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Original Research Article

Peripheral venous catheter related blood stream infection in intensive care unit

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ABSTRACT

Background: Peripheral venous catheter related blood stream infections (PVC-BSI) are a common cause of morbidity and mortality in hospitals. Most of the catheter related blood stream infections occurs due to lack of proper aseptic measures. This study points out the risk factors microbial profile and antimicrobial susceptibility of isolates associated with PVC-BSI. The common organisms causing Catheter related BSI are *Staphylococcus aureus* (41.1%), and *Klebsiella species* (17.6%) followed by CONS and *Enterococcus species*. Objective of present study was to isolate and identify the organisms causing PCV-BSI, perform antimicrobial sensitivity testing of isolated organisms and to identify the associated risk factors and preventive measures that should be used.
Methods: The study was conducted over a period of one year from August 2015 to July 2016 in the Department of Microbiology. Study group comprised of all the patients with peripheral venous catheterization who developed signs and symptoms of septicemia after 48 hrs of insertion of PVC. These patients were followed up from the time of catheterization till discharge. Peripheral venous catheter tip was collected under aseptic condition along with peripheral blood samples from a site other than the catheterized one. Samples were collected from patients at any point of time who developed signs and symptoms of septicemia after 48 hrs of catheter insertion. The length of time for which the PVC was in place was recorded.
Results: In total, 87 cases were included in the study with mean catheter duration of 4.8 days accounting for 418 catheter days. Out of these 87 cases, 17 cases developed PVC-BSI (19.5%) and 34 cases developed colonization (24.1%). *Staphylococcus species* (41.1%) was the most common isolate.
Conclusions: PVC-BSI has a significant role in hospital acquired infections and more studies are needed to establish this.

Keywords: Blood stream infection, Peripheral venous catheter, Septicemia

INTRODUCTION

Intravenous catheters are indispensable in day-to-day medical practice, especially in intensive care unit. Catheter related bloodstream infection (CRBSI) is defined as the presence of bacteraemia originating from an intravenous catheter.[1] Although such catheters provide necessary vascular access, their use puts patients at risk for local and systemic infectious complications, including local site infection , catheter related blood stream infection, septic thrombophlebitis , endocarditis and other metastatic infections (e.g lung abscess brain abscess, osteomyelitis and endophthalmitis).[2] Among the intravenous catheters, peripheral venous catheters (PVC) are most widely used as its insertion does not require any special instrument or phlebotomist, beside that it is available at lowest level of health care facility. Due to the wide use of PVC in ICU and general wards, there is an

increased risk of nosocomial blood stream infection caused by these venous catheters. Though studies on BSI related to central catheter are made, still studies on BSI related to PCV are scanty. Hence, we have done a study to find out BSI in relation to PCV in Southern Odisha.

METHODS

This prospective study was done in the department of Microbiology of a tertiary care hospital from Southern Odisha over a period of 1year from August 2015 to July 2016. The study was aimed to find out the incidence of PVC related blood stream infections, bacteriological profile and antimicrobial susceptibility pattern of the isolated organisms.

All the patients admitted in the ICU in whom a peripheral venous catheter was inserted and who developed signs and symptoms of septicemia after 48 hrs of insertion of PVC where included in the study.[3] Patients having bacteremia at the time of admission to ICU and in whom catheter was removed within 48hrs, also patients who expired or were transferred out from ICU within 48hrs of admission were excluded.[4]

Full medical and treatment history of all the patients were collected after taking informed consent from the patients or patient's attendant and concerned physician. Blood samples were collected from each patient before insertion of PVC to rule out blood stream infection at the time of admission to ICU.

Sample collection and processing

Peripheral venous catheter tip collection: Prior to collection of tip the skin around the site of catheter insertion was cleaned with 70% alcohol. The catheter was removed under aseptic condition and due care was taken to avoid contact with the skin.

Table 1: Samples collected.

Time	Blood	PVC-tip
At admission	+	--
Any time after 48hrs if C/F of septicemia develops	+	+

Distal 2 to 3 cm of the catheter tip was cut using sterile scissor and collected in sterile tube containing 10 ml of BHI broth. It was sonicated for 1 min at 55,000 Hz and vortexed for 15 s. This broth was further diluted by adding 0.1 ml broth to 9.9 ml of saline.[5]

Now 0.1 ml each from undiluted and diluted broth was spread on MacConkey agar and Blood agar media using loops. These culture plates were incubated at 37°C in presence of 5% CO_2. Peripheral blood sample were also collected from these patients under aseptic condition from a site other than the catheterized one. The blood sample was subjected to blood culture (Table 1).

Interpretation of results

Growth of same organism from culture of PVC tip broth and peripheral blood was considered as PVC-BSI where as growth of organism from culture of PVC tip only was considered as catheter colonization.

