

**SURVEILLANCE OF VASCULAR ACCESS RELATED INFECTION IN CHRONIC HEMODIALYSIS PATIENTS**

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**ABSTRACT:****Background:**

Access continues to be the most problematic aspect of dialysis treatment. Patients on maintenance hemodialysis had the highest risk of contracting a serious bloodstream infection that required admission to the intensive care unit. Central line-associated bloodstream infections (CLABSIs) are known as one of the major reason of hospital acquired infections, leading to life-threatening complications, reporting around 80 thousand cases per year from patients admitted in intensive care units, this number will raise dramatically if non ICU patients are also included. Mortality rate due to CLABSIs is reported as 25% of total infectious diseases mortalities.

**Objective:**

To evaluate the safe access for dialysis which can decrease the chances of infection and improve patient's prognosis, secondary objective of the study is to document dialysis event.

**Methodology:**

Prospective, cross sectional, follow up, analytical study was conducted at the hemodialysis unit, of Tabba Kidney Institute, Karachi. Patients on maintenance hemodialysis, aged from 18 to 70 years, both gender, vascular access including non-cuffed, cuffed and Arterio-venous fistula were included in the study. Three types of dialysis events (DEs) according to center of Disease and Prevention (CDC) were reported, Intravenous antimicrobial, Positive blood culture and Infection at the local vascular access site. Statistical package of social sciences (SPSS) version 22 was used, to enter, sort and analyse the data. The P-value of < 0.05 was considered as significant.

**Results:**

Total 72 patients completed the follow-up duration, mean age of study participants was  $61.4 \pm 13.3$  years. Hypertension was most frequently reported comorbidity with 31 (43%) followed by diabetes mellitus. Vascular access was categorized as non-cuffed, cuffed and AVF groups with frequency of 27 (37.5%), 27 (37.5%) and 18 (25%) respectively.

In non-cuffed group, 9(12.5%) positive blood cultures, 6(8.3%) local site infection, 13 (18%) IV antimicrobial treatment and 19 (26.3%) total Dialysis events were documented. In Cuffed group, 4 (5.5%) positive blood culture, 3 (4.1%) local site infections, 9 (12.5%) IV antimicrobial treatment and 11 (15.2%) total dialysis events were documented. AVF group had no positive blood culture, 1 (1.3%) local site infection and 1 (1.3%) IV antimicrobial treatment and 1 (1.3%) total dialysis event were documented.

**Conclusion:**

Patients undergoing central venous catheterization are susceptible to a number of illnesses, including sepsis. However, the burden of these problems can be lessened with appropriate catheter insertion technique and cleaning. Furthermore, Patients who are undergoing for hemodialysis should be educated for better and permanent vascular access that is arterio-venous fistula (AVF).

**Keywords:** Hemodialysis, Catheter, AVF, End stage renal disease, Mortality

**INTRODUCTION:**

Chronic kidney disease (CKD), defined by World Health Organization (WHO) as "Kidney damage or an estimated glomerular filtration rate (eGFR) less than 60 ml/min/1.73 m<sup>2</sup> persisting for three months or more, irrespective of the cause" is known as raising global concern for increased morbidity, mortality and financial burden on population<sup>1-2</sup>. Diabetes mellitus (DM) is reported to be the major determinant of CKD, an estimated prevalence report has indicated approximately 5.2 million adults of Pakistan living with DM in Pakistan in 2000s, and this number has been amplified to 33 million in 2021, encountering 3% out of 58% of total reported deaths in Pakistan due to non-communicable diseases during 2016<sup>3-4</sup>. CKD progress to declining eGFR to  $\leq 15$  mL/min, defined as End Stage Renal Diseases (ESRD) needs renal replacement therapy (RRT), an estimated prevalence rate was reported as 220,000-275,000 new patients of RRT every year<sup>5</sup>. One of the most frequent reasons for hospitalization, morbidity, and mortality among dialysis users is still infection. In a research of 332,442 incident individuals with end-stage renal disease (ESRD) receiving dialysis in the United States, the cumulative annual incidence of hospitalization attributable to infection was found to be 26% for children and 31% for adults<sup>6</sup>.

