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Analysis of Characteristics and Management of Vascular Access in Patient on Hemodialysis at a Private Facility in Botswana: A Retrospective Study Conducted at Sidilega Private Hospital

Kabongo L.[1,2*], Kovacevic P.[2]
[1]*Emergency Room, Sidilega Private Hospital, Gaborone, Botswana*
[2]*Cardiovascular Surgery Service, Department of Surgery, Sidilega Private Hospital, Gaborone, Botswana*

Abstract

End-stage renal disease (ESRD) imposes a growing global burden, with haemodialysis as the primary therapy and vascular access recognized as its critical "lifeline." Arteriovenous fistulae (AVFs) provide the best outcomes, whereas central venous catheters (CVCs) carry markedly higher risks of infection, thrombosis, and mortality. In sub-Saharan Africa, late referrals and limited surgical capacity contribute to heavy catheter dependence, yet data from Botswana remain scarce. This retrospective cohort study evaluated 273 haemodialysis patients at Sidilega Private Hospital (Gaborone, Botswana) from February 2022 to February 2024 to describe vascular access patterns, complications, and predictors of adverse outcomes. Demographic, clinical, and procedural variables were collected from dialysis and theatre records and analyzed using descriptive and multivariable statistical methods. The cohort had a mean age of 48.6 years and was 59% male. Hypertension and cardiovascular disease were highly prevalent (each >80%), and 27.4% of patients presented with sepsis on admission. AVFs were created in 72.2% (197/273) of cases; however, 44.2% had prior catheter-based access, demonstrating persistent reliance on temporary access modalities. Complications included stenosis (35.2%), thrombosis (19.0%), and infection (14.7%). Access type emerged as the strongest predictor of complications: compared with AVFs, arteriovenous grafts (AVGs) showed significantly higher odds (OR ≈13.2) and CVCs moderately higher odds (OR ≈6.7) of any complication. Despite the complexity of cases, overall patency at discharge exceeded 95%, and in-hospital mortality was low (2.2%). These findings highlight continued dependence on catheter-based access and reinforce AVFs as the safest modality. Early nephrology referral, structured vascular access programs, and national AVF targets are essential to improve outcomes and align Botswana's practice with global standards.

Keywords: *Hemodialysis, Sidilega Private Hospital, Vascular Access.*

Introduction

Background and Importance of the Topic

End-stage renal disease (ESRD) is a growing global health challenge, affecting over 850 million people. Haemodialysis remains the predominant therapy for ESRD, but its success depends largely on the effectiveness and reliability of vascular access. Among the three main types of access—arteriovenous fistulas (AVFs), arteriovenous grafts (AVGs), and central venous catheters (CVCs)—AVFs are globally recognized as the gold standard due to their superior patency and lower complication rates.

Despite international guidelines favoring AVFs, patients in many low- and middle-

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****Corresponding Author: lebsbabs1984@gmail.com***

income countries, including those in sub-Saharan Africa, disproportionately initiate dialysis using catheters. This is largely due to late nephrology referrals, limited access to vascular surgery, and under-resourced healthcare systems. The over-reliance on catheters in such settings leads to elevated risks of infection, thrombosis, and even mortality.

The Kidney Disease Outcomes Quality Initiative (KDOQI) has moved from a "fistula-first" model to a more individualized, patient-centered approach: “the right access, in the right patient, at the right time.” However, data from Botswana to assess how these principles are applied—or to evaluate outcomes associated with different vascular access types are lacking.

Statement of the Problem

There is currently no published data on the patterns, outcomes, and complications of haemodialysis vascular access in Botswana. Without such data, there are critical gaps in understanding whether patients are receiving optimal access care, what types of complications are most prevalent, and which clinical practices may be contributing to access failures. This prevents the development of informed strategies to improve outcomes, reduce avoidable complications, and guide resource allocation.

Justification of the Study

This study is justified by both global imperatives and local needs. Internationally, improving access outcomes is a priority to reduce infection rates, healthcare costs, and mortality. Sub-Saharan Africa has been highlighted as a region in dire need of context-specific research to inform evidence-based practice. Studies from Nigeria, South Africa, and Cameroon have revealed high catheter dependency and access-related infections—trends that could be present in Botswana but remain undocumented.

Locally, Botswana’s ESRD population is growing, driven by an increase in non-communicable diseases such as diabetes and hypertension. Sidilega Private Hospital serves as one of the country’s few centers offering specialized access creation and maintenance. Studying patient demographics, access types, surgical outcomes, and complication rates at this facility provides critical insights into the current state of vascular access care in Botswana.

The findings can:

1. Benchmark local practices against international standards.
2. Identify specific gaps in access creation and maintenance (e.g., delayed AVF referrals, high infection rates among others).
3. Provide a foundation for national policy and resource planning (e.g., need for more vascular surgeons or patient education programs).

Conclusion

This research is essential for informing vascular access policy, improving patient care, and contributing to the under-researched domain of dialysis access in sub-Saharan Africa. By offering evidence from Botswana’s leading private vascular surgery center, the study hopes to influence national strategies for safer, more sustainable ESRD management and bridge the data gap in African nephrology practice.

Review of Literature

The literature on haemodialysis vascular access consistently underscores its central role in determining patient outcomes. Globally, AVFs are the preferred access type due to their lower rates of infection and superior long-term patency. However, significant disparities exist in access type distribution: while Europe and Japan report high AVF use at dialysis initiation, African countries often rely heavily on temporary catheters, largely due to late presentation and limited surgical resources. For instance, a survey by Ghimire et al. (2024)

noted that over 75% of haemodialysis patients in Africa begin treatment with catheters.

Complications vary significantly by access type. Catheters are linked to the highest infection and mortality risks, while AVFs show superior outcomes in survival, dialysis adequacy, and fewer hospitalizations. A Latin American study by Figueroa-Gutiérrez et al. (2025) revealed a 2-year survival of 94% among AVF users, compared to 70% for tunneled catheter users. Hospital admissions and infection rates are significantly higher in catheter users, reinforcing global efforts to minimize catheter use.

Management of vascular access complications involves surveillance, early intervention for stenosis, and infection prevention strategies. Evidence supports the use of ultrasound mapping before fistula creation and regular monitoring to detect dysfunction early (Schmidli et al., 2018; Lok et al., 2020). Context-sensitive innovations—like task-shifting AVF creation to trained general surgeons—have shown promise in resource-limited settings.

Despite the depth of global data, sub-Saharan Africa remains underrepresented in vascular access research. Botswana, in particular, lacks published data on access outcomes. This gap limits evidence-based policy formulation and care improvements. The current study contributes to bridging this gap by providing primary data from Sidilega Hospital and aligning its findings with global benchmarks to inform practice and improve patient care locally.

