SURVEILLANCE OF CATHETER-RELATED BLOODSTREAM INFECTIONS AMONG ADULT PATIENTS IN ICU

Poulami P[1], Yashavanth R[2], Narendra N[3]

[1]Resident Medical Officer, Narayana Super Speciality Hospital, Howrah.
[2]Associate Professor, Department of Microbiology, A. J. Institute of Medical Sciences & Research Centre, Mangaluru.
[3]Professor, Department of Microbiology, A. J. Institute of Medical Sciences & Research Centre, Mangaluru.

ABSTRACT

BACKGROUND

Catheter-related bloodstream infections (CRBSI) are an important contributor for the increasing morbidity and mortality in patients on central venous catheter (CVC). The incidence of CRBSI increases with the duration of catheterisation. Hence, it requires a rapid diagnosis of CRBSI and initiation of an appropriate antibiotic therapy, if not it will lead to emergence of drug resistance and poor prognosis in these patients.

Aims and Objectives - The study was undertaken to confirm the CRBSI and to identify aerobic bacterial pathogens and evaluating their antimicrobial susceptibility pattern.

MATERIALS AND METHODS

The study was conducted on 150 admitted patients with indwelling Central Venous Catheter (CVC). Two sets of blood samples were collected, one each from CVC line and another from peripheral vein in BACTEC bottle and incubated in BD BACTEC 9050 system. CRBSI was diagnosed if same organism was isolated from both samples. Antibiotic susceptibility testing was done for those isolates.

RESULTS

CRBSI rate was found to be 2.81 per 1000 catheter days. The incidence of aerobic Gram-negative bacteria was 66.7% (*Klebsiella pneumoniae and Serratia marcescens*) and Gram-positive cocci were 33.3% (*Staphylococcus aureus*).

CONCLUSION

According to National Nosocomial Infections Surveillance (NNIS) System report, range should be within 2 to 11.3 per 1000 catheter days. In our study, it is 2.81 per 1000 catheter days, which falls within the range as per NNIS. There is a need for a prospective study in India so that it can help in formulating infection control policies to prevent catheter-related blood stream infections.

KEYWORDS

Central Venous Catheters, Blood Stream Infections, Antibiotic Susceptibility Testing.

HOW TO CITE THIS ARTICLE: Poulami P, Yashavanth R, Narendra N. Surveillance of Catheter-related bloodstream infections among adult patients in ICU. J. Evolution Med. Dent. Sci. 2017;6(2):118-123, DOI: 10.14260/Jemds/2017/30

BACKGROUND

Catheter-related bloodstream infections (CRBSIs) most of which are associated with central venous catheters (CVCs) accounts for 11% of all Healthcare Associated Infections (HAIs). Centres for Disease Control and Prevention (CDC) were informed in response to the growing awareness that HAIs are urgent public health and patient safety issue.[1] Blood stream infections (BSIs) which represent the failure of immune system to contain infection at a focal site and consequent disseminated disease are a major cause of morbidity and mortality in the world. Currently, such infections are the 13th leading cause of death and over the past 2 decades the death rate from septicaemia has risen by 8%.[2]

Financial or Other, Competing Interest: None.
Submission 30-11-2016, Peer Review 23-12-2016,
Acceptance 30-12-2016, Published 05-01-2017.
Corresponding Author:
Dr. Yashavanth R,
Associate Professor,
Department of Microbiology,
A.J. Institute of Medical Sciences & Research Centre,
Kuntikana, Bejai, Mangaluru, Karnataka.
E-mail: dryashwanthrai@gmail.com
DOI: 10.14260/jemds/2017/30

Nosocomial blood stream infections in patients in the intensive care unit (ICU) are associated and attributable to the mortality rate of 35%.[3] Patients on central venous catheters pose a greater risk of device related infection than any other type of medical device and also main source of bacteraemia and septicaemia in hospitalised patients.[4] The continued presence of foreign body and placement of the device through the skin and into the blood vessels bypasses one of the body's best barriers to infections and creates the potential for microorganisms to enter the bloodstream and predispose further to infection, which can result from colonisation of the catheters by the skin flora or less commonly by haematogenous seeding due to hub contamination.[5] Early detection and adequate treatment of pathogen causing central venous catheter infections should be done within 24 hours of clinically suspicious symptoms for favourable outcome as these infections develop when catheters are left in place for a period more than 48 hours, because of excessive manipulation of catheter hub and forgetting to disinfect the intravenous access port prior to infusion leading to contamination of the internal lumen.[6,7]

