Original Article

INCIDENCE OF CATHETER COLONIZATION AMONG PATIENTS WITH INDWELLING VASCULAR CATHETERS IN ICU PATIENTS AND THEIR MICROBIOLOGICAL PROFILE

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ABSTRACT

Introduction: Central venous catheters (CVCs) are increasingly used in hospitals to manage critically ill patients. In ICU Central lines are usually inserted for the administration of fluids, blood products, medication, nutritional solutions and for hemodynamic monitoring. The incidence of central venous catheter bloodstream infection (CVC-BSI) varies in ICUs due to different types of risk factors like prolonged catheterization, Poor hand hygiene, Underlying illnesses, Duration of hospitalization & multiple catheter insertions.

Aim & Objective: To isolate the organisms that colonising central venous catheter (CVCs), Antimicrobial Susceptibility and to determine the biofilm forming microorganisms with their Resistance pattern of isolated organisms.

Material and Methods: The study was carried out in the Department of Microbiology, GSVM Medical College. Patients admitted in Intensive care units who fulfilled the inclusion criteria were enrolled. Catheter tips were collected from patients at any point of time who developed signs and symptoms of septicemia after 48 hrs of catheter insertion. Catheter tips were processed using Semiquantitative Extraluminal Maki's roll over method and Quantitative Endoluminal catheter flush culture methods.

Results: During the study period, a total of 100 patients had been inserted with a central venous catheter in the Intensive care unit. A total of 22 catheters tips (22%) in which 14 (63%) were male & 8 (36%) were female yielded positive growth by both Semiquantitative Extraluminal & Quantitative Endoluminal methods. In our study duration of central venous catheter more than seven days & was associated with higher catheter colonization rate.

Conclusion: It may be possible to lower the risk of colonisation and subsequent catheter-related infections by implementing basic preventative measures such aseptic precaution during catheter

placement, daily catheter care, and patient monitoring.

Key Words: Central venous catheters (CVCs), Coagulase negative Staphylococcus (CONS), Antibiotic sensitivity, Biofilm production, Tube method.

INTRODUCTION

Intravascular catheters including central venous catheters are integral to the modern practices and are inserted in critically-ill patients for the administration of fluids, blood products, medication, nutritional solutions, and for hemodynamic monitoring. [1] Use of vascular catheters is common in both inpatient and outpatient care. CVCs plays an integral role in modern Healthcare, there use however is associated with a risk of bloodstream infections caused by microorganisms, Colonization of the central venous catheters may be either extra luminal (from surrounding skin or hematogenous seeding of the catheter tip) or intraluminal (due to biofilm formation by an organism leading to persistence of infection and hematogenous spread).[2] Although rarer, it is contaminated infusate that leads to the majority of epidemic intravascular device-related BSIs. [2,3] Potential risk factors for Central venous catheters infections include underlying disease, method of insertion, site of catheters, duration, and purpose of catheterization. Local risk factors like poor personal hygiene, occlusive transparent dressing, and moisture around the exit site. Other risk factors include contamination, inadequate water treatment, dialyzer re-use, older age, higher total intravenous iron dose, increased recombinant human erythropoietin dose, lower haemoglobin level, lower serum albumin level, diabetes mellitus, peripheral atherosclerosis, and recent hospitalization or surgery [4]
Gram-positive cocci were responsible for at least two-thirds of the infections followed by Gram-negative bacilli, which are responsible for a higher proportion of central venous catheter infection in intensive care unit (ICU). Staphylococcus aureus continue to be the most frequently encountered pathogens in device related infections. Other commonly encountered isolates include Enterococcus spp., CONS, Pseudomonas aeruginosa, Klebsiella spp., Citrobacter spp., Acinetobacter baumannii, and Candia species etc. [5]
Biofilm formation occurs in a series of steps, such as formation of conditioning layer, bacterial adhesion, bacterial growth and biofilm maturation when microbes form a maturated biofilm within human hosts through medical devices such as Central venous catheters (CVCs), prosthetic heart valve, urinary catheters, and intra uterine devices the infections becomes resistant to antibiotic treatment and can develop into a chronic condition. [6]

OBJECTIVES OF THE STUDY

- To isolate the organisms that colonising central venous catheter (CVCs), Antimicrobial Susceptibility
- To determine biofilm forming microorganisms that colonises the tip of catheter and their Resistance pattern.

