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VASCULAR ACCESS RELATED INFECTIONS AMONG HEMODIALYSIS PATIENTS IN TRITIARY CARE CENTRE, TAMILNADU

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ABSTRACT

BACKGROUND: Vascular access related infections (VARI) are important causes of increased mortality, morbidity and cost of therapy among hemodialysis patients. Prevention of VARI requires the identification of predisposing risk factors. **SAMPLING AND METHODOLOGY:** As per CDC guidelines, suspicion was made, and from them all possible samples were taken, 5-10 ml of blood both from Catheter and peripheral from patients with fever/rigors/hypotension. Exit-site swab when purulent discharge and Catheter tips (Suspected and non-suspected) removed aseptically for which semi-quantitative catheter tip culture by Maki's Roll plate method was done. This was followed by collection the samples inoculated into appropriate culture media plates and it was identified by its colony morphology and relevant biochemical reactions. **RESULTS:** Out of 156, 61 were catheterized patients and 95 were AVF. Of which 28 were suspected based on CDC guidelines i.e., 21 from catheterized and 7 from patients with AVF. Based on nature of catheter used, the highest risk of infection was found in permanent catheters than temporary catheters. Based on anatomical catheter site, FVC was found to be at more risk of infection in our study with 60%.Polymicrobial growth was also seen in patient with FVC. Based on antibiogram, *S.aureus,* 2 out of 6 showed resistance to oxacillin and *Enterococci,* 1 out of 3 showed resistances to vancomycin and the only E.coli was found to be MDR type. **DISCUSSION:** Vascular access related infections includes risk factors such as duration of catheterization maintenance which is more than the recommended days, increased preference of catheters than AVF due to late diagnosis of CKD and late referral to nephrologists and vascular surgeons for timely construction of AVF, anatomical site used. Also organisms in our study are mostly skin micro-organism found on patients and hands of health care workers, which indicates poor hand hygiene and inadequate or improper use of sterile technique. Our study's antibiogram result indicates the liberal usage of antibiotics.

KEY WORDS : ***Vascular access, Hemodialysis, Catheter related infections***

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INTRODUCTION

After decades of success in hemodialysis (HD) research and treatment for Chronic Kidney Disease (CKD) patients, the prompt availability of a well functioning Vascular Access (VA) for dialysis remains a disturbing problem *(Ravani P., et al., 2002)*. VA is usually considered an *ACHILLES HEEL*, as it is the life-line of CKD patients *(Kovalik EC., et al., 1999).* Chronic HD patients are vulnerable to Vascular Access Related Infections (VARI), especially with antimicrobial-resistant organisms due to their immunosuppressed status, require VA for *prolonged periods,* need for *routine puncture* of a vascular access site to remove blood for HD, which provides a *portal for the entrance of infectious organisms,* necessitate *frequent hospitalization,* and often treated with *long courses of antimicrobials*. Other potential risk factors for vascular access infections include anatomical site of vascular access: Femoral >IJ > subclavian; Catheter characteristic: cuffed/non-cuffed; tunneled/non-tunneled; Prolonged duration of catheterization; poor needle insertion technique; scratching over the access site; poor patient hygiene; diabetes; hypertension; older age *(Taylor. G., 2002).* In patients with chronic renal injury (CRI) submitted to HD, VARI are significant as they may cause disseminated bacteremia or loss of access, In addition to *Blood Stream Infections (BSIs)*, presenting higher mortality include *local catheter insertion site infections* as well. Etiological agents of VAI (in decreasing order of frequency): *Staphylococcus aureus* (32%-53%), *Coagulase Negative Staphylococcus* (CONS) (20%-32%), Gram Negative Bacilli (GNB) (10%-18%), Non-staphylococcal GPC (including *Enterococci*) (10%-12%), Fungi (<1%) *(Tokars JL., et al., 2002).*Among which *Staphylococcus aureus, Coagulase Negative Staphylococcus* (CONS) are the most common organism causing Catheter Related Infections (CRIs). Resistance of isolates to antimicrobial agents has become increasingly common during last decade, especially Methicillin Resistant *Staphylococcus aureus* (MRSA), Resistant CONS, Vancomycin Resistant *Enterococci* (VRE) are of particular concern. We designed the present study to identify the micro-organisms causing Vascular access Related Infections VARIs in particular Catheter Related Infections (CRI) i.e., Catheter Related Blood Stream Infections (CRBSI), Exit-Site Infections (ESIs), Catheter tip Colonizers and the risk factors of Vascular Access Related Infections among Hemodialysis (HD) patients in Renal Dialysis Unit (RDU) at SRM Hospital, Kattankulathur, thereby Implementing the strategies to control or eliminate VARI.

