



TO EVALUATE THE RISK FACTORS OF CENTRAL VENOUS CATHETER ASSOCIATED INFECTIONS IN INTENSIVE CARE UNIT OF A TERTIARY LEVEL HOSPITAL

Anaesthesiology

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ABSTRACT

Introduction: This study was designed to evaluate risk factors of bloodstream infections related to central venous catheterisation in intensive care unit of a tertiary level hospital.

Material and methods: Study place- Intensive care unit of a tertiary level hospital

Study population-150 patients were included in study after meeting inclusion and exclusion criteria. All the patients who received a CVC (Jugular/subclavian/femoral) in the operation theatre either as a part of anaesthetic care or in the ICU, were included in the study.

Study design- It was Prospective observational study.

Result: Presence of hypertension and diabetes was significantly associated with CRBSI incidence.

KEYWORDS

INTRODUCTION

Central venous catheters (CVCs) are an integral part of patient care in the intensive care unit (ICU). CVCs are often used as a portal for the delivery of medications, parenteral nutrition, collection of blood samples and monitoring hemodynamic variables in critically ill patients. However, complications associated with CVCs occur in nearly 15% of patients, mainly infectious complications (5-26%), mechanical complications (5-19%) and thrombotic complications (2-26%)[1]. These result in prolongation of ICU and hospital stay, increased hospital costs, morbidity and mortality[2]. Despite the advent of ultrasound-guided vascular cannulation, which has reduced the incidence of insertion complications drastically, many hospitals in India and other developing countries still rely on the landmark based technique for cannulation, which has a reported success rate of 75-99%[3].

Use of CVC puts patients at risk for local and systemic infectious complications, including local site infection, Catheter Related Blood Stream Infections (CRBSI), septic thrombophlebitis, endocarditis, and other metastatic infections (e.g., lung abscess, brain abscess, osteomyelitis, and endophthalmitis). CRBSI constitute one of the major nosocomial device associated infections[4]. The cost of CVC-associated BSI is substantial, both in terms of morbidity and in terms of financial resources expended.

To improve patient outcome and reduce health-care costs, strategies should be implemented to evaluate the risk factors to reduce the incidence of these infections. Absence of in-house data leads to difficulties in planning of local strategies to tackle the menace of catheter related complications esp CRBSI.

MATERIALS & METHODS

Study place

The study was conducted in department of anaesthesiology of armed forces medical college, Pune after approval from ethical committee and written consent taken from all patients before being included in the study.

Study population

Patients requiring CVCs admitted in adult surgical intensive care unit. 150 patients were included in study after meeting inclusion and exclusion criteria.

Study design

It was Prospective observational study.

Inclusion criteria

All the patients who received a CVC (Jugular/subclavian/femoral) in the operation theatre either as a part of anaesthetic care or in the ICU, were included in the study.

Exclusion criteria

- Patients with obvious source of infection excluded (fever, pneumonia, urinary tract infection, cellulitis, septicemia) by history, clinical examination, blood culture, chest X-ray, urine examination, etc. and relevant investigations pertaining to the suspected infection.
- Patients having infective endocarditis, retroviral disease and immunosuppressive drugs.
- CVC insertions performed on patients without verifying their coagulation profile (as in an emergency) or on patients with uncorrected coagulopathy were excluded from the study.

Methodology

- The study was conducted from May 2017 to Jun 2018. Approval and written permissions from the hospital ethics and research committee was obtained. All the patients who received a central venous catheter in the operation theatre either as a part of anaesthetic care or in the ICU were included in the study. Appropriate consent also was taken either from the patients themselves or from the next of kin or a legal surrogate.
- Baseline data on each patient, like primary diagnosis, presence of any comorbid illnesses, date of ICU admission and APACHE II score was recorded. For each CVC insertion, data was collected as per the proforma attached (Annexure I). Central venous cannulations were performed only when the platelet count was more than 50,000/cumm and the prothrombin time (International Normalized Ratio) was less than 1.5 s, as per the ICU protocol.

Central venous catheterization-

- Hand disinfection using an antiseptic rub was preferred during catheter insertion. For the insertion of CVCs, full scrub (up to the elbows) with an antiseptic solution was used. The maximal sterile barrier precautions in the form of use of cap, mask, sterile gloves, full-sleeved sterile gown and large sterile drapes were used. To prepare clean skin, alcoholic chlorhexidine (2%) was used. All lines were placed percutaneously using the Seldinger technique. The CVC was placed according to the indication of its insertion and was held in situ by using suture. Sterile transparent dressing was used at the catheter site.
- All the cannulations were performed either by an ICU consultant or anesthesiologist or by a 2nd or 3rd year resident (with a minimum prior experience of at least 20 CVC insertions, under the supervision of a consultant). The choice of the CVC insertion site (either IJV/SCV/Femoral) was left to the discretion of the performing doctor.
- Hand hygiene procedures were strictly followed before and after injection, blood sampling, dressing or any contact with the CVC or insertion site. The dressings were changed every day, the site was inspected for purulence and erythema and palpated for tenderness and induration (local signs of CVC infection).

