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Vascular Access Outcomes among Patients on Maintenance Hemodialysis in Perpetual Succour Hospital: A 3-Year Cross-Sectional Analysis

Joel John C. Mejos, Ruben A. Maguad, Grecia P. Darunday, Eratosthenes Polito

Department of Internal Medicine, Section of Adult Nephrology, Perpetual Succour Hospital, Cebu, Philippines
Email: joeljohncmejos@gmail.com

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Abstract

Introduction: Vascular access is the key to the successful management of chronic hemodialysis (HD) patients. Though native arteriovenous fistula (AVF) is considered the access of choice, many patients in our country initiate hemodialysis through the central venous catheter (CVC). Hence, successful HD depends on the creation and maintenance of adequate vascular access. **Methods:** A single-center, cross-sectional study of ESRD patients on maintenance hemodialysis enrolled in Perpetual Succour Hospital Hemodialysis Unit from April 1, 2021, to November 30, 2023, was employed so that vascular access outcomes of patients on maintenance hemodialysis were determined. **Results.** There were 260 hemodialysis patients included, with successful vascular access outcomes (73.13%) and were younger (57.2 ± 14.1). Those who had failed vascular access were females (54.2%), unemployed (61.4%) and had diabetes mellitus (50.6%) as the primary etiology of their ESRD. Those with failed vascular access were hypertensive (86.7%), with a history of CAD and MI (57.8%) and had diabetes mellitus (56.6%). The proportion of those with failed and successful vascular access significantly differs among hypertensives ($p = 0.012$), diabetics ($p = 0.039$), with chronic glomerulonephritis ($p = 0.011$), and those with malignancy ($p = 0.003$). **Conclusion:** In precis, the type of access, interventions carried out, and vascular access site significantly vary between HD patients with unsuccessful vascular access results and those who were successful. Patients with unsuccessful results despite treatment were those who switched to CVC, while most of those with successful vascular outcomes did not change. Reasons for changing vascular access were due to an absence of bruit and the main reason for those with failed access. Successful vascular access outcomes are significant in younger patients, and failed vascular

access is mostly observed in unemployed females with diabetes mellitus.

Keywords

Arteriovenous Fistula, Tunneled Central Venous Catheter (CVC-T), Non-Tunneled Central Venous Catheter (CVC-nT), Synthetic Vascular Graft

1. Introduction

1.1. Background

Hemodialysis (HD) is the most commonly utilized treatment option globally for managing patients with end-stage renal disease (ESRD). The effectiveness of the treatment is greatly influenced by the quality of vascular access and its adequate operation, which impacts the patient's quality of life. Vascular access issues continue to be a major contributor to high rates of morbidity, mortality, and healthcare expenses in this population.

Vascular access is crucial for the success of hemodialysis, as it directly impacts treatment efficacy and patient outcomes. Functional vascular access is mandatory to achieve good levels of dialytic efficiency, and it is considered the lifeline of patients on maintenance HD. Properly functioning vascular access enhances blood flow, minimizing risks of infection and clots [1]. The ideal vascular access should have specific characteristics such as ease of placement, delivery of adequate blood flow for effective dialysis, long-term and good primary patency rates, low complication rates, durability and cost-effectiveness. The arteriovenous fistula (AVF) is the preferred method due to its longevity, lower complication rates, and reduced costs compared to grafts and catheters [2] [3]. Some other types include the central venous catheter, which can be tunneled (CVC-T) or not (CVC-nT); and the synthetic vascular graft. The catheter is essential for emergency onset in HD but is associated with a higher number of infections, higher mortality, and greater costs.

Hospitals across various countries show considerable differences in their vascular access methods for hemodialysis. In the United States, there is a greater dependence on arteriovenous grafts (AVGs), with 58% utilizing grafts [4]. In contrast, arteriovenous fistulas (AVFs) prevail in Europe, comprising 80% of the cases [5], and account for 53% in Canada [6]. In the Philippines, practices related to vascular access for hemodialysis encounter various challenges and trends, with the most frequent vascular access methods being tunneled central venous catheters (CVC-T) and arteriovenous fistulas (AVF), which are less common, especially among new patients. This leads to differing success rates and access duration in the area [7]. Similar practices are noted in the Central Visayas area, where the institution for this research is situated. Consequently, the primary objective of this research is to assess the vascular access results in ESRD patients undergoing mainte-

nance hemodialysis in Perpetual Succour Hospital.

