RESEARCH ARTICLE

INCIDENCE, RISK FACTORS AND OUTCOME OF CENTRAL VENOUS CATHETERS IN MEDICAL INTENSIVE CARE UNIT, AN INSTITUTIONAL EXPERIENCE

[1]Dr. Dhanashree Deshpande, *[2]Dr. Padmanabh Inamdar, [3]Dr. Sujata Baveja, [3]Dr. Shripad Taklikar and [3]Dr. Atul Rukadikar

[1]Department of Microbiology, Bharati Vidyapeeth University's Medical College and Hospital, Sangli, Maharastra, India
[2]Department of Surgery, Bharati Vidyapeeth University's Medical College and Hospital, Sangli, Maharastra, India
[3]Department of Microbiology, LTMMC and LTMGH, Sion, Mumbai- 416416, Maharastra, India

ARTICLE INFO

ABSTRACT

Introduction: Nosocomial infections, even in this modern era of antibiotics, continue to remain an important and formidable consequence of hospitalization. Vascular access by use of intravenous (i.v.) catheters is an essential element of modern medical care, particularly in Medical intensive care units (MICU). Vascular catheters interrupt the protective barrier of the skin and enable microorganisms potentially to gain direct access to the bloodstream causing catheter related infections.

Material and Methods: 200 consecutive adult patients on central venous catheter admitted in MICU at our institute constituted the study population and among them those who developed systemic signs and symptoms of infections after 48 hours of admission were included in the study. Risk factors of patients and barrier precautions used by healthcare workers were observed during study period. Relevant samples were collected from patients for processing.

Results: Among study population ,47(23.5%) patients developed central line related local infection and 7 (3.5%) patients developed central line associated blood stream infection(CLABSI).Incidence of CLABSI was 4.55% per 1000 central line days. Barrier precautions played an important role. Alcoholic hand rub (p=0.049), soap handwash (p=0.021), mask (p=0.001) usage prevented the development of central line related infection. Risk factors observed in local catheter infections due to central line catheter were Diabetes mellitus (p=0.002), Ventilator (p=0.001), Immunocompromised condition (p=0.001) and end stage renal disease (p=0.031). Outcome was not significantly associated with local catheter infections (p >0.05) .Patients who developed systemic infection (n=7), all expired (100%) showing the increased risk of mortality in these patients.

Conclusion: Central venous catheterizations have an increased risk of developing local and systemic catheter associated infections particularly with risk factors. Hand hygiene constitutes the mainstay of preventing infection.

INTRODUCTION

Central line catheters play the mainstay to maintain haemodynamics in MICU (Medical Intensive Care Unit) patients. Infections are caused due to invasion by microorganisms which can cause local or systemic complications, the most serious one being bacteremia leading to sepsis and increased mortality. Diagnosis of catheter-related infections, especially in ICU patients, becomes difficult as these patients are usually severely ill and additional specific symptoms will be lacking (Richet *et al.*, 1990). Thus, the definitive diagnosis of catheter related infection can be made

*Corresponding author: Dr. Padmanabh Inamdar, Department of Surgery, Bharati Vidyapeeth University's Medical College and Hospital, Sangli, Maharashtra, India.

only by using a combination of clinical signs and symptoms along with semiquantitative cultures of vascular catheters (Maki *et al.*, 1977). Prevention of these infections becomes necessary as morbidity and health care cost increases if proper aseptic precautions are not taken. According to the National Nosocomial Infections Surveillance (NNIS) system of the Centers for Disease Control and Prevention (CDC), the median rate of catheter-related bloodstream infection in ICUs of all types ranges from 1.8 to 5.2 per 1000 catheter-days (NNIS 2004). Although there are standardized protocols for prevention of central venous catheter associated infections it is not followed routinely and also reports on incidence of Central line associated blood stream infections (CLABSI) is lacking as they tend to vary from centre to centre. In view of these above factors the present study was undertaken to know the

incidence, risk factors and outcome in patients on central venous catheter in ICU setting at a tertiary care hospital. Interventions which could reduce CLABSI was also noted.

