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SURVEILLANCE OF VASCULAR ACCESS RELATED INFECTION IN CHRONIC HEMODIALYSIS PATIENTS

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ABSTRACT

Background:

Access remains the most challenging component of dialysis care. The risk of developing a serious bloodstream infection that necessitated admission to the intensive care unit was highest among patients receiving maintenance hemodialysis. One of the main causes of hospital acquired infections is recognized to be central line-associated bloodstream infections (CLABSIs), which can result in life-threatening complications, which account for about 80,000 cases annually from patients admitted to intensive care units (ICUs). If non-ICU patients are also included, this number will increase significantly. According to reports, 25% of deaths from infectious diseases are attributable to CLABSIs.

Objective:

To assess the dialysis access that is safe and can reduce the risk of infection. Documenting dialysis events is the study's secondary goal.

Methodology:

A prospective, cross-sectional, analytical follow-up study was carried out at the Tabba Kidney Institute's hemodialysis unit in Karachi. The study included patients with vascular access,

including non-cuffed, cuffed, and arteriovenous fistula, which were receiving maintenance hemodialysis and ranged in age from 18 to 70 years. According to Centres for Disease and Prevention (CDC) reports, three types of dialysis events (DEs) were recorded: IV antimicrobial, positive culture of blood, and vascular access local site infection. Version 22 of the Statistical Package of Social Sciences (SPSS) was used to input, organize, and analyze the data. A P-value of less than 0.05 was regarded as noteworthy.

Results:

A total of 72 patients finished the follow-up period, with a mean age of 61.4 ± 13.3 years among study participants. With 31 (43%) cases reported, hypertension was reported the most common comorbidity 31 (43%) cases, followed by diabetes mellitus.

The frequency of different types of vascular access was divided into three groups: non-cuffed, cuffed, and AVF, with respective frequencies of 27, 27 and 18.

6 infections at the local site and 9 positive blood cultures were reported. 13 patients received IV antimicrobial treatments, and total 19 dialysis events recorded in non-cuffed group.

3 infections at the local site and 4 positive blood cultures were reported. 9 patients received IV antimicrobial treatments, and total 11 dialysis events recorded in cuffed group.

1 infection at the local site and 0 positive blood cultures were reported. 1 patient received IV antimicrobial treatments, and total 1 dialysis events recorded in AVF group.

Conclusion:

Patients awaiting the establishment of a permanent vascular access for hemodialysis will inevitably need hemodialysis catheters. Patients who have this kind of central venous catheterization are at risk for several infections, including sepsis. However, with the right

catheter insertion technique and cleaning, the burden of these issues can be reduced. Furthermore, patients must educate about the safest vascular access that is arteriovenous fistula.

Keywords: Hemodialysis, End Stage Renal Disease, Non-cuffed Catheter, Cuffed Catheter, Arteriovenous fistula.

INTRODUCTION:

The World Health Organization (WHO) defines chronic kidney disease (CKD) as "Kidney damage or an estimated glomerular filtration rate (eGFR) less than 60 ml/min/1.73 m2 persisting for three months or more, irrespective of the cause." CKD is associated with a higher risk of morbidity, mortality, and financial burden on the raising population. [1-2]According to reports, diabetes mellitus (DM) is the major cause of chronic kidney disease (CKD). In Pakistan, there were an estimated 5.2 million adults living with DM in the 2000s, and by 2021, there were 33 million. DM-related deaths accounted for 3% of all non-communicable disease-related deaths in Pakistan in 2016[3-4]. When eGFR declines to less than 15 mL/min, it is referred to as end-stage renal disease (ESRD) and requires renal replacement therapy (RRT). An estimated 220,000–275,000 new RRT patients are diagnosed with CKD each year.[5] Infection remains one of the most common causes of hospitalization, morbidity, and death among dialysis patients. A study conducted on 332,442 end-stage renal disease (ESRD) incident patients receiving dialysis in the US revealed that the cumulative annual incidence of hospitalization due to infection was 26% for children and 31% for adults[6].