Gram-positive organisms accounted for 64% of cases, Gram-negative organism which accounted for 28% and 8% were caused by fungi.[2] The most common organisms were coagulase negative *Staphylococcus (CONS), Staphylococcus*

aureus and *Enterococci*. *Enterobacter*, *Serratia, CONS* and *Candida* were more likely to cause infections in patients in critical care units.[2] The greater role of Gram-positive cocci as causes of nosocomial BSIs continue and is a nationwide phenomenon as illustrated by data from 49 hospitals across the United States that participated in the Surveillance and Control of Pathogens of Epidemiological Project (SCOPE).[2,8,9]

As there is very limited data available on the prevalence of CRBSI and sensitivity pattern of microorganisms associated with it and since A.J. Institute of Medical Sciences and Research Centre is one of the major tertiary care referral hospitals in Mangaluru, so this study was undertaken to guide the clinicians and the staff regarding the prevalence of CRBI in this setup and guide the clinicians in formulating an appropriate antibiotic policy. This will help in initiating proper care of intravenous devices and thus decreasing the percentage of nosocomial BSIs in ICUs.

Aims and Objectives

1. To study clinical and bacteriological profile in intravascular catheter related hospital acquired blood stream infections among adult patients in ICU.
2. To assess the antibiotic sensitivity pattern in organisms isolated from these patients.

MATERIALS AND METHODS

This study was conducted in the Department of Microbiology, A. J. Institute of Medical Sciences and Research Centre, Mangaluru for a period of one year from November 2013 to October 2014 with the permission from the ethical committee.

Source of Data

The study was conducted on admitted patients with indwelling central venous catheter in M.I.C.U, S.I.C.U and C.C.U of A.J.I.M.S & R C.

Methods

A cross sectional study of 1 year duration involving 150 patients who were on CVC admitted in intensive care units was done to ascertain the profile of the aerobic bacteria present in the blood and to study their antibiotic sensitivity pattern. Clinical assessment of the patient was done only after obtaining an informed consent regarding the nature of the study from their relatives.

Inclusion Criteria

1. All patients admitted in Intensive Care Units with central and/or peripheral lines, and who developed signs and symptoms of septicaemia 48 hours after insertion of the intravascular device.
2. Age – 18 years and above.

Exclusion Criteria

1. Patients with septicaemia on admission or within 48 hours of admission.
2. Blood culture showing more than two organisms.
3. Patient age – less than 18 years.

Two blood samples were collected from each suspected cases of CRBIs patients; one from CVC line and second one from peripheral vein by venepuncture. Then blood was inoculated into the BACTEC bottle and incubated in BD BACTEC 9050 system.[10,11,12]

Once the growth was detected by the BACTEC 9050 system, smear is prepared from the broth for Gram staining and the broth was subcultured onto sheep blood agar and MacConkey agar plates and incubated at 37^{0}C overnight. Gram staining was done to identify the morphology of the bacteria.

Identification of isolates were carried out by various biochemical tests as per CLSI guidelines.[11] CRBI confined when same organism was isolated from peripheral blood stream and central venous blood. Antibiotic susceptibility testing was carried out for the isolates by Kirby Bauer's disc diffusion method using commercially available discs (Hi Media Laboratories) on Muller Hinton Agar as per CLSI guideline. [11] Extended Spectrum Beta Lactamase (ESBL) production in *Klebsiella pneumoniae* was detected by phenotypic confirmatory disc diffusion test using ceftazidime (30 mcg) and combination of ceftazidime/clavulanic acid (30 mcg/10 mcg) disc according to CLSI guidelines. *K. pneumoniae* ATCC 700063 was used as quality control strain for detecting ESBL producer. Detection of Methicillin Resistant *Staphylococcus aureus* (MRSA) was done using cefoxitin (30 mcg) disc. *Staphylococcus aureus* ATCC 25923 was used as quality control. [11]

Catheter-related bloodstream infection rate was calculated by the following formula. [13]

$$\text{CRBSI rate} = \frac{\text{Number of CRBSI}}{\text{Total number of catheter days}} \times 1000$$

Expressed as number of CRBI per 1000 catheter days.

