positive from the 69 catheter samples processed. The most common organism among the central venous catheters was *Staphylococcus aureus* followed by *Klebsiella pneumoniae*. *Enterococcus species* (4, 12.9%) was the third most common organism followed *Escherichia coli* formed the next most common isolate (3,9.6%). However, it was observed (table 5) that *Staphylococcus aureus* was the most common isolate(12/26) in suspected catheter associated infection while *Klebsiella pneumoniae* was main isolate in confirmed CRBSI cases(3/5) which indicates towards a major breach in infection control while insertion of the catheter most likely. Other studies conducted by Braun *et al.*, (2014) in Israel and Gahlot *et al.*, (2014) in India also found *Klebsiella pneumonie* as the most common isolate associated with CRBSI with prevalence rate 19.5% and 8% respectively. (Braun *et al.*, Gahlot *et al.*,) The isolation of *S. aureus* in large numbers probably suggests the hub colonisation by the skin flora of the patient or medical personnel as the origin of infection and in our study also, the isolation of *S. aureus* in large number points towards the lapse in the catheter care (Winn *et al.*,). In most of the studies Gram positive cocci were the predominant colonizer of CVC. 5-9 According to various other newer literature common organism colonizing CVC and associated with infections are CONS, *Staphylococcus aureus*, *Candida spp* and gram negative bacilli. Our study also confirmed these findings.

Multidrug resistance was observed in almost all the isolates. MRSA (83.33%; n = 10/12strains), VRE (25% n = 1/4 strains), MBL (50%; n = 1/2 strains of *P. aeruginosa*) and ESBL (77.77%; n = 7/9strains of Enterobacterales) producers were isolated.

Most effective antibiotic for *Staphylococcus aureus* was Cotrimoxazole and Gentamicin (7/12, 58.33%) and most susceptible antibiotic for *E. fecalis* was Teicoplanin (4/4, 100%) (Table 3). Most susceptible antibiotic for Enterobacterales was Tigecycline(7/9,77.77%) (Table 4) while most susceptible antibiotic for non fermenters remained Meropenem and Cotrimoxazole. *Acinetobacter baumannii* was pan drug resistance and *Burkholderia cepacia* was susceptible only to Meropenem and Cotrimoxazole.

Table.1 Demographic and Clinical Characteristics patients with suspected vascular catheter associated infection

S.no.	Characteristics	Number(n=31)
1	Mean Age	30 years
2	Gender	
	Male	15(48.38%)
	Female	16(51.61%)
3	Underlying Comorbidities	
	Hypertension	4(12.9%)
	Diabetes Mellitus	4(12.9%)
	Malignancy	4(12.9%)
	COPD	0
	Heart Disease	15(48.38%)
	Bronchial Asthma	0
	Others	2(6.45%)
4	Average Duration Of Catheterization	15-21 days

Table.2 Potential Risk Factors in patients with suspected vascular catheter associated infection

S.no.	Potential Risk Factors	Number (n=31)
1	Age	
	<45 years	23(74.19%)
	>45 years	8(25.8%)
2	Primary Clinical Diagnosis	
	Medical	6(19.35%)
	Surgical	25(80.64%)
3	Multilumen Catheter	31(100%)
4	Duration of Catheterization	
	<10 days	13(41.93%)
	>10 days	18(58.06%)
5	Local signs of inflammation	4(12.9%)
	Local infection	1(3.22%)
	Local swelling	1(3.22%)
	Erythema	27(87.09%)
	None	

Table.3 Antimicrobial susceptibility pattern of Gram positive cocci in Vascular catheter isolates

Antimicrobial Agent	<i>S.aureus</i> n=12(%)	<i>E.faecalis</i> n=4(%)
Ampicillin	-	1(25%)
Amoxyclav	3(25%)	-
Cefoxitin	2(16.66%)	-
Ciprofloxacin	3(25%)	-
Levofloxacin	3(25%)	-
Cotrimoxazole	7(58.33%)	-
Gentamicin	7(58.33%)	-
Linezolid	2(16.66%)	3(75%)
Ofloxacin	2(16.66%)	-
Azithromycin	-	-
High Level Gentamicin	-	1(25%)
Teicoplanin	-	4(100%)
Vancomycin	-	3(75%)

Table.4 Antimicrobial susceptibility pattern of Gram negative organism in Vascular catheter isolates

Antimicrobial Agent	<i>Enterobacteriaceae</i> n=9(%)	<i>P.aeruginosa</i> n=2(%)
Ampicillin	0	-
Amoxycylav	1(11.11%)	-
Gentamicin	3(33.33%)	2(100%)
Tobramycin	4(44.44%)	2(100%)
Piperacillin Tazobactam	2(22.22%)	2(100%)
Ceftriaxone	0	-
Cefuroxime	0	-
Imipenem	2(22.22%)	2(100%)
Meropenem	2(22.22%)	2(100%)
Ciprofloxacin	2(22.22%)	2(100%)
Cotrimoxazole	1(11.11%)	2(100%)
Ticarcillin clavulanic acid	2(22.22%)	2(100%)
Amikacin	3(33.33%)	2(100%)
Netilmicin	4(44.44%)	2(100%)
Levofloxacin	3(33.33%)	2(100%)
Cefepime	0	1(50%)
Tigecycline	7(77.77%)	-
Ofloxacin	3(33.33%)	-
Cefotaxime	1(11.11%)	-
Ceftazidime	0	1(50%)
Cefoperazone Sulbactam	1(11.11%)	-
Colistin	5(55.55%)	2(100%)

