

Original Research Article

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Vascular Catheter Related Infections in a Tertiary Care Hospital – A Microbiological Study

M.V.M. Sainivedeta, I.M. Rejitha*, G. Sucilathangam and C. Revathy

Department of Microbiology, Tirunelveli Medical College, Tirunelveli - 627 011,
Tamil Nadu, India

*Corresponding author

ABSTRACT

Keywords

Catheter-related bloodstream infection (CRBSI), catheter colonisation, catheter site (local) infection, Intravenous catheter, Catheter days.

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Catheter-related bloodstream infection (CRBSI) is defined as the presence of bacteraemia originating from an intravenous catheter. It is one of the most frequent, lethal, and costly complications of central venous catheterization and also the most common cause of nosocomial bacteraemia. Hence the present study was undertaken to find the incidence of catheter colonisation, catheter site (local) infection and CRBSI among patients with indwelling vascular catheters in a tertiary care hospital and determine their microbiological profile. This was a cross-sectional observational study included 50 patients with an indwelling vascular catheter in Tirunelveli Medical college hospital for the period of 6 months. Catheter tips and Blood samples were collected and subjected into Culture and Antibiotic sensitivity testing. Out of the 50 patients studied, 34 isolates were obtained from the catheter tips and blood cultures. The majority of them were Coagulase negative staphylococci (44.1%) followed by *Staphylococcus aureus* (17.6 %) and *Klebsiella pneumoniae* (17.6%). Diphtheroids were 14.7 % and *Pseudomonas* sp were 5.9 % respectively. The incidence of CRBSI in this study was found to be 1.38 per 1000 catheter days. Of the 5 isolates that caused CRBSI, 2 were MRCONS, 2 were MRSA, and one was an ESBL producing *Klebsiella pneumoniae*. An estimation of the rate of infection, and identification of the causative organisms will provide a clue as to the route of entry and pathogenesis of the infection, and this in turn may point to effective preventive strategies.

Introduction

Catheter-related bloodstream infection (CRBSI) is defined as the presence of bacteraemia originating from an intravenous catheter. Some 20-30% of all nosocomial bacteraemia occur in the ICU, with an incidence rate that ranges from 2.5 to 6.7 episodes per 100 admissions. The majority of serious CRBSI up to 87% are

associated with central venous catheters (CVC) (Vincent *et al.*, 1995). Patients may be colonized with hospital-acquired organisms and venous access might be needed for extended periods of time. The catheter may be manipulated multiple times per day for the administration of fluids, drugs, and blood products.

CRBSI arise from any of four major sources: skin colonization, intraluminal or hub contamination, secondary seeding from a blood stream infection and rarely, contamination of the infusate (Anaissie *et al.*, 1995; Bjornson, 1993). The most common source of CRBSI is colonization of the intracutaneous and intravascular portions of the catheter by microorganisms from the patient's skin and occasionally the hands of health care workers (Bjornson *et al.*, 1982). Thus, common skin commensals, such as *coagulase-negative staphylococci* and *Staphylococcus aureus*, are often isolated from colonized catheters and patients with primary CRBSI. Administration of contaminated infusate or additives such as contaminated heparin flush can result in a BSI although this is now rare.

Catheter colonisation is characterised by significant growth of a microorganism on the catheter but no growth in blood cultures. Local site infection is indicated by the presence of erythema, swelling, tenderness, and purulent drainage around the catheter port that grows a microorganism on culture. Blood cultures may be positive or negative. CRBSI is often suspected clinically in a patient who presents with fever or chills, unexplained hypotension, and no other localizing sign. Mild symptoms include malaise and nausea, and severe symptoms include high fever with rigors, hypotension, vomiting etc.

The diagnosis of CRBSI requires a positive culture of blood from a peripheral vein and clear evidence that the catheter is the source. CRBSI means a patient with an intravascular catheter has at least one positive blood culture obtained from a peripheral vein, clinical manifestations of infections (i.e., fever, chills, and/or hypotension), and no apparent source for the BSI, except the catheter. In addition, one of the following is also present: A positive semi-quantitative (>15 CFU/catheter

segment) or quantitative (>10³ CFU/ml by catheter flush method) catheter tip culture also, the same organism (species and antibiogram) is isolated from the catheter segment and peripheral blood culture. Hence this study was undertaken to find the incidence of catheter colonisation, catheter site (local) infection and CRBSI among patients with indwelling vascular catheters in a tertiary care hospital and determine their microbiological profile.