RESULTS

Total 150 suspected patients' blood samples were processed out of which 3 were diagnosed as CRBSI, so culture-positive rate was 2%.(Table 1 & Fig 1).

	No. of Isolates	Percentage
Growth	3	2
No growth	147	98
Total	**150**	**100**

Table 1. Distribution of Cases based on Culture Isolates

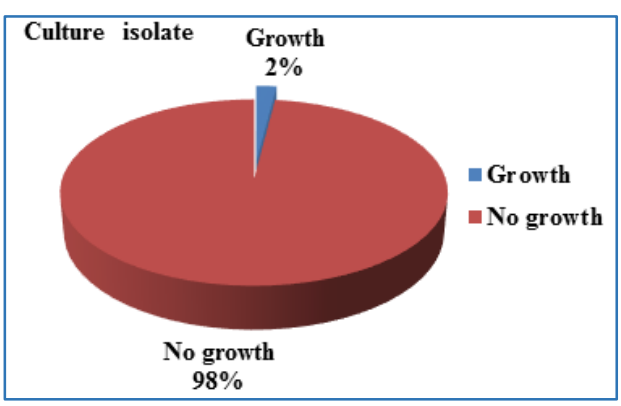

Figure 1. Distribution of Cases based on Culture Isolate

Out of 3 positive samples, Gram-positive cocci accounted for 33.3% and Gram-negative bacilli accounted for 66.7% (Fig 2).

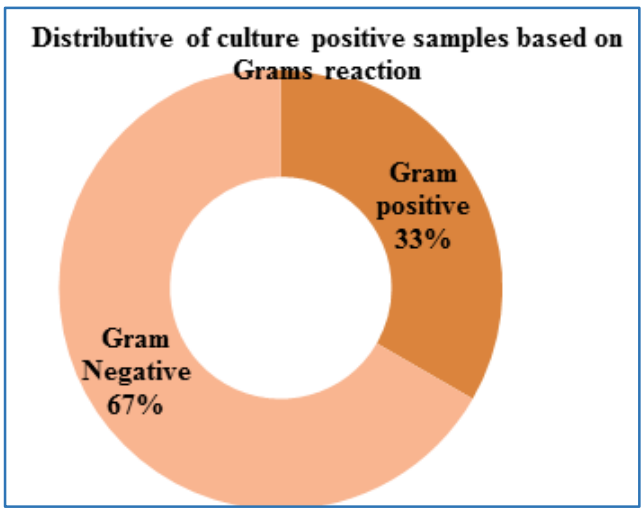

Figure 2. Distribution of Culture-positive samples based on Gram Reaction

Out of 3 positive cases in our study, male predominance was more accounting for 66.7% whereas female accounted for only 33.3%. (Table 2)

Gender	Growth of Organisms		Total
	Growth	No Growth	
Female	1 (33.3%)	50 (34%)	51 (34%)
Male	2 (66.7%)	97 (65%)	99 (66%)
Total	**3 (100%)**	**147 (100%)**	**150 (100%)**

Table 2. Gender-wise Distribution of Blood Culture-positive Cases

X^2=0.0603, p=0.90, ns, Chi-square test.

Out of 150 blood samples, 90.7% was taken from MICU, 8.7% from SICU and 0.6% from CCU. (Table 3 & Fig 3).

	Frequency	Percentage
MICU	136	90.7
SICU	13	8.7
CCU	1	0.6
Total	**150**	**100.0**

Table 3. Ward wise Distribution

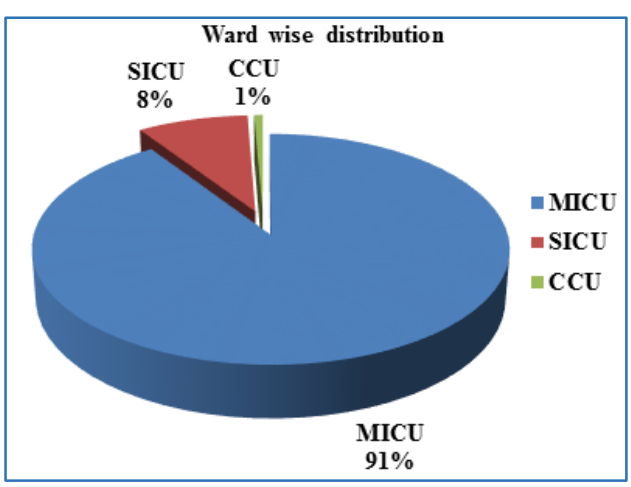

Figure 3. Ward wise Distribution

Among all 150 catheter samples collected for study, 28 (18.7%) were from age group 40-50 years, in 20-30 years and 50-60 years 27 (18%) each, 26 (17.3%) from age group 60-70 years. Out of 3 culture-positive cases, 1 (33.33%) was from age group 20-30 years, 1 (33.33%) was from age group 30-40 years and 1 (33.33%) was from age group 60-70 years. (Table 4 & Fig 4).

