

Original Research Article

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## Universal Precautions in Preventing Central Venous Catheter Associated Blood Stream Infections. A Study at Tertiary Care Hospital of 'Central Line Bundles' in MICU

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### ABSTRACT

Central venous catheter insertion is a necessity while dealing with patients in MICU due to associated comorbid conditions. But following sterile barrier precautions while inserting and handling central line catheters is much more important as infectious complications take an upper hand if these "central line bundles" are not followed with great care. A prospective study was carried in a tertiary care hospital. The central line bundles while inserting the catheter with site and type was studied. Fifty (50) patients developed Catheter related local infection (CRLI) and seven (6) patients developed Central line associated blood stream infections (CLABSI). Female preponderance was seen in both local (52%) and systemic (67%) catheter infection. 96.4% of total patients had insertion at jugular site. Single lumen catheter was most commonly used (98%). Decreased use of central line bundles like hand hygiene, cap and mask significantly ( $p < 0.5$ ) was noted. Central line bundles which includes insertion bundles and aftercare bundles plays a vital role in determining the infectious complications in MICU patients. A very attempt should be made to use barrier precautions to prevent further complications associated with central line because if not followed morbidity and mortality in the patients increases.

#### Keywords

Blood stream,  
Central line  
bundles, MICU,  
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### Introduction

Central line associated blood stream infections (CLABSI) are serious cause of morbidity and mortality in patients admitted in ICUs (Intensive care unit) (Atilla *et al.*, 2017). Precautions taken at every level while inserting central venous catheter plays a vital role in preventing morbidity in these patients. Although precautions play major role in

decreasing CLABSI, associated comorbid conditions also have a minor role in contributing to infection. Potential risk factors for catheter-related infection include underlying disease, method of catheter insertion, type of cannula, type of dressing used, and duration and purpose of catheterization (Charalambous *et al.*, 1998). However, the roles played by other factors, such as site of insertion; receipt of

antimicrobial agents before, during, or after catheterization; and frequency of intravenous (i.v.) administration set changes, remain unclear (Richet *et al.*, 1990). Central line bundles which include care bundle during and after insertion of central venous catheters have to be borne in mind when treating patients in ICUs (Caroline O'Neil *et al.*, 2016). Thus both central lines associated blood stream infections (CLABSI) and catheter related local infection (CRLI) in relation to Central line bundles was determined in the study.

The main aim of this study includes to determine site and type of central venous catheter commonly used in ICU. And to determine type of precautions used while inserting central venous catheter. Also to determine outcome in these patients.

### **Materials and Methods**

A prospective study was carried out in the department of microbiology in collaboration with Medical Intensive Care Unit (MICU) in a tertiary care hospital.

Two hundred fifty consecutive adult patients on central venous catheter admitted in MICU constituted the study population.

### **Inclusion criteria**

Adult patients on central venous catheters admitted in MICU and who developed systemic signs and symptoms of infections after 48 hours of admission.

### **Exclusion criteria**

Patients with septicaemia due to causes other than central line.

Patients developing systemic signs and symptoms < 48 hrs of admission.

### **Study procedure**

All adult patients who met inclusion criteria were included in the study. Detailed clinical history of each patient was noted as per the clinical proforma with every day follow up to check vitals, local and systemic signs of sepsis along with precautions used during and after insertion of central venous catheter. Patient's clinical details including all risk factors, complete hemogram and serum electrolyte levels were also recorded

Relevant specimens were collected to establish CLABSI and CRLI which included central venous catheter (Issam *et al.*, 2004) and blood samples. Other samples like urine, ET aspirate, sputum, pus was collected to rule out other infections.

Central line tip processing: The central venous catheter so collected was placed in sterile petri dish with the help of sterile forceps and then with sterile scalpel, the distal 5cm portion was cut.

Semi quantitative extra luminal Maki's roll over plate method (Maki *et al.*, 1977) and quantitative endoluminal catheter flush culture (Linares *et al.*, 1985) were used for processing the central line tip.

