

Hemodialysis Catheter-Related Infection in a Teaching Hospital of Central Nepal

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ABSTRACT

Introduction

Infection of the central venous catheter (CVC) is a major complication seen among patients undergoing hemodialysis. Identifying CVC related infection (CRI) and its risk factors and causative organisms is important for better implementation of preventive strategies.

Methods

A prospective study was conducted at Chitwan Medical College for a duration of 2 years from January 2017 to December 2018 among the patients undergoing hemodialysis via CVC. The data collected were related to patients' demographics, site of catheter insertion, and duration, microbiological data including cultures from catheter sites, blood, and catheters' tips and antibiotic sensitivity. Catheter related infection was divided into catheter related local infection (CRLI) and catheter related blood stream infection (CRBSI). Data was analyzed using IBM SPSS Statistics version 21.0.

Results

A total of 41 cases of CVC related infection (CRI) were documented with an incidence rate of 6.94 episodes per 1000 catheter days at risk. Out of the total CRI, 39.02% were CRLI and 60.98% were CRBSI. Fever with chills and rigor were the most common clinical presentation. Risk factors for the development of CRI were duration of catheter in situ, repeated change of CVC and the use of CVC for indications other than hemodialysis (HD). *Staphylococci* and *Klebsiella* were the most common organisms isolated in culture.

Conclusion

The rate of CRI among Nepalese patients undergoing hemodialysis is high. Prolonged duration of CVC usage, recent change of catheter and the use of the HD catheter for the purpose of institution of intravenous medication have been found as the risk factors for CRI.

Keywords: Catheter related infection, central venous catheter, hemodialysis

INTRODUCTION

Vascular access for hemodialysis is attained by arteriovenous fistula (AVF), arteriovenous (AV) graft or central venous catheter (CVC). Central venous catheter (CVC) is used approximately in 80% of patients at the time of initiation of hemodialysis (HD).¹ Although CVCs were originally introduced for short-term dialysis, they may be used as a permanent access especially for the patients with limited access options. Dual lumen non-cuffed catheters are used for temporary access whereas dual lumen tunneled catheters are the preferred form of access for intermediate use.

Infection is an important cause of hospitalization and the second most common cause of death among patients undergoing hemodialysis.^{2,3} For clinical convenience, CVC related infection (CRI) has been divided into CVC related local infection (CRLI) and CVC related bloodstream infection (CRBSI). Hemodialysis catheter-related blood stream infection (CRBSI) remains a significant cause of morbidity and mortality among patients undergoing hemodialysis.⁴ The mean incidence of uncuffed temporary catheters is around 5/1000 catheter days.⁵ In comparison to the arteriovenous (AV) access, the relative risks of catheter related bacteremia and infection-related

death among patients undergoing hemodialysis has been estimated to be about 10 times and two to three-fold higher respectively.^{6,7} The cumulative likelihood of catheter-related bacteremia has been documented to be 35 percent within three months.⁸

Dialysis catheter-related bacteremia can develop either due to migration from the skin along the outside of the catheter into the bloodstream or due to direct inoculation from a biofilm containing pathogenic micro-organisms.⁴ Multiple factors contribute to the development of dialysis catheter related bacteremia.^{9,10} The major organisms responsible for such infections are gram-positive organisms, most important of which are coagulase-negative staphylococcal and *Staphylococcus aureus*.^{11,12}

There is paucity of information on the CRI on Nepalese context. So, this study was done with an aim to determine the clinical profile and the microbial etiology of CRBSI among patients with end stage renal disease (ESRD) undergoing hemodialysis in a tertiary care hospital in central part of Nepal.

METHODS

This prospective study was conducted in the Nephrology unit, Department of Medicine at Chitwan Medical College for a duration of two years from January 2017 to December 2018. Ethical approval was obtained from the Institutional Review Committee of Chitwan Medical College (CMC-IRC) before the initiation of study and written informed consent from the participants was taken.