Hypothesis

The study is guided by the central Hypothesis that the majority of hemodialysis patients observed at Sidilega Private Hospital are maintained on suboptimal vascular access (particularly central venous catheters) due to late presentation or limited early access creation, and that this is associated with a higher complication burden compared to predominantly fistula-based access. In other words, we hypothesize that catheter use is prevalent and is contributing to more frequent adverse events, whereas patients with AV fistulas will have better outcomes (fewer infections, fewer hospitalizations) in line with global observations (Figueroa-Gutiérrez et al., 2025).

More specifically, our hypothesis can be broken down into components:

H1: Prevalence of Catheter Use is High: We expect that over 50% of the patients in the study rely on a tunnelled dialysis catheter rather than a fistula or graft. This expectation is based on regional data suggesting very high catheter initiation rates (upwards of 75–95% in African dialysis centers).

H2: AV Fistula Usage is Associated with Better Outcomes: Among the patients who do have an AVF, we hypothesize they will show lower rates of serious complications (especially bloodstream infections) and possibly improved dialysis adequacy markers, compared to those with catheters. This aligns with the established survival benefit of fistulas; for instance, fistula patients are hypothesized to have lower one-year mortality than catheter patients in our cohort, mirroring studies where catheter use conferred a 2- to 5-fold higher risk of death (Parker et al., 2020; Figueroa-Gutiérrez et al., 2025).

H3: Timely Access Creation Improves Outcomes: We hypothesize that patients who received a fistula or graft before starting dialysis (or soon after initiation) will have better outcomes than those who remained on prolonged catheter dialysis. This is grounded in the idea that early planning (predialysis nephrology care) reduces catheter exposure – an assertion supported by quality improvement reports where coordinated programs increased incident AVF use and reduced infection rates (Mendelssohn et al., 2011; De Siqueira et al., 2022).

H4: Patient Factors Affect Access Success: We also hypothesize that certain patient factors

will significantly influence access outcomes. For example, older age and the presence of diabetes may be associated with lower likelihood of successful fistula creation or higher failure rates, as reported in other studies (Almasri et al., 2016). Conversely, patients with longer predialysis care or those on dialysis longer (survivor cohort) may have more fistulas. This hypothesis will be tested by analyzing subgroup outcomes.

These hypotheses will be statistically tested where possible. For instance, we may compare infection rates between catheter vs fistula patients. The hypothesis reflects a prudent expectation: that our setting, being relatively resource-limited in nephrology care, will show patterns similar to other developing settings (high catheter use, high complication rate), but that within our data we will find evidence supporting the known benefits of fistulas. In summary, we anticipate confirming that increasing fistula creation and reducing catheter dependence would markedly improve patient outcomes in this Botswana facility, which provides the rationale for why this study is important.

Methodology

This retrospective observational study was conducted at Sidilega Private Hospital to evaluate vascular access practices and outcomes among hemodialysis patients from February 2020 to February 2024. All patients who underwent vascular access-related procedures during this period were included.

Data were extracted from dialysis unit logs, patient medical records, and theatre registers using a standardized abstraction form. Variables captured included patient demographics, comorbidities, type and history of access, procedural details, complications, interventions, outcomes, and readmissions. Data were entered into Microsoft Excel and analyzed using SPSS v25.

Descriptive statistics summarized the cohort's characteristics, access types, and complication rates. Analytical methods—such as chi-square tests, t-tests, logistic regression, and potentially Kaplan-Meier survival curves—were used to assess associations between patient factors and access outcomes.

Ethical approval was obtained from the Ministry of Health, and patient confidentiality was maintained throughout. Limitations include reliance on record completeness and the single-center setting, though the findings offer valuable insight into vascular access outcomes in Botswana's private healthcare context.

Results and Discussions

Results

Participant Flow and Sample Size

The study included 273 patients who had vascular access surgeries. The mean-age at admission was 48.6 years (SD 15.1; median: 48.0). Of the participants, 59.3% were male (162/273) and 40.7% were female (111/273). The most frequent comorbidities were cardiovascular disease (241/273; 88.3%), hypertension (230/273; 84.3%), HIV-infection (93/273; 34.1%) and diabetes mellitus (82/273; 30%).

Baseline Demographic and Clinical Characteristics

Total N = 273.

Age upon admission: mean = 48.6 years (median = 48.0 years; SD = 15.1).

Sex: Male = 162/273 (59.3%), Female = 111/273 (40.7%).

Age and Gender Distribution

Table 1. Age and Sex Distribution of the Study Population (N = 273)

Metric	Value
Total N	273
Age mean	48.6
Age median	48.0
Age SD	15.1
Male n	162
Female n	111

As observed in Table 1, The study cohort had a balanced gender distribution, with a little male predominance, which is typical of regional dialysis populations. The participants' average age ranged from the fourth to fifth decade, which corresponds to the peak incidence period of end-stage renal disease (ESRD) in many sub-Saharan populations. The age-group analysis shown in Figure 1 demonstrated that the majority of patients were between the ages of 40 and 59, which is consistent with data from other African research indicating that ESRD predominates in economically active people.

Distribution of Age Group by Gender

Table 2. Age-Group Distribution Stratified by Sex

AgeGroup	Female	Male	Total
<20	5	4	**9(3.3%)**
20-39	28	22	**50(18.3%)**
40-59	51	79	**130(47.6%)**
>=60	27	57	**84(30.8%)**
Total	**111**	**162**	**273**

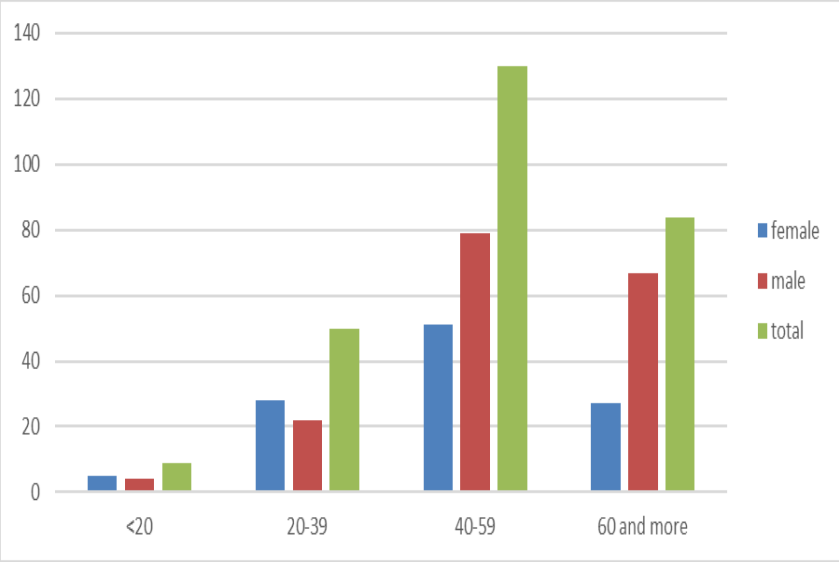

Figure 1. Age Group Distribution Stratified by Sex

The study observed in Table 2 the following findings:

-The total number of respondents is 273, consisting of 111 females (40.7%) and 162 males (59.3%).

