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Original research article

A STUDY ON CATHETER RELATED INFECTION IN CORRELATION TO PATTERN OF CAUSATIVE ORGANISMS.

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Abstract

Nosocomial infections are the fourth leading cause of death. About 60-70% of nosocomial infections are associated with some type of implanted medical device. When microorganisms gain access to the intraluminal or extraluminal surface of the catheter, they become irreversibly adherent and provides a protective environment against the host defenses and antibiotics. The present study was carried out to look for the pattern of microorganisms causing Catheter-related infections. Samples analyzed were intravascular catheters, Foley's catheters, blood and urine samples. A total of 106 catheter samples obtained from 105 patients were studied. Samples were processed as per standard methods. Out of 105 cases, maximum number of samples were from neonates. A total of 53 organisms were isolated, Out of which, 41 were isolated from IVC and 12 from urinary catheters. The commonest organism colonizing IVC were Candida spp. (73.1%), CONS (19.5%) and *Klebsiella* spp. (4.8%). Urinary catheter samples were commonly colonized with CONS (25%), *P. aeruginosa* and *Acinetobacter* spp. (16.6%).

Keywords: Catheter related infection, Intravascular catheters, Foley's catheters, microbial association, *Candida* species.

Introduction

Central venous catheters (CVCs) can become contaminated with microorganisms via two major routes.The patient's skin organisms at the insertion site can migrate along the surface of the catheter into the cutaneous catheter tract, resulting in colonization of the catheter tip for short-term catheters (non-tunneled CVCs, <10days), this is the most common source of infection.[1]

Most commonly, direct contamination of the catheter or at any point along the fluid pathway when the IV system is manipulated. This route has been associated with more

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prolonged CVC dwelt time (>10 days), including tunneled CVCs such as Hickman and Broviac-type catheters and PICG.

Less commonly, catheters can become seeded via the hematogenous route from an infection at another site such as UTI or *pneumonia*.[2]

Rarely, contamination of the infusate can be the source of infection. Infusate can become contaminated during manufacturing process or during its preparation or administration in patient care setting. This is a rare event, but it is the cause of most epidemic IV-device related BSI.[3]

After the catheter is inserted into the blood stream, plasma proteins begin to adhere to it, which can result in the formation of a fibrin sheath around the catheter. When microorganisms gain access to the intraluminal or extraluminal surface of the catheter, they become irreversibly adherent and begin to produce a biofilm that incorporates the microorganisms and provides a protective environment against the host defenses and antibiotics. Dispersal of single cell microorganisms or clumps from the biofilm results in hematogenous dissemination of biofilm bacteria. Microorganisms that are dispersed as single cells can be killed by host defenses, but if the dissemination becomes extensive or if host defenses are compromised, true CLABSI occurs. Biofilm dispersed in clumps remains resistant to host defenses and antimicrobials and may result in serious focal infections such as endocarditis.[4]

The catheter material can also influence the development of BSI. Some catheters have irregularities that can enhance the adherence of certain microorganisms (for e.g.: S. *Epidermidis* and *C. albicans*). Other catheters and their construction materials contribute to the formation of fibrin sheaths, which is why silastic catheters have a higher risk of infection associated with their use than do polyurethane catheters. Silocone elastomer catheter surfaces allow biofilm formation by *C. albicans* more readily than do polyurethane catheters. Silicon catheters are easier to infect than polyurethane, PVC and Teflon catheters. Organisms adhere better to PVC catheters than to Teflon catheters. Finally, some catheters are more thrombogenic than others, which may predispose them to colonization and infection.[5,6]

The present study was carried out to look for the pattern of microorganisms causing Catheter-related infections. Samples analyzed were intravascular catheters, Foley's catheters, blood and urine samples.

Methodology

Clinical samples were collected from the catheterized patients of both sex. Specimens included catheter samples (intravascular and Foley's urinary catheters), blood and urine samples from 110 patients.

An informed consent was taken from all the catheterized patients under study.

Detailed clinical history such as fever with or without chills, burning micturition, frequency of micturition, lower abdominal pain, swelling, pain at catheter site and duration of catheterization were recorded in the proforma.