Age in Years	Growth of Organism		Total
	Growth	No Growth	
‹20	0	6 (4.1%)	6 (4%)
20-30	1 (33.33%)	26 (17.7%)	27 (18%)
30-40	1 (33.33%)	19 (12.9%)	20 (13.3)
40-50	0 (0%)	28 (19%)	28 (18.7%)
50-60	0 (0%)	27 (18.4%)	27 (18%)
60-70	1 (33.33%)	25 (17%)	26 (17.3%)
›70	0 (0%)	16 (10.9%)	16 (10.7%)
Total	**3(100%)**	**147(100%)**	**150(100%)**

Table 4. Age wise Distribution

X^2=3.34, p=0.765, ns, Chi-square test.

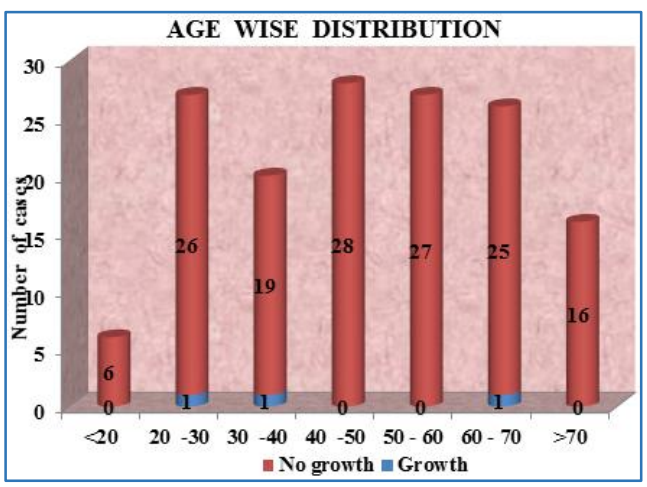

Figure 4. Age wise Distribution

Among all samples, 66 (44%) were collected from internal jugular vein, 65 (43.3%) were from femoral vein and 19 (12.7%) were from subclavian vein. Out of these, 1.5% and 3% were culture positive from internal jugular vein and femoral vein respectively. (Table 5).

Site of Insertion	Growth of Organisms		Total (n=150)
	Growth	No. Growth	
IJV	1 (1.5%)	65 (98.5%)	66 (44%)
Femoral vein	2 (3%)	63 (97%)	65 (43.3%)
Subclavian vein	0 (0%)	19 (100%)	19 (12.7%)

Table 5. Place of Insertion

Out of total 3 positive cases, one *Klebsiella pneumoniae*, one *Serratia marcescens* and one *S. aureus* were isolated. (Table 6)

	No. of Isolates	Percentage
Klebsiella pneumoniae	1	0.7
Serratia marcescens	1	0.7
S. aureus	1	0.7
NG	147	98.0
Total	**150**	**100.0**

Table 6. Pattern of Organism Isolated

According to National Nosocomial Infection Surveillance System (NNIS) report, CRBSI rate should be within 2 to 11.3

per 1000 catheter days. From this graph, we can say that CRBSI rate of our hospital is within limits. (Fig. 5).