- The date, site and side of cannulation and the number of punctures required for successful cannulation as well as complications, if any, were noted for each insertion procedure.
- The details of type of placement (emergency/elective), technique of placement (landmark/ ultrasound guided), duration of placement (<72 h/>72 h), type of catheter (7 fr 01 lumen/7 fr 02 lumen/7 fr 03 lumen), infection at catheter-insertion site, signs of systemic infections were also noted.
- CVCs were removed when no longer required or when suspected to be infected. The total duration of CVC placement was also be recorded. The catheter tip was sent for microbiological analysis after removal.
- On suspicion of an insertion-site infection (indicated by erythema/pus at the entry point), site swabs were sent for microbiological analysis. If catheter tip colonization/infection or catheter-related blood stream infection (CRBSI) was suspected, the CVC was removed and the distal 5 cm of the CVC was collected aseptically in a sterile test tube and transported immediately to the laboratory for culture. Immediately subsequent to catheter removal, two sets of blood (10ml) were collected aseptically from two different peripheral sites (right and left) for blood culture and sent for culture analysis. All CVC tips were cultured using the standard Semi Quantitative Culture (SQC) method.
- Catheter tip colonization was defined as growth of more than 15 colony forming units on culture of the distal segment of the CVC.

Negative semiquantitative culture technique

A negative SQC result was defined as an SQC yielding less than 15 colony forming units (cfu) in the absence of positive blood culture.

- Catheter-associated infections** were defined as follows:
- Exit site infection**- erythema, tenderness, induration or purulence within 2 cm of skin at the insertion site of catheter along with microbiological growth on culture of the purulent exudates.
- Catheter tip infection**- growth of more than 15 colony forming units on culture of the distal segment of the CVC with clinical signs of infection but without associated bacteraemia. (i.e. catheter tip colonization without associated bacteraemia)
- Catheter related local infection (CRLI)**- It includes exit site infection and catheter tip infection.
- Catheter-Related Bloodstream Infections (CRBSI/CRBI)**- isolation of the same organism from the catheter tip culture (growth of more than 15 colony forming units) and from at least one of the two blood cultures, along with signs and symptoms of infection. (i.e. catheter tip colonization with associated bacteraemia)
- Thus, patients with clinical signs of infection and in whom the CVC tip yielded a positive growth (but without associated bacteraemia) were considered as having catheter tip infections while patients with clinical evidence of infection along with positive growth of the same organism on blood culture as well as CVC tip were diagnosed to have CRBSI.

STATISTICAL ANALYSIS

After data collection, data entry was done in Microsoft Excel sheet. Data analysis was done with the help of SPSS software version 20.0.

Quantitative data was presented with the help of mean and standard deviation. Qualitative data was presented with the help of frequency, percentage. Analysis or their significance was done by using the p

values obtained through chi square test. For statistical comparison, the difference was considered significant when the p-value was found to be less than 0.05.

RESULTS

A total of 150 patients in the age group between 14 and 86 years of both genders with indwelling CVCs were included. Of 150 patients, 95 (63.33%) were males and 45 (36.66%) were females (Table-1). The minimum age was 14 years and the maximum age was 86 years, with an overall mean age of 53.82 (± 16.42) years (Table-1).

Internal jugular route was used in 130 (86.66%) patients, subclavian route in 18 (12%) and femoral route in 2 (1.33%) patients (Table-2).

Of the 130 patients who were having internal jugular venous catheters, 25 (19.23%) patients had catheter tip colonization and 8 (6.15%) patients had exit site infection. Of the 25 patients who were having catheter tip colonization, 7 patients were of CRBSI and 18 patients were of catheter tip infection. Of the 18 patients who were having subclavian venous catheters, 4 (22.22%) patients had catheter tip colonization and out of these 4 patients, 2 patients were of CRBSI and 2 patients were of catheter tip infection. There was no statistically significant difference in the incidence of catheter associated infections of internal jugular, subclavian venous catheters.