Aims and Objectives

1. To determine the incidence of central venous catheter related infections in medical intensive care unit (MICU) in tertiary care hospital and its association with infection control practices.
2. To determine the risk factors involved and the interventions to prevent the development of central line infections
3. To study the outcome in these patients

MATERIALS AND METHODS

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 obvious causes other than central line.
- Patients developing systemic signs and symptoms < 48 hrs of admission.

A prospective study was carried out in the department of microbiology in collaboration with Medical Intensive Care Unit (MICU) at Lokamanya tilak medical college and hospital, Mumbai. Two hundred consecutive adult patients on central venous catheter admitted in MICU constituted the study population. Detailed clinical history of each patient was noted with every day follow up to check vitals, local infection and systemic signs of sepsis. Patient's clinical details including all risk factors, complete hemogram, serum electrolyte levels were also recorded. Central venous catheters of the study population were collected under aseptic precautions. Semiquantitative extraluminal Maki's roll over plate method and quantitative endoluminal catheter flush culture techniques were used for processing the central line tip (Linares *et al.,* 1985). Blood was collected from the peripheral vein while procuring the central line tip. Other relevant clinical samples like urine, endotracheal secretions, sputum were also collected and processed under proper aseptic technique to rule out the other harbouring nosocomial infections.

Statistical Analysis

Data was analysed statistically by using SPSS software for windows version 20.0 for windows (IBM software, Newyork, USA). Chi square test was applied for univariate analysis and logistic regression analysis was applied for comparing cases (with infection) and control (without infection) for correlating risk factors and barrier precautions with infection.

RESULTS

During the study period a total of 200 consecutive adult patients with central venous catheter were analysed. Of these

forty seven (47) patients developed Catheter related local infection (CRLI) and seven (7) patients developed Central line associated blood stream infections (CLABSI). Out of 200 patients 113 (56.5%) cases were males and 87 (43.5%) were females as per (Table no.1).

Table 1. Catheter related local infection (CRLI) and Central line associated blood stream infections (CLABSI)

Clinical profile			
	control (n=146)	CRLI (n=47)	CLABSI (n=7)
Male	89(60.99)	21(44.7)	3(42.9)
Female	57(39.01)	26(55.3)	4(57.1)
Mean age	40.2	41.3	42.4

95.5% (191/200) of total patients had insertion at jugular site followed by 4.5% (9/200) of patients who had insertion at antecubital vein of the arm. Single lumen catheter was most commonly used (98%) followed by triple lumen catheter in 2% of patients (Table no.2).

Table 2. Triple lumen catheter

Catheter profile				
SITE	Control (n=146)	CRLI (n=47)	p valve	CLABSI (n=7)
Jugular	138(94.52)	46(97.87)	2.67	7(100)
femoral	0	0	-	0
peripheral	8(5.47)	1(2.13)	-	0
TYPE				
single lumen	145(99.32)	44(93.7)	0.107	7(100)
Triple lumen	1(0.68)	3(6.3)	0.04	0

The incidence of CLABSI in our study was 4.55%. Female preponderance was seen in both local (55.3%) and systemic (57.1%) catheter infection. Site of insertion of jugular vein was not found to be statistically significant (p=2.67) with local catheter infection. Use of triple lumen catheter increased the risk of local infection which was found to be statistically significant (p =0.048). All patients who developed systemic infection due to central line had jugular site of insertion and single lumen catheter was the type of catheter used in all these patients. Decreased use of alcoholic hand rub (p=0.049) and soap (p=0.021) by healthcare workers led to local infection in patients which was statistically significant. Less use of barrier precautions like mask (p =0.001) by health care workers also contributed to local infections (Table no. 3).

