

Risk Factors for Central Venous Catheter Related Bloodstream Infection: A Multicenter Study of Intensive Care Unit and Haemodialysis Unit

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Abstract

The clinical condition of the patient, type of central venous catheter (CVC), site and duration of CVC placement are the factors affecting the risk of infection. The aim of this study was to examine and find out the risk factors of CVC related bloodstream infections (CVC-BSI). This cross sectional study was carried out in the Department of Microbiology and Immunology of Bangabandhu Sheikh Mujib Medical University (BSMMU), Dhaka, Bangladesh during the period of July 2011 to June 2012. One hundred patients who were admitted in ICU of BSMMU and ICU and haemodialysis unit of Dhaka Medical College Hospital (DMCH) having central venous catheter, were enrolled in the study. The rate of CVC-BSI was 11% and the incidence was observed to be 11.14/1000 catheter days. Both CVC-BSI and CVC colonization were higher in trilumen than in bilumen central venous catheter. CVC-BSI rate was 12.79%

in trilumen whereas there was no CVC-BSI in patient with bilumen catheter. The mean duration from CVC insertion to development of CVC-BSI was 14 days, CVC colonization was 8.41 days and noninfected CVC was 6 days. CVC-BSI and CVC colonization were most common in right femoral vein where CVC-BSI was 18.52% and CVC colonization was 59.26%, whereas no CVC-BSI was found in right internal jugular vein. Risk factors for CVC-BSI included type of CVC, site of CVC placement, duration of catheterization were not found statistically significant in this study. CVC-BSI and CVC colonization were higher in trilumen catheter and rate raised with increased duration of placement and highest number of CVC-BSI and colonization was found in right femoral vein.

Keywords: Risk factors, CVC, ICU, haemodialysis unit.

INTRODUCTION

From the skin insertion site of central venous catheter (CVC), the organisms migrate down the external surface of the CVC to colonize the distal tip of the catheter and produce bloodstream infection (BSI).¹ Intravenous catheter use for more than seven days duration is a risk factor for infection.² Haematogenous colonization and contaminated infusion set are the other routes of CVC colonization and CVC-BSI.¹

Different studies have focused on various risk factors related to the acquisition of CVC related infection. The type of CVC, site and duration of CVC placement could be the potential risk factors for CVC-BSI.³ Multilumen CVCs have been associated with a high risk of infection than single lumen CVCs.⁴ Insertion of a CVC into the femoral vein or internal jugular vein rather than the subclavian vein may carry a higher risk of CVC-BSI probably because of higher risk of cutaneous colonization at the insertion sites.^{5,6} Prolonged CVC insertion may be another factor as there is higher chance of CVC colonization and contamination of CVC due to handling.²

This study was designed to assess the risk factors for CVC-BSI in patients with a central venous catheter admitted in intensive care unit (ICU) of Bangabandhu Sheikh Mujib Medical University (BSMMU) and ICU and haemodialysis unit of Dhaka Medical College Hospital (DMCH), Dhaka, Bangladesh.

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MATERIAL AND METHODS

This study was conducted during the period of July 2011 to June 2012. All laboratory works were performed in the Department of Microbiology and Immunology of BSMMU, Dhaka, Bangladesh.

Study population: Patients who had clinical signs and symptoms of septicemia after having the CVC insertion 48 hours after admission in ICU of BSMMU or ICU and haemodialysis unit of DMCH, Dhaka.

Sample size: A total of 100 patients admitted in ICU and Department of Nephrology (64 patients from ICU and 36 from Nephrology) were enrolled in this study.

About 8 ml of blood was collected simultaneously from the CVC line and peripheral vein. After inoculation of blood into paired blood culture vials (BACTEC 9240) they were brought to the laboratory as soon as possible and incubated in automated blood culture machine (BACTEC, Dickinson and Company, Maryland, USA). All samples were incubated at 37°C upto culture positivity and the vials were discarded if no growth was detected within seven days.

CVC-BSI was detected by Differential time to positivity (DTP) method as described by Raad et al.⁷ After organism identification antimicrobial sensitivity test was performed by disc diffusion method using Kirby-Bauer technique.⁸ CVC-BSI rate was determined by the following method as mentioned by Salomao et al.⁹

CVC-BSI rate = Total no. of CVC-BSI / Total no. of CVC days X 1000.

Ethical consideration:

This study was approved by Ethical Clearance Committee (ERC) of BSMMU. Informed written consent was taken from the patient or their guardians before collection of blood samples. The anonymity of the participants and confidentiality of information was maintained strictly.

Statistical analysis

Frequency distribution was calculated. Cross tabulation and statistical significance were analyzed by using chi-square test.

RESULTS

Potential risk factors for CVC-BSI were assessed in this study. Of the 100 recruited patients 83 were male and 17 were female and the mean age was 38 years. CVC-BSI was diagnosed in 11%, CVC colonization in 43% patients.

Mean duration of CVC-BSI was 14 days (12-63 days); 45.5% CVC-BSI occurred during 11-20 days of CVC placement. Majority of the CVC remained sterile during 3-10 days of CVC placement. Mean duration of CVC colonization was 8.41 days (6-31 days) and noninfected CVC was 6 days (3-14 days) (Table-I).