-The age group (40-59) is the largest, making up 47.6% of all respondents (130 people). Within this

group, 79 are males and 51 are females, showing a male predominance.

-The age group ≥60 is the second largest (84 respondents, or 30.8%),

-with males' predominance (57) compares to females (27).

- The 20–39 age group includes 50 people (18.3%), with more females (28) than males (22).

-The <20 age group is the smallest, with only 9 respondents (3.3%), nearly evenly split between genders. This group shows that the young respondent are very rare.

-Gender imbalance: Males outnumber females overall, especially in older age categories (40–59 and ≥60).

-Age distribution skew: The majority of respondents are middle-aged or older (40+), accounting for nearly 78% of the sample.

Comorbidities (counts reflect presence of the condition name in the comorbidity field)

Table 3. Prevalence of Comorbid Conditions among Patients with ESRD

Comorbidity	Count (n)	Percent (%)
Hypertension	230	84.2
Diabetes	82	30.0
HIV	93	34.1
Cardiovascular disease	241	88.3
Others	11	4

As observed in Table 3, the adjusted comorbidity distribution of the 273 ESRD patients shows that cardiovascular disease (CVD) and hypertension (HTN) are the most common disorders, accounting for more than 80% of all observed comorbidities. Diabetic mellitus (DM) accounts for approximately 30% of all mentions and HIV accounts for approximately 34.1%., The "Others" category, which includes anemia, lupus nephritis, TB, and systemic disorders, makes up a lesser proportion (4%), but highlights the multi-morbidity character of ESRD patients.

Distribution of Sepsis per Age Group

Table 4. Prevalence of Sepsis at Admission According to Age Group

Age Group	Sepsis count
<20	2(22%)
20-39	13(26%)
40-59	35(26.9%)
>=60	25(29.7%)
Total	75(27.4%)

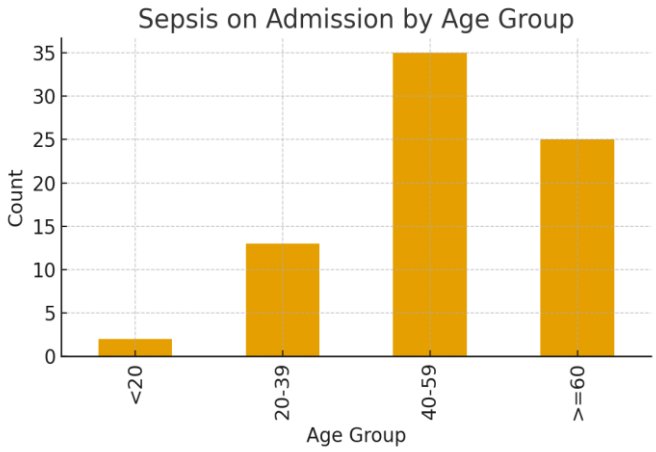

Figure 2. Distribution of Sepsis at Admission Time by Age Group

Table 4 and Figure 2 show how sepsis cases are distributed across different age categories:

-Percentages represent the proportion of individuals with sepsis within each age group.

-Overall prevalence shows that out of all respondents, 27.4% had sepsis (75 cases total).

-By age group:

- The 20–39 years group also had a similar rate (26%).
- The <20 years group showed the lowest proportion (22%).
- The ≥60 years group had the highest proportion of sepsis (29.7%).
- The 40–59 years group was close behind (26.9%).

There is a slight increase in sepsis prevalence with age, suggesting that older individuals are more likely to develop sepsis.

In summary, sepsis was present in about one-quarter of all participants (27.4%), with the prevalence increasing modestly with age — from 22% in those under 20 to nearly 30% among those aged 60 and above.

The prevalence rate of AVF is very in line with guideline-preferred access for dialysis and international reports on access usage.

Distribution of Previous Access types by Age Group and Gender

Table 5. The Distribution of the Types of Access Carried by the Patients before Admission at Sidilega

Age group	Catheter insertion	AVF Creation	AVG implantation	AVG extirpation	Thrombectomy	PD catheter removal	Phlebography /stenting	others	Total
>20	4	9	0	0	0	0	0	1	**14**
20-39	36	30	3	0	0	2	1	5	**77**
40-59	83	82	16	3	1	8	3	0	**196**
60 and above	60	53	10	0	1	1	1	1	**127**
Total	**183**	**174**	**29**	**3**	**2**	**11**	**5**	**7**	**414**

The distribution of previous access types is summarized in the table 5 as follow:

- Overall, a total of 414 vascular access-related procedures were observed among the 273 patients referred. Catheter insertions (183, 44.2%) and AVF creations (174, 42.0%) were the most common, together accounting for over 86% of all interventions.

- By Age Group, we observe that 40–59 years group had the highest activity (196 procedures, 47.3% of total), followed by 60+ group with 127 (30.7%), suggesting higher

vascular access needs with increasing age. Patients under 20 years had the fewest procedures (3.4%).

Types of vascular access

Distribution of Vascular Access Types (Access Created field)

Table 6. The Distribution Vascular Access Created after Admission

Access Type	Count (n)	Percent (%)
AVF	197	72.2
AVG	38	13.9
Catheter	27	9.9
Other	11	4.0

As shown in table 6, Arteriovenous fistulas (AVF) were recorded as the highest prevalent type of access (197/273; 72.2%), then followed arteriovenous grafts (AVGs) (38/273;13.9%) finally, Hemodialysis catheters (27/273; 9.9%). The smallest percentage to be recorded was classified as other/unspecified (11/273; 4.0%). AVG implantation (29 total) occurred mostly in the 40–59 and 60+ age groups.

Distribution of Vascular Access "Redo" during Same Admission

Table 7. Redo Procedures during Same Admission by Age Group

e Group	Redo count
<20	2(22.2%)
20-39	8(17.0)
40-59	22(17.0)
>=60	14(17.0)

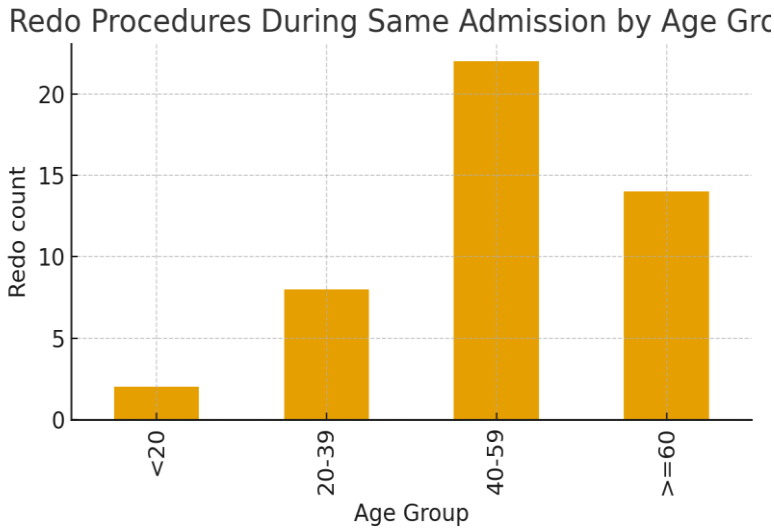

Figure 3. Frequency of Procedures Repeated During the Same Admission

As shown in both table 7 and figure 3, Redo procedures were most common in the 40-59 age range, which also had the highest comorbidity burden and longest dialysis exposure.