A comparative analysis of data from the United States Renal Data System (USRDS) shows that the annual mortality rate secondary to sepsis was 100–300 times higher in patients receiving dialysis treatment than in the general population<sup>7</sup>. Access continues to be the most problematic aspect of dialysis treatment, Patients on maintenance haemodialysis had the highest risk of contracting a serious bloodstream infection that required admission to the intensive care unit (relative risk 208.7, 95% confidence interval [CI] 142.9–296.3), according to a population-based study on the epidemiology of severe bloodstream infection<sup>8</sup>. The clinical relevance of bloodstream infection in patients receiving haemodialysis is widely documented. Worldwide, between 20% and 60% of haemodialysis patients require grafts or catheters, at least in part due to the unsuitability of their arteries for the development of fistulas<sup>9</sup>. An appropriate vascular access is necessary for haemodialysis to be effective. For individuals with chronic kidney disease (CKD), an arteriovenous fistula (AVF) is advised as a definitive access.

When compared to a double lumen catheter, the AVF has fewer problems and offers better vascular access for dialysis<sup>10-11</sup>. However, the primary patient reasons linked to a delay in the development of an AVF were denial of renal disease or the requirement for an AVF (76.4%), dialysis anxieties and practical concerns (75.9%) and patient refusal (73.1%). The two most significant hospital and physician factors were inadequate predialysis treatment and education (63.7%) and delayed referral to a nephrologist (56.6%)<sup>12</sup>.

Although the catheter approach has certain advantages, the frequency of problems that come makes it a less desirable option<sup>6</sup>. It has complications, just like any other procedure, some of which are potentially fatal. Pneumothorax, hematoma, hemorrhage, infection, and extravasation are among the complications associated with central line implantation<sup>13</sup>.

Central line-associated bloodstream infections (CLABSIs) are known as one of the major reason of hospital acquired infections, leading to life-threatening complications,<sup>12</sup> reporting around 80 thousand cases per year from patients

admitted in intensive care units, this number will raise dramatically if non ICU patients are also included. Mortality rate due to CLABSIs is reported as 25% of total infectious diseases mortalities.<sup>11-13</sup> The population and environment have an impact on the occurrence of CLABSIs worldwide.<sup>11</sup> The frequency of CLABSIs can be slightly high in healthcare environments like hospitals and long-term care facilities.<sup>14</sup> In developing country like Pakistan, the cost of treatment is considered as remarkable strain on financial strength of patient's family. Associated factors such as type of central line used, population, patient's comorbidities and weak immune systems are also linked with higher incident of CLABSIs.<sup>13</sup> This study aims to evaluate the safe access for dialysis which can decrease the chances of infection and improve patient's prognosis, secondary objective of the study is to document dialysis event.

**METHODOLOGY:**

Prospective, cross sectional, follow up, analytical study was conducted at the hemodialysis unit, of Tabba Kidney Institute, Karachi. Study was conducted from 25<sup>th</sup> October 2023 till 23 march 2024, for the duration of 06 months. Patients 18 to 70 years of age, were included in the study. Sample size was calculated with the help of WHO sample size calculator, using total dialysis patients registered at the time of study in Tabba Kidney Institute, as population (n=350) with confidence interval of 95% and margin of error as 5%, the minimum required sample size was **85**.

Patients on maintenance hemodialysis, aged from 18 to 70 years, both gender, vascular access including non-cuffed, cuffed and Arterio-venous fistula were included in the study. Consent form in the language of understanding was presented to potential study participants, upon signing informed consent a pre-structured questionnaire containing demographic details, laboratory investigation and, vascular access details were filled. Dialysis events, culture and sensitivity were recorded during six months follow up.

Three types of dialysis events (DEs) according to Canters for Disease and Prevention (CDC) were reported:

Event Type	Date of Event Criterion
IV antimicrobial start	Date of first outpatient dose of an antimicrobial course
Positive blood culture	Date of specimen collection
Pus ,redness or increased swelling at vascular access site	Date of onset
Combination	Earliest date of the three types

Intravenous antimicrobial:

Requirement of intravenous (IV) antibiotics or antifungals to treat diagnosed or suspected infection, even only been receiving therapy for one day, was considered and dialysis event, IV antivirals and oral antibiotics were not included.

Positive blood culture:

All positive blood cultures obtained from outpatients and those obtained from inpatients one day following their hospital admission are documented. All positive blood cultures must be reported in accordance with CDC procedure, even if it is believed that the infection is not to be true or unrelated to Hemodialysis.