Of the 09 patients in which catheter duration was ≤ 3 days, 01 (11.11%) patient had catheter tip infection and 01 (11.11%) patient had exit site infection. Of the 141 patients in which catheter placed for more than 3 days, 28 (19.85%) patients had catheter tip colonization and 7 (4.96%) patients had exit site infection. Of the 28 patients who were having catheter tip colonization, 9 patients were of CRBSI and 19 patients were of catheter tip infection. The Catheter tip colonization increased with the duration of catheterization, it was not statistically significant.

Of the 12 patients in which catheter inserted as an emergency procedure, there was no colonization of catheter and 2 (16.66%) patients had exit site infection. Of the 138 patients in which catheter inserted as an elective procedure, 29 (21.01%) patients had catheter tip colonization and 6 (4.35%) patients had exit site infection. Of the 29 patients who were having catheter tip colonization, 9 patients were of CRBSI and 20 patients were of catheter tip infection. Catheter related overall infections were higher in the elective procedure than in emergency procedures, it was not statistically significant.

Of the 87 (58%) patients in which central venous catheterizations done in a single attempt, 11 (12.64%) patients had catheter tip colonization and 4 (4.59%) patients had exit site infection. Of the 11 patients who were having catheter tip colonization, 3 patients were of CRBSI and 8 patients were of catheter tip infection. Of the 53 (35.33%) patients in which central venous catheterizations done in two attempts, 15 patients had catheter tip colonization and 4 (7.55%) patients had exit site infection. Of the 15 patients who were having catheter tip colonization, 4 patients were of CRBSI and 11 patients were of catheter tip infection. Of the 10 (6.7%) patients in which central venous catheterizations done in three attempts, 03 showed catheter tip colonization and out of these 03 patients, 2 were of CRBSI and 1 patient was of catheter tip infection. Overall catheter related infections were more in patients requiring two attempts in catheter insertion followed by three attempts and one attempt which is statistically significant.

Various risk factors associated with catheter associated infections (CRBSI, Catheter tip infections, Exit site infections) are shown in Table 3, Table 4, Table 5, Table 6 with their significance.

Table 1: Univariate analysis comparing the demographic profile and insertion characteristics among different cannulation site

Variables studied	Total	IJV	SCV	Femoral Vein	F score/chi square	p value	Significance
Total CVCs	150	130	18	2	84.76	0.00	Significant
Mean age (S.D.)	53.82(16.42)	54.07(16.32)	52 (17.47)	47.5(31.82)	0.27	0.767	Not Significant
Gender (male/female)	(95/55)	(81/49)	(13/5)	(1/1)	0.67	0.413	Not Significant
APACHE II score; mean (S.D.)	14.26(2.68)	14.28(2.76)	14.06(2.10)	15(1.41)	0.13	0.875	Not Significant
NO. OF PUNCTURES	1.49(0.62)	1.38(0.52)	2.28(0.75)	1.5(0.71)	21.13	0.00	Significant
DURATION OF CENTRAL LINE	7.04(2.23)	6.85(2.04)	8.72(2.87)	4.5(0.71)	7.48	0.001	Significant

Table 2: Prevalence of central catheter-related factors

Variables	Total	Percent	Chi Square	p value	Significance
Site of catheterization					

SUBCLAVIAN VEIN	18	12.0	194.56	0.00	Significant
FEMORAL VEIN	2	1.3			
INTERNAL JUGULAR VEIN	130	86.7			
Type of Procedure					
Elective	138	92.0	105.84	0.00	Significant
Emergency	12	8.0			
Number of Punctures					
1	87	58.0	59.56	0.00	Significant
2	53	35.3			
3	10	6.7			
Duration of Central Line					
Less than or equal to 3	9	6.0	116.16	0.00	Significant
Greater than 3	141	94.0			
Side of insertion					
RT	139	92.7	109.23	0.00	Significant
LT	11	7.3			
USG/LANDMARK					
LANDMARK	127	84.7	72.11	0.00	Significant
USG GUIDED	23	15.3			
Type of Cental Line					
7 FR 03 Lumen	104	69.3	102.01	0.00	Significant
7 FR 02 Lumen	43	28.7			
7 FR 01 Lumen	3	2.0			

