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Vascular Access for Hemodialysis in Sub-Saharan Africa: Patterns, Complications, and Gaps in Evidence – A Narrative Review

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Abstract

Vascular access is a critical determinant of outcomes in hemodialysis, with arteriovenous fistulas (AVFs) offering superior patency and lower complication rates compared with arteriovenous grafts (AVGs) and central venous catheters (CVCs). Despite strong international recommendations favoring AVFs, catheter dependence remains disproportionately high in sub-Saharan Africa. This narrative review synthesizes current evidence on patterns of vascular access use, associated complications, and management strategies in sub-Saharan Africa, with a focus on identifying gaps relevant to low- and middle-income settings. A narrative review of published literature was conducted, focusing on epidemiology, patient outcomes, complication profiles, and access management strategies related to hemodialysis vascular access globally and within sub-Saharan Africa. Available evidence demonstrates marked regional disparities in vascular access utilization. While high-income countries report increasing AVF prevalence, most African dialysis centers remain heavily reliant on catheters, largely due to late nephrology referral, limited surgical capacity, and health system constraints. Catheter use is consistently associated with higher rates of infection, thrombosis, hospitalization, and mortality. Data on AVF maturation, patency, and long-term outcomes in Africa remain sparse, and reported complication rates appear higher than in high-income settings. There is a substantial evidence gap regarding vascular access outcomes in sub-Saharan Africa. Context-specific data are urgently needed to guide policy, improve access planning, and reduce catheter dependence. This review underscores the importance of regionally grounded research to inform quality improvement and align practice with global standards.

Keywords: *Arteriovenous Fistula, Central Venous Catheter, Dialysis Complications, Hemodialysis, Sub-Saharan Africa, Vascular Access.*

Introduction

Vascular access is a fundamental component of effective hemodialysis care and is widely regarded as the "lifeline" of patients with end-stage renal disease (ESRD). Among available access modalities, arteriovenous fistulas (AVFs) are consistently associated with superior long-term patency, lower infection rates, and improved survival when compared with arteriovenous grafts (AVGs) and central venous catheters (CVCs). Consequently, international guidelines, including those from the Kidney Disease Outcomes Quality Initiative (KDOQI), strongly advocate minimizing catheter use and prioritizing permanent vascular access whenever feasible.

Despite these recommendations, major global disparities persist. In high-income regions, although catheter use at dialysis

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initiation remains common, substantial progress has been made toward increasing AVF prevalence. In contrast, sub-Saharan Africa continues to experience heavy reliance on catheters, driven by late presentation of chronic kidney disease, limited access to vascular surgery, and health system constraints. This catheter dependence exposes patients to preventable complications, including bloodstream infections, thrombosis, frequent hospitalizations, and excess mortality.

Published data from sub-Saharan Africa remain limited and fragmented, with few studies systematically examining access outcomes, complication rates, or management practices. In Botswana, no prior comprehensive assessment of hemodialysis vascular access has been reported. This narrative review therefore aims to synthesize existing evidence on vascular access use and outcomes in sub-Saharan Africa, identify key gaps in knowledge, and contextualize the relevance of emerging data from Botswana to the broader regional and global literature.

Discussion and Analysis of Literature

Epidemiology of Vascular Access in Haemodialysis

Global Patterns

Worldwide, there are striking variations in the types of vascular access used by patients initiating haemodialysis. In high-income countries like the United States, despite concerted efforts, about 80% of incident dialysis patients still start with a catheter as their access. This figure has remained stubbornly high over two decades, even with initiatives aimed at catheter avoidance [1]. By contrast, many European countries and Japan report much lower catheter rates at initiation – in Europe, the proportion of patients starting HD with an AVF is 2–3 times higher than in the U.S. [1]. A recent international survey by the ISN Global Kidney Health Atlas found that in Western Europe and North Asia, a majority of patients (>50%) initiate dialysis with an AVF, whereas in the African region, temporary catheters dominate the landscape [2]. Specifically, in that 2024 report, respondents from 75% of African countries indicated that most patients (>75%) begin HD on a temporary catheter due to emergency presentations and limited surgical services. These global patterns highlight the disparity: patients in resource-limited settings are far less likely to benefit from an optimal access at the start of dialysis, which likely contributes to outcome differences.