Materials and Methods

This was a cross-sectional observational study included 50 patients with an indwelling vascular catheter in Tirunelveli Medical college hospital for the period of 6 months. Patients above 12 years of age and either sex were included in this study. Patients with sepsis at the time of admission were excluded from the study. The presenting symptoms and risk factors such as duration of hospital stay, duration of catheter in situ, site of placement of catheter, diabetes, renal failure, immune suppression etc was identified and noted in the proforma.

Sample collection and processing

Catheter tip sampling and processing

The skin was cleaned with 70% alcohol prior to catheter removal. The catheter was held at the proximal end and carefully removed from the patient with a sterile instrument, taking care to avoid contact with the skin. The distal end was held over a sterile tube, and the tip was cut with sterile scissors. A 5cm segment from the distal tip of the catheter was collected in the tube and transported to the lab as soon as possible. Extra luminal Maki's roll over plate method and endo luminal catheter flush culture was used for processing. Extra luminal Maki's roll over plate method: Using sterile forceps, the catheter tip was rolled

back and forth across the entire surface of a blood agar plate using sterile forceps. For endo luminal catheter flush culture, the catheter lumen was flushed into a sterile vial with 1 ml of sterile normal saline with the help of sterile syringe and placed in culture broth and vigorously stirred to release attached microorganisms of which 0.01 ml was streaked onto blood agar and MacConkey agar, using a 4 mm inoculating loop and incubated at 37°C for 24 to 48 hours.

Blood sampling and processing

Blood (10 ml) was collected from a peripheral vein (not through the catheter) within 48 hours of catheter collection under aseptic precautions in a blood culture bottle. After 24 hours subculture was made onto blood agar and Macconkey agar plates and incubated at 37°C. In case of drainage from the catheter site, sample was taken with a sterile swab and inoculated onto blood agar and MacConkey agar plates and incubated at 37°C. All the culture isolates are further identified by using standard biochemical tests up to genus/species level. Antibiotic sensitivity testing was done by the Modified Kirby-Bauer disc diffusion method according to the Clinical and Laboratory Standards Institute (CLSI) guidelines (2006).

Detection of MRSA

Screening for Methicillin-resistant *Staphylococcus aureus* (MRSA) was performed using a cefoxitin disk on Mueller Hinton agar.

Detection of Extended spectrum Beta lactamase producers

The screening for extended spectrum beta lactamase (ESBL) was done using, ceftazidime disc (≤ 22 mm) and cefotaxime (≤ 27 mm). The phenotypic confirmation was done by testing the strain against ceftazidime

and ceftazidime with clavulanic acid discs. A >5 mm diameter of the zone of inhibition for ceftazidime with clavulanic acid in comparison to ceftazidime was considered indicative of ESBL.

Catheter colonisation - significant growth of a microorganism on the catheter but no growth in blood cultures.

Local site infection - presence of erythema, swelling, tenderness, and purulent drainage around the catheter port and catheter tip shows significant growth of a microorganism on culture. Blood cultures may be positive or negative.

Significant growth in catheter tip was defined as ≥ 15 colony forming units (CFU) by Maki's roll plate method or $\geq 10^3$ CFU/ml by the catheter flush method.

Criteria for CRBSI: Significant growth of catheter tip as well as the same organism (species and antibiogram) isolated from the catheter segment and peripheral blood culture.

Results and Discussion

Out of the 50 patients in the study group majority were in the 20 – 40 year age group with a slight male preponderance. Out of the 50 patients studied 28 were admitted in the intensive care units. Among a total of 34 isolates, *Coagulase negative staphylococci* (44%) were the most frequent isolates followed by *Staphylococcus aureus* (17.6%) and *Klebsiella pneumoniae* (17.6%). *Diphtheroids* and *Pseudomonas* constituted 14.7 % and 5.8 % respectively.

In this study, 18 patients had growth in the catheter tips (18 were positive by roll plate method out of which 8 were positive by flush method also). 16 were blood culture positive. Similar isolates in catheter tip & blood culture

with the same antibiogram was observed among 5 patients (Table 1).

The incidence of CRBSI was calculated to be 1.38 per 1000 catheter days. (Device-associated infection rate = Number of device-associated infections for an infection site X 1000 divided by Number of device days) (Table 2)

The antibiotic susceptibility pattern of the organisms are summarised in Figure-1

Out of the 6 *Klebsiella* isolates, 1 was an extended spectrum beta lactamase (ESBL) producer.. Among the 5 isolates which were implicated in CRBSI, 2 were *MRCNS*, 2 were *MRSA* and 1 was ESBL producing *Klebsiella pneumoniae* (Table 3).