MATERIALS AND METHODS

The present study was conducted in Renal Dialysis Unit (RDU) at Nephrology Department at SRM HOSPITAL, Kattankulathur. The study protocol was approved by Institutional ethical committee (Ethical clearance number: 47/IEC/2010). Of total 156 out patients with chronic kidney disease (CKD) who underwent chronic hemodialysis, 28 were suspected for VARIs based on CDC guidelines over a period of 10 months (April 2010-Feb 2011). All in Informed consent was taken from each patient after briefing them about the study. Demographic data was collected from medical records.

Inclusion Criteria

Chronic renal failure patients admitted to RDU who have been under vascular access for more than 48 hrs.

Exclusion Criteria

Acute renal failure patients with clinical or lab evidence of another infected site were excluded.

At the time of our study, types of vascular access used in patients included were of AVF (n = 95) and CVCs (n = 61)

Suspicion of vascular access related infections (VARI)

It was based on signs and symptoms: Fever/ Chills/ Hypotension; Erythema/ Pain/ Induration/ Tenderness/ Presence of Purulent discharge at the access site. From those patients, possible samples were collected.

Even all the samples [blood (catheter and peripheral), Exit-site swab [Catheter tip] from single patient also were taken if necessary and possible.

Samples collected: Samples included in our study are as follows: 5-10 ml of blood collected aseptically from both catheter (port) and peripheral; Exit site swab; Catheter tips (suspected and non-suspected patients) removed aseptically.

Clinical suspicion and laboratory confirmation of CRBSI & exit-site infections:

Patients were suspected based on signs and symptoms like fever/ chills/ hypotension, thereby seen for the catheter site for the presence of purulent discharge, if present based on clinician's advice. Catheter tip was collected and semi-quantitative catheter tip culture along with peripheral blood culture (PBC) was done or central venous blood culture (CBC) and peripheral blood culture was done simultaneously where CBC: PBC (5:1) was considered to be significant for CRBSI.

Exit-site Infections: If the patient had erythema/ pain/ induration/ tenderness/ presence of purulent discharge at the catheter site, he was clinically considered for ESI and followed by microbiological confirmation done with any growth of 5CFU and more.

Catheter tip colonization

Semi-Quantitative Catheter tip culture technique (Maki's Roll-plate method): Patients with no signs and symptoms were selected. From them catheter tips were collected aseptically. Following removal of the catheter from the insertion site under aseptic conditions, the distal (~5cm) tip of the catheter was cut and placed in the sterile container for transport to the microbiology laboratory. By Maki's roll plate method, the tip is rolled back and forth on the blood agar plate for atleast four times. After incubation of 48 hrs, a colony count of 15 colonies or greater is significant according to CDC guidelines.

Confirmation of suspected cases by Microbiological analysis

Samples are inoculated onto culture media nutrient agar, 5%sheep blood agar and Mac-conkey agar, Sabouraud dextrose agar and incubated at 37 degree Celsius for 24-48 hrs, followed by growth. It is confirmed by relevant biochemicals and special tests like germ tube for Candida for further categorization [Media procured from HIMEDIA (*Mumbai*). Each batch of media and biochemicals were tested with suitable controls and utilized only if satisfactory]. Antibiogram is done by Kirby-Bauer disk-diffusion method and reported by using CLSI/NCCLS guidelines which will be essential for treatment for the patients in RDU. Categorization of VARI into CRBSI, ESI, and Catheter tip colorizations were done by CDC guidelines (TABLE [1]).

TABLE [1]
DIAGNOSIS OF VARI BASED ON DEFINITIONS

DEFINITIONS GIVEN BY CENTERS FOR DISEASE CONTROL AND PREVENTION (*MMWR March 9,2002;51(RR-10*) FOR CRBSI, BEFORE AND AFTER CATHETER REMOVAL; CATHETER EXIT SITE INFECTION; CATHETER COLONIZATION.

DEFINITIVE CRBSI:

- *Clinical manifestations of infections*: Fever/Chills
- Organism isolated from one or more blood cultures

BEFORE CATHETER REMOVAL

Clinical evidence: Purulent discharge at the catheter insertion site.

Microbiological evidence: Positive Quantitative skin culture or Differential quantitative blood cultures with 5:1 ratio of the same organism isolated from blood drawn simultaneously from the catheter and peripheral vein.

AFTER CATHETER REMOVAL:

Clinical evidence: Responds to antibiotic therapy upon catheter removal after being

refractory to therapy in the presence of the catheter.