The annual mortality rate due to sepsis was 100–300 times higher in dialysis patients than general population, according to a comparative analysis of data from the United States Renal

Data System (USRDS) [7]. Access remains the most challenging component of dialysis care. A population-based study on the epidemiology of severe bloodstream infection found that patients receiving maintenance hemodialysis were most at risk of developing a serious bloodstream infection that necessitated admission to the intensive care unit (relative risk 208.7, 95% confidence interval [CI] 142.9–296.3) [8]. Bloodstream infections have a documented clinical significance for patients undergoing hemodialysis. Globally, grafts or catheters are necessary for 20% to 60% of haemodialysis patients, partly because their arteries are not suitable for the formation of fistulas[9]. An adequate vascular access is required for effective hemodialysis. As a definitive access, an arteriovenous fistula (AVF) is recommended for people with chronic kidney disease (CKD).

The AVF has less issues and provides better vascular access for dialysis than a double lumen catheter[10-11]. However, the main patient reasons associated with a delay in the development of an AVF were patient refusal (73.1%), anxiety and practical concerns related to dialysis (74.9%), and denial of renal disease or the need for an AVF (76.4%). Inadequate pre-dialysis treatment and education (63.7%) and delayed referral to a nephrologist (56.6%) were the two most important hospital and physician factors. [12]

Even though the catheter approach has some benefits, the frequency of issues with it makes it a less preferred choice[6]. Like any procedure, it can have complications, some of which could be fatal. Among the side effects of central line implantation are pneumothorax, hematoma, bleeding, infection, and extravasation. [13]

Approximately 80,000 cases of central line-associated bloodstream infections (CLABSIs) are reported annually from patients admitted to intensive care units (ICUs). If non-ICU patients are also included, this number will increase significantly. CLABSIs are recognized as a primary

cause of hospital acquired infections, which can result in life-threatening complications[12]. According to reports, CLABSIs account for 25% of all infectious disease deaths. [11-13] The global incidence of CLABSIs is influenced by both the environment and the population[11]. Healthcare settings such as hospitals and long-term care homes may have a slightly elevated incidence of CLABSIs. [14] The financial burden of medical expenses on a patient's family is significant in developing nations such as Pakistan. Higher incidence of CLABSIs is also associated with concomitant conditions, population, type of central line used, and comorbidities of patients and weakened immune systems. [13]

The primary goal of this research is to assess safe dialysis access, which can lower the risk of infection and enhance patient outcomes. Documenting dialysis events is the study's secondary goal.

METHODOLOGY:

A prospective, cross-sectional, analytical follow-up study was carried out at the Tabba Kidney Institute's hemodialysis unit in Karachi. The study was carried out for six months, starting on October 25, 2023, and ending on March 23, 2024. Participants in the study ranged in age from 18 to 70. The minimum required sample size was 85. The sample size was determined using the WHO sample size calculator, using the total number of dialysis patients registered at the time of the study at Tabba Kidney Institute as the population (n=350), with a 95% confidence interval and a 5% margin of error.

The study included patients with vascular access, including non-cuffed, cuffed, and arteriovenous fistula, who were receiving maintenance hemodialysis and ranged in age from 18 to 70. Potential study participants were given a consent form in the language of understanding,

and after signing it, they filled out a pre-structured questionnaire with information about their demographics, the results of a laboratory investigation, and their vascular access. During the six-month follow-up, dialysis events, culture, and sensitivity were documented.

The Centers for Disease and Prevention (CDC) reports three different types of dialysis events (DEs): (Table 1)

Kind of Event	Event Date
IV antimicrobial initiation	The initial date of an antimicrobial course as outpatient
Positive culture of blood	The specimen collection date
Pus, redness, or swollenness at the site of vascular access	The beginning date
Combination	earliest date among the three categories

Intravenous antimicrobial:

Dialysis events was considered as those requiring intravenous (IV) antibiotics or antifungals to treat an infection that has been diagnosed or suspected, even if the patient has only been on therapy for one day. IV antivirals and oral antibiotics were not included in this definition.

Positive blood culture:

All positive blood cultures are recorded, including those from inpatients taken the day after their hospital admission and those from outpatients. It is mandatory to report any positive blood cultures in compliance with CDC protocol, even in cases where the infection is thought to be unrelated to hemodialysis.