Table 3. Barrier precautions used with central line related local infection (CRLI)

Precautions used	CRLI (n= 47) (%)	Odds Ratio	Confidence Interval		p value
			lower	Upper	
Alcoholic rub	4 (8.5)	14.63	3.99	53.61	0.049
Soap usage	10 (21.2)	2.927	1.17	7.28	0.021
gloves	47 (100)	-	-	-	-
cap	4 (8.5)	2.38	0.71	7.93	0.156
mask	8 (17.02)	6.24	2.55	15.27	0.001
gown	3 (6.38)	1.23	0.235	6.531	0.82

Diabetes mellitus (p=0.002), immunocompromised condition (p=0.001), ventilator use (p=0.001) and end stage renal disease (p=0.031) were found to be risk factors leading to CRLI in ICU patients (Table no. 4). Among the patients who developed systemic central line catheter associated infections were 71.42% were immunocompromised with ventilator support and 28.57% were diabetic. There was no significant association of local catheter infection with outcome of patients (p=0.442). Whereas all seven patients who developed systemic infections expired.

Table 4. Risk factors with central line related local infection(CRLI)

Risk factors	CRLI (n= 47) (%)	Odds Ratio	Confidence Interval		p value
			Lower	Upper	
Diabetes mellitus	11 (23.4)	0.215	0.083	0.588	0.002
Steroid use	3 (6.3)	0.413	0.089	1.917	0.259
Cancer	0	-	-	-	-
Immunocompromised	19 (40.4)	0.102	0.026	0.404	0.001
Ventilator	35 (74.4)	0.071	0.032	0.155	0.001
End stage renal disease	20 (42.5)	0.149	0.026	0.843	0.031

DISCUSSION

The incidence of central line associated blood stream infection was calculated after the diagnosis of CLABSI was made according to CDC/NHSN criteria (http://www.CDC.gov.in). In a study carried out by Pawar *et al.* (2004) the incidence of CLABSI was found to be 4.01 per 1000 catheter days which is comparable with the results of present study. According to NNIS(3) (National Nosocomial Infections Surveillance) it ranges from 2-11.3% and it is also comparable with the results of present study. Richet *et al.* (1990) observed a significant association of infection due to central venous catheter with the insertion site (jugular). Though jugular vein (95.5%) was the most common site of central line insertion in the present study, statistically significant association was not seen with infection. One study done in 2001 on complications of Femoral and Subclavian Venous Catheterization in Critically Ill Patients which was a randomized controlled trial by Merrer *et al.* (2001) showed that femoral catheterization was associated with a higher incidence rate of overall infectious complications (19.8% vs 4.5%; *P*,.001) when compared to other sites of catheter insertion (Merrer *et al.,* 2001). But in the present study we did not have femoral or subclavian site of catheter insertion to be compared with subclavian or jugular. Triple lumen catheter association with infection was significant risk factor (p value=0.004) in the present study. Bicudo, Batista, Furtado *et al.* (2011) in the year 2011 did a study on risk factors for catheter-related bloodstream infection. A study on device-associated infection rates in pediatric and neonatal intensive care units in El Salvador in 2011 by Lourdes *et al.* (2011) showed the correlation of non-adherence of standard infection control protocols with the increased risk of infections. In the present study every healthcare worker used gloves but only 17.5% performed hand hygiene which is not universally

recommended. Hand hygiene with either an alcohol-based waterless product or antiseptic soap and water is mandated prior to CVC placement regardless of the fact that sterile gloves will be donned during the procedure (2010). Alcohol based hand rubs and soap handwash was found to be significant in decreasing the incidence of central line related infections. Although mask prevented the development of infections with a significant p value in the present study, cap and gown usage was least used in MICU due to continuous inflow of patients in busy settings but its significance cannot be underestimated. CDC recommends use of all the barrier precautions in preventing this type of infection (http://www.CDC.gov.in). Of all different risk factors studied, Diabetes mellitus, use of Ventilator, Immuno compromised status and End stage renal disease were found to be significantly associated with infections (local) due to central venous catheter. Diabetes mellitus was found to be a risk factor for CLABSI in a study conducted by Gupta *et al.* (2011). Ramanathan *et al.* (2011) had found CRLI in 34.9% of diabetic patients. In the present study out of 20 patients who had diabetes 11 (55%) patients developed CRLI and 2 (28.57%) patients developed CLABSI which was correlating with the above two studies.