The number of colonies on the undiluted broth culture plate was multiplied by 10^2 CFU. If the colonies were too numerous to count, than the number of colonies on the diluted culture plate was multiplied by 10^5. A count of greater than 102 CFU is considered significant for catheter-related infection.[6] The genus and species of organism were identified by using colony morphology, Gram staining and biochemical reactions according to standard identification methods.

Catheter days were calculated as sum total of days for which individual catheter was used. Catheter related bloodstream Infection Rate per 1000 Central Line Days was calculated as followes[7]

PVC-BSI rate = Number of catheter-related bloodstream infections/ Number of central line days x 1000

Colonization rate = Number of confirmed cases of catheter colonization/ Number of central line days x 1000

Antimicrobial susceptibility of isolates

Antibiotic sensitivity of the bacterial isolates was determined by Kirby-Brauer disk diffusion method as per CLSI guidelines. Screening for Methicillin resistant Staphylococcus aureus (MRSA) was performed using cefoxitin disk on Muller Hinton agar with 3% NaCl. Screening for extended spectrum beta- lactamases (ESBL) was done as per CLSI guideline.[8]

RESULTS

A total of 87 patients were included in this study in whom PVC was inserted for a duration ranging from 3 to 6 days with a mean of 4.8 days and total 418 catheter days. All the patients in this study were >26 yrs old and had developed signs and symptoms of septicemia after 48 hrs of insertion of catheter. Most of the patients belong to age groups of 56-70 yrs and 41-55yrs comprising 30 and 28 patients respectively. There were 55 male and 32 females in the study with male: female ratio of 1.7:1 (Table 2).

Table 2: Age and sex distribution of the study group.

Age group	Male	Female	Total
26-40 yrs	08	04	12
41-55 yrs	19	09	28
56-70 yrs	18	12	30
> 70 yrs	10	07	17
Total	55	32	87

All the patients in the study were categorized into four groups based on the growth of microorganism from peripheral catheter tip and blood culture. In 17 (19.5%) patients growth of same bacteria was detected in both PVC tip culture and blood culture suggesting of peripheral venous catheter related blood stream infection (PVC-BSI) whereas colonization was detected in 21 (24.1%) patients and blood stream infection not related to catheter was detected in 26 (29.9%) patients. No growth of any organism could be detected in 23 (26.5%) patients. As PVC-BSI was observed in 17 and colonization in 21 patients, thus the PVC-BSI rate and colonization rate was 40.6/1000 and 50.2/1000 catheter days respectively (Table 3).

Table 3: Categories of infections based on isolation from PVC tip and peripheral blood culture (n=87).

Categories	Growth in PVC tip	Growth in blood	Number of cases (%)
PVC-BSI	+	+	17 (19.5%)
Colonization	+	--	21 (24.1%)
BSI	--	+	26 (29.9%)
No growth	--	--	23 (26.5%)

Out of 17 patients with PVC-BSI, Staphylococcus aureus was identified as the most common causative agent accounting for 7 (41.1%) cases, followed by *Klebsiella species* for 3 (17.6%), CONS for 3 (17.6%), *Enterococcus species* for 2 (11.8%) and 1 (5.9%) case each for *Acinetobacter species* and *Pseudomonas species* (Table 4).

Table 4: Bacterial isolates of PVC-BSI samples (n=17).

Isolated bacteria	No. of isolates (%)
Staphylococcus aureus	7 (41.1%)
Klebsiella species	3 (17.6%)
CONS	3 (17.6%)
Enterococcus species	2 (11.8%)
Acinetobacter species	1 (5.9%)
Pseudomonas species	1(5.9%)

Among the colonization cases Gram positive bacteria were responsible for 15 cases which include 8 cases of S.aureus and 5 cases of *Enterococcus species*, 2 cases of CONS. *Candida species* were isolated in 4 cases (Table 5).

Table 5: Bacterial isolates of colonized samples (n=21).

Isolated organisms	No. of isolates (%)
Staphylococcus aureus	8
Enterococcus species	5
CONS	2
Pseudomonas species	2
Candida species	4

Factors contributing to PVC- BSI

Age and sex distribution among the 17 PVC-BSI cases showed that maximum number of patients with PVC-BSI belongs to 56-70 yrs age group followed by >70 yrs age group. The PVC-BSI was more common in male patients as compared to female patient with old age patients being at high risk (Figure 1).