1.2. Significance of the Study

The results of this study would determine the longevity of the different types of vascular access associated with the different factors and demographic profiles of patients on maintenance hemodialysis in our institution. This will provide data on what type of vascular access is more favorable, suitable, and efficient for a particular patient.

1.3. Study Objectives

This study determined the vascular access outcomes of patients on maintenance hemodialysis. Specifically, this study 1) described the clinicodemographic profile of the patients in terms of age, sex, primary etiology of ESRD, employment status, comorbidities, hepatitis status and family history of the disease; 2) determined the vascular access used on the HD patients (AVF/AVG, CVC or IJ); 3) identified interventions performed to maintain vascular access for hemodialysis; 4) determined the categories of the vascular access site; 5) assessed the vascular access outcome; 6) determined the reason and number for vascular access change and the 7) clinical outcome of the HD patients.

2. Review of Related Literature

Vascular access complications remain the leading cause of morbidity among chronic hemodialysis patients. The use of dialysis catheters is associated with a higher risk for bacteremia. Their use is also associated with an inflammatory state and, hence increased cardiovascular risk. Arteriovenous fistulas or grafts, on the other hand, are associated with cardiac remodeling and can induce or aggravate heart failure [8]. In general, it is accepted that the infectious risk of dialysis catheters outweighs the cardiac risk of AV fistulas or grafts. Hence, the policy on vascular access in hemodialysis patients is to promote the use of an AV fistula or graft unless there is severe heart failure, access-induced limb ischemia or a limited prognosis. Based on their retrospective cohort study, dialysis with arteriovenous access is associated with a 39% lower mortality risk than dialysis with a catheter [8].

In the CHOICE study by Astor *et al.* [9], several potential mechanisms have been proposed by which venous catheters may be related to a higher risk for mortality. Catheters provide a lower blood flow rate; therefore, a lower dialysis dose may be achieved. The increased rate of access-related complications may result in more missed or shortened dialysis sessions. This again may lead to a lower dialysis dose, more frequent hospital admissions, and other untoward effects. The study also found a 41% higher risk for infection-related death in patients who were using a catheter as compared with those who were using an AVF.

Moreover, a systematic review and meta-analysis on outcomes of vascular access on hemodialysis by Almasri *et al.* [10] stated that the decision about the type

and location of hemodialysis vascular access is challenging. Arteriovenous fistula (AVF) is recommended as a first-line long-term access but is not always feasible. Consistent with prior research, patency, infection, and mortality outcomes were lowest in AVFs, followed by AVGs and then catheters. Patency was lower in women, the elderly, and those with diabetes.

In the study of Ethier *et al.* [11] on Vascular Access Use and Outcomes, wide variation in VA use remains across countries. AVF has a lower frequency of complications and a lower long-term cost than catheters and grafts and should therefore be favored as the VA of choice. Catheter use has been shown to increase mortality risk after adjustment for many comorbidities. Creation and maintenance of a functional AVF will remain the greatest challenge in the dialysis field. The achievement of target goals can only be achieved through dedicated and sustained teamwork and the development of specific expertise.

3. Methodology

3.1. Study Design and Setting

This is a single-center, cross-sectional study of ESRD patients on maintenance hemodialysis enrolled in Perpetual Succour Hospital Hemodialysis Unit from April 1, 2021, to November 30, 2023. The purpose of this study was to determine the vascular access outcomes of patients on maintenance hemodialysis.

3.2. Population and Sampling Frame

This study is a complete enumeration of all adult patients who were new and or with established chronic hemodialysis who were currently enrolled in the hospital's dialysis center and are undergoing hemodialysis on AVF, IJ catheter, tunneled catheter and AVG were included in this study. Otherwise, if they were anticipated to require hemodialysis for less than 90 days or were terminally ill, the treating team considers them unsuitable to be included in the study.