Immunocompromised status was an important predisposing risk factor for development of catheter-related infections with a statistically significant *p* value - 0.011 in a study done by Ramanathan *et al.* (2011). In the above mentioned study 61.1% of the cases were immuno compromised and the remainder (38.9%) were immune competent which significantly contributed to infection. In the present study patients developing systemic catheter infections 5 (71.42%) were immunocompromised which correlated with the above study and for patients who developed local catheter infections 19 patients were immunocompromised with significant association (p<0.05). In the present study cancer was not significantly associated with infection as none (0%) of the patients with cancer developed local infection. In a study done among children and adolescents with central venous catheters in ambulatory care by Kevin *et al.* (2008) in 2007 there was no statistical significance of cancer with infection. As cancer is one of the predisposing risk factors for infection according to CDC guidelines, it is therefore necessary to perform preventive measures to decrease incidence of central venous catheter associated infections in these patients. Patients with End stage renal disease (ESRD) have increased risk of developing central venous catheter associated infections as they undergo hemodialysis. In a study conducted by Nabi *et al.* (2009) on catheter related infection in hemodialysis patients they observed a significant association between infection and renal disease in patients on hemodialysis. However in the present study none of the patients who developed CLABSI (0%) had ESRD. In another study done in 2011 by Gupta *et al.* (2011) on incidence of bacteremia associated with central venous catheter in patients on hemodialysis, they observed a significant correlation with infection with an incidence of 8.75%. In the present study association of ESRD with local infection was observed in 42.5% which was statistically significant (p < 0.05). Ventilator use was found to have a significant association with CLABSI, in a study done by Margerette *et al.* (2009) with (<0.01) p value. In the present study,71.42% of patients who were ventilated developed systemic infection due

to catheter which was similar to the findings of the above study and out of the 47 patients who developed local infection, 74.4% were ventilated which was statistically significant (p< 0.05) in this study. The use of steroid among patients admitted in ICU's with central line had no significant association of infection in the present study. In a study conducted by Kevin *et al*. (2008) on polymicrobial bloodstream infections among children and adolescents with Central Venous Catheters evaluated in ambulatory care observed no significant association of steroid usage with increased risk of infection (p value of 0.059). In the present study of 47 patients who developed local infection only three (6.3%) patients were on steroids which was not statistically significant and of 7 patients who developed systemic infections none (0%) were on steroids which corresponded with the above study. In a study done by Pawar *et al*. (2004), it was observed that nosocomial intravascular device– related bacteremia or candidemia are associated with a 2- to 3-fold increase in attributable hospital mortality and 75% of these were device related. In the above study patients with CVC-BSI had significantly greater mortality rate than patients without CVCBSI (22.9% *v* 0.2%; *p* _ 0.001).Central venous catheterization was associated with a markedly increased risk of death and an attributable mortality of 35% (28%–47%).In another case–control study done by Renaud *et al*. (2001) in France in 2001 the mortality was 20% (p 0.03) in patients without CLABSI and 55% (p 0.001) in patients with CLABSI. This study showed the association of catheterization in an ICU patient with increased mortality. In the present study all seven patients who developed CLABSI expired which is consistent with the findings of the above two studies. Local infections caused by central venous catheters had no relation with the outcome, p value was statistically insignificant (p>0.05) and very less data is available on relation of local catheter infection with outcome.

Conclusion

Patients admitted to ICU and with central venous catheterization have an increased risk of developing local and systemic catheter associated infections .Risk factors like Diabetes, Immune suppression, ventilation etc increase the risk of infection. Triple lumen catheters significantly increases the risk for infection. Maximum sterile barrier precautions and hand hygiene are the mainstay to prevent these infections and if not followed increase the morbidity and mortality in these patients.

REFERENCES

Daniela BR, Guilherme H, Furtado. Risk factors for catheter-related blood stream infection: a prospective multicenter study in Brazilian intensive care units. *Braz J Infect Dis* 2011; 15(4):328-331.