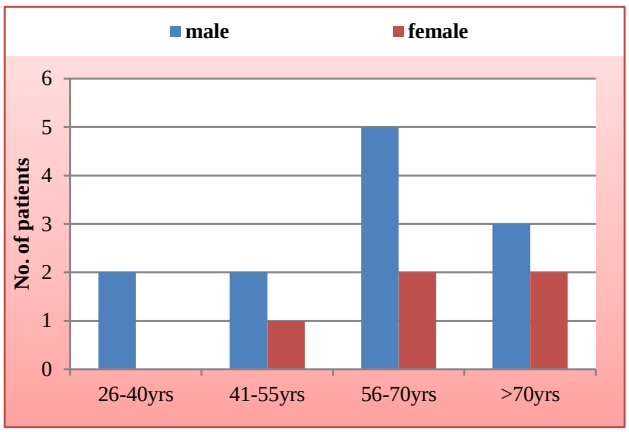

Figure 1: Age and sex wise distribution of pvc-bsi cases.

It was observed that the incidence of PVC –BSI increases significantly with the duration of catheterization. There was only one case of PVC-BSI after 48 hrs, 3 cases at 72 hrs, 5 cases after 96 hrs and 6 cases after 120 hrs suggesting a direct relation between the period of catheterization and incidence of PVC-BSI (Table 6).

Table 6: Incidence of PVC-BSI with duration of catheterization in hours.

Duration in hours	Number of cases
After 48 hrs	1
After 72 hrs	3
After 96 hrs	5
After 120 hrs	6
After 144 hrs	2
Total	17

Table 7: Risk of PVC-BSI in cases catheterized under emergency condition.

	No. of PVC inserted	Developed PVC-BSI
Inserted under emergency condition	31 (35.6%)	10 (58.8%)
Inserted in ICU	56 (64.4%)	7 (41.2%)
Total	87 (100%)	17 (100%)

The incidence of PVC-BSI was higher in those cases, who had been catheterized under emergency condition before admission into ICU. In present study 31 case were catheterized under emergency condition out of which 10

cases had developed PVC-BSI S accounting for 58.8% of all positive cases (Table 7).

Table 8: Risk of PVC-BSI in cases with multiple attempts for catheter insertion.

	No. of PVC inserted	Developed PVC-BSI
Inserted with multiple attempts	27 (31%)	9 (52.9%)
Inserted with single attempt	60 (69%)	8 (47.1%)
Total	87 (100%)	17(100%)

Multiple attempts for catheter insertion were done in27 (31%) of cases out of which 9 cases had developed PVC-BSI (Table 8).

In cases of colonization, blockage of the catheter was the most common risk factor. It was observed that 14 (66.7%) cases out of the 21 colonized cases had reported for catheter blockage and flushing (Table 9).

Table 9: Risk factor for colonization.

Total number of colonized cases	Catheter blockage and flushing done	No blockage
21	14 (66.7%)	7 (33.3%)

Antibiotic sensitivity of isolated organisms

All the Gram positive bacterial isolates were found to be sensitive to vamcomycin, whereas only 62.5% of *S. aureus*, 66.6% of CONS and 50% of *Enterococcus spp*. were found to be sensitive to ceftriaxone sulbuctum. Amikacin was sensitive for 85.7% *S. aureus*, 66.6% CONS and 50% *Enterococcus species*. Vancomycin was found to be the most sensitive drug for Gram positive cocci. Methicillin resistance was detected in 4 out of 7 *S. aureus* isolates (Table 10).

Table 10: Antibiotic sensitivity pattern of Gram positive bacteria.

Organism	No. of isolates	AS	OX	AK	CD	CIS	VA
Staph. aureus	7	3 (42.8%)	3 (42.8%)	6 (85.7%)	5 (75%)	5 (62.5%)	7 (100%)
CONS	3	1 (33.3%)	1 (33.3%)	2 (66.6%)	2 (66.6%)	2 (66.6%)	3 (100%)
Enterococcus spp.	2	2 (100%)	1 (50%)	1 (50%)	1 (50%)	1 (50%)	2 (100%)
Total	12	6	5	10	8	8	12

Table 11: Antibiotic sensitivity pattern of Gram negative bacteria.

Organism	No. of isolates	AS	CIS	AK	IPM	CPM	PIT
Klebsiella spp.	3	2 (66.7%)	1 (33.3%)	2 (66.7%)	3 (100%)	2 (66.7%)	1 (33.3%)
		CAZ	CIS	AK	IPM	CPM	PIT
Acinetobacter spp.	1	-	-	1	1	-	-
		CAZ	CIP	AK	IPM	CPM	PIT
Pseudomonas spp.	1	-	1	-	1	-	1

Among the Gram negative bacteria *Acinetobacter spp*. was found to resistant to most of the drugs. Klebsiella isolates were found fully susceptible to imipenem, whereas only 66.7% to ampicillin sulbactam, cefepime and amikacin. ESBL production was detected in 2 Klebsiella isolates (Table 11).