Infection at the nearby vascular access site:

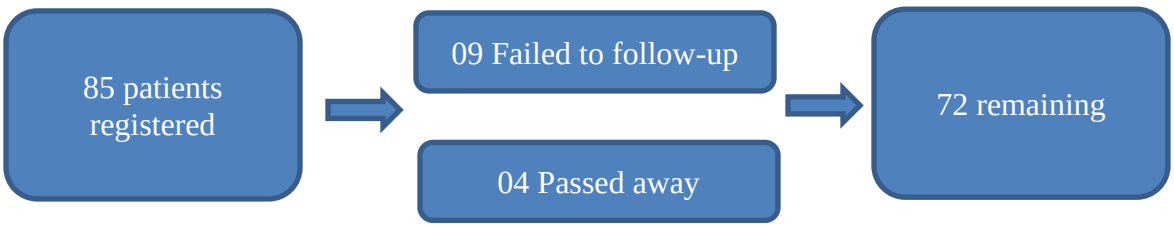
Regardless of whether the patient received any treatment or not. Any redness, pus discharge, or swelling at the vascular access site was noted.

The CDC DE procedure called for the implementation of the 21-day rule in order to prevent two events that might be related from being reported as separate incidents. As per the 21-day rule, an occurrence can be considered distinct if it has take place after 21 days following a previous incident involving the same patient.

Version 22 of the Statistical Package of Social Sciences (SPSS) was used to input, organize, and analyze the data. Utilizing the Shapiro-Wilk test, continuous variables were examined and expressed as mean and standard deviation in order to determine whether the data were normal. Cross-tabulation was utilized to assess two categorical variables, and the chi-square test was employed to determine the significance of two mean values. A P-value of less than 0.05 was regarded as noteworthy.

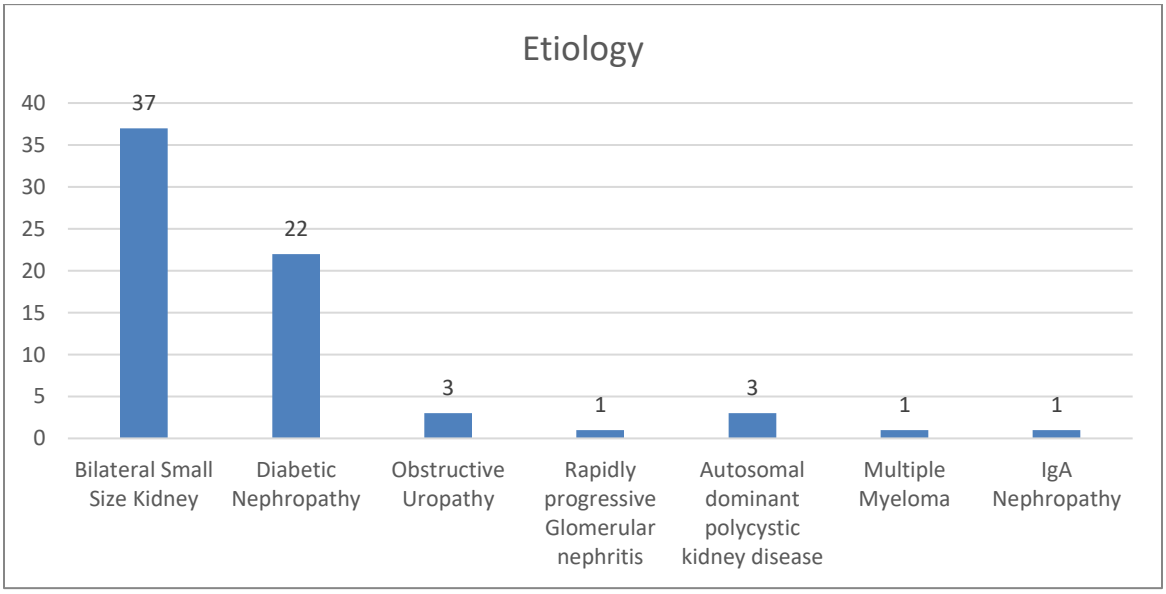
RESULTS:

Of the 85 patients who were recruited for the study, 9 were found to have been lost to follow-up, and 4 passed away while the study was underway. (Figure 01)