Inclusion Criteria

All the in-patients who have been catheterized for more than 48 hours showing clinical signs of sepsis.

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Signs of BSI: Fever, hypothermia, chills, rigors, tachycardia, hypotension, tachypnea.

Signs of UTI **:** Fever, dysuria, frequency, urgency, suprapubic tenderness.

Exclusion Criteria

- All the catheterized patients without any signs of sepsis.
- All the catheterized patients < 48 hours.

METHODS

1) a. Collection of Intravenous Catheters

At the time of catheter removal the site was examined for the presence of swelling, erythema, local rise in temperature and tenderness. The site was cleaned with an alcohol pledget and the catheter was withdrawn with sterile forceps, the externalized portion being directed upward and away from the skin surface. After removal, the site was examined and milked to express any exudate.

For short catheters (< 6 cm), the entire length of the cannula was cut 1 cm below the surface/catheter junction aseptically. For long catheters, two 5cm segments were collected: the tip and the intracutaneous segment. The catheter segments were transported to the laboratory in sterile, dry containers.

b. Collection of Blood sample

The venepuncture site was disinfected and with standard aseptic precautions, 5ml of blood was drawn. The sampling needle was safely detached and discarded; then a fresh needle was fitted and the drawn blood was inoculated into the blood culture bottle.

c. Gram Staining

Catheter segments were air dried and clotted blood if present was removed with sterile wire. Sterile forceps was used to handle the segment. Opaque catheters were cut in half longitudinally. The staining procedure was done in a series of different sterile petri dishes, each containing Crystal violet, Lugol's iodine solution and dilute carbol fuchsin. It was then air dried and examined under oil immersion at 1000x after being taped firmly on a glass slide.

d. Culture of Catheter sample

Catheters were cultured by using the semiquantitative method described by Maki et al. Flamed forceps were used to transfer the entire catheter segment onto the surface of a 5% sheep blood agar plate and the catheter was rolled back and forth four times across the agar surface. Plates were incubated at 37^0 C for 48 hours, inspected for microbial growth and colonies were enumerated.

Growth >15 colonies on agar plate indicates infection, 1-14 colonies on agar plate indicates contamination. Samples which grew > 15 colonies on plate were considered for the study. All the colony types were identified by standard microbiological methods.

Catheter segment was inoculated into 5ml trypticase soy broth (TSB) and incubated overnight at 37^0 C. Subculture was done from the broth onto Blood agar and Mac Conkey agar, incubated for 24 hours and colonies were enumerated and identified.

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2) a. Collection of Urine from Catheterized Patients

Urinary catheterization will allow collection of bladder urine with less urethral contamination. Specimen collection from such patients was done with strict aseptic techniques. A pair of gloves was worn while handling urinary catheter. The catheter tubing was clamped off above the port to allow collection of freshly voided urine. The catheter port or the wall of the tubing was then cleaned vigorously with 70% ethanol and urine aspirated with a sterile needle and syringe, the integrity of closed system was maintained to prevent introduction of organisms into the bladder.

b. Removal of Foley's Catheter

Using another syringe (without the needle), the water or saline injected initially during catheter insertion was drained out. Care was taken to see to it that the entire fluid was removed. Initially one or two gentle tugs were given on the catheter and it was slowly withdrawn. With the help of sterile scissor, a 5 cm portion of the catheter tip was cut off and placed in a sterile test tube and plugged. It was then taken to the laboratory and processed.

c. Urine culture

A 5% sheep blood agar and a Mac Conkey agar were used for plating. Before inoculation, urine was mixed thoroughly and the top of the container was then removed. The calibrated loop was inserted vertically into the urine in the container. The loop is touched to the centre of the plate. Without flaming or re-entering urine, the loop is drawn across the entire plate, crossing the first inoculum streak numerous times to produce isolated colonies.

A colony count of $> 10^3$ CFU/ml was taken as indicative of a positive culture as all urine samples collected were catheterized urine samples.

d. Processing of Urine Catheters

The catheters were placed in 10ml of 0.15M phosphate buffer saline with 0.1% Tween-80 and sonicated for 30 minutes at room temperature to detach adherent microorganisms. The microbial suspension was vortexed vigorously for 15 seconds to break up clumps. Tenfold serial dilutions of each suspension were plated on 5% blood agar, incubated at 30^0 C for 18 hours and the mean number of colony forming units was determined.