Gupta P, Set R, Mehta K, Shastri J. Incidence Of Bacteremia Associated With Central Venous Catheter In Patients On Hemodialysis. *Int J Pharm Pharm* 2011;3(3):135-138.

Kevin J, Joshua P, Louis M, Karin L, Michael R, Elliott *et al*. Polymicrobial Bloodstream Infections among Children and Adolescents with Central Venous Catheters Evaluated in Ambulatory Care. Clinical Infectious Diseases 2008; 46:387–94.

Linares J, Antonio S, Javier G, José l, Rogelio M. Pathogenesis of Catheter Sepsis: a Prospective Study with

Quantitative and Semiquantitative Cultures of Catheter Hub and Segments. *Journal of clinical microbiology* 1985: 21(3); 357-360.

Lourdes D, Ana CB, Rosenthal VD, Machuca LJ. Device-associated infection rates in pediatric and neonatal intensive care units in El Salvador: *Findings of the INICC J Infect Dev* 2011; 5(6):445-45.

Maki D, Weise C, Sarafin H. A semiquantitative culture method for identifying intravenous-catheter-related infection, *New England Journal of Medicine* 1977; 296: 1305-1309.

Margarete V, Sergio B, Maria A, Victor D, Kerry B , Reinaldo S. Rate and Time to Develop First Central Line-Associated Bloodstream Infections When Comparing Open and Closed Infusion Containers in a Brazilian Hospital, *The Brazilian Journal of Infectious Diseases* 2009;13(5):335-340.

Merrer J , Jonghe B , Golliot F , Lefrant J , R Brigitte , P Rigaud, Dominique Q. Complications of Femoral and Subclavian Venous Catheterization in Critically Ill Patients A Randomized Controlled Trial. JAMA 2001; 286(6):700-707.

Nabi Z., Anwar S., Barhamein M., Mukdad H. A. Nassri A. E. 2009. Catheter related infection in hemodialysis patients. *Saudi Journal of Kidney Diseases and Transplantation.* 20(6):1091- 1095.

National Nosocomial Infections Surveillance System. National Nosocomial Infections Surveillance (NNIS) System report, data summary from January 1992 through June 2004, issued October 2004. *Am J Infect Control* 2004;32:470-85.

Pawar M, Mehta Y, Kapoor K, Sharma J, Gupta A, and Trehan N. Central Venous Catheter–Related Blood Stream Infections: Incidence, Risk Factors,Outcome, and Associated Pathogens. *Journal of Cardiothoracic and Vascular Anesthesia* 2004;18(3): 304-308.

Ramanathan P, Jatan BS, Muralidhar VD, Chiranjay M, Sudha V. Intravascular Catheter-Related Infections In An Indian Tertiary Care Hospital. *J Infect Dev Ctries* 2011; 5(6):452-458.

Renauld *et al*. Outcomes of Primary and Catheter-related Bacteremia A Cohort and Case–Control Study in Critically Ill Patients. *Am J Respir Crit Care Med* 2001; 163: 1584–1590.

Richet H, Hubert B, Nitemberg G, Andremont A, Buu hoi A, Ourbak P *et al*. Prospective Multicenter Study of Vascular-Catheter-Related Complications and Risk Factors for Positive Central- Catheter Cultures in Intensive Care Unit Patients, *Journal of Clinical Microbiology* 1990; 28(11); 2520-2525.

Richet H, Hubert B, Nitemberg G, Andremont A, Buu hoi A, Ourbak P *et al*. Prospective Multicenter Study of Vascular-Catheter-Related Complications and Risk Factors for Positive Central- Catheter Cultures in Intensive Care Unit Patients, *Journal of Clinical Microbiology* Nov. 1990; 28(11); 2520-2525.

Use of barrier precautions (CDC Website). June 1, 1996. Available at: http://www.CDC.gov.in. Accessed June 26, 2011.

Zhuolin H, Stephen YL, Marschall J. Current strategies for the prevention and management of central line-associated bloodstream infections. Infection and Drug Resistance 2010:3 147–163.

****