MATERIAL & METHODS

The Catheter tips were collected from patients admitted in ICU and in whom CVC (Central Venous Catheter) was inserted after ICU admission at G.S.V.M Medical College, over a period of 1 year.

Inclusion Criteria: All Patients admitted in the ICU, with central line for > 48 hours (2 calendar days) having signs & symptoms of infection, fever, chills and hypotension were included in the study.

Exclusion Criteria: These patients were followed up from the time of catheterization till discharge. Patients with CVC, having obvious other source of infection were excluded.

Collection of CVC tip and processing

The skin was disinfected with 70% alcohol prior to catheter tip removal. The catheter was held at the proximal end and carefully removed from the patient with a sterile forceps, taking care to avoid contact with the skin. The terminal 4-5cm segment of catheter tip was cut with sterile scissor and collected in the sterile screw capped container and was to be transported to lab as soon as possible.[7]

Catheter tip were processed by using both Semiquantitative Extraluminal Maki's roll over method & Quantitative Endoluminal catheter flush culture methods.

Semiquantitative Extraluminal Maki's roll over method

The catheter tip was rolled back and forth across agar surface using slight pressure at least four times with the help of sterile forceps. It was made sure that the catheter tip has good contact with the surface of the Blood agar and MacConkey agar plate. The plates were incubated aerobically at 37ºC for 48- 72hr. & colonies counted. [7, 8]

Interpretation

The results were expressed as CFU. Significant growth is defined as ≥ 15 colony forming units (CFU).

Quantitative Endoluminal catheter flush culture

One mL of sterile normal saline was flushed in to the lumen of the segment using a sterile syringe and 0.1 ml of the suspension inoculated each onto Blood agar and MacConkey agar plates respectively. The plates were incubated aerobically at 37ºC for 24 to 48 hours.

Interpretation

Colonies were identified, enumerated and expressed in CFU. (Significant growth is defined as ≥ 10^3 CFU/ml). [8,9]

Identification & Interpretation

The organisms were identified by Colony characteristics, Gram staining, and various Biochemical tests such as Catalase, Coagulase, Oxidase, Indole, MR, Citrate utilization, Ureahydrolysis, & TSI. [10]

Antimicrobial Sensitivity test

All the isolates after identification were tested for their antibiotic susceptibility by using Kirby-Bauer disc diffusion method on Muller Hinton agar (MHA) plates and interpreted according to CLSI (Clinical and Laboratory Standards Institute), guidelines (M100,Ed33- March 2023).[11]

Biofilm production by Tube Method

A loopful of test organisms was inoculated in 10 mL of trypticase soy broth with 1% glucose in test tubes. The tubes were incubated at 37o C for 24 h. After incubation, tubes were decanted and washed with phosphate buffer saline (pH 7.3) and dried. Tubes were then stained with crystal violet (0.1%). Excess stain was washed with deionized water. Tubes were dried in inverted position. Biofilm Production was considered positive when a visible film lined the wall and bottom of the tube. Tubes were examined and amount of biofilm formation was scored as 0- absent, 1-weak, 2-moderate, 3-strong [12, 13].

RESULT

A total of 22 catheters tips (22%) in which 14 (63%) were male & 8 (36%) were female yielded positive growth by both Semiquantitative Extraluminal & Quantitative Endoluminal methods. Gram positive Organisms were the most common isolates in our study 16 (72.72%) and six Gram negative bacilli were isolated (27.27%). *Staphylococcus aureus* was the commonest organism found isolated in the current study those were about 10(45%). Second most common organism was Coagulase negative staphylococci (CONS) 06(27.27%) followed by *E.coli* 3(13%), *K. pneumoniae* 2 (9.09%) and *P. aeruginosa* 1(4%). **(Table: 2)**

Table: 1 Percentage of Positive catheter tips Culture

Result	Total no. of casesn=22	Percentage
SemiquantitativeExtraluminal	14	63.63%
Quantitative Endoluminal	08	36.36%
Total	22	100%