Intravascular catheters are indispensable in current medical practice.. Although such catheters provide necessary vascular access, their use puts patients at risk of catheter related blood stream infections. The study was done at a tertiary care hospital over a period of 2 months to find the incidence of vascular catheter related blood stream infections among 50 adult patients. Twenty two of them were in the age group of 20-40 years and 13 were in the age group of 40-60 years. In the study by Ramanathan Parameswaran *et al.* the mean age in years among controls was 43.53 and that among patients with local catheter infections and CRBSI were 42.1 and 42.84 respectively. In this study, 28 patients were males and 22 were females. Maximum number of patients (28 patients) in the study were from the intensive care units and 22 patients were from wards. Maki DG *et al* in 2006 have reported that 32 % of CRBSI were from the ICU (Maki *et al.*, 2006).

All the patients included in the study had a mean duration of 10.5 days of hospital stay. They were catheterized for venous access to

administer IV fluids and antibiotics. A majority of them (28 patients) especially in the ICU were catheterized in an emergency circumstance. 19 patients had diabetes, 7 had renal failure and 2 patients were on steroids. Ramanathan *et al.*, have noted that the commonest premorbidity among the controls and patients with CRBSI was renal failure (35.5% and 40% respectively) while that among the patients with local catheter infections was diabetes (34.9%)

In this study all the 50 catheters sampled were peripheral venous catheters made of Teflon. According to E. Bouzal *et al.*, Teflon or polyurethane catheters were associated with fewer infections than catheters made of PVC or polyethylene. All catheters were changed within 72 to 96 hours of insertion in this study. Eighteen patients in this study had growth in the catheter tips and 16 were blood culture positive. Similar isolates with the same antibiogram was observed among 5 patients (who also had clinical signs of infection) and those were considered as catheter related blood stream infections (CRBSI). Subba Rao *et al.*, in their study reported that out of the 54 patients with positive tip cultures, 19 had corresponding positive blood cultures (Subba Rao *et al.*, 2005). Only 7 patients had similar organisms grown from both the tip culture and simultaneous blood culture.

The incidence of CRBSI in this study was 1.38 per 1000 catheter days. It was calculated using the following formula. Device-associated infection rate = Number of device-associated infections for an infection site X 1000 divided by Number of device days. Device-days are the total number of days of exposure to the device (e.g., vascular catheter) by all of the patients in the selected population during the selected time period.

The CRBSI rate of 1.38 per 1000 catheter days observed in this study is comparable to

the study by Singh *et al.*, (2010) in which the overall infection rate for CRBSI was found to be 0.48 per 1000 device days. According to Ramanathan *et al.*, the incidence of CRBSI was 8.75 per 1,000 catheter days. Incidence of CRBSI reported varies from country to country and even hospital to hospitals.

Catheter tips were processed by Maki's roll plate method and flush method. 18 had growth in the roll plate method, out of which 8 catheters had growth in the flush method also. Maki *et al* have considered Maki's semi quantitative method as the international diagnostic method. They have reported a specificity ranging between 76-96% for this method in diagnosing CRBSI. Twelve patients were found to have catheter colonisation in this study. Several studies have used significant catheter tip colonisation as a measure of CRBSI. Local infections was found among 6 patients. All the 5 patients with CRBSI had local infections..

The low rates of CRBSI (p value 0.8) observed in this study may be due to the fact that all the catheters were changed within 72-96 hours after insertion. This could also account for the low rates of local site infections. The low values obtained in this study have to be interpreted in the light of the small sample size studied and the multiple antibiotics received by the patient.

Thirty four isolates were obtained from the catheter tips and blood cultures. The majority of them were *Coagulase negative staphylococci* (44%) followed by *Staphylococcus aureus* (17.6%) and *Klebsiella pneumoniae* (17.6%). *Diphtheroids* and *Pseudomonas* constituted 14.7 % and 5.8 % respectively. In the study by Ramanathan parameswaran *et al.*, 40% of the pathogens causing CRBSI was *Staphylococcus aureus* followed by *Pseudomonas aeruginosa* 16%, *CONS* 8% and *Klebsiella pneumoniae* 8%.

Most cases of catheter related bloodstream infection are caused by skin commensals, These organisms migrate from the skin at the insertion site, and colonise the external catheter surface, eventually causing a catheter related bloodstream infection. This colonisation can take less than 24 hours following insertion. Microorganisms colonise the catheter by forming a bio film over the catheter surface. Bacteria in bio films are more resistant to antimicrobials and host defence mechanisms

Approximately 65% of CRBSI originate from skin flora, 30% from contaminated hub and 5% from other pathways. *Staphylococci* are the most frequently isolated pathogens in catheter related infections particularly *CONS*, followed by *Enterococci*, *Staphylococcus aureus* and *Candida spp*. Microbial factors include bio film formation and adhesion of pathogens to catheter surfaces (*CONS*, *staphylococcus aureus*). In the study by Pittet *et al.*, *CONS*, followed by *Enterococci*, *Staphylococci aureus* and *Candida sp* were the major pathogens observed. Before 1986, *Staphylococcus aureus* was the most frequently reported pathogen. The distribution of pathogens nevertheless varies with the type of patient, underlying condition, type of catheter, the quality of health care.