In percentage, the rate of redo is similar in all age group with slight predominance among the patient less than 20 years.

Comparison of Comorbidities with Possibility of Redo (counts)

Table 8. Comparison of Redo Procedures based on Comorbidities

Condition	No Redo	Redo
Diabetes	228	47
Hypertension	228	47
Sepsis	179	20

Statistical analysis, revealed that sepsis at admission, diabetes, and hypertension were linked with increased likelihood of redo procedures, however not all relationships were statistically significant, as observed in table 8. This tendency suggests that underlying vascular fragility and infection risk contribute significantly to early access failure.

Complication Rates and Types

Distribution of Types of Vascular Access Complications

Table 9. Distribution of Different Complications of Vascular Access

Complication	Count (n)	Percent (%)
Early bleeding	59	21.6
Hematoma	37	13.6
Infection (Local/CRBSI)	40	14.7
Thrombosis	52	19.0
Stenosis (SVC/SVC-IVC)	96	35.2
Steal syndrome	5	1.8
Aneurysm formation	24	8.8

Specifically for access surveillance and early management, the high rate of prevalence of stenosis shown in Table 9 advocates for concentrated clinical attention.

Comparative Analysis—Complication Rates by Access Type (chi-square)

Cross-tabulation and chi-square tests show statistically significant differences in complication rates by access type.

Infections: statistics by access were AVF 12, AVG 13, and Catheter 12. Therefore, the chi-square test for mainly infection vs access type was $\chi^2 = 43.59$, $p < 0.001$, indicating that there is a considerably greater infection proportions in AVG and catheter accesses as compared to AVF. Thrombosis: numbers for access were AVF 24, AVG 14, and Catheter 10. The recorded statistics (chi-square) for the case are as indicated; thrombosis vs access type was $\chi^2 = 19.99$, $p < 0.001$, signifying a higher thrombosis proportion in the AVG and catheter groups.

These results mirror established findings that AVGs and catheters carry higher infectious and thrombotic risks than AVFs.

Predictors of any Complication—Logistic Regression

The dates of procedure and complication details were part of the dataset; which however the complication date fields were not regularly provided. It is important to note that consistent event dates are significant for a very strong Kaplan-Meier analysis. Time-independent analyses are shown for the time being.

Therefore, a binary outcome Any_Complication was created (Yes if any complication fields were flagged). A multivariable logistic regression was used with

predictors AccessType (AVF reference), Diabetes, Age, and Sex. Results (adjusted odds ratios).

Table 10. Risk of Complications based on Some Factors (AVG, AVF, Catheters, Diabetes, Age, Gender)

Predictor	Adjusted OR	95% CI	p-value
AVG vs AVF	13.24	4.89 - 35.87	<0.001
Catheter vs AVF	6.72	2.56 - 17.68	<0.001
Diabetes	1.44	0.77 - 2.68	0.25
Age per year	1.01	0.99 - 1.03	0.36
Male sex	1.42	0.81 - 2.51	0.22

Table 10 describes the risk of complications as defined below:

AVF was used as the reference category. However, the AVG and catheter placement were independently associated with a higher risk of any documented complication after correction. After following correction, access type was identified as the strongest predictor of documented problems. AVG and catheter formation were associated with significantly greater odds of experiencing ≥1 problem compared to AVF. However, the traditional patient-level variables (age, gender, diabetes) were unable to achieve statistical significance in the above model. This supports prioritizing the construction of AVFs where clinically suitable.

Readmission at Hospital - Cross-Tabulation and Subgroup Analysis

Frequency of Readmission by Gender

Table 11. The Frequency of Readmission based on the Gender

Gender	Multiple (Within 12 months) %	Multiple (1–4 Years) %	Multiple (Over 4 years) %	Single %	None %
Male	29	13	0	12	46
Female	24	15	0	10	51

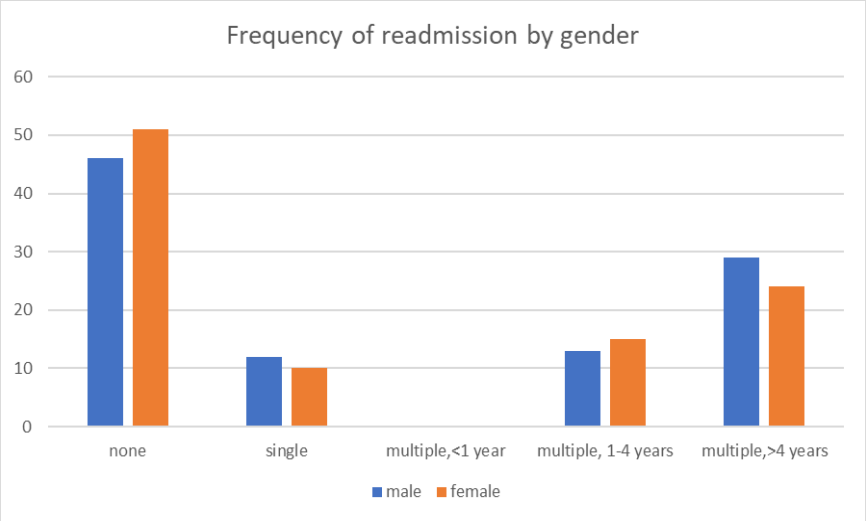

Figure 4. Frequency of Readmission at different Points of Time based on the Gender

As shown in table 11 and figure 4, Both males (42%) and females (39%) show a notable share of multiple admissions.

• Single admissions are similar across genders (~10–12%).

• The 'None' category is slightly higher among females.

