

## HEMODIALYSIS CATHETER-RELATED BLOOD STREAM INFECTION: RATES, RISK FACTORS AND PATHOGENS

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### Abstract

**Background:** Central venous catheters (CVC) are an important means of delivering hemodialysis (HD) to patients who require immediate initiation of dialysis. Haemodialysis (HD) catheter-related bloodstream infections (CRBSIs) are a major complication of long-term catheter use in HD.

**Aims:** This study was conducted to identify the rates, risk factors and spectrum of infecting organisms of Hemodialysis catheter-related blood stream infection (CRBSI).

**Methods:** This prospective Observational study was carried out in the Department of Nephrology, Dhaka Medical College Hospital, Dhaka during January 2018 to July 2019. A total of 125 patients with Central Venous Catheter for Hemodialysis were included in this study.

**Results:** Twenty four patients with a mean age of 42.9±17.5 years were confirmed to have CRBSI with a rate of 6.6 per 1000 catheter days in Temporary Uncuffed Catheter group and 1.4 per 1000 catheter days in Permanent Cuffed Catheter group. Independent risk factor associated with CRBSI was diabetes. 70.8% patients had gram-negative infections, 4(16.7%) patients had gram-positive infections and 3(12.5%) patients had polymicrobial infections. *Pseudomonas* species (37.5%) were the most common identified bacteria.

**Conclusion:** The rate of CRBSI in Hemodialysis patients was significant and the only identified risk factor was diabetes mellitus. Infection by Gram-negative bacteria was noteworthy among the patients.

**Key words:** Catheter-related blood stream infection (CRBSI), Haemodialysis (HD), Temporary Uncuffed Catheter (TUC), Permanent Cuffed Catheter (PCC)

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### Introduction

Central venous catheters (CVC) are required for initiation of dialysis in patients who need immediate hemodialysis (HD). There are two types of central venous catheter (CVC) namely Temporary uncuffed catheter and Permanent cuffed catheter.<sup>1</sup>

Central venous catheter (CVC) related infection comprises of local infection and catheter related

blood stream infection (CRBSI).<sup>2</sup> The incidence of CRBSI ranges between 0.6 and 6.5 episodes per 1000 catheter-days CVC related infection and particularly CRBSI is attributes to a considerable increase in health care costs, morbidity, and mortality.<sup>3</sup> The second most common cause of death in hemodialysis patients after cardiovascular disease is septicemia.<sup>3</sup>

The factors responsible for this infection include colonization of the skin around the insertion

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site, of the catheter tip, in the catheter by hematogenous dissemination from another location and contamination of the locking solution.<sup>4</sup> The process of CRBSI can be prevented by practicing strict infection control measures and hand hygiene protocols.<sup>2</sup> For the setting prevention policies it is very important to identifying the risk factors for CRBSI. Determining risk factors of catheter associated infections may aid in its prevention and subsequently lower therapeutic cost and improve patient survival and quality of life.<sup>5</sup>

Gram-positive bacteria are the most common causative pathogens. 40% to 80% of CRBSI are caused by *Staphylococcus aureus* and coagulase-negative staphylococci. Gram-negative organisms accounts for 20% to 40% of CRBSIs. CRBSI by polymicrobial infections (10%-20%) and fungal infections (<5%) are less common.<sup>6</sup>

In this prospective study, we aimed to determine the rates of hemodialysis catheter related blood stream infection, causative microorganisms, and predisposing factors contributing to these infections at our center.

**Materials and methods**

This prospective Observational study was carried out in the Department of Nephrology, Dhaka Medical College Hospital, Dhaka during January 2018 to July 2019. A total of 125 patients with Central Venous Catheter for Hemodialysis were included in this study. Specimens were sent to the microbiology lab for culture and sensitivity testing when CRBSI was suspected.