Table.5 Bacterial profile of confirmed CRBSI Vs suspected catheter associated infection

Organism (31)	Confirmed CRBSI (5)	suspected catheter associated infection (26)
<i>Staphylococcus aureus</i>	0	12
<i>E.faecalis</i>	0	4
<i>Klebsiella pneumoniae</i>	3	2
<i>Escherichia coli</i>	1	2
<i>Acinetobacter baumannii</i>	1	0
<i>P.aeruginosa</i>	0	2
<i>Burkholderia cepacia</i>	0	1
<i>Non albicans candida</i>	0	2
<i>Candida albicans</i>	0	1

Fig.1 Indications for Removal of Vascular Catheter

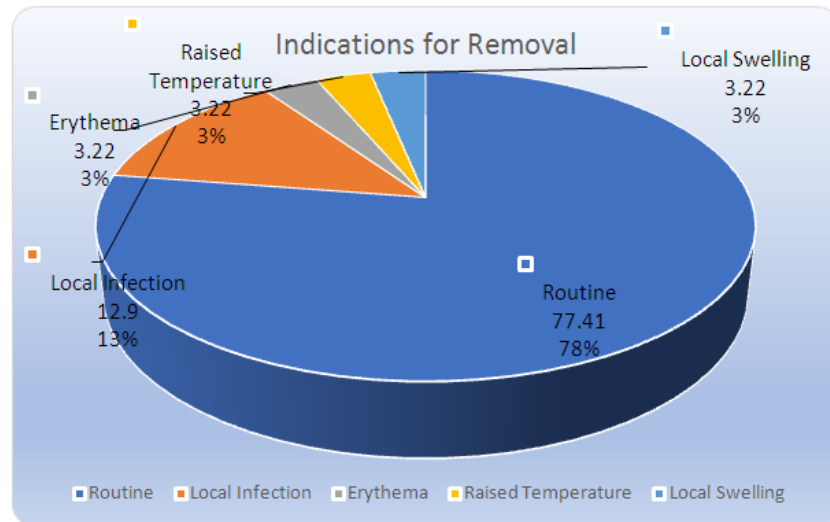
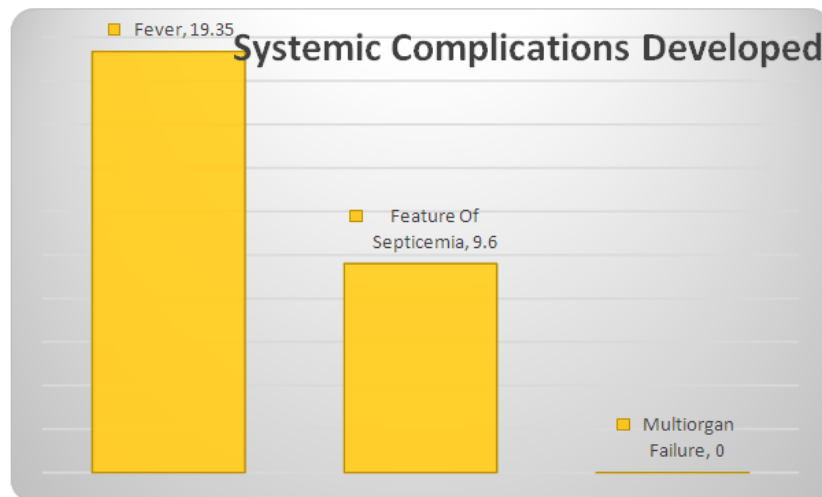


Fig.2 Systemic Complications Developed in Patients patients with suspected vascular catheter associated infection



Linezolid (2/12,16.66%) and Ofloxacin (2/12,16.66%) were least susceptible drug for *S.aureus* while High level Gentamicin (1/4,25%) remained the least susceptible drug for *E. fecalis*. Cephalosporins, Ampicillin derivatives(0%)were least susceptible for the Enterobacteriales group. Cephalosporins remained the least susceptible group for drugs for Nonfermenter group as well.(Table 4). Such high degree of drug resistance among isolates has been observed in ICUs from other centres also. (Sapkota *et al.*,) (Parameswaran *et al.*,) Parameswaran *et al.*, in his study found MRSA to be responsible for 26.7% CRBSIs and single isolate of *A. baumannii* resistant to all the routine drugs. (Parameswaran *et al.*,)

The limitation in our study was that the short duration of the study and less number of CRBSI cases to draw any significant conclusion at the end, hence a study on a large scale for a sufficient time period can be planned.

CRBSI remains an important complication of central venous access in ICUs. Active intervention of the intensivist is required to ascertain the signs of sepsis in the patient at the earliest and to send properly collected samples at appropriate time for an early diagnosis, in turn decreasing the morbidity and mortality associated with CRBSIs.

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