Microbiological evidence: Isolation of the same microorganism from the peripheral blood and from semi-quantitative culture of a catheter segment or tip.

EXIT-SITE INFECTION:

Purulent discharge from the catheter exit site or erythematic: tenderness, and swelling within 2 cm of the catheter exit-site.

CATHETER COLONISATION:

Isolation of 15 CFUs of any microorganism by semi-quantitative culture (roll-plate method) from a catheter tip in absence of simultaneous clinical symptoms.

RESULTS

The present study conducted in all out patients who underwent chronic hemodialysis in Renal Dialysis Unit-Nephrology Department at SRM Hospital- Kattankulathur for the period of ten months (APRIL'27 2010 - FEB'27 2011).

The Present study included a total study population of, N=156.The patient characteristics according to Hemodialysis access type are tabulated in TABLE [2].

TABLE [2]
PATIENT CHARACTERISTICS ACCORDING TO HD ACCESS TYPE

CHARACTERISTIC	OVERALL	AVF	CVC
N (%)	N (%)	N (%)	N (%)
NUMBER	156(100)	95(60.9)	61(39.1)
SEX			
Male	113(72.4)	66(69.48)	47(77.04)
Female	43(27.57)	29(30.52)	14(14.74)
AGE(YEARS, MEAN± S.E)	52.25±0.96	51.23±1.1	53.84±1.63
SOCIAL STATUS			
Urban	32(20.5)	19(20)	13(21.3)
Rural	124(79.49)	76(80)	48(78.69)
UNDERLYING DISEASE			
Diabetes Mellitus(DM)	10(6.41)	6(6.31)	4(6.56)
Hypertension(HTN)	64(41.02)	41(43.15)	23(37.70)
Both DM &HTN	49(31.41)	28(29.473)	21(34.43)
Unknown	33(21.15)	20(21.05)	13(21.31)
HEMODIALYSIS DURATION(MNTHS, MEAN±S.E)	27±1.92	30.38±2.74	21.92±2.32
SUSPECTED CASES	28(17.94)	7(7.37)	21(34.43)

Based on *CDC* guidelines, suspicion for VARI was made, thereby suspected cases among study population (156), N=28/156 (17.948%), of which AVF were N=7(25%), CVCs were N=21(75%). The distribution of suspected cases based on clinical criteria is shown in TABLE [3].

TABLE [3]
DISTRIBUTION OF SUSPECTED CASES BASED ON CLINICAL CRITERIA

CLINICAL SIGNS AND SYMPTOMS		FREQUENCY	PERCENTAGE
BASED ON BODY TEMPERATURE	NATURE OF CATHETER ENTRY SITE		
NORMAL	PURULENT	3	10.7
FEVER	PURULENT	7	25
FEVER	NORMAL	10	35.7
FEVER	ERYTHEMA	5	17.86

FEVER	PAIN	1	3.57
CHILLS	NORMAL	2	7.14

Among suspected cases of catheterized patients (21) who met the criteria clinically, it was found, N=14/21 (66.66%) infected and none of AVF patients (7) with confirmed cases of VARI.VARI includes, CRBSI - N=11/14 (78.571%), Catheter Related Infections - N=3/14 (21.428%).This categorization made based on CDC definitions TABLE [1].

Among catheterized patients with no signs and symptoms (40), catheter tips, N=7 were collected. Of which N=4 /7 (57.142%) had catheter colonization. Therefore, INFECTIONS N=14/18 (77.8%) and COLONIZERS 4/18 (22.2%) were found during the study. The patients' characteristics for Catheter Related Infections and Non-Infected TABLE [4]

TABLE [4]
PATIENT CHARACTERISTICS FOR CRIs AND NON-INFECTED

CHARACTERISTIC	OVERALL	INFECTED	NON-INFECTED
N (%)	**N (%)**	**N (%)**	**N (%)**
NUMBER	61(100%)	18(29.5%)	43(70.5%)
	SEX		
Male	47(100%)	13(27.65%)	34(72.34%)
Female	14(100%)	5(35.71%)	9(64.3%)
	AGE(YEARS)		
<45	12(100%)	3(25%)	9(75%)
45-52	9(100%)	3(33.33%)	6(66.67%)
53-60	20(100%)	5(25%)	15(75%)
>60	20(100%)	7(35%)	13(65%)
	SOCIAL STATUS		
Urban	13(100%)	3(23.08%)	10(76.92%)
Rural	48(100%)	15(31.25%)	33(68.75%)
	UNDERLYING DISEASE		
DM	4(100%)	2(50%)	2(50%)
HTN	23(100%)	7(30.43%)	16(69.57%)
BOTH	21(100%)	7(33.33%)	14(66.67%)
IDIOPATHIC	13(100%)	2(15.39%)	11(84.61%)

In our study, highest risk of infection was found in permanent catheters than temporary catheters. Based on anatomical catheter site, FVC N=3/5 (60%) was found to be at more risk of infection in the study FIGURE [1].