3.3. Data Collection Procedure

After the approval of the protocol by the Research Technical Committee, it was then submitted to the Research Ethics Committee of the hospital for clearance to proceed. A structured Data Collection Form (DCF) was used to extract the data from the patients enrolled in this study. These data were collected to answer the specific objectives of this study. Once these data were collected using the DCF, it was encoded manually in the MS Excel Spreadsheet and was further analyzed using Jamovi 2.4.7.

3.4. Statistical Analysis

Categorical data were summarized and shown as frequency distribution—counts and percentages, whereas continuous data were summarized and displayed as the arithmetic mean and standard deviation. The chi-square test was mainly employed to assess the relationship between categorical variables, including patient

profiles, types of vascular access, interventions conducted, and access sites, with another categorically summarized variable related to vascular access outcomes for HD patients. Logistic regression was then employed to jointly analyze all the variables that were found significant in bivariate analysis for associations when assessed together. A two-tailed p-value < 0.05 was deemed significant.

3.5. Ethical Consideration

The study was conducted in compliance with the ethical principles set forth in the Declaration of Helsinki and National Ethical Guideline for Health and Health-related Research (2017). Prior to the study initiation, the protocol was reviewed and approved by the Institutional Review Board of PSH. The researcher ensured that all records from the participants were treated with strict confidentiality. Patient's names were not reflected in the file for data analysis. Instead, only the numbers which correspond to their names in the source code were seen. The source code was in possession of the researcher only. Only the researcher and the biostatistician had the sole access to collected data. Excel sheets for data processing did not contain any information that would give away the identity of patients. Also, this paper is self/department-funded since this is a requirement of the subspecialty training program of the hospital and is not financially or in any aspect supported by a drug company or an individual who might benefit from the results of the study.

4. Results

Table 1. Clinicodemographic Profile of the HD Patients.

Profile	All HD Patients *n* = 260	Vascular Access Outcomes		p-value
		Failure *n* = 83	Success *n* = 177	
Age, years	59.0 ± 14.6	62.8 ± 15.1	57.2 ± 14.1	0.004
Sex				
Male	113 (43.5)	38 (45.8)	75 (42.4)	0.605
Female	147 (56.5)	45 (54.2)	102 (57.6)	
Employment				
Unemployed	148 (56.2)	51 (61.4)	95 (53.7)	0.446
Employed	36 (13.8)	9 (10.8)	27 (15.3)	
Self-employed	78 (30.0)	23 (27.7)	78 (30.0)	
Primary Etiology of ESRD				
ADPKD	5 (1.9)	2 (2.4)	3 (1.7)	0.264
CGN	75 (28.8)	16 (19.3)	59 (33.3)	
DM	116 (44.6)	42 (50.6)	74 (41.8)	
HPN	44 (16.9)	14 (16.9)	30 (16.9)	
DM, HPN	4 (1.5)	2 (2.4)	2 (1.1)	

Continued

GM	4 (1.5)	3 (3.6)	1 (0.6)	
Lupus nephritis	5 (1.9)	2 (2.4)	3 (1.7)	
Obstructive uropathy	2 (0.8)	-	2 (1.1)	
	Comorbidities			
HPN	241 (92.7)	72 (86.7)	169 (95.5)	0.012
DM	123 (47.3)	47 (56.6)	76 (42.9)	0.039
Hx of CAD and MI	126 (48.4)	48 (57.8)	78 (44.1)	0.070
Hx of stroke	10 (3.8)	5 (6.0)	5 (2.8)	0.211
Pulmonary disease	10 (3.8)	5 (6.0)	5 (2.8)	0.211
Liver disease	3 (1.2)	1 (1.2)	2 (1.1)	0.958
Malignancy	9 (3.5)	7 (8.4)	2 (1.1)	0.003
	Hepatitis Status			
Negative both hep B and C	246 (94.6)	79 (95.2)	167 (94.4)	0.911
Hep B positive	8 (3.1)	2 (2.4)	6 (3.4)	
Hep C positive	6 (2.3)	2 (2.4)	4 (2.3)	
	Family History			
ADPKD	2 (0.8)	2 (2.4)	-	0.052
CGN	2 (0.8)	-	2 (1.1)	
DM	102 (39.2)	39 (47.0)	63 (35.6)	
HPN	111 (42.7)	35 (42.2)	76 (42.9)	
HPN, DM	39 (15.0)	7 (8.4)	32 (18.1)	
HPN, ADPKD	2 (0.8)	-	2 (1.1)	
HPN, CGN	2 (0.8)	-	2 (1.1)	