### **Diagnosis of central line related local and systemic infections**

#### **Central line related local infections (CRLI) was diagnosed as**

Any sign of local infection (induration, erythema, heat, pain, purulent drainage) and

Catheter tip colonization was defined as "Significant growth of a microorganism by >15 colony-forming units from the catheter tip by semiquantitative method or >10<sup>3</sup> by quantitative culture."

### **Central Line Associated Blood Stream Infections (CLABSI) was diagnosed as**

Recognized pathogen isolated from blood culture and pathogen not related to infection from another site (other than site of an intravascular device i.e. it should not have been isolated from urinary tract / respiratory tract / wound, etc).

OR

One of the following –

Fever (>38 C)

Chills

Hypotension

And any of the following:

Common skin contaminant isolated from two blood cultures drawn on separate occasions, and organism is not related to infection at another site.

Common skin contaminant isolated from blood culture from patient with intravascular access device and physician institutes appropriate antimicrobial therapy.

Positive antigen test on blood or organism is not related to infection at another site.

### **Statistical analysis**

Results were noted down. Data was analysed statistically by using SPSS software for windows version 15.0, open epi software version 2.3, Microsoft excel 2007. Chi square analysis and Mid p test (wherever chi square cannot be applied i.e. failure to meet Cochran's criteria) was applied for comparing cases (with infection) and control (without infection).

### **Results and Discussion**

During the study period a total of 250 consecutive adult patients with central venous

catheter were analysed. Of these fifty (50) patients developed Catheter related local infection (CRLI) and seven (6) patients developed Central line associated blood stream infections (CLABSI).

Female preponderance was seen in both local (52%) and systemic (67%) catheter infection (Table 1). Maximum patients having Local catheter infection were distributed among age group of 35-44 years (32%), followed by 15-24 years (20%) and 25-34 years (20%). While those with systemic catheter infections age group of 15-24 years (66.6%) was common followed by 25-34 years (33.4%) as seen in Table 2. 96.4% of total patients had insertion at jugular site followed by 3.6% of patients who had insertion at antecubital vein of the arm (Table 3). Single lumen catheter was most commonly used (98%) followed by triple lumen catheter in 2% of patients (Table 4). Site of insertion was not found to be statistically significant with local catheter infection and systemic infection. All patients who developed systemic infection due to central line had jugular site of insertion (Table 5). Use of triple lumen catheter (p value=0.048) increased the risk of local infection (CRLI) which was found to be statistically significant but none of the patients who developed CLABSI had triple lumen catheter (Table 6). Decreased use of alcoholic hand rub by healthcare workers lead to local infection in patients which was statistically significant (p value<0.005).

Less use of barrier precautions like cap (p value<0.005) and mask (p value<0.005) by health care workers also contributed to local infections. In CLABSI All healthcare workers used gloves. However only one healthcare worker used cap and two healthcare workers wore mask. None of the healthcare workers used alcoholic rub or washed their hands before performing the procedure (Table 7).

Intravascular catheter related blood stream infections are significant cause of illness in MICUs as they increase the morbidity and mortality of patients particularly those with associated comorbid conditions admitted in ICU's and additional medical cost.

### **Association of catheter related infection with age and sex**

Female preponderance was observed in both CRLI (52%) and CLABSI (67%) in the present study. Although male gender was found to be a significant risk factor in a study conducted by Saxena and Bodh (2005) the present study did not show such significance.

Age was not a risk factor in the present study in comparison with a study conducted by (Pooja Gupta *et al.*, 2011) on incidence of bacteremia associated with central venous catheter in patients on hemodialysis. But studies conducted by Powe *et al.*, (1995) and Saxena and Bodh (2005) shows a significant association of catheter related infection with increasing age.

### **Association of catheter related infection with the site of catheter used**

Jugular vein (96.4%) was the most common site of central line insertion in the present study, significant statistical association was not seen with infection. One study done in 1990 observed a significant association of infection due to central venous catheter with the insertion site (jugular) which was conducted by (Richet *et al.*, 1990).