Infection at the local vascular access site:

Any redness, pus discharge or swelling at the vascular access site was documented regardless of whether the patient received treatment for infection or not.

The 21-day rule was implemented in accordance with the CDC DE procedure to avoid reporting two events that could be connected as separate incidents.

According to the 21-day rule, an event may only be regarded as unique if it has occurred at least 21 days after a potential prior incident involving the same patient.

Statistical package of social sciences (SPSS) version 22 was used, to enter, sort and analyse the data. To assess the normality of data, Shapiro-Wilk test was used, and continuous variables were evaluated and represented in mean and standard deviation. The evaluation of two categorical variables were analysed with the help of cross-tabulation, chi-square test was used to identify the significance of two mean values. The P-value of < 0.05 was considered as significant.

**RESULTS:**

Out of 85 patients enrolled in the study, 09 patients were identified as lost to follow up and 04 patients expired during study. Total 72 patients completed the follow-up duration, mean age of study participants was 61.4 ± 13.3 years. From 25<sup>th</sup> October 2023 till 23 march 2024, total 85 patients were enrolled in the study, while 72 completed the study. 28 (38.8%) females and 44 (61.1%) male participants were included, overall etiology of study participants identified as Bilateral small size kidney as most frequently reported with 37 (51.3%), followed by Diabetic nephropathy in 22 (30.5%). Hypertension was most frequently reported comorbidity with 31 (43%) followed by diabetes mellitus and hypertension in combination with 21 (29.1%), the p-value of etiology and comorbidities were 0.031 and 0.052 respectively. (Table 01)

Table I: Descriptive demographics of study participants.

Variables		Frequency	Percent	P-Value
Etiology of Chronic Kidney Disease	Bilateral Small Size Kidney	37	51.3	0.031
	Diabetic Nephropathy	22	30.5	
	Obstructive Uropathy	3	4.1	
	Rapidly progressive Glomerular nephritis	1	1.3	
	Autosomal dominant polycystic kidney disease	3	4.1	
	Multiple Myeloma	1	1.3	
	IgA Nephropathy	1	1.3	
Comorbidities	Hypertension	31	43	0.052
	Diabetes Mellitus and Hypertension	21	29.1	
	Diabetes Mellitus, Hypertension and Cardiovascular disease	9	12.5	
	Hypertension and Cardiovascular disease	5	6.9	

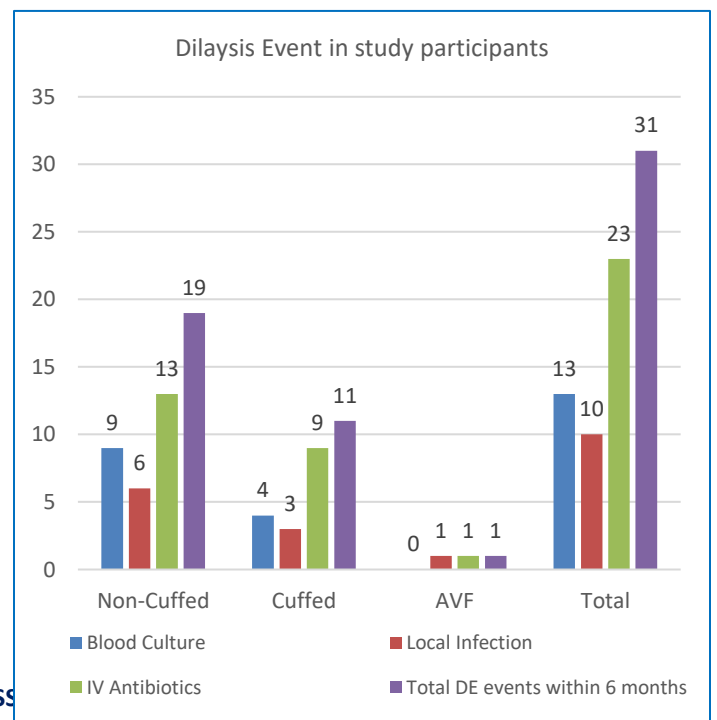
Hypertension and Stroke	3	4.1
Diabetes Mellitus	1	1.3
Diabetes Mellitus and Cardiovascular Disease	1	1.3
Diabetes Mellitus, Hypertension, Cardiovascular Disease and Stroke	1	1.3

Vascular access was categorized as non-cuffed, cuffed and AVF groups with frequency of 27 (37.5%), 27 (37.5%) and 18 (25%) respectively.