Sub-Saharan Africa and Regional Disparities

Within sub-Saharan Africa, published data on vascular access are gradually emerging, though still sparse. In South Africa, for example, an audit at Livingstone Hospital revealed that 95% of patients initiated dialysis with a catheter, and even among prevalent patients, 56% were using catheters vs 38% on fistulas and 5% on grafts [3]. This underscores issues with pre-dialysis care and surgical capacity: only 12% of patients in that cohort had a fistula created pre-emptively (i.e., before dialysis initiation). Nigeria has reported similarly low fistula prevalence – an earlier single-center study noted that at one point, merely 20% of their dialysis patients had a functioning AVF as their initial access [4]. The reasons are multifactorial: late referral of CKD patients, shortage of vascular surgeons, and sometimes patient reluctance or misinformation about fistulas [5].

In Botswana, no formal data had been published prior to this study. However, extrapolating from regional experience, one can infer that catheter use would be high at initiation. Botswana's healthcare system, while relatively well-resourced for a middle-income African country, has only a handful of nephrologists and surgeons capable of AVF creation. Many patients likely initiate dialysis in urgent settings at tertiary hospitals like

Princess Marina Hospital (public sector) or Sidilega and other private Hospital (private sector), which would necessitate catheters. Our study's findings in the literature context will serve as the first data point for Botswana, adding to the body of African vascular access epidemiology. Establishing these baseline rates is important for tracking improvements over time, especially as countries adopt programs to increase AVF use.

Impact of Vascular Access Type on Patient Outcomes

Survival and Mortality

The relationship between vascular access type and patient outcomes is one of the most extensively studied aspects of dialysis care. Survival and Mortality: Patients dialyzing with AVFs have consistently demonstrated better survival rates compared to those with CVCs or grafts. In a large U.S. cohort, all-cause mortality was significantly higher in catheter-dependent patients – one analysis reported a 50–70% higher risk of death for patients using a catheter versus an AVF, after adjusting for comorbidities [6]. A contemporary 7-year cohort study from Latin America quantified this starkly: at 2 years, survival was 94% for AVF users, 70% for tunneled catheter users, and only ~37% for patients on non-tunneled catheters [7]. Even at 7 years, two-thirds of fistula patients were alive vs only 26% of tunneled catheter patients. The higher infection burden and cardiovascular stress associated with catheters are thought to drive this difference. To illustrate, 90-day mortality in the UK is 3.5% in those starting with a fistula or graft, but doubles to 7% in those starting with a CVC [8, 9]. Similarly, in the U.S., 6-month mortality was found to be 9% for incident AVF patients vs 32% for incident catheter patients. These outcome gaps remain significant even after accounting for patient selection bias (acknowledging that sicker patients are more likely to have a catheter). Our study will later compare whether the Botswana data reflect similar outcome disparities.

Infections

Among all complications, infections are the most discriminating by access type. Central venous catheters confer a high risk of bacteremia due to their indwelling nature and frequent manipulation. The U.S. CDC estimates around 37,000 central line-associated bloodstream infections occur each year in dialysis patients, mostly from catheters. In one multi-center study, 48% of catheter-dependent dialysis patients developed at least one episode of bacteremia within 18 months [28]. AVFs, by contrast, have much lower infection rates since they are entirely subcutaneous. AV grafts have intermediate infection risk, but any prosthetic material can harbor bacteria if colonized. A Canadian study found that the annual risk of septicemia was 0.5% for fistula patients, ~5% for graft patients, and 20% for catheter patients [11]. In our literature survey, we note that Packer & Kaufman (2020) [1] highlighted a 29% one-year infection incidence in catheter starters vs 10% in fistula starters, a pattern likely generalizable. Infection is not only an acute risk but has downstream effects: each episode can cause hospitalization, need for catheter removal, loss of vascular access sites, and even endocarditis or other metastatic infections (epidural abscess, septic arthritis) [11]. These severe outcomes reinforce why reducing catheter use is a top priority in dialysis quality initiatives.

Hospitalization and Mortality

Vascular access complications are a leading cause of hospitalization in the dialysis population. Data from the U.S. Dialysis Outcomes and Practice Patterns Study (DOPPS) indicate that >20% of all hospital admissions in dialysis patients are related to vascular access issues – either infections or surgeries to create/revise an access [12]. Patients using catheters have roughly twice the

hospitalization rate of those using fistulas [13]. In Diaz-Martinez's prospective study, 1-year hospitalization was 80% in catheter patients vs 40% in fistula patients. Morbidity also includes complications like venous stenosis (from catheters) that can limit future access options, and limb issues from fistula-related ischemia.