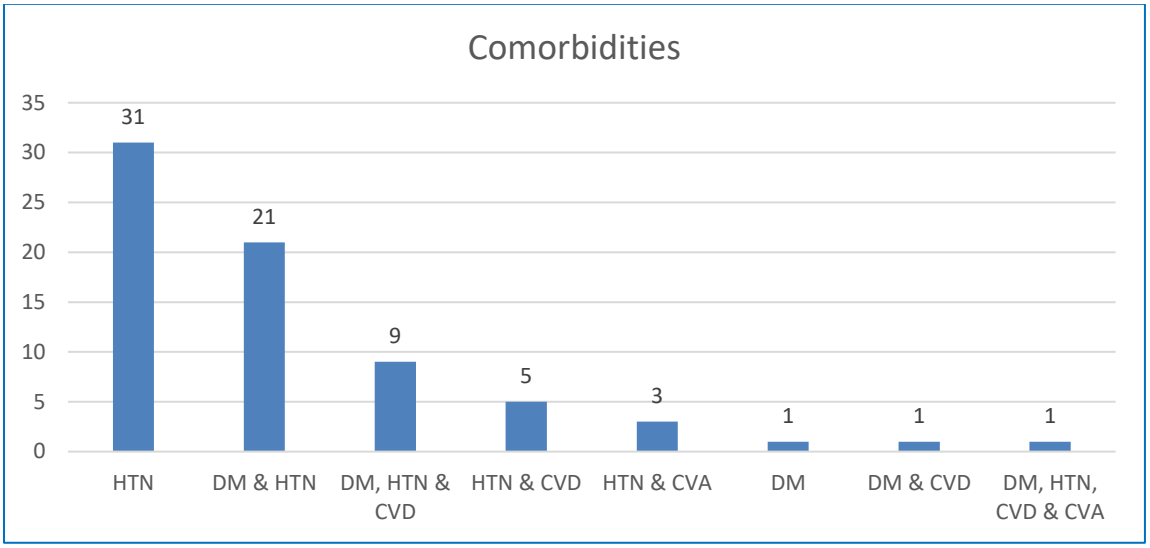
A total of 72 patients finished the follow-up period, with a mean age of 61.4 ± 13.3 years among study participants. A total of 85 patients were enrolled in the study between October 25, 2023, and March 23, 2024; 72 of those patients finished the study. Included in the study were 28 (38.8%) female participants and 44 (61.1%) male participants. The most common etiology reported by study participants was bilateral small size kidney, with 37 (51.3%), followed by diabetic nephropathy in 22 (30.5%). (Fig 02)

Fig I: Etiology of CKD in study participants



The most common comorbidity reported was hypertension, with 31 cases (43%) followed by diabetes mellitus and hypertension together with 21 cases (29.1%); the p-values for the comorbidities and etiology were 0.052 and 0.031, respectively. (Fig 03)