There were 260 hemodialysis patients who were enrolled in PSH from April 1, 2021, to November 30, 2023. Most of them had successful vascular access outcomes, 117 out of 260 (73.13%), and were younger compared to those whose vascular access failed. Those who had failed vascular access were predominantly females (54.2%), unemployed (61.4%), and had diabetes mellitus (50.6%) as the primary etiology of their ESRD. Moreover, they were also hypertensive (86.7%), with a history of CAD and MI (57.8%) and were of course having diabetes mellitus (56.6%). Although most of them were negative for hepatitis B and C, some were found to be positive for hepatitis B (2.4%) and hepatitis C (2.4%). Lastly, those with failed vascular access had a family history of ADPKD (2.4%). Autosomal dominant polycystic kidney disease (ADPKD) is the most common genetic cause of renal failure worldwide. Diabetes mellitus (47.0%) and hypertension (42.2%) are also a common heredofamilial medical condition in most patients. Data showed that the proportion of those with failed and successful vascular access significantly differs among hypertensives ($p = 0.012$), diabetics ($p = 0.039$), and those

with malignancy (p = 0.003) concerning their comorbidities (see Table 1).

Regarding Table 2, the type of access, interventions carried out, and vascular access site significantly vary between HD patients with unsuccessful vascular access results and those who were successful (p < 0.001). A group of these patients had arteriovenous (AV) fistula (80.4%), similar to those with unsuccessful vascular access outcomes (67.5%) and those with successful outcomes (86.4%).

The site of access was primarily on the left brachiocephalic of the patients (37.7%) and aligns with all vascular access results. Mainly, patients underwent no interventions (58.8%), whereas some did (41.2%). Individuals with unsuccessful results despite treatment were those who switched to CVC (45.1%), whereas those who achieved success were on thrombolysis (48.0%).

Table 2. Type of vascular access, interventions performed, and access site of the HD Patients.

Parameters	All HD Patients *n* = 260	Vascular Access Outcomes		p-value
		Failed *n* = 83	Successful *n* = 177	
Type of Access				
AV Graft	3 (1.2)	2 (2.4)	1 (0.6)	<0.001
AVF	209 (80.4)	56 (67.5)	153 (86.4)	
CVC-T	42 (16.2)	24 (28.9)	18 (10.2)	
IJ	6 (2.3)	1 (1.2)	5 (2.8)	
Access Site				
Left brachiocephalic	100 (38.5)	30 (36.1)	70 (39.5)	<0.001
Left CVC-T	1 (0.4)	1 (1.2)	-	
Left femoral	3 (1.2)	1 (1.2)	2 (1.1)	
Left IJ	11 (4.2)	7 (8.4)	4 (2.3)	
Left radio cephalic	48 (18.5)	10 (12.0)	38 (21.5)	
Right brachiocephalic	40 (15.4)	11 (13.3)	29 (16.4)	
Right IJ	35 (13.5)	19 (22.9)	16 (9.0)	
Right radio cephalic	22 (8.5)	4 (4.8)	18 (10.2)	
Interventions Performed				
NONE	153 (58.8)	1 (1.2)	152 (85.9)	<0.001
With Interventions, *n* = 107	107 (41.2)	82 (98.8)	25 (14.1)	
Banding	1 (0.9)	-	1 (4.0)	
Change to CVC-T	40 (37.4)	37 (45.1)	3 (12.0)	
Change to IJ	20 (18.7)	19 (23.2)	1 (4.0)	
Change to AVF/AVG	4 (3.7)	1 (1.2)	3 (12.0)	
Change to femoral catheter	6 (5.6)	6 (7.3)	-	
Fistulogram	9 (8.4)	4 (4.9)	5 (20.0)	
Thrombolysis	27 (25.2)	15 (18.3)	12 (48.0)	

Most of those with successful vascular outcomes did not change access (96.0%) while those who had failed vascular outcomes changed (96.4%) (see Table 3).