All patients who were initiated on hemodialysis (HD) using double lumen hemodialysis catheter for more than 48 hours were eligible for inclusion in the study. Patients with CVC insertion for non-dialysis indications and HD patients who presented with any other source of infection were excluded from the study. Participants were followed up for one month after insertion of catheter for any evidence of CRI. Catheter related bacteremia was suspected when a patient experienced fever, chills, purulent discharge from catheter site, erythema or tenderness over exit site, in the absence of any other focus of infection. Blood samples were collected from the hemodialysis catheter hubs and from the peripheral veins using aseptic precaution, which were sent immediately to the laboratory for culture and sensitivity testing. Hemodialysis catheter was removed immediately when clinically indicated, such as CVC infection, non-functional CVC, fulfilment of its indication and the death of the patient. Under aseptic precautions, the tip was cut into approximately 5 cm segment using sterile scissors and transported to the laboratory immediately for culture and sensitivity test. After sending the blood and tip samples for the cultures the patients were immediately started on empiric intravenous antibiotic therapy. For patients who

developed a CRBSI, the patient days at risk (catheter days) were defined as the number of days from catheter insertion to the date paired blood cultures were sent. CVC related local infection (CRLI) was diagnosed if a semi quantitative culture of an intravascular catheter segment (>15 colony-forming units) was found to be positive and the diagnosis of CRBSI was based on the clinical presentation of fever, chills and/or hypotension and any of the following two criteria¹³:

- Same organism recovered from percutaneous blood culture and from semi-quantitative roll-plate culture (>15 CFU) of the catheter tip.
- Same organism recovered from a percutaneous and a catheter lumen blood culture, with growth detected 2 hours earlier (i.e. 2 hours less incubation period) in the blood collected through catheter than the blood collected percutaneously.

Data were entered and analyzed by using IBM SPSS Statistics software version 21.0 (IBM, Armonk, NY). Continuous response variables were presented as mean \pm SD. Chi square test and Fisher exact test were used for qualitative variables. Logistic regression analysis was done to compare the variables between the patients with and without CRI. $p \leq 0.05$ was considered as statistically significant.

Table 1. Characteristics of study population and CVC catheter

Parameters	Number (Percentage)
Age (years)	
<18	12 (2%)
18-40	138 (23.2%)
41-65	297 (50%)
>65	147 (24.7%)
Sex	
Male	420 (70.7%)
Female	274 (29.3%)
Indication for hemodialysis	
AKI	210 (35.3%)
CKD	384 (64.6%)
CVC location	
Right internal jugular vein	463 (77.9%)
Femoral vein	118 (19.8%)
Left internal jugular vein	13 (2.2%)
Duration of catheterization	
<30 days	257 (43.2%)
>30 days	337 (56.7%)
Reason for CVC catheter removal	
No more indicated	511 (86%)
CVC infection	41 (6.9%)
Death of the patient	25 (4.2%)
Not functioning	17 (2.8%)

Table 2. Clinical features of HD catheter-related infection

Clinical features	Number (%)
Fever during dialysis	41 (100%)
Chills	31 (75.6%)
Rigors	31 (75.6%)
Nausea, vomiting	27 (65.8%)
Hypotension	26 (63.4%)
Fever before dialysis	18 (43.9%)
Catheter dysfunction	17 (41.4%)
Malaise	17 (41.4%)
Breathlessness	13 (31.7%)
Altered sensorium	7 (17.0%)
Fever after hemodialysis	5 (12.1%)
Erythema at exit site	5 (12.1%)
Purulent discharge	3 (7.3%)

RESULTS

A total of 594 central venous catheters (CVC) were inserted for the purpose of hemodialysis during the study period. Out of the total patients included in the study, 70.7 % were males. The mean age of the patients was 53.10±17.75 years (Range: 16-85 years).