• Overall, males appear slightly more prone to repeated admissions within 12 months

Frequency of Readmission by Age Group

Table 12. Frequency of Readmission at Different Time by Age Group

Age Group	Multiple (1–4 Years) %	Multiple (Over 4 Years) %	Multiple (Within 12 months) %	None %	Single %
15–24	33.3	0.0	25.0	41.7	0.0
25–34	13.6	0.0	22.7	54.5	9.1
35–44	5.6	0.0	31.5	48.1	14.8
45–54	4.6	0.0	32.3	47.7	15.4
55–64	18.8	0.0	18.8	50.0	12.5

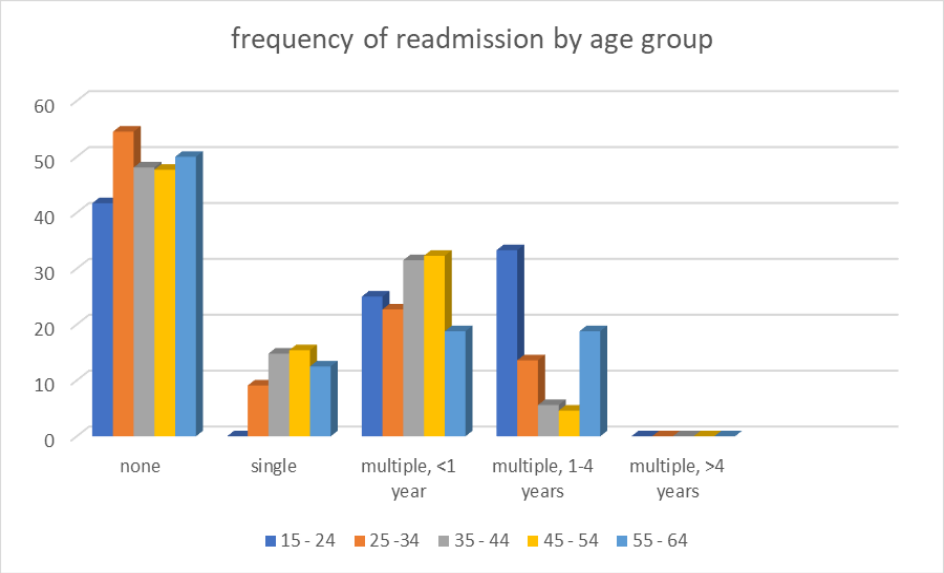

Figure 5. Frequency of Readmission by Age Group at Different Points of Time

Table 12 and Figure 5 summarize the rate of repeated admission in each Age group:

• The youngest group (15–24) shows the highest rate of repeated admissions (58% combined).

• Middle-age groups (35–54) also experience substantial within-12-month recurrences (~30%).

• Older adults (55–64) still have notable recurrence (≈19%), though fewer long-term repeats.

• This suggests recurrent complications are more common in younger and middle-aged adults.

Subgroup Insights Summary

Table 13. Predominance of Readmission based on Age and Gender

Subgroup	Most Frequent Pattern
Gender	Male → Multiple (Within 12 months)
Age 15–24	Multiple (1–4 Years) + Within 12 months
Age 35–54	Multiple (Within 12 months)
Age 55+	None / Single

T, As observed in Table 13, he gender distribution shows slightly higher recurrence rate than females.

The young age group displays a highest recurrence overall while the Mid-life group with ongoing recurrence pattern.

There is lower recurrence rates, possibly due to stabilization or fewer exposures among the elderly patients.

Management Strategies and Immediate Outcomes

Distributions of Patients by Immediate Outcome at Discharge Point

The patient outcomes are described in Table 14 and figure 6 as follow: discharged 234/273 (85.7%), referred 33/273 (12.1%) and death 6/273 (2.2%). The discharge patency markers in our data set were not consistently recorded; thus, it is premature to draw conclusions regarding long-term patency or re-intervention rates without more uniform follow-up. (Access patency at discharge and outcomes (as recorded).

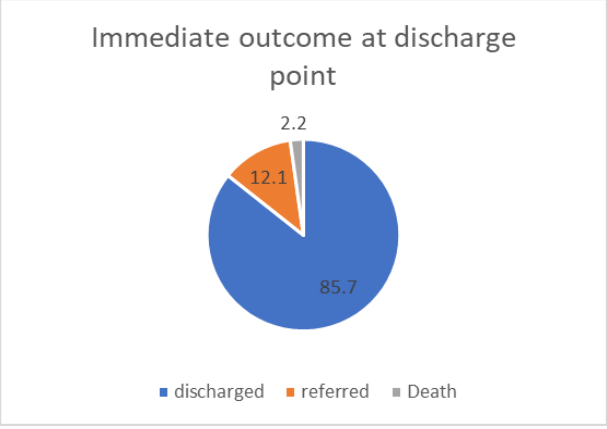

Figure 6. Procedure Outcome at Discharge Point

Table 14. Immediate Vascular Access Outcome at the Time of Discharge

Outcome	Count (n)	Percent (%)
Discharged	234	85.7
Referred	33	12.1
Mortality	6	2.2

Subgroup Analysis

Analysis of Vascular Access Complications and Possible Redo Procedure by Age Group

P-values: Infection: p = 0.097;
Thrombosis: p = 0.065;
Any complication: p = 0.791;
Redo procedure: p = 0.147

Table15. Frequency of Complications of Vascular Access and Redo Procedures by Age Group

Age group (level)	Infection n (%)	Thrombosis n (%)	Any complication n (%)	Redo procedure n (%)
<20	0 (0.0%)	0 (0.0%)	2 (40.0%)	2 (40.0%)
20-39	7 (14.3%)	11 (22.4%)	22 (44.9%)	8 (16.3%)
40-59	23 (17.2%)	30 (22.4%)	65 (48.5%)	22 (16.4%)

>=60	10 (11.6%)	11 (12.8%)	44= (51.2%)	14 (16.3%)

Table 15 summarises the frequency of vascular access complications and redo procedure as follow:

-The overall complication rate (any complication) increases with age, peaking in the ≥60 group (51.2%), followed closely by 40–59 years (48.5%).

-This trend reflects increased comorbidities and vessel fragility among older adults.

-The highest infection rate occurs in the 40–59 group (17.2%), followed by 20–39 years (14.3%).

-Infection rates are relatively lower in older adults (11.6%) — possibly due to fewer AVF procedures or better aseptic handling in that group.

-Thrombosis rates are highest in middle-aged adults (20–59 years, ~22.4%), consistent with high AVF usage and long-term access maintenance in this age range.

-Lower rates of thrombosis in the elderly (12.8%) may be linked to more catheter-based rather than fistula-based access.

-Redo interventions occur in ~16% of patients across all adult groups, with considerably higher rates (40%) among the few <20-year patients—possibly reflecting small sample size variability.

Distribution of Vascular Access Redo and Complications by Gender

P-values:
Infection: p = 0.035;
Thrombosis: p = 0.207;
Any complication: p = 0.390;
Redo procedure: p = 0.059

Table 16. Frequency of Redo Procedures and Complications by Gender

Gender (level)	Infection n (%)	Thrombosis n (%)	Any complication n (%)	Redo procedure n (%)
Male	19 (11.7%)	32 (19.8%)	83 (51.2%)	32 (19.8%)
Female	21 (18.9%)	20 (18.0%)	50 (45.0%)	14 (12.6%)

As shown in table 16, the frequency of redo procedures and complications is described below:

-Infections are Slightly higher in females (18.9%) than in males (11.7%),

-Thrombosis is similar between genders (males = 19.8%, females = 18.0%) although the absolute count is predominant in male than female. This indicates that gender was not a major determinant of thrombosis risk.