Table 3. Proportion of vascular access changed of the HD patients.

Parameters	All HD Patients $n = 260$	Vascular Access Outcomes		p-value
		Failed $n = 83$	Successful $n = 177$	
Access				
Not changed	173 (66.5)	3 (3.6)	170 (96.0)	<0.001
Changed	87 (33.5)	80 (96.4)	7 (4.0)	

Most of the HD patients who were initially on AVF were not given any interventions (69.4%); however, a small proportion were changed to CVC (13.4%) while those on initial CVC-T were given thrombolysis (57.1%) (see Table 4).

Table 4. Vascular access and interventions.

Interventions	Total Patients $n = 260$	Vascular Access			
		AV Graft $n = 3$	AVF $n = 209$	CVC-T $n = 42$	IJ $n = 6$
None	153 (58.8)	-	145 (69.4)	6 (14.3)	2 (33.3)
Banding	1 (0.4)	-	1 (0.5)	-	-
Change to CVC-T	40 (15.4)	1 (33.33)	28 (13.4)	10 (23.8)	1 (16.7)
Change to IJ	20 (7.7)	-	19 (9.1)	1 (2.4)	-
Change to AVG/AVF	4 (1.5)	-	-	1 (2.4)	3 (50.0)
Change to femoral catheter	6 (2.3)	1 (33.33)	5 (2.4)	-	-
Fistulogram	9 (3.5)	-	9 (4.3)	-	-
Thrombolysis	27 (10.4)	1 (33.33)	2 (1.0)	24 (57.1)	-

Table 5. Reasons for vascular access change of the HD patients.

Parameters	All HD Patients $n = 87$	Vascular Access Outcomes	
		Failed $n = 80$	Successful $n = 7$
Reasons for changing			
Developed AVF	3 (3.4)	-	3 (60.0)
Infection	1 (1.2)	1 (1.2)	-
No bruit	53 (60.9)	52 (65.0)	1 (20.0)
Thrombosed	30 (34.5)	27 (33.8)	3 (20.0)

Reasons for changing vascular access were an absence of bruit (60.9%), which is also the main reason for those with failed access (65.0%). Some reasons were

also due to vascular graft thrombosis (33.8%) on those who failed vascular access (see Table 5).

The majority of individuals who survived had effective vascular access (76.8%), but among those with unsuccessful vascular access, the mortality rate was 57.6%. The relationship between patient clinical outcomes (whether deceased or not) and the success or failure of vascular access is statistically significant, $p < 0.001$ (see Table 6).

Table 6. Clinical outcomes of the HD patients.

Clinical Outcomes $n = 260$	Vascular Access Outcomes		p-value
	Failed $n = 83$	Successful $n = 177$	
Alive, $n = 194$	45 (23.2)	149 (76.8)	<0.001
Dead, $n = 66$	38 (57.6)	28 (42.4)	

Lastly, a significant number of patients with AVF were alive (87.6%); however, most of those who died also had AVF (59.1%) as their vascular access, followed by a CVC-T (36.4%) (see Table 7). The proportion of those who were alive and dead among the different types of vascular access significantly differ, $p < 0.001$.

Table 7. Clinical outcomes of different vascular access.

