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Factors affecting incidence of indwelling central venous catheter infection in intensive care unit

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Abstract

Aim: incidence of central venous catheter-related infections and to identify the factors influencing it, which would help to institute better prophylactic measures.

Material and Method: To evaluate possibility of bacteremia, blood cultures will be taken either from peripheral vein or when no peripheral vein is accessible, obtained directly from the catheter in place. Catheters will be then removed, and the distal 3cm segment will be cut off with sterile scissors and send for culture along with the blood. Isolates from the catheter tip and from blood cultures will be compared. Antibiotic susceptibility tests will be performed in keeping with national committee for clinical laboratory standards recommendations.

Result: Out of 82 patients with central venous catheters studied, 46 (56.09%) catheters showed negative semiquantitative and blood cultures.

Conclusion: The antimicrobial sensitivity patterns of common isolates provide guidelines to start appropriate antibiotic therapy. This can be cost effective and prevent indiscriminate use of antibiotics.

Keywords: Central venous catheter, prophylactic measures

Introduction

The intravascular access either arterial or venous has become an integral component of modern medical care ^[1]. The catheters allow monitoring of the hemodynamic status of the patient and allow access for the administration of fluids, blood products, medications and total parenteral nutrition ^[1], of critically ill patients during complex therapeutic interventions, especially in anesthesia, intensive care and emergency medicine ^[2]. The type of catheter used and the insertion site vary with the purpose of catheterization, vascular access availability and physician's preference ^[2].

Majority of serious catheter-related infections are seen in critically ill patients because they need central venous catheters for longer duration. Also in these patients, the catheters are manipulated multiple times per day for the administration of fluids, drugs, hemodynamic measurements or to obtain blood samples for laboratory analysis, augmenting the potential for contamination and subsequent clinical infection ^[3].

Patients with central venous catheters are at risk of developing local as well as systemic infectious complications like local insertion site infection, catheter-related bloodstream infection, septic thrombophlebitis, endocarditis and other metastatic infections. The most serious complications are bacteremia, sepsis and death ^[4].

The serious medical sequelae, and the often difficult and expensive management of catheter-related infections have prompted a major interest in preventing these infections. The preventive measures include the use of maximal sterile barriers, institution of an experienced infusion team, optimal local care of catheter insertion site and offering quality improvement programmes and educate clinical practitioners ^[5].

This study was undertaken to find out the incidence of central venous catheter-related infections and to identify the factors influencing it, which would help to institute better prophylactic measures. If infection occurs, the sensitivity patterns of common isolates would provide a guideline to the clinicians to start appropriate antibiotic treatment.

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Material and Method

This is prospective and descriptive study. Patients will be assessed and examined for development of central venous catheter infection. When inserting a catheter, we will use maximal sterile-barrier precautions. Once catheter-related infections are suspected, all catheter sites will be examined carefully. If there is any purulence or erythema, an exit-site infection will be considered likely and the catheter will be removed. To evaluate possibility of bacteremia, blood cultures will be taken either from peripheral vein or when no peripheral vein is accessible, obtained directly from the catheter in place. Catheters will be then removed, and the distal 3cm segment will be cut off with sterile scissors and send for culture along with the blood. Isolates from the catheter tip and from blood cultures will be compared. Antibiotic susceptibility tests will be performed in keeping with national committee for clinical laboratory standards recommendations.

A minimum of 10 ml of blood is taken through venipuncture and injected into two "blood culture bottles" [ie. Tryptose Phosphate Broth (TPB) and Bile Broth (BB)] with specific media for aerobic and anaerobic organisms. They are send to microbiology lab, incubated at 37C overnight and is subcultured onto agar plates to isolate pathogenic organism and for susceptibility testing, which takes upto 3 days. If cultures are negative, then blood culture bottles are incubated at 37C upto 10 days with subcultures on solid media on alternate days. After removal of the catheter under aseptic conditions, the distal 3cm of the catheter should be cut with sterile scissors into a sterile container for transport to the laboratory. *Broth immersion method:* Unopened (unsplit) catheter tip was placed in enriched boiled beef liver broth. Broth was incubated at 37C overnight. When turbid, broth was subcultured on macconkey's, heated blood agar and blood agar plates in a standardised manner. Organisms recovered from any of the cultures were identified after 3 days using standard methods as described in the manual of clinical microbiology. Infusate culture was not done in our study.

Result

Out of 82 patients, 47 were males and 35 were females. Majority of the patients i.e. 23 of them were above 60 years of age, followed by 20 patients who were between 41 to 50 years. There was a predominance of patients above 60 years of age. (Table No.1)

Table1: Age and Sex distribution of patients studied

Age group	Male	Female	Total
< 20	4	4	8
21-30	6	4	10
31-40	3	5	8
41-50	7	13	20
51-60	10	3	13
>60	17	6	23
Total	47	35	82

Out of 82 patients with central venous catheters studied, 46 (56.09%) catheters showed negative semiquantitative and blood cultures. Total 36 catheters were positive on semiquantitative culture of which 28 (34.14%) were with catheter associated infection, 5 (6.09%) with probable catheter associated bacteremia and 3(3.65%) with definite catheter associated bacteremia. (Table no. 3)Organism

cultured in definite CAB was coagulase positive staphylococcus in 2 patients and klebsiella spp in 1 patient. Out of total 43 isolates, 20 (46.51%) were coagulase positive staphylococcus (COPS). Maximum isolates were COPS comprising of 46.51% of the isolates, 17 were from catheter tip culture and 3 was from blood culture. Chi-square test was used to find significance of difference and association between two or more events. If the expected value in any cell was less than 5, then Yates correction was used.