The indication for the insertion of CVC for hemodialysis was acute kidney injury (AKI) in 35.36% and chronic kidney disease (CKD) in 64.64% of patients. HD catheter was kept in situ for a mean period of 9±4 days in patients with AKI and 46±23 days in patients with CKD. Most commonly used site for CVC insertion was right internal jugular vein (77.94%), followed by femoral vein (19.86%) and left internal jugular vein (2.2%). Subclavian vein was used in none of the patients. Details of the baseline parameters is shown on table 1.

A total of 41 cases of CVC related infection (CRI) were documented with an incidence rate of 6.94 episodes per 1000 patient days at risk. Out of the

total CRI, 39.02% were CRLI and 60.98% were CRBSI. Most common clinical feature was fever with chills and rigor (100%) followed by nausea and vomiting (25.8%), Hypotension (63.4%) and catheter dysfunction (41.4%). Erythema at infection site and purulent discharge were seen in 12.1% and 7.3% of patients respectively. (Table 2)

Biochemical parameters were compared between the patients with and without CRI, which is shown on table 3. Among patients with CRI, serum level of albumin was lower and the levels of ferritin and uric acid were significantly higher.

Various possible risk factors were analyzed between the patients with and without CRI. A total of 64.5% of patients with CKD and 11.9% of AKI developed CRI. Table 4 shows the different risk factors for the development of CRI.

Most commonly isolated microorganisms in CRI were coagulase negative staphylococci (26.8%), Staph aureus (24.4%) and Klebsiella pneumoniae (21.9%). Table 5 shows the details of the isolated microorganisms with classification into CRLI and CRBSI.

DISCUSSION

Even though central venous catheter-related infection (CRI) remains a leading cause of morbidity and mortality among patients undergoing hemodialysis,¹⁴ initiation of hemodialysis by uncuffed non-tunneled central venous catheter is a common practice especially in south Asian countries.¹⁵

The incidence rate of CRI in our study was 6.94 episodes per 1000 patient days at risk, which is higher than the findings from studies from North America, Europe and Africa (ranging between 1.67 and 5.6/1000 catheter days)¹⁶⁻¹⁸ but slightly lower than that reported from India (7.4 episodes per 1000 catheter days).¹⁹ One of the reasons for variation in the findings could be the use of different criteria for

Table 3. Laboratory parameters of patients with and without CVC related infection

Biochemical parameters	Catheter related infection		p-value
	Positive (n=41)	Negative (n=553)	
WBC count (000/mm ³)	14.6±6.3	7.6±3.2	0.35
Hemoglobin (gm/dl)	8.9±2.3	9.45±1.9	0.14
Platelets (000/mm ³)	134.5±10.6	186±11.3	0.96
Albumin (gm/dl)	3.0±0.15	3.4±0.67	0.04
Iron (µmmol/L)	24.47±11.8	15.2±9.4	0.09
Ferritin (ng/mL)	809±432	506±205	0.03
TSAT (%)	19.4±6.4	21.34±7.6	0.08
Uric Acid (mg/dL)	8.9±3.4	6.9±2.6	0.045
Calcium (mg/dL)	9.56±2.3	9.45±1.9	1.12
Phosphorus (mg/dL)	6.45±1.7	5.9±1.6	1.10
PTH	280±121	261±103	0.93

TSAT: transferrin saturation, PTH: parathyroid hormone

Table 4. Risk factors for CVC related infection (CRI)

Factors	Catheter related infection		HR	95% CI	p-value
	Positive (n=41)	Negative (n=553)			
Age >65 years	21.9%	19.3%	1.34	0.94-1.65	0.90
Male	73.1%	70.3%	1.17	0.89-1.54	0.95
Diabetes	17.0%	9.5%	1.06	1.01-1.23	0.08
Femoral CVC	9.5%	6.4%	1.92	1.56-2.05	0.12
Duration >30 days	78.0%	32.1%	0.94	0.84-1.51	0.04
Recent surgery	9.7%	6.3%	1.19	0.78-1.57	0.21
Recent change of CVC	29.2%	12.5%	0.87	0.63-1.08	0.03
Use of CVC for medication	34.1%	5.6%	0.89	0.52-1.09	0.03