DISCUSSION

The study analyzed the incidence and microbiological profile and risk factors of PVC-BSI. The study group included 87 patients of age more than 26 years, in whom PVC was inserted and had developed signs and symptoms of septicemia after 48 hrs of insertion of catheter. These 87 patients were monitored for 418 catheter days. Most of the patients in the study group belonged to more than 56 yrs age group i.e. 47/87 patients accounting for 54% of total cases. It was observed that 7 out of the 17 PVC-BSI cases belongs to 56-70 years age group followed by 5 cases in more than 70 years age group. Thus 70.6 % (12/17) of the PVC-BSI cases belongs to age group more than 56 years which correlates to the age distribution of our study group reflecting positive correlation between the old age and incidence of PVC-BSI. This suggests that elderly patients are at higher risk which may be associated with poor immune status. In a study done by Parameswaran et al. immune compromised status was observed in 61.1% cases of the study group.[2] Male preponderance was observed with male: female ratio of 1.7:1.

Among the 87 patients included in the study group there were 17 cases of PVC-BSI which account for PVC-BSI rate of 40.6/1000 catheter days. Different studies on central venous catheter (CVC) related BSI showed that the CVC-BSI rate was 10/1000 catheter days, 1.8 to

5.2/1000 and 20.06/1000 catheter days in studies conducted by Gahlot et al, National Nosocomial Infection Surveillance System and Almuneef et al respectively.[1,9,10] Clearly the rate of catheter infection was found to be quite high in case of PVC as compared to CVC signifying its role in nosocomial blood stream infection. The rate of colonization in our study was 24.1% (21/87) with Gram positive bacteria responsible for 62% cases. The colonization rate in various other studies ranges from 31.58% to 76%.[11-13]

In present study *Staphylococcus aureus* was found to be the most common causative agent 41.1% (7/17), which is comparable to 53% in a study conducted by Pujol M et al.[14] Among the Gram negative bacterial isolates *Klebsiella species* was most common accounting for 17.6% (3/17). Gram positive cocci including *S. aureus*, CONS and *Enterococcus species* were found to be the major causative agents, together accounting for 70.6% of PVC-BSI cases whereas Gram negative bacteria were responsible for the remaining 29.4% cases.

The mean duration of catheterization in our study was 4.8 days comparable to that of 4.9 days of Pujol M et al.[14] Although CDC guideline had recommended to routinely replace the PVC by 96 hours, no such attempts were made.[15] The incidence of PVC-BSI increased steadily with increase in duration of catheterization, having highest incidence in cases where catheter was retained for 96 to120 hours, showing increase in risk of infection from catheter with increase in duration of catheterization. Similar findings were observed by in a study by Sato et al where the incidence of infection increased within 4-7 days of catheterization.[16] Other risk factors observed in our study were catheterization under emergency condition and multiple attempts for catheter insertion. It was observed that the incidence of PVC-BSI was higher in cases, who had been catheterized under emergency condition before admission into ICU. In our study 35.6% cases were catheterized in emergency condition comparable to 42% of the study by Pujol et al. out of which 10 cases had developed PVC-BSI, i.e. 52% of total positive cases. This shows an increased risk of catheter infection when catheterized under emergency condition which may be due to inadequate aseptic measures or less experienced staff.

In case of colonization blockage of the catheters was the most common risk factor and Gram positive cocci including *S.aureus* and *Enterococcus species* were the most common bacteria isolated. Other risk factors like poor personal hygiene, occlusive dressings and moisture around the exit site may contribute to colonization.

All the Gram positive isolates were sensitive to vancomycin whereas ofloxacin was the least sensitive drug (41.7%). It was observed that Ente*rococcus species* had higher resistance to drugs as compared to *S. aureus* and CONS. MRSA had accounted for 57% *S. aureus* isolates as compared to 26.7% in the study by Parameswaran et al.[2] All the gram negative isolates were found sensitive to Imipenim. *Acinetobacter species* was resistant to most of the drugs. The higher rate of MRSA detection is a matter of concern as it adversely affects the disease outcome.

CONCLUSION

There was a significant contribution of PVC in development of catheter related infection leading to increase in morbidity, mortality and prolonged hospital stay of patients. Duration of catheterization, multiple attempts and catheterization under emergency condition has significant implication in the development of PVC-BSI. *Staphylococcus aureus* being the major contributor in PVC-BSI with higher rate of MRSA is an emerging threat. Though PVC are the most widely used catheter for intravascular assess, it possesses a significant risk of development of blood stream infection. Hence its insertion under aseptic condition and timely replacement are the key to decrease PVC-BSI.

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Ethical approval: The study was approved by the Institutional Ethics Committee

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