Table-3 Factors Associated With Crbsi

Variables		Incidence of CRBSI	P-value
Various Comorbidities	Yes	5/78	Chi Square = 0.05 P value = 0.83
	No	4/72	
Hypertension with Diabetes II	Yes	4/23	Chi Square = 6.25 P value = 0.01
	No	5/127	
Site of insertion	IJV	7/130	Chi Square = 1.05 P value = 0.59
	SCV	2/18	
	FEMORAL V	0/2	
Type of insertion	Elective	9/138	Chi Square = 0.83 P value = 0.36
	Emergency	0/12	
No. of puncture	01	3/87	Chi Square = 4.70 P value = 0.10
	02	4/53	
	03	2/10	
Technique	Landmark	7/127	Chi Square = 0.35 P value = 0.55
	USG guided	2/23	
Type of central line	7 Fr 01 lumen	1/3	Chi Square = 5.66 P value = 0.06
	7 Fr 02 lumen	4/43	
	7 Fr 03 lumen	4/104	
Duration of catheter	Less than & equal to 3 days	0/9	Chi Square = 0.61 P value = 0.43
	> 3 days	9/141	

Table-4 Factors Associated With Exit Site Infection

Variables		Incidence of Exit Site Infection	P-value
Various Comorbidities	Yes	5/78	Chi Square = 0.37 P value = 0.54
	No	3/72	
Hypertension with Diabetes II	Yes	2/23	Chi Square = 0.61 P value = 0.44
	No	6/127	
Site of insertion	IJV	8/130	Chi Square = 1.30 P value = 0.52
	SCV	0/18	
	FEMORAL V	0/2	
Type of insertion	Elective	6/138	Chi Square = 3.32 P value = 0.07
	Emergency	2/12	
No. of puncture	01	4/87	Chi Square = 1.17 P value = 0.56
	02	4/53	
	03	0/10	
Technique	Landmark	7/127	Chi Square = 0.05 P value = 0.82
	USG guided	1/23	
Type of central line	7 Fr 01 lumen	0/3	Chi Square = 4.78 P value = 0.09
	7 Fr 02 lumen	5/43	
	7 Fr 03 lumen	3/104	

Duration of catheter	Less than & equal to 3 days	1/9	Chi Square = 0.63 P value = 0.43
	> 3 days	7/141	

Table-5 Factors Associated With Catheter Tip Infection

Variables		Incidence of Catheter Tip Colonization	P-value
Various Comorbidities	Yes	8/78	Chi Square = 1.33 P value = 0.25
	No	12/72	
Hypertension with Diabetes II	Yes	2/23	Chi Square = 0.51 P value = 0.48
	No	18/127	
Site of insertion	IJV	18/130	Chi Square = 0.41 P value = 0.81
	SCV	2/18	
	FEMORAL V	0/2	
Type of insertion	Elective	20/138	Chi Square = 2.01 P value = 0.16
	Emergency	0/12	
No. of puncture	01	8/87	Chi Square = 3.91 P value = 0.14
	02	11/53	
	03	1/10	
Technique	Landmark	18/127	Chi Square = 0.51 P value = 0.48
	USG guided	2/23	
Type of central line	7 Fr 01 lumen	0/3	Chi Square = 0.68 P value = 0.71
	7 Fr 02 lumen	5/43	
	7 Fr 03 lumen	15/104	
Duration of catheter	Less than & equal to 3 days	1/9	Chi Square = 0.04 P value = 0.84
	> 3 days	19/141	

Table-6 Factors Associated With Catheter Associated Overall Infections (including Catheter Tip Infection, Exit Site Infection, Crbsi)

Variables		Incidence of Catheter Related overall infections	P-value
Various Comorbidities	Yes	18/78	Chi Square = 0.22 P value = 0.64
	No	19/72	
Hypertension with Diabetes II	Yes	8/23	Chi Square = 1.50 P value = 0.22
	No	29/127	
Site of insertion	IJV	33/130	Chi Square = 0.75 P value = 0.69
	SCV	4/18	
	FEMORAL V	0/2	
Type of insertion	Elective	35/138	Chi Square = 0.45 P value = 0.50
	Emergency	2/12	
No. of puncture	01	15/87	Chi Square = 6.30 P value = 0.04
	02	19/53	
	03	3/10	

Technique	Landmark	32/127	Chi Square = 0.13 P value = 0.72
	USG guided	5/23	
Type of central line	7 Fr 01 lumen	1/3	Chi Square = 2.25 P value = 0.32
	7 Fr 02 lumen	14/43	
	7 Fr 03 lumen	22/104	
Duration of catheter	Less than & equal to 3 days	2/9	Chi Square = 0.03 P value = 0.86
	> 3 days	35/141	

DISCUSSION

Blood stream infections related to Central Venous Catheterization are a cause of significant morbidity and mortality. The cost of CVC-associated BSI is substantial, both in terms of morbidity and in terms of financial resources expended.