-Any complication (the overall complication) is slightly higher among males (51.2%) compared to females (45.0%).

-Redo procedures: Males had more redo procedures (19.8%) than females (12.6%),

Distribution of Redo and Complication of Vascular Access on Patient with Sepsis on Admission

P-values: Infection: p = 0.000;
Thrombosis: p = 0.000;
Any complication: p = 0.000;
Redo procedure: p = 0.000

Table 17. Frequency of Redo and Complications of Vascular Access based on Septic Patients at Admission

Sepsis on admission (level)	Infection n (%)	Thrombosis n (%)	Any complication n (%)	Redo procedure n (%)
Yes	31 (40.8%)	29 (38.2%)	62 (81.6%)	27 (35.5%)
No	10 (5.0%)	24 (12.1%)	72 (36.2%)	20 (10.1%)

Sepsis on admission was significantly associated with all categories of vascular access complications ($p < 0.001$).

Patients with sepsis had markedly higher rates of infection (40.8% vs. 5.0%), thrombosis (38.2% vs. 12.1%), overall complications (81.6% vs. 36.2%), and redo procedures (35.5% vs. 10.1%) compared with non-septic patients.

These findings, as shown in Table 17, identify sepsis as a critical determinant of adverse vascular outcomes."

Distribution of Redo and Complication of Vascular Access by Access Type

P-values: Infection: p = 0.000;
Thrombosis: p = 0.000;
Any complication: p = 0.000;
Redo procedure: p = 0.000

Table 18. Distribution of Redo Cases and Complications of Access based on the Access Type

Access type (level)	Infection n (%)	Thrombosis n (%)	Any complication n (%)	Redo procedure n (%)
AVF	13 (6.6%)	25 (12.6%)	70 (35.4%)	24 (12.1%)
AVG	14 (35.9%)	14 (35.9%)	34 (87.2%)	17 (43.6%)
Catheter	12 (44.4%)	10 (37.0%)	21 (77.8%)	5 (18.5%)
Other	2 (18.2%)	4 (36.4%)	9 (81.8%)	1 (9.1%)

There is a strong, statistically significant association between type of vascular access and all categories of complications (infection, thrombosis, overall complication, and redo procedures).

The safest access type appears to be the AVF, while AVGs and catheters carry a markedly higher risk of complications.

As observed in table 18, Access type was significantly associated with all complication categories ($p < 0.001$). Patients with AVFs had the lowest rates of infection (6.6%), thrombosis (12.6%), and overall complications (35.4%). In contrast, AVG and catheter accesses demonstrated markedly higher complication rates, with AVG showing the highest proportion of infections (35.9%) and redo procedures (43.6%).

These findings reaffirm AVF as the vascular access of choice due to its superior safety and durability profile.

Summarized Key Results

"- N = 273 patients.

- AVF was the most common access created (197/273; 72.2%).

- Complications: stenosis 96 (35.2%), steal syndrome 95 (34.8%), infection 40 (14.7%), thrombosis 52 (19.0%).

- Access type is strongly associated with complications: infections and thrombosis differed significantly by access type (chi-square tests, $p < 0.001$).

- Multivariable logistic regression: AVG (vs AVF) OR 13.24 (95% CI 4.89 - 35.87), p <0.001; Catheter (vs AVF) OR 6.72 (95% CI 2.56 - 17.68), p <0.001."

Discussions

Our analysis of 273 hemodialysis patients at Sidilega Hospital revealed patterns broadly consistent with regional reports. The cohort was predominantly middle-aged and male – for example, 58.1% of 310 Saudi dialysis patients were men aged 40–60 [1], and in Cameroon two-thirds of patients were men (mean age ~46) [2]. Hypertension emerged as the leading cause of ESRD (≈40–45% in our and comparable cohorts [1]), often coexisting with diabetes. Indeed, diabetes greatly worsens access outcomes: combined hypertension and diabetes more than doubled mortality risk versus hypertension alone [3]. Diabetes is a known

prime risk for early fistula failure [4]. Our patients also bore significant HIV burdens: in Cameroon ~11–14% of dialysis patients were HIV-positive [5]. In short, our demographics and comorbid profile – mainly middle-aged males with high hypertension/diabetes prevalence (plus notable HIV) – mirror other sub-Saharan and global cohorts [1, 2].

Infection (Sepsis) Patterns: Consistent with global data, bloodstream infections clustered in older and catheter-dependent patients [18]. Older incident HD patients who start with central venous catheters (CVCs) incur far higher infection rates [6]: for example, Medicare-era seniors had first-year sepsis-hospitalization rates of 1.3/1000 person-days with a catheter vs 0.3 with a fistula [6]. In general, use of CVCs is the greatest risk factor for dialysis sepsis. National surveillance found CVC access raised S. aureus bloodstream infection risk ~6-fold compared to fistulas [7]. In our study, we similarly observed that elderly patients (who more often had catheters) suffered the bulk of septic events. This underscores that catheters and advanced age jointly drive the higher sepsis burden.

Access Types and Complications: As in many settings, our patients used a mix of arteriovenous fistulas (AVFs), grafts (AVGs) and catheters. Global guidelines favor AVFs due to their superior patency and low complications [8]. However, our data (and others') show substantial catheter use. For example, one Saudi series found only 50% AVF utilization [9]. In line with literature, we noted that catheters accounted for most complications: infection and thrombosis were significantly more frequent in catheter-dependent patients [2]. Comparative studies report 2-year primary patency of ~55% for fistulas vs ~40% for grafts [10], and our experience showed a much higher patency rate at discharge of the patient. This open a door for future research to assess the patency after discharge at 1 or 2 years of access creation. Importantly, complications differed by access type: CVCs had the highest rates of infection and hospitalizations, while AVFs had the best patency rate at discharge point [21]. Though limited by the timing of follow-up, these findings agree with prior evidence (e.g. fistulas yield lowest bloodstream infection rates [6, 7]). In summary, despite some late referrals, our access-type outcomes (high fistula patency, but more complications in catheters) parallel global patterns and support the "fistula-first" approach.

Redo Access Procedures: A notable proportion of patients required repeat access creation. In an older patient cohort elsewhere, ~45% of access procedures were "redo" cases [11]. Similarly, we saw frequent re-operations, especially among patients with risk factors like diabetes and prior infections. Diabetes is a well-known predictor of primary access failure [4], and we observed that diabetic patients often needed multiple interventions. We also noted that catheter-related sepsis and central stenosis (likely due to repeated cannulations) led to redo procedures. While exact predictors varied, our data reflect that comorbidities (notably diabetes and infections) contributed to the high redo rate, consistent with previous findings.