**Operational definitions:**

**CRBSI (Catheter related blood stream infection):** The diagnosis of CRBSI was based on the clinical presentation of fever, chills and/ or hypotension and any of the following two criteria:

- Same organism recovered from percutaneous blood culture and from culture of the catheter tip
- Same organism recovered from a percutaneous and a catheter lumen blood culture

**Microbiological methods**

For each catheter removed, its tip was cut to a length of 5 cm approximately, under sterile

conditions and avoiding contact with the patient’s skin and was transported in a dry, sterile container and cultured semi quantitatively. Blood culture was done when suspecting CRBSI (Both peripheral and central blood). This was done with the automated microbial detection system.

*Statistical analysis:*

Statistical analyses of the results were obtained by using window based computer software devised with Statistical Packages for Social Sciences (SPSS-22).

**Observations and Results**

Among the 125 patients included in this study 49.6% patients were male and 50.4% were female. The mean age of the patients was 46.05±13.41 years. The age range varied from 18 to 82 years. Most of the patients (48%) belonged to age 41-60 years. This study showed the mean age of the patients with CRBSI was 42.9±17.5 years (Table I). Among the patients included in this study, CRBSI (Catheter related blood stream infection) was diagnosed in 24(19.2%) patients. Among them 14(18.4%) patients were with JVC, 9(22.0%) with FVC and 1(12.5%) with PCC (Table II). The rate of CBBSI in TUC was 6.6 per 1000 catheter days, in JVC was 5.6 per 1000 catheter days, in FVC was 9.3 per 1000 catheter days and in PCC was 1.4 per 1000 catheter days (Figure 1).

**Table I**

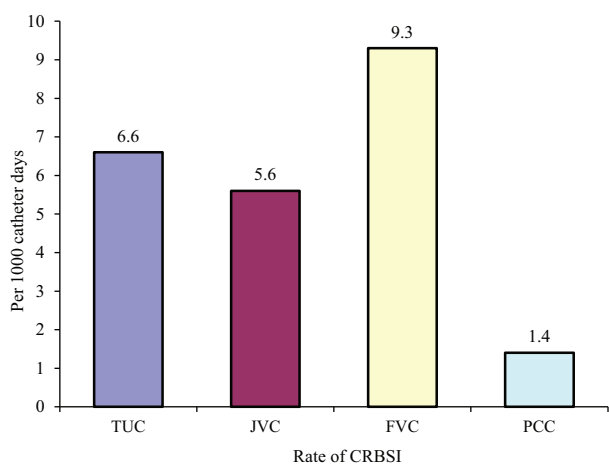
*Distribution of the study patients by socio-demographic characteristics (N=125)*

Socio-demographic characteristics	Number of patients	Percentage
Age (in Years)		
≥20	5	4.0
21-40	41	32.8
41-60	60	48
>60	19	15.2
Mean±SD	46.05±13.41	
Range(min-max)	18-82	
Sex		
Male	62	49.6
Female	63	50.4

**Table II**

Frequency of the study patients diagnosed as CRBSI (Catheter related blood stream infection) in different catheter group (N=125)

Types of Catheter	Number of patients	Percentage
<b>JVC</b>		
Yes	14	18.4
No	62	81.6
<b>FVC</b>		
Yes	9	22.0
No	32	78.0
<b>PCC</b>		
Yes	1	12.5
No	7	87.5



**Fig.-1:** Rates of the CRBSI (Catheter related blood stream infection) in patients of different catheter group (per 1000 catheter days)

More than one third (35.7%) of the patients with JVC were diagnosed as CRBSI during 3<sup>rd</sup> week. Almost half (44.4%) of the patients with FVC were diagnosed as CRBSI during 2<sup>nd</sup> week. The mean duration of occurrence of CRBSI was 2.93±1.07 week in JVC and 2.33±0.87 week in FVC (Table III). Three fourth (75.0%) patients had DM in positive CRBSI and 36(35.6%) in negative CRBSI. Almost one third (33.3%) had HTN in positive CRBSI and 16(15.8%) in negative CRBSI (Table IV). DM had significantly increased risk 4.753 times to developed CRBSI with 95% CI 1.688-13.388%.