Upon categorizing vascular access, Dialysis events were recorded within 6 months. In non-cuffed group, 9(12.5%) positive blood cultures, 6(8.3%) local site infection, 13 (18%) IV antimicrobial treatment and 19 (26.3%) total Dialysis events were documented. In Cuffed group , 4 (5.5%) positive blood culture, 3 (4.1%) local site infections, 9 (12.5%) IV antimicrobial treatment and 11 (15.2%) total dialysis events were documented. AVF group had no positive blood culture, 1 (1.3%) local site infection and 1 (1.3%) IV antimicrobial treatment and 1 (1.3%) total dialysis event were documented.

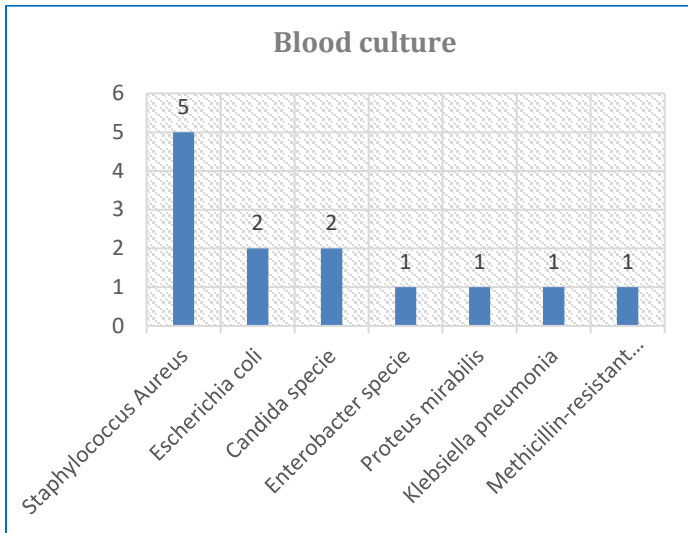
Within six months total positive blood culture were 13 (18%), local site infections were 10 (13.8%), IV antimicrobial requirement were 23 (31.9%) and overall DE of 31 (43%) respectively. Highest to lowest recorded from non-cuffed → cuffed → AVF (Fig 02) Also, within 6 months, the frequency of changing of vascular access from previous one to new one (due to infection, undesirable outcome or for better access), in non-cuffed group was 1.7 times (45/26), in cuffed group was 0.6 time (18/27) and in AVF group was 0.2 time (5/19) lesser required in AVF group.

Fig II: Dialysis event frequency in study participants.



Most frequently reported microorganism was staphylococcus aureus in 5 (6.9%) followed by Escherichia coli in 2 (2.7%) and Candida specie 2 (2.7%). Remaining microorganism were Enterobacter specie, Proteus mirabilis, Klebsiella pneumoniae and methicillin-resistant Staphylococcus aureus (MRSA) were reported in 1 (1.3%) patient per microorganism respectively. (Fig III)

Fig III: Microorganisms reported in blood culture of study participants.



Vancomycin was most frequently used antibiotic in 12 (16.6%) patients, followed by Meropenem in 6 (8.3%), Ertapenum 2 (2.7%) and Fluconazole 2 (2.7%). Piperacillin + Tazobactam was used in only 1 (1.3%) patients.

Table II: Frequency of IV Antimicrobial used in study participants.

Frequency of IV Antimicrobial		
Drugs	N	Percentage
Vancomycin	12	16.6
Meropenem	6	8.3
Ertapenum	2	2.7
Fluconazole	2	2.7
Piperacillin + Tazobactam	1	1.3