A total of 150 patients with 1056 catheter days were included in our study. In this study an attempt was made to study the risk factors of Central Venous Catheter associated infections. In this study, out of 150 patients with CVCs, 37(24.66%). were having Catheter associated infections. Twenty (13.33%) were with catheter tip infection and 9 (7.41%) were with CRBSI. Exit site infection was present in 8 (5.33%) patients.

Chopdekar et al reported incidence of CRBSI is 6.7% in femoral vein site and 9% in subclavian site. The site of insertion did not appear to influence the rate of CRBSI in this study [5]. CRBSI risk was more in subclavian vein followed by jugular vein and femoral vein in a study conducted by Lorente *et al* [6]. No statistically significant difference was found in the incidence of infection and colonization at the internal jugular, subclavian and femoral sites in a study conducted by Deshpande et al. [7]. In some studies, higher incidence of catheter tip colonization was occurred with femoral access. [1]

Some studies reported CRBSI incidence was higher with femoral access. [1] In one study both CVC-related infection as well as CRBSI incidence were found to be higher with IJV catheters as compared with the SCV catheters. [6] IJV route is more commonly associated with catheter related Complications. [1]

The incidence density of CRLI was higher for femoral than for jugular and subclavian accesses, and higher for jugular than for subclavian access and incidence density of CRBSI was higher for femoral than for jugular and subclavian access, and higher for jugular than for subclavian access in a study conducted by Leonardo Lorente et al. [6]

In our study the incidence of CRBSI was 5.38% in IJV and 11.11% in subclavian vein. Incidence of catheter tip infection was higher (13.84%) in IJV than subclavian vein (11.11%), incidence of catheter associated infections was higher (25.38%) in IJV than subclavian vein (22.22%). No statistically significant difference was found in the incidence of infection and colonization at the internal jugular, subclavian and femoral sites. This finding is similar with a study done by Deshpande et al. [7]. Also, the site of insertion did not appear to influence the rate of CRBSI in study conducted by Chopdekar et al. [5]

A study conducted by Eyes et al., stated that patients requiring central catheters for <72 h had zero catheter-related sepsis incidence. The patients with central catheters for >7 days had a significant incidence of bacteremia and death. Risk factors associated with CRBSI were presence of diabetes, emergency insertion & duration of CVC >7 days and site of insertion was not significantly associated with CRBSI incidence in a study conducted by Abirami E et al. [8] Diabetes was significantly associated with CRBSI in a study conducted by Jia et al. [9]

Risk factors associated with catheter related infections were - emergency insertion & duration of CVC >3 days and three attempts in catheter insertion in a study conducted by Patil et al. [10] Charalambous et al reported that risk of catheter-related infection was high in central venous catheterization longer than five to seven days. [11] Catheters placed under emergency situations, was significantly associated with higher risk of catheter-related infection in some studies. [12,13] Incidence of both CRBSIs and CVC tip infections was higher in patients with catheters *in situ* for longer than 7 days. [14]

Incidence of CRBSI and exit site infection was more in patients having any comorbid conditions present in this study. It is not statistically significant. Presence of hypertension and diabetes was

significantly associated with CRBSI incidence in this study. Risk factors associated with CRBSI were presence of diabetes, in a study conducted by Abirami E et al. [8] and by Jia et al. [9].

In present study, catheter placed under emergency situations was associated with higher incidence of exit site infections. It is not statistically significant. CRBSI, catheter tip colonization were more in patients having central line catheter in place for more than 3 days but it was not statistically significant.

In present study, three attempts in catheter insertion were associated more with CRBSI. Overall catheter related infections were more in patients requiring two attempts in catheter insertion followed by three attempts and one attempt which is statistically significant. Three attempts in catheter insertion was associated with catheter related infections in a study conducted by Patil et al. [10]

In present study, incidence of CRBSI was more in patients requiring USG guidance in insertion of catheter. Exit site infection, catheter tip colonization, overall catheter related infections were higher in landmark technique but there was no statistically significant difference found.

In present study, CRBSI was more common in patients having 01 lumen central line, exit site infections were more common in patients having 02 lumen central line & catheter tip colonization were more in patients having 03 lumen central line but there was no statistically significant difference found.

LIMITATION

The population in the present study sample includes only surgical ICU patients and number of emergency catheter insertion was small. More prospective studies of sufficient size and to address all potential risk factors will enhance our understanding of the pathogenesis of CVC-related BSI and guide to develop more effective strategies for their prevention.

CONCLUSION

Presence of hypertension and diabetes was significantly associated with CRBSI incidence. Overall catheter related infections were more in patients requiring two attempts in catheter insertion followed by three attempts and one attempt which is statistically significant.

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