Dialysis Adequacy and Quality of Life

Vascular access influences the quality of dialysis delivered. AVFs and grafts generally permit higher blood flow rates (typically 300–500 mL/min) and can achieve adequate clearance (Kt/V) more consistently. Catheters often have flow limitations due to positional issues or clotting, leading to inadequate dialysis doses. Additionally, patients with catheters have to adhere to swimming restrictions and have body image concerns with an external device. Paradoxically, some studies have found that patients' perceived quality of life can be lower with fistulas than with catheters – presumably because fistulas involve needles and can be painful to cannulate. Maguire et al. (2022) conducted a survey in Ireland and found that, despite the clinical drawbacks of catheters, patients with AVFs reported lower satisfaction in some domains of dialysis-specific quality of life (e.g., having more pain and anxiety about needling) compared to those with tunneled CVCs [14]. This highlights an important point: the "best" access from a medical standpoint may not be viewed as such by the patient, which has led to calls for better patient education and involvement in access choice [15]. Nonetheless, from a pure clinical outcome perspective, literature strongly favors AVF (and AVG to a lesser extent) over CVC for long-term dialysis.

Vascular Access Complications and Management Strategies

Complications Rate and Types

Each type of access has specific failure modes. For AVFs, the most common complication leading to dysfunction is venous outflow stenosis, often due to neointimal hyperplasia, resulting in access thrombosis [16]. Primary failure (failure to mature) occurs in 20–30% of fistulas as noted earlier. Grafts are prone to stenosis at the graft-vein anastomosis, leading to thrombosis; primary patency at 1 year for grafts is typically lower than fistulas (around 50% vs 60–70% for fistulas) [17]. Catheters can dysfunction from thrombosis/fibrin sheath formation, and have a finite lifespan; about 40–50% of tunneled catheters fail by one year due to infection or flow issues [18]. Steal syndrome (hand ischemia) occurs in up to 5–10% of upper-arm fistulas in some series, though severe cases requiring intervention are less common (~1–2%) [19]. High-output cardiac failure due to large AVFs is rare but documented especially in patients with already reduced cardiac function (unsuccessful fistulas may be ligated if causing heart failure symptoms).

Management and Surveillance

The literature emphasizes proactive management to prolong access survival. Guidelines recommend regular clinical monitoring (examining for thrills/bruits) and periodic surveillance (e.g., measuring venous pressures, access flow via dilution techniques) to detect problems before thrombosis occurs [25]. If a significant stenosis is detected (usually >50% luminal narrowing with clinical/flow evidence of dysfunction), prompt intervention via angioplasty or surgical revision can salvage the access and extend patency [20]. The KDOQI 2019 update, however, advises a more individualized approach to surveillance, favoring interventions only when clinically indicated [9] – evidence had emerged that aggressive pre-emptive angioplasty without clinical indicators did not improve outcomes.

For catheters, rigorous infection control protocols are critical. Use of antibiotic or citrate lock solutions, minimizing catheter lumens handling, and using sterile technique for dressing changes are evidence-based practices

that reduce catheter-related bloodstream infections [21]. Some units have successfully decreased infection rates with staff training and chlorhexidine-impregnated dressings [22]. Nonetheless, literature suggests that even the best protocols cannot eliminate the inherent infection risk of a catheter; thus, the consensus is that catheters should be used as a bridge to a permanent access and not as a long-term solution [23].

Improving AVF Utilization

Given the advantages of AVFs, many studies have looked at how to increase their use. Interventions include patient education, training nephrologists to refer earlier, and employing vascular access coordinators. A systematic review by De Siqueira et al. (2022) examined strategies to increase AVF (and AVG) creation before dialysis start [9]. The review found mixed results: some programs (like dedicated access coordinator nurses) showed improved fistula rates, while others (like patient education classes) did not always yield a significant change. The authors concluded that a comprehensive approach – identifying patients early and coordinating timely surgery – likely works best, but there isn't a one-size-fits-all solution. Another angle is improving fistula maturation success: studies have tested pharmacological interventions (e.g., fish oil, clopidogrel) and novel devices (e.g., the VasQ external support) to reduce early failure. For example, a meta-analysis in Journal of Vascular Surgery [24] indicated that no medication has definitively improved maturation, but surgical techniques (like optimal vessel selection using pre-op ultrasound mapping) clearly help. The European guidelines (2018) strongly endorse routine ultrasound vein mapping before fistula creation to choose the best site and improve odds of success [16]. Our literature review suggests that in centers where this is done, fistula success rates are higher.