Figure: 1 Percentage of Positive catheter tips Culture

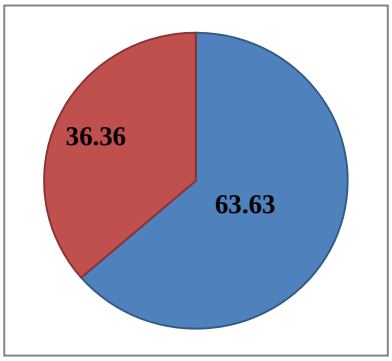

Table: 2 Microbiological profile of catheter tip colonization

Isolates	Catheter Tip		
	Semiquantitative Extraluminal N=14	Quantitative Endoluminal N=8	TotalN=22
S. aureus	6	4	10
CONS*	4	2	06
E. coli	2	1	03
K. pneumoniae	2	0	02
P. aeruginosa	0	1	01

Figure: 2 Microbiological profile of catheter tip colonization

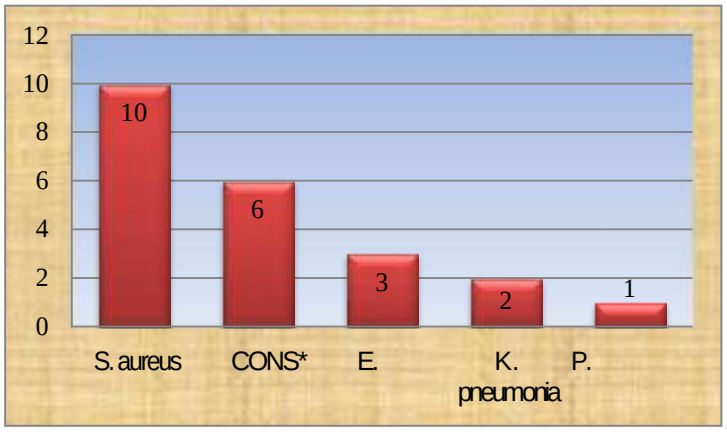

Table: 3 Biofilm formations by Tube method

Method	Tube Method		
Isolated organismn=22	Weak/ none	Moderate	High/Strong
S. aureus N=10	2	2	6
CONS N=06	2	0	4
E. coli N=03	2	1	0
K. pneumoniaeN=02	1	1	0
P. aeruginosaN=01	1	0	0

Figure: 3 Biofilm formations by Tube method

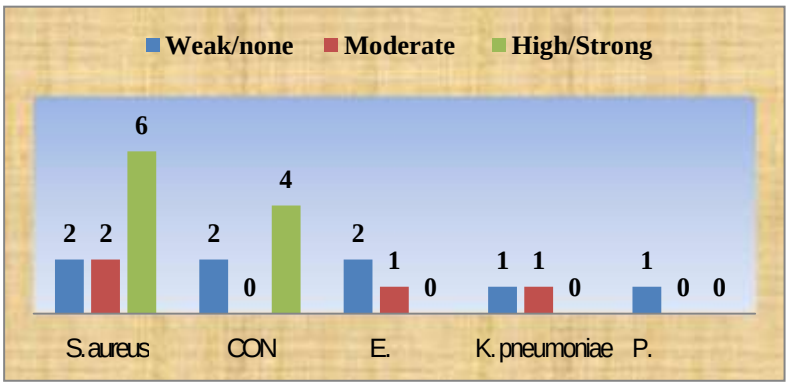

Table:4 Antibiotic sensitivity & resistant pattern of Gram positive organism withBiofilm

producing (BP) and Non Biofilm producing (NBP)