**Table III**

Frequency of CRBSI with respect to duration of catheterization in patient with TUC (n=23)

When does CRBSI occur	JVC (n=14)		FVC (n=9)		P value
	n	%	n	%	
1 <sup>st</sup> week	2	14.3	1	11.1	
2 <sup>nd</sup> week	3	21.4	4	44.4	
3 <sup>rd</sup> week	5	35.7	3	33.3	
4 <sup>th</sup> week	3	21.4	1	11.1	
>4 <sup>th</sup> week	1	7.1	0	0.0	
Mean±SD	2.93±1.07		2.33±0.87		0.177 <sup>ns</sup>

**Table IV**

Risk factors of CRBSI

Risk factors	Positive CRBSI (n=24)		Negative CRBSI (n=101)		P value
	n	%	n	%	
DM	18	75.0	36	35.6	0.001 <sup>s</sup>
HTN	8	33.3	16	15.8	0.050 <sup>ns</sup>
Previous hemodialysis catheterization within past 2 months	5	20.8	9	8.9	0.096 <sup>ns</sup>
Previous hemodialysis catheterization 2 months prior	2	8.3	19	18.8	0.217 <sup>ns</sup>

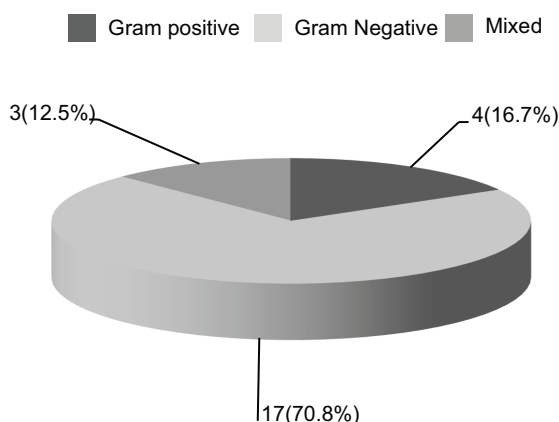
More than one third (37.5%) patients had Pseudomonas species followed by (25.0%) Staphylococcus aureus, 5(20.8%) Acinetobacter species, 5(20.8%) Escherichia coli, 2(8.3%) Klebsiella, 1(4.2%) Proteus, 1(4.2%) Citrobacter species and 1(4.2%) Enterococcus species (Table V). In JVC more than half (57.1%) patients had Pseudomonas species. Almost half (44.4%) patients had Staphylococcus aureus in FVC (Table VI). Almost two third (70.8%) patients had infection by Gram negative organism. Gram positive organism was found in 4 (16.7%) patients and mixed organism in 3(12.5%) patients (Figure 2).

**Table V**  
*Frequency of causative microorganisms of CRBSI (n=24)*

Name of Infecting organism of CRBSI	Number of patients	Percentage
Pseudomonas Species	9	37.5
Staphylococcus Aureus	6	25.0
Acinetobacter Species	5	20.8
Escherichia Coli	5	20.8
Klebsiella	2	8.3
Proteus	1	4.2
Citrobacter Species	1	4.2
Enterococcus Species	1	4.2

**Table VI**  
*Comparison of different CVC group by frequency of isolated infecting organism of CRBSI (n=24)*

	JVC(n=14)		FVC(n=9)		PCC(n=1)	
	n	%	n	%	n	%
Pseudomonas Species	8	57.1	1	11.1	0	0.0
Staphylococcus Aureus	2	14.3	4	44.4	0	0.0
Acinetobacter Species	2	14.3	3	33.3	0	0.0
Escherichia Coli	4	28.6	1	11.1	0	0.0
Klebsiella	0	0.0	1	11.1	1	100.0
Proteus	0	0.0	1	11.1	0	0.0
Citrobacter Species	1	7.1	0	0.0	0	0.0
Enterococcus Species	1	7.1	0	0.0	0	0.0



**Fig.-2:** Distribution of the study patients by types of infecting organisms of CRBSI (n=24)

**Discussion**

Patients with renal failure undergoing hemodialysis (HD) are at increased risk of infection. Central venous catheter related blood stream infection (CRBSI) is a major cause of morbidity and mortality in HD patients. This prospective observational study was carried out with an aim to determine the rate and underlying risk factors and the microorganisms responsible for CRBSI.