Out of 70 single lumen catheters, 26(37.14%) were infected. Whereas, out of 12 double lumen catheters, 10(83.33%) were infected. There is significant difference in incidence of catheter-related infection between single lumen and double lumen at 1% level corresponding to $p=0.01$. Out of 8 subclavian venous catheters, 4(50.00%) were infected catheter-related infection with femoral and internal jugular venous catheters were 5(71.42%) and 27(40.29%) respectively. There is no significant difference in the incidence of catheter-related infection of subclavian, femoral and internal jugular venous catheters at 5% level corresponding to $p=0.05$

Discussion

Vascular catheters are the most frequently used indwelling medical devices and have become necessary tools for the successful treatment of patients with chronic or critical illness. Since Aubaniac's [6] first description in 1952, the use of central venous catheters has increased dramatically. Placement of these catheters however has an associated risk of morbidity and mortality. In most cases this is outweighed by the benefit gained, especially when long term access to the central venous system is needed. Extensive experience with this technique has lead to the recognition of infectious complications that may result from its use and factors affecting infection rate. Potentially non- infectious complications such as phlebitis can occur with signs and symptoms similar to those of infection [7]. Thus the definitive diagnosis of catheter-related infection can be made only by using a combination of clinical signs and symptoms together with the culture of the catheter. A prominent problem in detecting infection of intravascular catheters is the difficulty in distinguishing infection from contamination. This distinction has become easy with the semiquantitative culture technique [8].

Total 82 patients with central venous catheters were included in this study. Patients with any obvious source of infection were not included in the study. The catheter tips and blood cultures were collected from these patients [9]. An attempt was made to study the incidence and risk factors associated with catheter-related infections. The total study population comprised 47 males and 35 females. The minimum age was 17 years and maximum age was 102 years with overall mean age of 51.7(+14) years. The mean age for males was 50.15(+11.89) years. The mean age for females was 50.15 (+11.89) years and 53.95 (I 16.65) years for females (Table). There was a predominance of patients above 60 years of age. The patients who need central venous catheters are critically ill and belong to all age groups. Predominance of patients above 60 years of age [10] can be explained in the present study as this study was carried out in adult medical wards. Secondly, this is the age group more likely to land up with serious illness which necessitates central venous catheterization. The age above 60 years is one of the risk factors for catheter-related infections.

This variability of incidences in various studies could be due to various factors like techniques, site of catheterization, type of catheter used, catheter care and diagnostic criteria used for diagnosing catheter-related infections. The high infective complication rate in the present study may have been due to the fact that our hospital is catering to the lower socioeconomic group. So, the overall hygiene of the patients is poor secondly, the patient population consisted mainly of elderly people above 60 years of age. Also most of the catheters were retained for more than 3 days.

The semiquantitative culture technique was found to be a sensitive marker of catheter-related infection. A positive semiquantitative culture could serve as an index of local catheter-related infection which could be a precursor of catheter-related bacteremia^[9].

The only disadvantage of this technique is that it requires removal of the catheter and exposes the patient to the risk of catheter replacement when the catheter is not an identified source of infection.

In the present study, out of 82 catheters studied, 36 catheters (43.90%) were positive on semiquantitative culture. Out of these, 28 were associated with catheter-associated infection (34.14%), 5 was probable catheter associated bacteremia (6.09%) and 3 with definitive catheter associated bacteremia (3.65%). The site of CVC insertion was cleaned initially with spirit, followed by Betadine (5% Povidone Iodine) and again cleaned with spirit. In 1991, Maki DG *et al* found that chlorhexidine provided the best protection against catheter colonization with incidence of 2.3% followed by 70% alcohol with 7.1% infection rate and then by 10% Povidone-iodine which was 9.3%.

Members of the family *Enterobacteriaceae* are associated with catheter-related sepsis. But many a times they seed the catheter tip secondarily from other infected foci. The incidence of intravascular catheter related bloodstream infection (CRBSI) due to gram negative bacilli (GNB) may also be increasing. These microorganisms are commonly associated with contaminated infusate and are a common cause of bloodstream infection (BSI) in immunocompromised patient with intravascular devices. *Escherichia coli*: Colvin MP *et al* in 1972 reported that *E. coli* was the commonest pathogen isolated from catheters. But 79% of them were cultured from patients with pre-existing *E. coli* septicemia. Bozzetti F *et al* 69 in 1982 analyzed the causes and routes of infection due to central venous catheters. He isolated *E. coli* from 17 catheters but every time it came from distant infective foci.

Coagulase negative staphylococci (CONS) by definition are cluster forming cocci that produce catalase but not coagulase. They include *S. epidermidis*, *S. haemolyticus* and *S. saprophyticus*. They are commonly found on the surface of healthy persons in whom they are rarely the cause of infection, except in immunocompromised patients. They are opportunistic pathogens that cause infection in persons with defective resistance, often by colonizing plastic devices. The emergence of CONS as a major pathogen reflects the increased use of implants such as indwelling intravascular catheters, CSF shunts, cardiac valves, pace makers, artificial joints, vascular grafts and urinary catheters.

Conclusion

Thus, we conclude that the central venous catheter infections are fairly common cause of morbidity in hospitalized patients. Double lumen catheters are associated with

increased incidence of catheter-related infection. Emergency procedures, systemic antibiotics, duration of catheterization, site of catheter, local site infection and diabetes mellitus did not affect catheter related infections. The antimicrobial sensitivity patterns of common isolates provide guidelines to start appropriate antibiotic therapy. This can be cost effective and prevent indiscriminate use of antibiotics.

Conflict of Interest: No conflict of interest

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