Another study showed that femoral catheterization was linked with a higher incidence rate of infectious complications (19.8% vs 4.5%;  $P, 001$ ) when compared to

other sites of catheter insertion by Merrer *et al.*, (2001).

As in the present study we did not have femoral or subclavian site of catheter insertion which could be related to infectious consequences with subclavian or jugular site of insertion.

A study conducted by Nuria Fernandez – Hidalgo *et al.*, in 2006 on antibiotic-lock therapy for long-term intravascular catheter-related bacteraemia: an open, non-comparative study showed that location of catheter in patients did not significantly increase the risk of infection ( $p$  value=0.74). In another randomized control trial done by Jean-Jacques *et al.*, (2008) in 2008 the risk of catheter colonization did not differ significantly between the femoral and jugular groups (incidence of 40.8 vs 35.7 per 1000 catheter-days;  $P=0.31$ ) which was comparable with the present study where we did not find any significant association of infection with jugular site of insertion.

### **Association of catheter related infection with the type of catheter used**

Triple lumen catheter association with infection was significant risk factor ( $p$  value=0.047) in the present study.

In a study conducted by Ramanathan *et al.*, (2011) in 2011, the incidence of catheter-related infection was highest with triple lumen catheters (39.8%,  $p = 0.002$ ). (Marlene *et al.*, 2010) observed an incidence of 19% among triple lumen and only 3% among single lumen subclavian catheters used for total parenteral nutrition. The present study was comparable with the above two studies.

**Table.1** Gender wise distribution among CRLI and CLABSI

Gender	CRLI (N=50)		CLABSI (N=06)		Total	
	No. of cases	Percentage (%)	No. of cases	Percentage (%)	No. of cases	Percentage
Male	24	48%	02	33%	27	48.2%
Female	26	52%	04	67%	29	51.8%
<b>Total</b>	<b>50</b>	<b>100%</b>	<b>06</b>	<b>100%</b>	<b>56</b>	<b>100%</b>

**Table.2** Age wise distribution among CRLI and CLABSI

Age distribution	CRLI (N=50)		CLABSI (N=06)	
	No. of cases	Percentage (%)	No. of cases	Percentage (%)
15 – 24	10	20%	04	66.6%
25 – 34	10	20%	02	33.4%
35 – 44	16	32%	00	00
45 – 54	09	18%	-	-
55 – 64	04	8%	-	-
>65	01	2%	-	-
<b>Total</b>	<b>50</b>	<b>100%</b>	<b>06</b>	<b>100%</b>

**Table.3** Distribution of patients as per site of insertion of central venous catheter (n=250)

Site	No. of patients	Percentage (%)
Femoral	0	0%
Jugular	241	96.4%
Antecubital	9	3.6%
Subclavian	0	0%
<b>Total</b>	<b>250</b>	<b>100%</b>

**Table.4** Distribution of patients as per type of catheter used (n=250)

Type	No. of patients	Percentage (%)
Single lumen	246	98.4%
Triple lumen	4	2%
<b>Total</b>	<b>250</b>	<b>100%</b>

**Table.5** Association of CRLI and CLABSI with site of insertion (n=250)

Site (n=250)	Control (n=194)	CRLI (n=50)	p valve	CLABSI(n=6)
Jugular	185(95.3%)	49(98%)	2.35	6(100%)
antecubital	9(4.7%)	1(2%)	0.17	-----
subclavian	-----	nil	-----	-----
femoral	-----	nil	-----	-----

**Table.6** Association of CRLI and CVCBSI with the type of catheter used (n=250)

TYPE(n=250)	Control(n=194)	CRLI(n=50)	p valve	CLABSI(n=6)
Single lumen	190(97.9%)	47(94%)	0.20	6(100%)
Triple lumen	4(2.1%)	3(6%)	<b>0.047</b>	-----