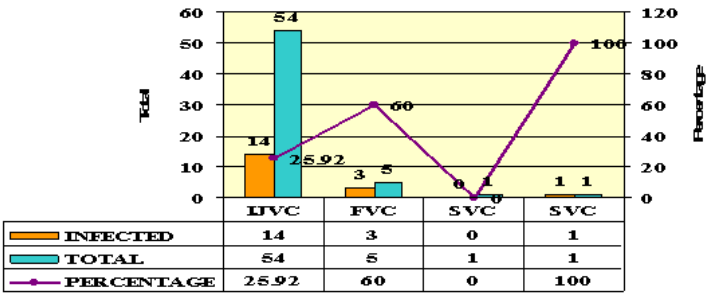

FIGURE [1]
SHOWS THE HIGHEST RISK OF INFECTIONS BASED ON ANATOMICAL CATHETER SITE

Organisms were distributed based on Gram staining and morphology, GPC 16/19 (84.2%); GNB 3/19 (15.8%).In the study, among the microbial isolates, *Staphylococcus aureus* (6/19) and *Coagulase Negative Staphylococcus* (CONS) (6/19) were common with the percentage of 31.6%, followed by *Enterococci species* (3/19) 15.8%; *Pseudomonas aeruginosa* (2/19) 10.5%; Escherichia coli (1/19) and *Candida non-albicans* (1/19) with 5.3%. The distribution of microbial isolates from blood (CRBSI); catheter tip (catheter colonization), exit-site swab (exit-site infections) are separately shown in TABLE [5].

TABLE [5]
DISTRIBUTION OF MICROBIAL ISOLATES FROM BLOOD (CRBSI); CATHETER TIP (CATHETER COLONIZATION), EXIT-SITE SWAB (EXIT-SITE INFECTIONS)

ORGANISMS	CRBSI		CATHETER COLONISERS		ESI		TOTAL	
	N	%	N	%	N	%	N	(%)
S.aureus	4	36.36	2	40	0	0	6	31.57
CONS	4	36.36	1	20	1	33.33	6	31.57
Enterococci	2	18.18	1	20	0	0	3	15.8
E.coli	1	9.09	0	0	0	0	1	5.26
P.aeruginosa	0	0	1	20	1	33.33	2	10.52
Candida-non albicans	0	0	0	0	1	33.33	1	5.26
Total	11	100	5	100	3	100	19	100

Note: The above table shows among 11 cases of CRBSI 4 cases is due to S.aureus (36.36%) and out of 5 catheter colonizers 2 i.e., 40% caused by S.aureus. Also the commonest organism isolated causing VARI is S.aureus with the percentage of 31.57%.

Based on antibiogram, *Staphylococcus aureus* showed 33.33% (2/6) resistance to oxacillin and Enterococci showed 33.33% (1/3). The only *Escherichia coli* was found to be MDR type.

DISCUSSION

Proper vascular access is necessary for successful HD. In our study, based on percentage analysis hypertension was the leading cause of CKD with 41.02%.Similarly, *Kieren A. Marr., et al., 1996* findings gives hypertension as the leading cause with 75%.
Vascular access types involved in our study among the study population include, Arterio-Venous Fistula (AVF), N=95 (60.9%) and Central Venous Catheters (CVCs), N=61 (39.1%). Further the CVCs are of two types based on nature of catheter, i.e., Temporary catheters (non-tunneled, non-cuffed), N=60/61 (98.36%); Permanent catheters (tunneled, cuffed), N=1/61 (1.64%).Similar report was found in other study from Casablanca Morocco, where the rate of temporary catheter use was quite high (86.3%) *(Ghislaine M., et al., 2006).* The usage of temporary catheter was variable (15.0-60.0%) in the studies published from United States *(Astor BC, et al., 2001; Ravani P., et al.,2002).* The *reason* behind high usage of temporary catheter was due to late diagnosis of CKD and late referral to nephrologists and vascular surgeons for timely construction of AV fistula *(Rodriguez Hernandez JA., et al 2007).*Based on the anatomical site of insertion, types include Internal Jugular Venous Catheters (IJVC), N=54 (88.52%); Femoral Venous Catheters (FVC), N=5 (8.2%); Subclavian Venous Catheters (SVC), N=2 (3.28%).In our study the commonly used catheter was IJVC followed by FVC and then SVC. In our study, VARI includes, CRBSI - N=11/14 (78.571%), Exit-site infections - N=3/14 (21.428%).This