3) All isolates so obtained were identified by biochemical reactions as per standard protocol. Antibiotic susceptibility testing was done on Mueller Hinton agar using Kirby-Bauer disc diffusion method.

Results

A total of 106 catheter samples obtained from 105 patients were studied of the 106 catheters. Out of 105 cases, maximum number of samples were from neonates. 65 were males and 40 were females. The male: female ratio was 1.6:1.

Positive tip culture was found in 46.98% peripheral intravascular catheters (IVC) and 31.8% urinary catheters. A total of 53 isolates were obtained. Of these, 41 isolates were obtained from IVC and 12 isolates were from Foley's catheter. 4 isolates were obtained

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from blood culture only, indicating the primary site of infection other than vascular catheter (not included for the study).

Table 1: Distribution of organisms associated with Catheter colonization

Isolates	IVC (%) n=41	Urinary Catheter (%) n=12	Total (%) n-53
CONS	8 (19.5)	3 (25)	11 (20.7)
E. coli	1 (2.4)	1 (8.3)	2 (3.7)
Klebsiella	2 (4.8)	1 (8.3)	3 (5.6)
Enterobacter	-	1 (8.3)	1 (1.8)
Pseudomonas	-	2 (16.6)	2 (3.7)
Acinetobacter	-	2 (16.6)	2 (3.7)
NF – GNB	-	2 (16.6)	2 (3.7)
Candida	30 (73.1)	-	30 (56.6)

The commonest organism colonizing IVC were Candida spp. (73.1%), CONS (19.5%) and *Klebsiella* spp. (4.8%). Urinary catheter samples were commonly colonized with CONS (25%), *P.aeruginosa* and *Acinetobacter* spp. (16.6%).

Table 2: Relationship between direct catheter – staining with Gram's stain and semi-qualitative culture

Types of Catheter	Catheter Culture Positive	Gram stain positive	Percentage
Peripheral venous catheter	39	20	51.2

Gram's stain was applied to the vascular catheters and not to the urinary catheters.
Gram's stain did not show any organisms in culture negative cases and was positive only among the culture positive cases.
Among 39 culture positive catheter samples. Gram stain was positive in 51.2%.

Table 3: Isolation from the Catheter-tips and corresponding samples

Catheter type	No. of Positive cultures from	
	Catheter tip	Both tip & Sample (%)
Peripheral IVC	39	14 (30.8)
Urinal Catheter	7	2 (28.5)
Total	46	16 (34.7)

* Same organisms were isolated from both samples

Of the 39 patients with positive IVC tip cultures, 30.8% had similar organisms grown from both the tip culture and simultaneous blood culture indicating catheter related infection.
Out of 7 positive urinary catheter cultures, 28.5% had same growth on catheter tip as

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urine.

Table 4: Organisms isolated from cultures of catheter – tip and corresponding samples

Organisms	No. of Positive cultures from		
	Catheter tip	Sample	Both
CONS	11	6	5
Gram negative bacteria	12	7	4
Candida	30	7	7

Out of 46 positive catheter cultures, coagulase negative staphylococci was isolated from catheter and corresponding sample in 5; gram negative bacteria was isolated from 4 and Candida was isolated from 7 samples.

Table 5: Comparison between catheter duration and colonization

Catheter duration	Total No. of Cases	No. of Catheter Colonization (%)
≤ 3days	16	2 (12.5)
> 3 days	90	44 (48.8)

Out of 105 cases, maximum number of catheter colonization (48.8%) was observed with catheter duration of more than 3 days.