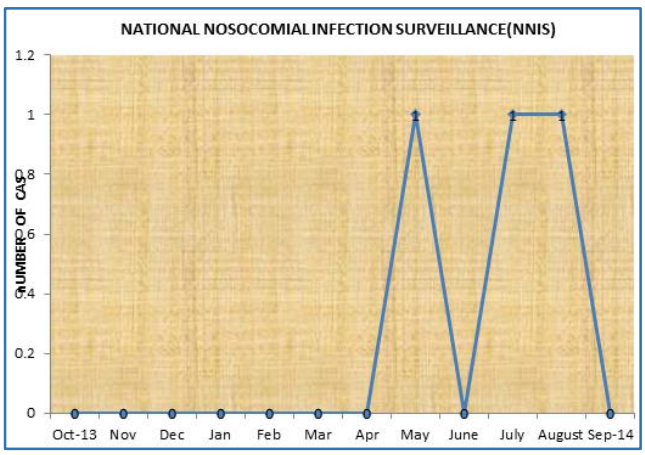

Figure 5. CRBIs rate as per NNIS

GPC	CX	P	Cot	Cd	E	Cip	Gen	Va	Lz	Te
S. aureus	R	R	S	S	S	S	S	S	S	R

Table 7. Antibiotic Susceptibility pattern of Gram-positive Cocci

S= Sensitive, R=Resistant

Staphylococcus aureus showed sensitivity to cotrimoxazole, clindamycin, erythromycin, ciprofloxacin, gentamicin, vancomycin, linezolid and showed resistance to cefoxitin, penicillin, and tetracycline, which was Methicillin-Resistant *Staphylococcus aureus* (MRSA). (Table: 7).

GNB	Amp	Gen	Amc	Pi	Pit	Cpm	Ctr	Ctx	Cfs	Caz	Cip	Le	Imp	Mrp
Klebsiella pneumoniae	R	R	R	R	R	R	R	R	R	R	R	R	S	R
Serratia marcescens	R	S	R	S	S	S	S	S	S	S	S	S	S	S

Table 8. Antibiotic Susceptibility pattern of Gram-negative Bacilli

S=Sensitive, R=Resistant

Klebsiella pneumoniae was sensitive only to imipenem and resistant to ampicillin, gentamicin, amoxyclav, piperacillin, piperacillin-tazobactam, cefepime, ceftriaxone, cefotaxime, cefoperazone-sulbactam, ceftazidime, ciprofloxacin, levofloxacin and meropenem.

Serratia marcescens was sensitive to ampicillin, gentamicin, piperacillin, piperacillin-tazobactam, cefepime, ceftriaxone, cefotaxime, ceftazidime, cefoperazone-sulbactam, ciprofloxacin, levofloxacin, imipenem, meropenem and resistant to ampicillin, and amoxyclav (Table: 8).

DISCUSSION

Catheter-related bloodstream infection (CRBSI) is one of the most frequent, lethal and costly complications of central venous catheterisation and also most common cause of nosocomial bacteraemia compounded by the emerging antibiotic resistances that were effective earlier.

In this study, total of 150 suspected cases in 1064 catheter days were observed and CRBI rates were 2.81 per 1000 catheter days. This is comparable to the National Nosocomial Infection Surveillance (NNSI) System report (2 to 11.3 per 1000 catheter days).[13] Similarly, CRBSI rate in the study of S. Singh et al[14] showed 0.48 per 1000 catheter days, Deepti et al[15] showed 8.2 per 1000 catheter days, Ramanathan Parameswaran et al[16] was 8.75 per 1000 catheter days, Daniela Bicudo[17] showed 10.22 per 1000 catheter days, M. Kaur[18] showed 14.59 per 1000 catheter days, Harsha V Patil[19] showed 47.31 per 1000 catheter days. Total 150 catheter samples included in this study. Out of those 3 samples were positive for bacterial growth, so the culture-positive rate is 2%. Studies conducted by S. Singh et al[14] showed 0.8%, Adolf W. Karchma[8] showed 15.68%, Ann O Connor et al[20] showed 11.2% and M. Kaur et al[18] showed 21.73% of culture positivity. Out of these studies, last three studies reported high culture-positive rates. Culture-positive rate may have a wide range, because it depends on various factors like type of catheters, site of insertion and catheter care. The CRBSI rate varies from hospital to hospitals. It depends on socioeconomic status of patients who were admitted in the hospital, various predisposing factors like diabetics, hypertension, cancers, lymphomas, steroid therapy, chemotherapy, aseptic measures followed by hospitals, diagnostic criteria of CRBSI and protocol of antibiotic used. In our hospital, all these parameters were properly followed by doctors, nurses and staff, so CRBSI rate is low.

In our study, total three culture-positive cases were reported, 1 (33.33%) from age group 20-30 years, 1 (33.33%) from age group 30-40 years and 1(33.33%) from age group 60-70 years. Other studies conducted by H. V Patil,[19] Deepti et al,[15] showed high CRBSI rate among 50-60 years of age group whereas study done by Manjula et al[21] showed high culture positivity rate between 19-30 years of age group.