In our study, 19.2% patient was diagnosed as CRBSI (Catheter related blood stream infection), which is closely resembled with Nabi et al.<sup>2</sup> where 19.3% patients developed CRBSI. Lorente et al<sup>7</sup> found higher incidence of CRBSI in patients with femoral venous catheter which is also similar to us.

The rate of catheter related blood-stream infection (CBBSI) in TUC and PCC was 6.6 per 1000 catheter days and 1.4 per 1000 catheter days respectively in our study which are consistent with the findings of Chandra et al and Meneguetti et al.<sup>8</sup> Some other study observed the rate of CRBSI was 8 per 1000 catheter days which are almost consistent with present study.<sup>9</sup> Mansur et al study found the rate of CRBSI was 16.1 per 1000 catheter days which differ with the present study.<sup>11</sup> The factors which are responsible for our relatively accepted rate of CRBSI are adequate skin disinfection and good placement technique of catheter. Saran et al found the rate of CRBSI was 1.4 per 1000 catheter-days, which differs from the present study. This may be due to practice of strict aseptic technique.<sup>10</sup>

In our study, CRBSI rate was high in femoral site than jugular site and the result is consistent with Sahli et al<sup>9</sup> study findings. Femoral vein access shows a higher incidence of CRLI and CRBSI than the other sites, probably because of the higher density of local skin flora in the groin area.<sup>12</sup>

This study found significant association between the presence of Diabetes Mellitus and the occurrence of CRBSIs ( $P = 0.003$ ). Hoen et al showed that Diabetes Mellitus has been associated with a higher risk of CRBSIs in hemodialysis patients.<sup>13</sup> it was also observed that DM was an independent risk factor associated with CRBSI. Similarly Sahli et al study also showed independent risk factors associated with CRBSI were Diabetes Mellitus.<sup>9</sup>

*Pseudomonas* species were the most common bacteria (37.5%) identified in the current study. This result was consistent with the findings of Mansur et al.<sup>11</sup> Afroz et al obtained in their study that the most common bacteria causing CRBSI was *Klebsiella* spp. (36.4%) which is not consistent with the present study. *Staphylococcus aureus* was the most common gram positive organism in our study. Gafor et al study obtained that *Staphylococcus* and *Bacillus* sp. were the most common gram-positive organisms, which is similar with the present study.

In patients with JVC, *Pseudomonas* species were the most common (57.1%) organism causing CRBSI. On the contrary, *Staphylococcus aureus* was the most common (44.4%) in FVC group. It can be explained by the fact that in 3<sup>rd</sup> week CRBSI occurs mainly by gram negative organism. In FVC group infection occurs in early period from contamination of skin by *Staphylococcus aureus*.

The dominance of gram positive organisms in HD CRBSI has been shown in a number of studies. Our study did not follow the trend of predominant Gram-positive organisms as cause of CRBSI. In this study, there was predominance of Gram negative organism (70.8%). These findings were in accordance with the findings of Meneguetti et al [8]. Some other studies found the predominance of Gram-positive organisms which differ from the present study.<sup>10</sup> Alexandraki et al stated that growing prevalence of Gram-negative bacteria has been related to the immunocompromised state of patients, contaminated infusate and overexposure of antibiotics.<sup>14</sup> That there was a linear shift towards predominance of Gram-negative bacilli throughout the study period from 1996-2012. The shift towards Gram-negative CRBSIs and the associated mortality mandates that empirical treatment for CRBSIs should be directed by local epidemiology.

The limitation of this study is that this is a single centre study. The present study was conducted at a short period of time. Small sample size was also a limitation of the present study. Multicentre study with large number of patients should be conducted to indentify the national infection pattern.

### Conclusion

The rate of CRBSI in Hemodialysis patients was significant. The only identified risk factor of CRBSI was Diabetes Mellitus. Infection by Gram-negative bacteria was noteworthy. Tailoring antibiotics according to the antibiogram will decrease the emergence of antibiotic resistant bacterial strains and will ensure the successful treatment of CRBSI.

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