Context-Specific Innovations are Worth Noting

In East Africa, where vascular surgeons are few, some programs have started training general surgeons in fistula creation and using interventional radiology camps to do angioplasties [26]. These efforts have reportedly improved access outcomes in pilot projects, hinting that creative solutions can mitigate resource gaps.

Summary of Gaps in Literature and Relevance to Low-Resource Settings

From the above review, it's clear that while the benefits of optimal vascular access (AVF) are well-documented, many low- and middle-income countries (including Botswana) lack data on their performance in this area. There is a gap in understanding whether the global best practices are being met locally and what the local obstacles are. Our study's value lies in applying the insights from the literature – such as the known risk factors for poor outcomes – to interpret Botswana's situation. For instance, if we find a high catheter rate, literature would suggest that's likely leading to avoidable infections and hospitalizations in our patients; if we find many fistulas failing early, literature might point to the need for better vessel mapping or surgeon training.

Several authors have emphasized the lack of robust, region-specific data on dialysis care in sub-Saharan Africa, noting that most clinical practices are extrapolated from high-income countries despite major differences in health-system capacity and patient pathways [10]. Furthermore, studies from low-resource settings have consistently shown that late referral, limited surgical expertise, and reliance on catheters contribute substantially to poor vascular access outcomes, highlighting the need for locally generated evidence to inform practice and policy [27].

Implications for Practice and Policy in Sub-Saharan Africa

Addressing vascular access disparities requires coordinated, context-sensitive strategies. Strengthening early CKD detection and referral pathways, expanding surgical and interventional capacity, and integrating multidisciplinary access planning into routine care are critical steps. Investment in training, infrastructure, and data collection systems will be essential to reduce catheter dependence and improve outcomes.

Conclusion

This narrative review demonstrates that vascular access remains a critical yet under-optimized component of hemodialysis care in sub-Saharan Africa. Although robust international evidence consistently confirms the superiority of arteriovenous fistulas in terms of patency, infection risk, hospitalization, and survival, catheter dependence continues to dominate dialysis practice across the region. The reviewed literature highlights that this disparity is driven largely by late presentation of chronic kidney disease, inadequate pre-dialysis planning, limited availability of trained vascular surgeons, and broader health system constraints. As a result, many patients are exposed to preventable complications that significantly worsen morbidity, mortality, and healthcare costs.

Importantly, this review identifies a substantial evidence gap regarding vascular access outcomes in sub-Saharan Africa. Data on AVF maturation rates, long-term patency, complication profiles, and effectiveness of access-focused interventions remain sparse and fragmented, particularly in countries such as Botswana where no prior comprehensive assessments have been published. The absence of locally generated data limits the ability of clinicians and policymakers to benchmark performance against global standards or to design targeted quality-improvement strategies.

The findings of this review underscore the urgent need for region-specific research to inform vascular access policy and practice. Strengthening early nephrology referral pathways, expanding surgical and interventional capacity, promoting routine preoperative vessel mapping, and investing in multidisciplinary vascular access programs represent feasible and high-impact strategies for reducing catheter dependence. By contextualizing global evidence within the realities of sub-Saharan Africa, this review provides a foundation for future research and supports the integration of evidence-based, patient-centered vascular access planning to improve outcomes for hemodialysis patients in the region.

Conflict of Interest

The authors have no conflicts of interest to declare.

Ethical Approval

Our review is solely focused on published articles and reports, and non-human-subject data. Therefore, no ethical approval is needed prior publication.

Data Availability

No new data were generated or analysed in this review. All data analysed are publicly available from the cited original sources in the reference.

Author Contribution

Leba Kabongo conceived the review, conducted the primary literature search and analysis, as well as drafted the manuscript.

Both authors performed critical revisions and edited the final manuscript, as well as approved its submission

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