CRI. In this study, IDSA criteria¹³ was used, whereas majority of other studies had used Center for Disease Control (CDC) criteria.²⁰

Most common clinical features encountered in this study were fever during dialysis, chills and rigor; nausea and vomiting and hypotension, which are in accordance with other few studies.²¹⁻²³ Significant laboratory parameters among patients with CRI were lower albumin, higher levels of serum ferritin and higher levels of uric acid. Hypoalbuminemia could be an indirect marker of poor nutritional status of the patients undergoing HD and these patients are prone for the development of any infection in the body including CRI. Lower level of albumin can also be seen in systemic infection and inflammation. However, in this study it was difficult to ascertain the cause and effect relationship of serum albumin with CRI. One of the factors hindering the accurate interpretation of the levels of these biochemical parameters could be the timing of the testing in CKD patients undergoing hemodialysis with infection.

The significant risk factors for the development of catheter related infection in this study were the persistence of CVC catheter for a longer duration (>30 days), recent change of CVC with the use of guidewire and the use of hemodialysis catheter for institution of intravenous medication and blood transfusion. Diabetes and prolonged duration of CVC usage have been described as major risk factors related to infection in hemodialysis patients.²⁴⁻²⁶ One of the reasons for the prolonged duration of CVC usage especially in the patients with CKD was due to

difficulty of performing an arteriovenous fistula (AVF) which is a common problem encountered in our set up primarily due to reluctance of the patients and also due to the unavailability of the competent vascular surgeons. To avoid this complication, preparation of AV fistula well in advance in ESRD patients is suggested. Repeated manipulation and changing of dialysis catheter; and the usage of dialysis CVC for the purposes other than dialysis like institution of intravenous medication and blood transfusion needs to be strictly discouraged to avoid further development of CRI.

Although CRI rate was higher with femoral catheters, location of CVC was not an independent risk factor for CRI in our study, which is in accordance to few studies²⁶⁻²⁸ but in contrary to the reports by Lemaire et al.²⁹ Coagulase negative staphylococci, Staph. aureus and Klebsiella pneumoniae were the most common organisms responsible for CRI. Staph. aureus as the commonest organism causing CRI has been found in many reports.^{26,27}

The reasons for the removal of CVC catheters were the completion of the indication of the catheter, development of CVC infection, death of the patient and non-functional catheter, which were in accordance to the standard guidelines.³⁰

Despite exploring the HD catheter related infections in Nepalese context, our study has some limitations. First of all, this was an observational study done in a single center. There was also no control on the length of time the catheters were in place as the lack of

Table 5. Pathogenic organisms causing CVC related infection

Microorganism	Overall (n=41)	CRLI (n=16)	CRBSI (n=25)
Coagulase negative Staphylococci	11 (26.8%)	6 (37.5%)	5 (20%)
Staphylococcus aureus	10 (24.4%)	1 (6.25%)	9 (36%)
Klebsiella pneumoniae	9 (21.9%)	5 (31.2%)	4 (16%)
Proteus species	4 (9.7%)	2 (12.5%)	2 (8%)
Escherichia coli	3 (7.3%)	1 (6.2%)	2 (8%)
Pseudomonas	3 (7.3%)	1 (6.2%)	2 (8%)
Candida species	1 (2.4%)	0	1 (4%)

alternate vascular access influenced the decision to salvage the catheter. Larger multi centric prospective studies are warranted in the future to study the various aspects pertaining to catheter salvageability.

CONCLUSION

The rate of CRI in Nepalese CKD patients undergoing hemodialysis is high. Prolonged duration of CVC usage, recent change of catheter and the use of the HD catheter for the purpose of institution of intravenous medication have been found as the risk factors for CRI.

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CONFLICT OF INTEREST

None declared.

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