Discussion

Table 6: Microorganisms associated with catheter colonization (%)i) Peripheral IVC

Studies [7,8,9,10]	**CONS**	***E. coli***	***Klebsiella***	***Enterobacter***	**Pseudomanas**	***Acinetobacter***	**NFGNB**	**Candida**
Akash *et al*. (2004)	18.8	7.5	20.7	-	18.8	5.6	-	3.7
Subha *et al*. (2005)	29.6	3	-	13	-	-	-	-
Patricia *et al*. (2008)	23.4	4.9	3.7	-	1.2	-	-	3.7
Shaimaa *et al*. (2011)	10	5	-	3.3	11.7	-	-	5
Present study	19.5	2.4	4.8	-	-	-	-	73.1

In the present study, among 41 clinical isolates, maximum colonization was with Candida spp. (72.1%); more compared to the studied of Akash *et al*. (3.7%), Patricia *et al*. (3.7%) and Shaimaa *et al*. (5%).

Coagulase negative staphylococci accounted for 19.5% colonization which is similar to

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studied conducted by Akash *et al*. (18.8%) and Patricia *et al*. (23.4%), but more compared to the studies of Shaimaa *et al*. (10%).

Klebsiella spp. was isolated in 4.8% isolated which is similar to the studied conducted by Patricia *et al*. (3.7%) but less compared to the studied of Akash *et al*. (20.7%).

E.coli accounted for 2.4% of isolates, similar to the studied of Subha *et al*. (3%), Patricia *et al*. (4.9%) but less compared to the studies conducted by Akash *et al*. (7.5%) and Shaimaa *et al*. (5%).

ii) Urinary catheter colonization (%)

Studies[7,8,9]	**CONS**	***E. coli***	***Klebsiella***	***Enterobacter***	**Pseudomanas**	***Acinetobacter***	**NFGNB**	**Candida**
Akash *et al*. (2004)	-	34.4	51.7	-	6.8	-	-	6.8
Abdallah *et al*. (2011)	11.7	31.7	15	1.7	6.7	-	-	-
Sangita *et al*. (2012)	-	30	10	10	30	10	-	-
Present study	25	8.3	8.3	8.3	16.6	16.6	16.6	-

In our study, out of 12 isolates, most common colonization was seen with coagulase negative staphylococci (25%), more compared to the study of Abdallah *et al*. (11.7%).

P. aeruginosa accounted for 16.6% of isolates, more compared to the studied of Akash *et al*. (6.8%) and Abdallah *et al*. (6.7%).

Acinetobacter spp. accounted for 16.6 isolates, similar to the study conducted by Sangita *et al*. (10%).

E.coli accounted for 8.3% isolates which is less compared to the studied conducted by Akash *et al*. (34.4%), Sangita *et al*. (30%) and Abdallah *et al*. (31.7%).

In the present study, 8.3% *Klebsiella* spp. were isolated, similar to the studies of Sangita *et al*. (10%) and Abdallah *et al*. (15%) but less compared to the study of Akash *et al*. (51.7%).

Enterobacter spp. accounted for 8.3% colonization, similar to the study of Sangita *et al*. (10%).

In the present study, the Gram's stain was positive in 51.2% of the culture positive cases which compares with the study of Francois *et al*. who showed sensitivity of 44%.In the present study, out of 39 positive IVC – tip cultures, 30.8% samples had similar organisms grown from both the tip culture and simultaneous blood culture indicating catheter – related infection. This study correlates with the studies of Akash *et al*. (43.1%) and Harsha *et al*. (28.5%). 28.5% of the patients in the present study with Foley's catheter had the same growth on catheter tip as urine, similar to the study of Carlos *et al*. (20.3%), but less compared to the study of Akash *et al*. (56.5%).

In the present study, 16 catheter were placed for ≤ 3 days, of which 12.5% were infected. Of the 90 catheters placed for more than 3 days, 48.8% were infected. The catheter-related infection increased with duration of catheterization, similar to the study of Harsha *et al*., who showed 12.5% catheters infected that were placed ≤ 3 days and

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34.2% catheters infected which were placed > 3 days.

Conclusion

- Catheter culture was positive in 46.9% IVC and 31.8% urinary catheters.
- Candida spp. was the common isolates (73.1%) followed by CONS (19.5%) and *Klebsiella* spp. (4.85) among IVC isolates.
- CONS was the most common isolate (25%) followed by *Pseudomonas* spp. (16.6%) and *Acinetobacter* spp. (16.6%) among urinary catheters.
- Hence, indwelling catheters pose a great threat to infection nidus. Early identification and treatment of catheter related infections aids good patient outcome.

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