Access	All HD Patients $n = 260$	Clinical Outcomes		p-value
		Alive $n = 194$	Dead $n = 66$	
AV Graft	3 (1.2)	2 (1.0)	1 (1.5)	<0.001
AVF	209 (80.4)	170 (87.6)	39 (59.1)	
CVC-T	42 (16.2)	18 (9.3)	24 (36.4)	
IJ	6 (2.3)	4 (2.1)	2 (3.0)	

5. Discussion

Successful HD lies heavily in the creation and maintenance of adequate vascular access. Central venous catheters have the highest rate of complications associated with decreased survival, while internal arteriovenous fistulas are considered the most favorable vascular access. Although AVF is considered to be the ideal choice of vascular access for hemodialysis, however many patients initiate dialysis through catheters [11]. In this cross-sectional study, most patients on maintenance hemodialysis had AVF (80.4%) as their vascular access and are usually located in the patients' left brachiocephalic area (38.5%).

This is followed by CVC-T, IJ and AVG. In the KDOQI 2019 guidelines for HD patients, the use of AVF is recommended in >66% of patients while use of CVC-T and IJ are for temporary purposes for a limited time period in order to limit infection risk. They emphasize that dialysis access strategy reflects the ESKD Life Plan, whereby the appropriate dialysis access must be individualized in each patient. Successful vascular access outcomes were significant among younger popu-

lations (p-value = 0.004) as compared to the older ones, similar to what is found in this study.

Studies found [12] [13] that an interaction term of age by access type is statistically significant and that patients with an AV fistula who were younger than 65 years old had an estimated risk of access failure that was always lower than for patients older than 65 years old. The younger the patient, the better the fistula survival and the relative risk of fistula failure increased by 40% with each additional 10 years of age until 65 years (p-value < 0.01). Sex, employment status and primary etiology of ESRD did not differ significantly.

With regards to the interventions performed, most of the patients in this study had no interventions done (p-value < 0.001), predominantly those who had AVF as vascular access (69.4%). This is followed by CVC-T, IJ and AVG. Accordingly, vascular access outcomes with or without interventions performed showed that AVF has the highest success rate in this 3-year cross-sectional study (p-value < 0.001). Likely with failed vascular access outcomes, due to a significant number of patients in the study with AVF access, it also has the highest percentage of failed outcomes followed by CVC-T, IJ and AVG.

In those who had failed access outcomes, most of the interventions performed were change to CVC-T (45.1%), followed by a change to IJ (23.2%), thrombolysis (18.3%), change to a femoral catheter (7.3) and fistulogram (4.9%). The absence of bruit and thrombosed access were the leading causes of access change/failure. The success rate in this study is also comparable to a cohort study of 5466 incident patients by Manuel Praga *et al.* [14] that survival was higher in AVF patients in comparison to CVC patients (AVF 88% and 63% at 2 and 5 years respectively and 75% and 48% in CVC patients including tunneled and non-tunneled catheters, p-value: <0.001). The advantages of CVC-T vary in different populations. In the retrospective study by Min *et al.* [15] of 59 patients who used CVC-T as long-term vascular access from 2009 to 2014, the median survival duration was 45 months (95% CI: 29.3 - 69.7 months) and 59 months median survival compared with other access. Advanced age and diabetes mellitus were the significant risk factors in their study, which was affirmed by the findings that most of those whose vascular access failed had type 2 diabetes mellitus.

Lastly, survival outcomes (dead or alive) of patients across all types of vascular access revealed AVF as the highest survival rate, and CVC-T, IJ and AVG have inferior survival rates. These findings did not differ much from the recent literature. However, it is noteworthy that the reasons for changing vascular access are not mainly due to infection but because of the absence of bruit, and patients are eventually thrombosed. When there is an absence of a bruit in vascular access, this indicates potential complications, particularly thrombosis, which was found in this study to be the leading cause of change in vascular access.

6. Conclusion

In precis, the type of access, interventions carried out, and vascular access site

significantly vary between HD patients with unsuccessful vascular access results and those who were successful. Patients with unsuccessful results despite treatment were those who switched to CVC, while most of those with successful vascular outcomes did not change. Reasons for changing vascular access were due to an absence of bruit and the main reason for those with failed access. Successful vascular access outcomes are significant in younger patients, and failed vascular access is mostly observed in unemployed females with diabetes mellitus.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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