According to this study, male predominance was more which accounted for 66.7% compared to female 33.3%. Other studies also showed male predominance like the study done by H.V Patil[19] which showed 59% males and 41% females were affected, the study done by Deepti et al[15] showed 69% males and 31% females affected, the study done by Daniela Bicudo[17] showed 58.85 males and 41.2% females affected and the study by Ramanathan Parameswaran et al[16] showed 72% males and 28% females were affected. CRBSI rates were high in all these studies because of associated or predisposing factors which were seen more in males like smoking, alcohol intake and comorbid illness like HTN, DM, ketoacidosis bronchial asthma, COPD, renal failure, patient on immune suppressive therapy, chemotherapy, etc.

In our study, 90.7% of the samples were from medical intensive care unit (MICU), 8.7% from surgical intensive care unit (SICU) and 0.6% from cardiac care unit (CCU). In the study by S. Singh et al,[14] 12% of the blood samples were collected from patients admitted in MICU and 88% from SICU.

In our study, 66 (44%) blood samples were collected from internal jugular vein (IJV), 65 (43.3%) were collected from femoral vein and 19 (12.7%) were collected from subclavian vein. The study conducted by Harsha V Patil[19] showed that 22.22%, 38.89% and 38.89% CVC were placed into internal jugular vein, femoral vein and subclavian vein respectively. The study conducted by Ramanathan Parameswaran[16] showed that 22.2%, 33.3% and 23% CVC were placed into internal jugular vein, femoral vein and subclavian vein respectively.

In our study, all 150 patients were on empirical antibiotic therapy. Out of those, three (2%) patients were positive for CRBSI. That means empirical antibiotics showed high protection from CRBSI. Similarly, S. Singh et al[14] also showed that systemic empirical antibiotic therapy provided high protection from CRBSI.

From the three culture-positive cases, two were Gram-negative bacilli and one Gram-positive cocci; Gram-negative bacilli were *Klebsiella pneumoniae* (33.33%), *Serratia marcescens* (33.33%) and Gram-positive cocci was *Staphylococcus aureus* (33.33%). Similar study done by Deepti et al[15] showed Methicillin-Resistant *Staphylococcus aureus*(45%), *Klebsiella pneumoniae* (11%), followed by *MSSA, Enterococci* and *Acinetobacter spp*.

In this study, *Klebsiella pneumoniae* was sensitive only to imipenem. *Serratia marcescens* was sensitive to ampicillin, gentamicin, piperacillin, piperacillin-tazobactam, cefepime, ceftriaxone, cefotaxime, ceftazidime, cefoperazone-sulbactam, ciprofloxacin, levofloxacin, imipenem, meropenem and resistant to ampicillin and amoxyclav. Study done by H.V Patil[19] also showed that *Klebsiella pneumoniae* was resistant to all antibiotics except fluoroquinolone and carbapenem.

In this study, *Staphylococcus aureus* was sensitive to cotrimoxazole, clindamycin, erythromycin, ciprofloxacin, gentamicin, vancomycin and linezolid and resistant to penicillin, tetracycline and cefoxitin (MRSA). M. Kaur et al,[18] Deepti et al,[15] Ramanathan Parameshwaran et al[16] and H. V. Patil et al[19] also showed that *MRSA* was responsible for majority cases of CRBSI.

CONCLUSION

CVCs are increasingly used in the inpatient and outpatient setting to provide longterm venous access. Duration of catheterisation and catheter colonisation has an important role in development of CRBSI which may lead to septicaemia. While inserting CVC preventive measures should be used like local antibiotics and catheter lock solution. Duration of catheterisation increases the morbidity, so regular monitoring of catheterised patient should be done for both insertion site and general condition.

This prospective study has highlighted the incidence, aerobic bacteriological profile of CVC infections and also the changing trends in the susceptibility pattern of the isolates to routinely used antibiotics in our tertiary care centre.

In our hospital, CRBSI rate is low (2.81 per 1000 catheter days) which is within normal range as per National Nosocomial Infection Surveillance System (NNIS). Proper training programme of hospital staff, maintenance of proper hand hygiene, following up of proper guidelines of catheter insertion and maintaining aseptic precaution prior to CVC insertion can reduce CRBSI.