Fig II: Reported comorbidties in study participants



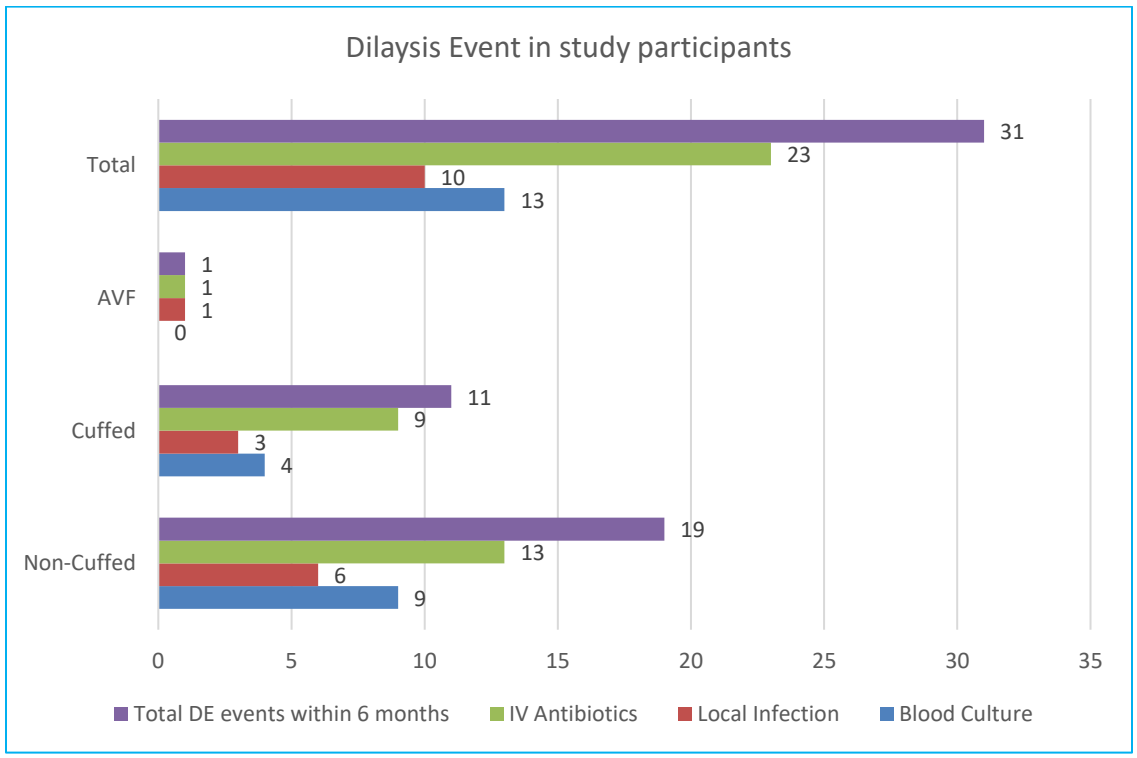
The frequency of vascular access was divided into three groups: non-cuffed, cuffed, and AVF, with respective frequencies of 27 (37.5%), 27 (37.5%) and 18 (25%).

Within six months of classifying vascular access, dialysis events were documented.

Nine (12.5%) positive blood cultures, six (8.3%) local site infections, thirteen (18%) IV antibiotic treatments, and nineteen (26.3%) total dialysis events were recorded in the non-cuffed group. Nine (12.5%) IV antimicrobial treatments, four (5.5%) positive blood cultures, three (4.1%) local site infections, and eleven (15.2%) total dialysis events were recorded in the Cuffed group. There were no positive blood cultures in the AVF group, 0ne (1.3%) local site infection, one (1.3%) IV antibiotic treatment, and one (1.3%) total dialysis event recorded.

Thirteen (18%) of the total samples had positive blood cultures within six months, ten (13.8%) had local site infections, twenty-three (31.9%) had IV antibiotic requirements, and thirty-one (43%), had overall DE. Peak to minimum values observed between uncuffed → cuffed → AVF (Fig 04).

Fig IV: Dialysis event frequency in study participants



Additionally, within a 6-month period, the frequency of switching from one vascular access to another (for better access, or unfavorable outcome or infection on previous one) was 1.7 times (45/26) in the non-cuffed group, 0.6 times (18/27) in the cuffed group, and 0.2 times (5/19) in the AVF group—less frequently in the AVF group.

Staphylococcus aureus was the most commonly reported microorganism, accounting for 5 times (6.9%), followed by Escherichia coli 2 times (2.7%), and Candida specie 2 times (2.7%). The remaining microorganisms included methicillin-resistant Staphylococcus aureus (MRSA), Proteus mirabilis, Enterobacter specie, and Klebsiella pneumoniae, each of which was identified one time (1.3%) each.

Out of 23 patients who received IV anti-microbial therapy, 12 patients (52%) received vancomycin the most frequently, followed by six (26%), two (8.6%), two (2.7%), two (8.6%)

and one (4.3%) patient received Ertapenum, Meropenem, Fluconazole and Piperacillin + Tazobactam respectively. (Table 02)

Table II: Percentage of Antimicrobial among 23 patients who received IV therapy.