Antibiotics	**S. aureus (NBP) N=4**		**CONS (NBP) N=02**		**S. aureus (BP) N=6**		**CONS (BP) N=4**	
Resistant/Sensitive	**R**	**S**	**R**	**S**	**R**	**S**	**R**	**S**
Ampicillin(30µg)	1(25%)	3(75%)	0(0%)	2(100%)	6(100%)	0(00%)	3(75%)	1(25%)
Amoxyclav(30µg)	2(50%)	2(50%)	0(0%)	2(100%)	6(100%)	0(0%)	2(50%)	2(50%)
Amikacin(30µg)	1(25%)	3(75%)	1(50%)	1(50%)	3(50%)	3(50%)	3(75%)	1(25%)
Amoxy/clavulanicacid	0(0%)	4(100%)	1(50%)	1(50%)	4(66%)	2(33%)	4(100%)	0(0%)
Cotrimoxazole(25µg)	2(50%)	2(50%)	1(50%)	1(50%)	3(50%)	3(50%)	2(50%)	2(50%)
Clindamycin(2µg)	2(50%)	2(50%)	1(50%)	1(50%)	3(50%)	3(50%)	2(50%)	2(50%)
Erythromycin(15µg)	1(25%)	3(75%)	0(0%)	2(100%)	3(50%)	3(50%)	3(75%)	1(25%)
Linezolid(30µg)	1(0%)	4(100%)	1(50%)	1(50%)	5(83%)	1(16%)	4(100%)	1(0%)
Vancomycin(30µg)	2(50%)	2(50%)	1(50%)	1(50%)	1(16%)	5(83%)	2(50%)	2(50%)
Gentamycin (30µg).	5(50%)	2(50%)	1(50%)	1(50%)	3(50%)	5(50%)	2(50%)	5(50%)

DISCUSSION

Urinary catheterization is an essential component of many surgical procedures but increases risk of urinary tract infection (UTI) .[2] Catheter colonization and duration of catheterization has an important role in development of CRBSI which may lead to septicaemia and multi-organ failure. CRBSI must be suspected in the catheterized patient having sign and symptoms of septicaemia. Overall 23.6% of hospital patients are catheterized [14]. Decreasing catheter duration significantly lowers UTI risk [15], but the risk is still substantial: as much as 38% in the 6 weeks following catheter removal among women undergoing short-term catheterization for elective gynecological surgery [16] . Bacterial pathogens causing UTI during and following hospitalization are increasingly resistant to antibiotics, complicating treatment and increasing costs [17] .

In our study Antimicrobial resistance was significantly higher in biofilm producing Gram positive bacteria i.e. *Staphylococcal aureus* (60%) & CONS (67%). Biofilm forming bacteria generally show a greater resistance to antibiotics than Non biofilm forming bacteria because of the difficulty in penetration of drugs through the biofilm.

Many studies have been undertaken which reported high resistance among different biofilm forming bacteria. Most of the study results were similar to the present study but some differences in sensitivity to antibiotics were seen. Different authors have performed studies on different clinical samples and antibiotic susceptibility pattern vary with the geographical area and hospital environment.

In present study *Staphylococcus aureus* was resistant to ampicillin and Amoxyclav was seen in 100% (of each) of biofilm producers while only 25% and 50% resistance was seen in biofilm non-producers. Previously, several studies have found similar rate of resistant pattern with biofilm producers in Staphylococcus aureus.[18,19]

In our study duration of central venous catheter more than seven days & was associated with higher catheter colonization rate. Similar findings were observed by in a study by Sato et al where the incidence of infection increased within 8-10 days of catheterization.[15] Catheter tip colonization may result from health care interventions and constitutes an important cause of morbidity and mortality among ICU patients.

As catheter use cannot always be avoided, many investigators have focused on limiting biofilm growth on catheter surfaces, under the assumption that catheters are a reservoir for infection. Biofilm formation protects bacteria from flowing urine, host defenses, and antibiotics [20]. Simple

preventive measures, such as aseptic precaution during catheter insertion, daily catheter care, monitoring of catheterised patients, could help to reduce risk of colonisation and subsequent catheter related infections.

Conclusion

In order to prevent UTI after short-term catheter placement, using appropriate aseptic technique, rather than preventing bacterial colonisation of the catheter surface, is probably more crucial. Culture results and sensitivity pattern will also guide to treat specific organism, and since most isolates are resistant to common antibiotics this may be accompanied by removal of the catheter to reduce morbidity and mortality

Declarations:

Conflicts of interest: There is no any conflict of interest associated with this study

Consent to participate: We have consent to participate.

Consent for publication: We have consent for the publication of this paper.

Authors' contributions: All the authors equally contributed the work.

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