The antibiotic sensitivity pattern of the isolates showed that majority of *CONS* and *Diphtheroids* were sensitive to the drugs tested like Gentamicin, Cephalosporins, Ciprofloxacin, Amikacin, Ampicillin and Cotrimoxazole; Methicillin resistance was observed among 2 *CONS* and 2 *Staphylococcus aureus* isolates. All the gram positive isolates were sensitive to vancomycin. Gram negative bacilli like *Klebsiella pneumoniae* and *Pseudomonas sp* showed a higher degree of resistance to Ciprofloxacin and Gentamicin; Most of them

were sensitive to Amikacin, Ceftazidime and Ceftazidime with clavudinic acid.

Out of the 6 *Klebsiella* isolates, 1 was an extended spectrum beta lactamase (ESBL) producer. Among the 5 isolates which were

implicated in CRBSI, 2 were *MRCONS*, 2 were *MRSA* and 1 was ESBL producing *K.pneumoniae*. In a study in Brazil by Sadoyma *et al.*, 41% of the isolates were *MRSA* and 59% were Methicillin sensitive.

Table.1 Catheter Tip and Blood Culture Results

Isolates	1.Catheter tip		2.Blood culture n=16	CRBSI (similar isolates in 1 & 2) n=5
	Roll plate method n=18	Flush method n=8		
<i>CONS</i>	10	4	5	2
<i>Diphtheroids</i>	2	1	3	-
<i>Staphylococcus aureus</i>	3	2	3	2
<i>Klebsiella pneumoniae</i>	3	1	3	1
<i>Pseudomonas spp</i>	-	-	2	-

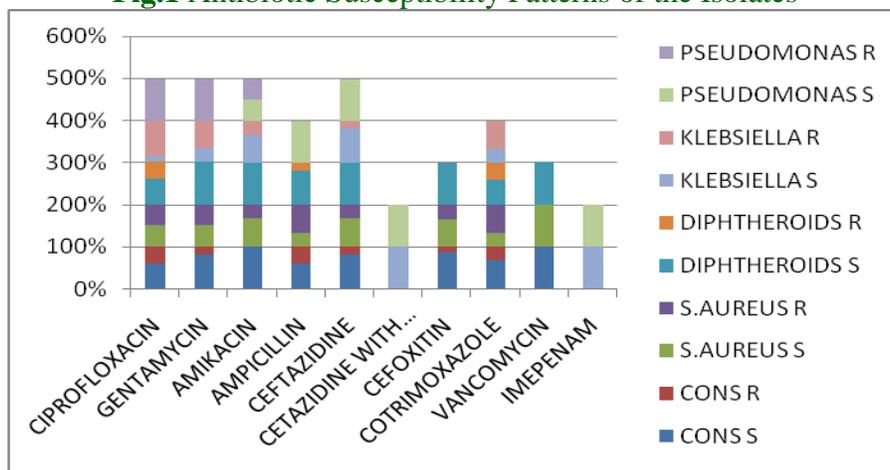
Table.2 Incidence of Catheter Related Infections

Results	Number	Percentage
Catheter colonisation	12	24%
Local catheter site infection	6	12%
CRBSI	5	10%

Table.3 Prevalence of MRSA & ESBL among the isolates

Resistant isolates	Number
<i>MR CONS</i>	2
<i>MRSA</i>	2
<i>ESBL Klebsiella pneumoniae</i>	1

Fig.1 Antibiotic Susceptibility Patterns of the Isolates



Among the MRSA isolates, multiple drug resistance to Gentamicin, Cotrimethoxazole, Erythromycin was seen. Knowledge of the CRBSI in a particular centre is the first-step toward assessing the success of existing measures to prevent these infections and the need for further corrective measures. Using proper aseptic technique, changing catheters at a fixed interval and using catheters made of materials more resistant to adherence by pathogens can reduce the number of bloodstream infections at a facility.

In conclusion, CRBSI is an iatrogenic problem that causes significant morbidity and mortality, excess length of hospital stay and excess costs of health care especially to patients in the ICUs. An estimation of the rate of infection, and identification of the causative organisms will provide a clue as to the route of entry and pathogenesis of the infection, and this in turn may point to effective preventive strategies. The findings from this study will help to implement educational programs on CRBSI for health personnel and help to initiate infection control interventions at the earliest.

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