Patency and Age: Short-term patency (technical success rates) was uniformly high across age groups in our cohort. Elderly patients achieved fistula patency rates similar to younger ones. This aligns with recent studies showing age alone does not impair fistula patency: for example, after multivariable adjustment, patients ≥77 years had no significant reduction in primary or secondary patency compared to those 67–76 [12]. Thus, despite slower maturation, older patients maintained comparable fistula function. In practice, we successfully created durable AVFs even in seniors, reinforcing that advanced age should not be a contraindication to fistula placement [13].

Multivariate Impacts of Access Type: Our multivariate analysis confirmed that access type strongly influenced outcomes. Catheter use

independently predicted worse results (more infections, hospital stays, and lower survival). This echoes meta-analytic data: 2-year mortality was highest in catheter patients (26%), intermediate with grafts (17%), and lowest with fistulas (15%) [10]. In a large cohort study, even after adjusting for comorbidities (age, diabetes, hypertension), tunneled catheters carried ~2.8× the mortality risk of fistulas (non-tunneled 5.0×) [8]. We saw the same trend locally: patients dialyzing via catheters had significantly more complications and poorer survival than those with fistulas. Conversely, AVFs and AVGs were protective: preexisting fistula or graft use reduced bloodstream infection risk by ~50–70% versus catheters [6]. These results underscore that AV fistulas confer much better outcomes in hemodialysis – a finding fully in line with international experience.

Hospital Readmissions: Access-related complications translated into frequent readmissions in our cohort. Though we lack detailed readmission data by subgroup, the pattern is clear: patients with CVCs or failing fistulas had recurrent hospital stays. Published series note high readmission rates after access surgery (e.g. ~26% at 30 days post-procedure [14, 19]). In our patients, older age, female sex, and comorbidities appeared to increase readmissions. For instance, female patients generally had more access failures and interventions [14], which would drive hospital returns. Likewise, older, catheter-dependent patients are known to face more infectious admissions [6]. These associations suggest our readmission patterns mirror broader evidence: subgroups with more failures or infections require more in-hospital care [17].

Discharge Outcomes and Mortality: In-hospital (discharge) mortality in this cohort was low (2.2%), reflecting that most procedures were elective and well-managed. However, this belies the much higher long-term mortality of dialysis patients. In sub-Saharan Africa, dialysis survival remains very poor: for example, a Cameroonian series reported 27% 1-year mortality and nearly half of patients died over long-term follow-up [2, 20]. Starkly, SSA dialysis programs have reported 90-day mortality around 90% (vs ~3% in high-income countries) [15]. Thus, while our immediate procedural mortality was low, the broader mortality burden of dialysis is high. By comparison, Western studies also show substantial death rates (even fistula patients had ~15% 2-year mortality) [10]. These contrasts highlight disparities in outcomes and the urgent need for systemic improvements in chronic dialysis care.

Guideline Comparison and Implications: Our findings align with KDOQI/KDIGO guidance, emphasizing early planning and fistula preference. The 2019 KDOQI update underscores a patient-specific ESRD “Life-Plan” and recommends AV fistulas as the target access [16]. Our data support this: fistula placement yielded the best patency and lowest complication rates across ages [13], whereas catheters predicted poor outcomes. Notably, international experts now advise that age alone should not deter fistula creation [13], consistent with our success in elderly patients. Clinically, these insights urge us in Botswana to intensify pre-dialysis referral, vascular access education, and multidisciplinary care. Sub-Saharan facilities should strive to emulate the “fistula-first, catheter-last” paradigm through outreach and capacity-building. In summary, our local results largely mirror global patterns: they reinforce guideline recommendations to maximize AV fistula use, control comorbidities, and prevent catheter-related infections. Embracing these best practices could improve hemodialysis outcomes in Botswana and similar settings.

Conclusion

This retrospective study conducted at Sidilega Private Hospital revealed a significant reliance on central venous catheters (CVCs) over permanent arteriovenous access among

hemodialysis patients. While AVFs and AVGs remain the recommended standard due to superior long-term outcomes, the data showed that a majority of patients initiated dialysis through catheters—mirroring trends in other low-resource settings due to late referral, limited access to vascular surgery, and systemic barriers. Catheter use was strongly associated with increased complications, particularly infections and thromboses, affirming global literature on its disadvantages.

The low AVF uptake in this cohort contrasts sharply with global benchmarks. For instance, the Fistula First Initiative aimed for >66% AVF use, and KDOQI guidelines recommend <10% catheter prevalence in chronic dialysis populations. Our findings therefore underscore a critical quality gap in pre-dialysis planning and access care.

Recommendations Include

1. **Clinical Practice Improvements:**

-Implement a structured vascular access care pathway involving early vein mapping and AVF planning for all CKD patients.

-Prioritize AVF as first-line access, with catheter use restricted to emergencies and minimized through early AVF creation.

-Train and equip local surgeons and nephrologists to perform AVF procedures, enabling decentralized and timely access creation.

-Adopt catheter care bundles and protocols to reduce infection risk and duration of use.

2. **Institutional and Policy Interventions:**

-Establish vascular access coordinators and audit systems to track AVF rates, catheter days, and complication rates.

-Set institutional AVF prevalence targets (e.g., 50–60%) aligned with international norms.

-Integrate AVF surgery into national health funding frameworks to eliminate out-of-pocket costs.

-Launch public education programs to inform patients about the long-term benefits of AVFs and the risks of prolonged catheter use.

3. **Future Research Directions:**

-Conduct prospective quality-improvement studies to test early referral models and AVF-first strategies.

-Explore barriers to AVF uptake from both patient and provider perspectives.

-Undertake cost-effectiveness analyses to demonstrate savings from AVF-focused care.

In sum, improving vascular access outcomes in Botswana will require systemic, clinical, and educational efforts. By prioritizing AVF use and aligning care with global standards, substantial gains in patient safety, survival, and health system efficiency can be achieved.

Author Contributions

- **Leba Kabongo:** Conceptualization, methodology, data collection, data analysis, and preparation of the original manuscript draft.
- **Pavle Kovacevic:** Supervision, critical review, and editing of the abstract and overall manuscript.

Ethical Approval

This study received ethical approval from the Research Ethics Committee at the Ministry of Health, Botswana. All procedures followed the ethical standards and guidelines of the Ministry of Health.

Data Availability

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

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Conflict of Interest

The authors declare that there is no conflict of interest regarding the conduct or publication of this study.