Both CVC-BSI and CVC colonization were higher in trilumen than in bilumen central venous catheter. CVC-BSI rate was 12.79% in trilumen whereas there was no CVC-BSI in patient with bilumen catheter. CVC colonization was 44.19% in trilumen but it was 35.71% in bilumen catheters used. The difference of positivity between the trilumen and bilumen catheter was not statistically significant (Table- II).

Table-I: Study patients according to duration of CVC placement (n = 100)

Category	Mean in days (range)	Cases by duration of CVC placement (days)			
		3-10	11-20	21-30	>30
CVC-BSI (n=11)	14(12-63)	0(0)	5(45.5)	4(36.4)	2(18.2)
CVC colonization (n=43)	8.41(6-31)	13(30.2)	21(48.8)	7(16.3)	2(4.6)
Noninfected CVC (n=46)	6(3-14)	33(71.7)	13(30.2)	0(0)	0(0)

Table-II: CVC-BSI and CVC colonization in catheter with multiple lumens (n = 100)

Catheter	CVC-BSIn(%)	CVC colonizationn(%)	Non-infected CVCn(%)
Bilumen (n=14)	0 (0)	5 (35.71)	9 (64.29)
Trilumen (n=86)	11 (12.79)	38 (44.19)	37 (43.02)

Out of 27 central venous catheters inserted in femoral vein, 18.52% were associated with CVC-BSI and 59.26% had CVC colonization. Among 59 CVC in subclavian vein, 10.17% were associated with CVC-BSI and 37.29% were associated with CVC colonization. No CVC-BSI was diagnosed in patients with CVC in internal jugular vein and 35.71% were associated with CVC colonization (Table-III).

Table-III: CVC-BSI and CVC colonization according to different CVC insertion sites (n = 100)

	Right femoral vein (n=27)	Right subclavian vein (n=59)	Right internal jugular Vein (n=14)
CVC-BSI (n=11)	5(18.52%)	6(10.17%)	0(00%)
CVC colonization (n=43)	16(59.26%)	22(37.29%)	5(35.71%)

DISCUSSION

Central venous catheter related risk factors of CVC-BSI, such as type of catheter, site of CVC insertion, duration of CVC placement were analyzed in this study. It was found that when duration of CVC placement is longer there is an increased chance of development of blood stream infection. Duration of CVC placement was a significant factor for a CVC-BSI¹⁰ and additional days of hospital stay have been associated with higher BSI rates.^{11,12} The mean duration of CVC placement was 14 days in developing CVC-BSI, 8.41 days in CVC colonization and 6 days in non-infected CVC in this study. Similar results were observed in different studies; in Brazil, Bicudo et al reported that duration of CVC placement was 14 days in CVC-BSI and 9 days in non-infected CVC.⁴ Mean duration of CVC placement was 11.6 days in CVC-BSI, 7.1 days in non-infected CVC found by Holton et al in Canada.¹⁰

In this study all CVC-BSI occurred after 11 days of CVC insertion and no CVC remained noninfected after 20 days of insertion. Bicudo et al in their study concluded that a patient who had CVC for longer than 13 days presented progressive risk for infection of approximately three times higher in relation to a patient who had the CVC for less than 13 days.⁴ Long term use of CVC increases patient's colonization potential by microorganisms secondary to increasing CVC manipulation. Such associated factors can also increase the risk of acquiring CVC-BSI.⁴ This data gives

an idea about how many days a CVC can be placed in a patient, so that CVC-BSI occurring due to long duration of insertion can be prevented.

All the cases of CVC-BSI were found in tri-lumen catheter and CVC colonization were also higher in tri-lumen than in bi-lumen catheter. Bicudo et al reported that CVC-BSI were associated with different types of catheter inserted and several studies demonstrated that chance of CVC-BSI increases when the number of lumen of catheter increases which coincides with the findings of this study.^{13,14}

The location of CVC insertion is an important risk factor for the development of CVC-BSI¹⁵. Among patients with CVC in femoral vein, 18.52% were associated with CVC-BSI but 10.17% of the subclavian vein and no CVC-BSI was diagnosed in patient with CVC in internal jugular vein. However this finding was not statistically significant. In their study, Bicudo et al and Goetz et al have demonstrated that patients with CVC in right femoral vein were more subjected to CVC-BSI and CVC-colonization.^{4,16} The rate of CVC-BSI and CVC colonization in right femoral vein in this study correlated with the finding of Merrer et al in France who have reported that insertion at the femoral site increased the risk of infection and the infection were recorded in 19.8% of the femoral catheters.⁵ Reasons for infection and colonization may be favored by several factors such as-approximation of the site to genital and anal region, probably because of the higher density of local skin flora in the groin area,¹⁷ difficulties in CVC immobilization and dressing, higher skin temperature.^{11,18}

No CVC-BSI was diagnosed in patients in with CVC inserted in right internal jugular vein, though CVC colonization was 35.71%. The reason might be due to the fact that all the patients with jugular venous catheter were from Nephrology department used for dialysis and these catheters were all biluminal. Overall prevalence of CVC-BSI was higher in ICU than in haemodialysis unit in this study.

CONCLUSIONS

It may be concluded that central venous catheterization with a trilumen catheter rather than bilumen in femoral vein is a potential risk factor for infection and the risk of infection increases with the longer duration of catheter insertion. The data may suggest that to avoid CVC-BSI, duration of placement of CVC should not exceed 14 days and CVC insertion in femoral vein should be avoided.

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Conflict of Interest

We do not have any potential conflicts of interest.

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