Percentage of different antimicrobial	
Antimicrobial	Percentage
Vancomycin	52
Ertapenum	26
Meropenem	8.6
Fluconazole	8.6
Piperacillin + Tazobactam	4.3

DISCUSSION:

Hemodialysis patients require a vascular access, such as an AVF, graft, or catheter. Bloodstream infections and localized infections of the vascular access site are major causes of morbidity and mortality in hemodialysis patients. [13] Arteriovenous fistulas created from the patient's own blood vessels, arteriovenous grafts primarily composed of synthetic materials, tunnelled central lines, and non-tunnelled central lines are the vascular access techniques used in hemodialysis, in increasing order of risk of infection. Patients on hemodialysis are especially susceptible to antibiotic-resistant bacteria because of their frequent hospital stays and use of antimicrobial drugs. [14-15]

The annual mortality rate for patients with HD is 23%; infections are the second most common cause of death, and sepsis is the most common infectious cause of death for patients on ESRD. [16-17] Numerous studies report that monthly rates of vascular access site infections (with or without blood stream infection) range from 1.3 to 7.2% and BSI, respectively, from 0.63 to 1.7% of patients. Among 230 infections in HD patients that are related to HD[18-19]. The monitoring method utilized in this investigation was the same one employed by the US CDC to determine the frequency of HD-associated infections at our facility. First, having underlying disorders is one of the biggest risk factors for infections related to HD.[20] The study population was representative of developed countries; approximately 40% of cases of HD were associated with a diagnosis of diabetic nephropathy. [21]

However, because CDC census statistics do not account for the incidence of underlying disorders or dialysis indications, it is difficult to fully rule out the impact of intrinsic risk factors for HD-associated infections. More than 70% of ESRD patients received fistula treatment, compared to 31% of CDC patients. The percentages of vascular catheterization were 15.4% and 28.2%, correspondingly. [22–24] The Infectious Diseases Society of America's guidelines recommend catheter removal without tip culture when sepsis is not present. Nevertheless, this recommendation cannot be followed in the intensive care unit because a systemic inflammatory response syndrome manifests in 80% of patient days. In addition, we found that systemic inflammatory response syndrome was present in 2,854 (87%) of the 3,276 catheters in ICUs from a prior prospective randomised study.[25]

Moreover, colonisation has demonstrated to be a dependable marker of a bloodstream infection linked to catheter use. Ultimately, it is believed that CRI is ruled out by a negative quantitative or semi-quantitative catheter-tip culture. [26] There was evidence of a systemic infection in 43.8% of

the patients. [28] The most common type of infections, according to the current study, were Staphylococcus infections. Ratnaja and Susan's [29] findings, which indicated that 35–62% of hemodialysis patients had S. aureus infections, are in line with this. Staphylococcus aureus (S. aureus) was found in both the catheter and the nose (or skin) in 35–62% of hemodialysis patients, according to a study by Astor 30 and his colleagues. This finding may have increased the patients' risk of contracting S. aureus. [31–33] When passing hemo-dialysis catheters, it is best to adhere to strict aseptic protocols, especially if a member of the medical staff comes into contact with the catheters while performing dialysis. In addition, administering a local disinfectant during handling during a session and combining heparin with an antibiotic lock may significantly reduce the risk of infection. When necessary, local antibiotics like mupirocin ointment have also been shown to be effective in treating localized infections. [34] When treating illnesses that are more widely distributed, systemic antibiotics are recommended. Our research is limited by the fact that this was a single center study with a small sample size. A larger sample size would be required to show a stronger relationship between related bloodstream infections and hemodialysis. Second, we were unable to identify any potentially fatal long-term effects from these bloodstream infections because we were unable to keep a long-term follow-up with our patients.

CONCLUSION:

Patients awaiting the establishment of a permanent vascular access for hemodialysis will inevitably need hemodialysis catheters. Patients who have this kind of central venous catheterization are at risk for several infections, including sepsis. However, with the right catheter insertion technique and cleaning, the burden of these issues can be reduced.

Furthermore, once these infections have started, early treatment can help prevent potentially fatal outcomes. In order to reduce the rate of morbidity and mortality among patients receiving hemodialysis, medical professionals need to be proficient in handling these issues. Also patients must educate about the safest vascular access i.e: arterio-venous fistula and its importance regarding the timely fashioned to reduce the rate of infection of temporary catheter.

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