## DISCUSSION:

Patients undergoing hemodialysis need a vascular access, such as a catheter, graft, or AVF. Significant morbidity and mortality are caused by bloodstream infections and localised infections of the vascular access site in patients receiving

hemodialysis.<sup>13</sup> Hemodialysis vascular access methods include arteriovenous fistulas made from the patient's own blood vessels, arteriovenous grafts made mostly of synthetic materials, tunneled central lines, and non-tunneled central lines, in increasing order of risk of infection. Hemodialysis patients are particularly vulnerable to infection by bacteria that are resistant to antibiotics due to their frequent hospital stays and usage of antimicrobial medications.<sup>14-15</sup> Patients with HD have a yearly death rate of 23%, infections rank as the second most prevalent cause of death, with sepsis being the most common infectious cause of death in ESRD patients.<sup>16-17</sup> According to many studies, 0.63–1.7% of patients get BSI per month, and 1.3–7.2% of patients experience vascular access site infections (with or without blood stream infection) each month. Among 230 HD-associated infections in HD patients.<sup>18-19</sup> The current investigation used the same monitoring technique used by the CDC in the United States to assess the incidence of HD-associated infection in our institution. First, one of the biggest risk factors for infections linked to HD is the presence of underlying disorders.<sup>20</sup> The population under investigation was representative of industrialised nations, with roughly 40% of instances of HD being diagnosed as diabetic nephropathy.<sup>21</sup> It is hard to completely rule out the impact of intrinsic risk factors for HD-associated infections, nevertheless, because CDC census statistics do not account for the incidence of underlying disorders or dialysis indications. Compared to 31% of CDC patients, the majority of ESRD patients (> 70%) had fistula treatment. Vascular catheterization rates were 15.4% and 28.2%, respectively.<sup>22-24</sup> In the absence of sepsis, catheter removal without tip culture is advised by the guidelines set out by the Infectious Diseases Society of America. Nevertheless, since a systemic inflammatory response syndrome is present in 80% of patient days, this guideline cannot be implemented in the intensive care unit. Furthermore, we discovered that 2,854 (87 %) of the 3,276 catheters in ICUs in a previous prospective randomised research had systemic inflammatory response syndrome.<sup>25</sup> Furthermore, colonisation has been shown to be a reliable indicator of bloodstream infection associated with catheter use. In the end, it is thought that a negative quantitative or semi-quantitative catheter-tip culture rules out CRI.<sup>26</sup> In 43.8% of the patients, a systemic infection was detected.<sup>28</sup> According to the current study, Staphylococcus infections were the most prevalent form of infections. This is consistent with the findings of Ratnaja and Susan<sup>29</sup>, who showed that 35–62% of patients receiving hemodialysis had S. aureus infections. According to a research by Astor<sup>30</sup> and his colleagues, 35–62% of hemodialysis patients had nasal carriage of Staphylococcus aureus (S. aureus), which may have put these patients at risk for S. aureus. According to Jean et al., patients with nasal colonisation had the highest rate of S. aureus-related bloodstream infection (CRBSI) with central venous catheters; in over 50% of the infected patients, the same strain of S. aureus was discovered in both the catheter and the nose (or skin).<sup>31-33</sup> It is advisable to follow absolutely aseptic procedures when passing hemo-dialysis catheters, particularly each time a member of the medical staff touches the catheters while doing dialysis. Besides, local disinfectant should be given while handling during session and antibiotic lock with heparin may be of great benefit to lower incidence of infection. Local antibiotics, such as mupirocin ointment, have also been demonstrated to be useful in treating localised infections when necessary.<sup>34</sup> Systemic antibiotics are advised for illnesses that are more

widely distributed. The fact that this was a single centre study with a small sample size places limitations on our research. A greater number of participants would be necessary to demonstrate a more robust correlation between hemodialysis and related bloodstream infections. Second, due to our inability to maintain a long-term follow-up with our patients, we were unable to detect any potentially fatal consequences from these bloodstream infections later in life.

#### CONCLUSION:

Patients who are waiting for the creation of a permanent vascular access for hemodialysis will inevitably need to utilise hemodialysis catheters. Patients undergoing this central venous catheterization are susceptible to a number of illnesses, including sepsis. However, the burden of these problems can be lessened with appropriate catheter insertion technique and cleaning. Furthermore, prompt treatment after these infections have begun can help avoid potentially fatal consequences. To lessen the burden of morbidity and mortality in hemodialysis patients, clinicians should be well-versed in addressing such problems. Patients who are undergoing for hemodialysis should be educated for better and permanent vascular access that is arterio-venous fistula (AVF).

#### DECLARATIONS:

Authors declared no conflict of interest.

No funding (agency or individual) are included.

Ethical approval was taken prior to data collection.

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