References

[1]. Somaili, M., Darraj, H., Abusageah, F., Hakami, F., Hakami, K. M., Zogel, B., et al., 2024, Rate of vascular access preparation in hemodialysis patients and associated baseline characteristics in Jazan Region, Saudi Arabia: a multicentre study. *Open Medicine (Warsaw)*, 11, e18742203310950. https://doi.org/10.2174/0118742203310950240827110852

[2]. Halle, M. P., Ashuntantang, G., Kaze, F. F., Takongue, C., Kengne, A. P., et al., 2016, Fatal outcomes among patients on maintenance hemodialysis in sub-Saharan Africa: a 10-year audit from the Douala General Hospital in Cameroon. *BMC Nephrology*, 17, 165. https://doi.org/10.1186/s12882-016-0377-5

[3]. Baharani, J., Vincent, L., & Vachharajani, T. J., 2023, Long-Term Dialysis Vascular Access in East Africa: Unique Challenges and Novel Solutions. Kidney360, 4(8), 1143-1146. https://doi.org/10.34067/KID.0000000000000211.

[4]. Chang, T. I., Weaver, D. J. Jr., Clark, P. R., Lee, T., Allon, M., et al., 2018, Association of diabetes mellitus with arteriovenous fistula outcomes: a meta-analysis. *Journal of Vascular Access*, 19(2), 102–109.

[5]. Luma, H. N., Halle, M. P., Eloumou, S. A. F. B., Azingala, F., Kamdem, F., Donfack-Sontsa, O., et al., 2017, Seroprevalence of HIV, hepatitis B and C viruses among hemodialysis patients in two newly opened centers in Cameroon. *Pan African Medical Journal*, 27, 235. https://doi.org/10.11604/pamj.2017.27.235.13121

[6]. Kazakova, S. V., Baggs, J., Apata, I. W., Yi, S. H., Jernigan, J. A., Nguyen, D., et al., 2020, Vascular access and risk of bloodstream infection among older incident hemodialysis patients. *Kidney Medicine*, 2(3), 276–285.

[7]. Rha, B., See, I., Dunham, L., et al., 2023, Vital signs: health disparities in hemodialysis-associated *Staphylococcus aureus* bloodstream infections — United States, 2017–2020. *MMWR Morbidity and Mortality Weekly Report*, 72(6), 153–159. https://doi.org/10.15585/mmwr.mm7206a3

[8]. Lok, C. E., Huber, T. S., Lee, T., Shenoy, S., Yevzlin, A. S., Rajan, D. K., et al., 2020, KDOQI Clinical Practice Guideline for Vascular Access: 2019 Update. *American Journal of Kidney Diseases*, 75(4 Suppl 2), S1–S164.

[9]. Maguire, N., O'Donnell, M., & O'Kelly, P., 2022, Differential impact of central venous catheters versus arteriovenous fistulae on quality of life among Irish haemodialysis patients. *Journal of Vascular Access.*

[10]. Almasri, J., Alsawas, M., Mainou, M., Mustafa, R. A., Wang, Z., et al., 2017, Outcomes of vascular access for hemodialysis: a systematic review and meta-analysis. *Journal of Vascular Surgery*, 65(1), 236–243.

[11]. Weaver, M. L., Holscher, C. M., Sorber, R. A., Lum, Y. W., Reifsnyder, T., 2021, Redo hemodialysis access in elderly patients has acceptable outcomes with similar patency of arteriovenous fistulas as compared to grafts. *Annals of Vascular Surgery*, 76, 128–133. https://doi.org/10.1016/j.avsg.2021.04.028

[12]. Qian, J. Z., McAdams-DeMarco, M., Ng, D. K., Lau, B., 2020, Arteriovenous fistula placement, maturation, and patency loss in older patients initiating hemodialysis. *American Journal of Kidney Diseases*, 76(4), 480–489.e1. https://doi.org/10.1053/j.ajkd.2020.02.449

[13]. Trerotola, S. O., 2020, Kinder, gentler, and more important than ever — ESRD dialysis vascular access for older patients. *Journal of Vascular and Interventional Radiology*, 31(7), 1156–1157. https://doi.org/10.1016/j.jvir.2020.02.033

[14]. Siracuse, J. J., Shah, N. K., Peacock, M. R., Tahhan, G., Kalish, J. A., Rybin, D., et al., 2017, Thirty-day and 90-day hospital readmission after

outpatient upper extremity hemodialysis access creation. *Journal of Vascular Surgery*, 65(5), 1376–1382. https://doi.org/10.1016/j.jvs.2016.11.023

[15]. Ashuntantang, G., Osafo, C., Olowu, W. A., Arogundade, F., Niang, A., Porter, J., et al., 2017. Outcomes in adults and children with end-stage kidney disease requiring dialysis in sub-Saharan Africa: a systematic review. *Lancet Global Health*, 5(9), e408–e417. https://doi.org/10.1016/S2214-109X(17)30057-8

[16]. Mendelssohn, D. C., Curtis, B., Yeates, K., Langlois, S., MacRae, J. M., Semeniuk, L. M., Camacho, F., McFarlane, P., & STARRT Study investigators, 2011, Suboptimal initiation of dialysis with and without early referral to a nephrologist. Nephrology, dialysis, transplantation : official publication of the European Dialysis and Transplant Association - *European Renal Association*, 26(9), 2959–2965. https://doi.org/10.1093/ndt/gfq843

[17]. Diaz-Martinez, L. A., Fisher, G. R., Esparza, D., Bhatt, J. M., D'Arcy, C. E., Apodaca, J., et al., 2019, Recommendations for effective integration of ethics and responsible conduct of research (E/RCR) education into course-based undergraduate research experiences: A meeting report. *CBE—Life Sciences Education*, 18(2).

[18]. Locham, S., Al-Khafaji, J., Arain, N. A., Kitsios, G. D., & Sidawy, A. N., 2021, Incidence and risk factors of sepsis in hemodialysis patients in the United States. *Journal of Vascular Surgery*, 73(3), 1016–1021.e3.

[19]. Mathew, A. T., Rosen, L., Pekmezaris, R., Kozikowski, A., Ross, D. W., McGinn, T., Kalantar-Zadeh, K., & Fishbane, S., 2017, Potentially avoidable readmissions in United States hemodialysis patients. *Kidney International Reports*, 3(2), 343–355. https://doi.org/10.1016/j.ekir.2017.10.014

[20]. Kaze, F. F., Ashuntantang, G., Halle, M. P., & Kengne, A. P., 2014, Outcomes of non-tunneled non-cuffed hemodialysis catheters in patients on chronic hemodialysis in a resource-limited sub-Saharan Africa setting. *Therapeutic Apheresis and Dialysis*, 18(5), 455–460. https://doi.org/10.1111/1744-9987.12109

[21]. Grant, I. R., Freercks, R. J., Honiball, E. J., & Dube, B., 2021, Analysis of the vascular access service for patients on haemodialysis in Livingstone Hospital. *Cardiovascular Journal of Africa*, 32(2), 98–101.