**Table.7** Association of CRLI and CLABSI with barrier precautions used (n=250)

Precautions used	CRLI (n=50) %	Odds Ratio	95% Confidence interval Lower upper	Z statistics	Level of significance	CLABSI
Alcoholic rub	3(6%)	0.1131	0.0339 0.3767	3.55	<b>(P&lt;0.05) Significant</b>	-----
Soap	10(20%)	0.6651	0.3106 1.4243	1.050	(P>0.05) Not significant	-----
fingernails	2(4%)	4.000	0.5493 29.1266	1.369	(P>0.05) Not significant	-----
Gloves	50(100%)	0.2596	0.0051 13.2347	0.67	(P>0.05) Not significant	6(100%)
Caps	3(6%)	0.1743	0.0520 0.5843	2.831	<b>(P&lt;0.05) Significant</b>	1(16%)
Masks	8(16%)	0.1395	0.0622 0.3128	4.779	<b>P&lt;0.05 significant</b>	2(33%)
Gown	2(4%)	0.7667	0.1625 3.6161	0.336	P>0.05 Not significant	-----

In the present study infection was significantly associated when comparison was made between triple lumen catheters vs single lumen catheters (75% vs 25%) for local catheter infection. Similar observations were made by (Mathias *et al.*, 2004).

They compared infections during use of triple lumen with single lumen catheters (12.8% vs. 0%) for administering parenteral nutrition. Higher rates of infection in triple lumen catheters were attributed to frequent handling of such catheters by health-care providers and the possibility of contamination during such procedures.

Another study has also demonstrated an increase in BSI rates in patients who used multiple-lumen catheters (Moretti *et al.*, 2005).

### Central line bundles

#### Hand hygiene

Hand hygiene remains a key measure in reducing nosocomial infections in the health care setting.

Health care workers' hands are frequently contaminated by organisms acquired from colonized patients and their immediate environment, and these may be readily transmitted to other patients in the absence of adequate hand hygiene (Zhuolin *et al.*, 2010).

Alcoholic hand rub was not used in majority of opportunities observed in the present study and contributed to significant infection. Every healthcare worker used gloves while inserting central line catheter but performing handwash

or using an alcoholic hand rub was very little. Although gloves provide skin barrier contributing to infection, still use of either an alcohol-based waterless product or antiseptic soap and water is recommended prior to central line placement (Zhuolin *et al.*, 2010).

### **Personal protective equipments**

Protective sterile barriers and clothing help minimize the risk of contamination and colonization of the catheter and insertion site during CVC placement.

The benefit of maximal sterile barrier precautions (MSBPs), consisting of a surgical gown, sterile gloves, mask, cap, and a large sheet drape, in limiting CLABSI was initially borne out in a single-center randomized, controlled trial involving cancer outpatients receiving chemotherapy. In the above study CLABSI rates were 6-fold higher in the control group which used only sterile gloves and a small drape (standard sterile barrier precautions, SSBP) during catheter placement when compared to the intervention group assigned to use MSBP (0.5 versus 0.08 infections/1000 catheter-days for the control versus the intervention group, respectively;  $P = 0.02$ ) (Raad *et al.*, 1994).

In the present study only 3 (6%) healthcare workers used cap and 8 (16%) used mask, thereby increasing risk of local infections and which was also found to be statistically significant ( $p < 0.05$ ), whereas 16% used cap and 33% used mask which contributed to systemic infections due to central venous catheter in MICU.

### **Outcome**

In the present study all six patients who developed CLABSI expired which is consistent with the findings of a study done by Pawar *et al.*, (2004).

CRLI which is a Local infection caused due to central venous catheterization did not show relation with the outcome as p value was statistically insignificant ( $p > 0.05$ ). Further studies need to be done in this area as no studies are available relating local infection with bad outcome in the patients. One such reason is removal of catheter when local infection is suspected and antibiotic therapy to decrease the further complication.

To conclude, central line bundles play a vital role in preventing infectious complications in patients with central line catheters. Site of insertion and type of the catheter to be chosen should also be kept in mind as they do contribute to increase the morbidity and mortality in patients particularly in ICUs.

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