categorization made based on CDC definitions TABLE [1]. Similarly According to *Balwait and Rezabek (2002),* vascular access-related infections account for 50%-73% of bacteremias *Oliver et al (2000*) conducted a prospective study of 218 patients who required temporary uncuffed hemodialysis catheters and reported a 13.9% incidence of ESIs. Among catheterized patients with no signs and symptoms (40), catheter tips, N=7 were collected. Of which N=4 /7 (57.142%) had catheter colonization. Similar results in one study were 15 of 28 catheter tips analyzed showed bacterial growth (53.5%) *(De Freitas LW., et al., 2008).*

Infections due to catheters (CRIs); N=18/61.Therefore Prevalence of HCRIs among catheterized patients is 29.508%. Similar studies show that there were 11 (19.3%) patients who developed HCRI *(Zahid Nabi., et al., 2009).*

Prevalence of *VASCULAR ACCESS RELATED INFECTIONS* among HD patients is 11.538% (N=18/156).Similar studies made, where a total of 65 (34.6%) patients had a VAI during the study period *(Qasaimeh., et al ., 2008).*

Highest risk of infection was found in permanent catheters than temporary catheters. Based on anatomical catheter site, FVC N=3/5 (60%) was found to be at more risk of infection in the study. Among 3 infected, 2 cause CRBSIs 2/3 (66.67%).Use of femoral venous catheters is a major risk factor for catheter-related bloodstream infection *(Ishizuka M., et al., 2009).*Femoral catheter insertions have been associated with an increased risk of infection *(Merrer et al., 2001; Oliver et al., 2000).*The *disadvantage of the femoral site* is that it presents a field that is potentially contaminated because of the proximity of the perineal area. This may relate to accumulation of sweat and moisture around the exit site. In our study more than the recommended days were in place, which also is the reason of the highest infection rate among femoral catheters. According to NKF/KDOQI Guideline #6 of the 2000 Clinical Practice Guidelines for Vascular Access (NKF, 2001), which recommends that femoral-inserted catheters should be placed for no longer than 5 days from time of insertion. Femoral catheters are more susceptible to infections than thoracic catheters *(Zaleski GX., et al., 1999).*

In the study, among the microbial isolates, *Staphylococcus aureus* (6/19) and Coagulase Negative *Staphylococcus* (CONS) (6/19) were common with the percentage of 31.6%,followed by *Enterococci species* (3/19) with 15.8%; *Pseudomonas aeruginosa* (2/19) 10.5%; *Escherichia coli* (1/19) 5.3% and *Candida non-albicans* (1/19) 5.3%.

Similar results as of our study is *(Wenzel., et al., 1983),* the microorganisms most frequently involved are gram positive (*Staphylococcus aureus* and CONS), fungi (*Candida sps*), and gram negative *(Pseudomonas aeruginosa). Staphylococci species* is the most frequent isolated microorganism in CRIs and the reason ,since they are the predominant aerobic skin microorganism found on the skin of patients and hands of health care workers *(Hanna et al., 2001; Pearson, 1996; Piraino, 2000).*Similarly, *E. coli* is also found on the skin. The high occurrence of E. coli infections may be due to poor hand hygiene and inadequate or improper use of sterile technique *(Schwab SJ and Beathard G., 1999).*

40% catheter tips were colonized with *S.aureus,* 20% were *P.aeruginosa,* 20% were CONS, and 41.9% catheter tips were found to be colonized by *Staphylococcus epidermidis*, 35.4% by *Staphylococcus aureus,* and 3.2% by *P .aeruginosa (Abid Latif Qureshi and Kauser Abid 2010).* The resistant pattern of the organisms in our study suggests the liberal usage of antibiotics. The limitation of the study is the MIC of the resistant drugs were not determined.

Finally, we conclude that the pattern of pathogenic organisms of HCRIs observed in this study was similar to other studies, and thus we have identified the VARI in our hospital, also their prevalence and risk factors associated with VARI. A *septic* technique (*CDC guidelines for prevention of intravascular catheter –Related Infections, 2011*) in catheter manipulations may prevent VARIs and administration of antibiotics with proper dose and duration may save catheters. Surveillance for vascular access related

infections should be recommended as a routine activity in HD facilities (Inf.control Hosp Epidemio 2002; 23: 538-541)

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