Combined effort of the Microbiologists, clinicians and hospital infection control team are needed to tackle CRBSI.

REFERENCES

[1] Abad CL, Safdar N. Catheter-related Blood stream Infections. Infectious diseases. Special edn. New York, US: McMahon Publishing 2011:84-98.

[2] Edmond MB, Wallace SE, McClish DK, et al. Nosocomial bloodstream infection in United States hospitals: a 3 years analysis. Clinical Infectious Disease 1999;29(2):239-44.

[3] Pittet D, Tarara D, Wenzel RP, et al. Nosocomial bloodstream infection in critically ill patients. Excess length of stay, extra costs and attributable mortality. JAMA 1994;271(20):1598-601.

[4] Storti A, Manzato AJ, Pizzolitto AC, et al. Assessment of central venous catheter associated infections using semi quantitative or qualitative culture methods. Journal of Basic and Applied Pharmaceutical Sciences 2006;27(3):213-20.

[5] Maki DG, Weise CE, Sarafin HW. Semi quantitative culture method for identifying intravenous catheter-related infection. New England Journal of Medicine 1977;296(23):1305-9.

[6] Frasca D, Dahyot-Fizelier C, Mimoz O. Prevention of central venous catheter-related infection in the intensive care unit. Critical Care 2010;14(2):212.

[7] Akan OA. Microorganisms isolated from catheter tip cultures: Ibni Sina hospital. Journal of Ankara Medical School 2003;25(3):113-118.

[8] Karchmer AW. Nosocomial bloodstream infections: organism, risk factors and implications. Clinical Infectious Disease 2000;31(Suppl 4):S139-S43.

[9] Pittet D, Wenzel RP. Nosocomial blood stream Infections: trends in rates, mortality and contribution to total hospital deaths. Arch Internal Medicine 1995;155(11):1177-84.

[10] Konemann EW, Allen SD, Janda WM, et al. Colour atlas and textbook of diagnostic microbiology. 4th edn. Philadelphia: Lippincott Company 2011.

[11] Clinical and Laboratory Standards Institute. Performance standards for antimicrobial susceptibility testing. Twenty-Second informational supplement. 2012;32(3):M100-S22.

[12] Mermel LA, Allon M, Bouza E, et al. Clinical practice guidelines for the diagnosis and management of intravascular catheter-related infection: 2009 update by the infectious diseases society of America. Clinical Infectious Diseases 2009;49(1):1-45.

[13] National Nosocomial Infection Surveillance (NNIS) system report, data summary from January1992 to June 2002, issued August 2002. American Journal of Infection Control 2002;30(8):458-75.

[14] Singh S, Pandya Y, Patel R, et al. Surveillance of device-associated infections at a teaching hospital in rural Gujarat-India. Indian Journal of Medical Microbiology 2010;28(4):342-7.

[15] Deepti, Sinha S, Sharma SK, et al. Central venous catheter related blood stream infection in medical intensive care unit patients in a tertiary referral centre. Indian Journal of Chest Disease and Allied Science 2014;56(2):85-91.

[16] Parameshwaran R, Sherchan JB, Varma DM, et al. Intravascular catheter related infection in an Indian tertiary care hospital. Journal of Infection in Developing Countries 2011;5(6):452-8.
[17] Bicudo D, Batista R, Furtado GH, et al. Risk factors for Catheter-related bloodstream infections: a prospective multi centres study in Brazilian intensive care units. Brazilian Journal of Infectious Disease 2011;15(4)328-31.
[18] Kaur M, Gupta V, Gombar S, et al. Incidence, risk factors, microbiology of venous catheter associated blood stream infections - a prospective study from a tertiary care hospital. Indian Journal of Medical Microbiology 2015;33(2):248-54.
[19] Patil HV, Patil VC, Ramteerthkar MN, et al. Central venous catheter related blood stream infection in the intensive care unit. Indian Journal of Critical Care Medicine 2011;15(4):213-23.
[20] O'Connor A, Hanly AM, Francis E, et al. Catheter-related bloodstream infections in patients receiving parenteral nutrition: a prospective study of 850 patients. Journal of Clinical Medicine Research 2013;5(1):18-21.
[21] Varagali MA, Metgud SC, Kanadesai SG. Bacteriological profile of catheter tips and their antibiogram. National Journal of Basic Medical Sciences 2012;11(4):333-5.