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Research Article

Comparative Profile between Catheters and Arteriovenous Fistulas for Hemodialysis in Brazil

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Abstract

Introduction: Vascular access is a key determinant of the quality and safety of hemodialysis treatment. Despite the well-recognized superiority of arteriovenous fistulas (AVF), there are still gaps in the Brazilian literature regarding the patterns of use and clinical outcomes associated with each type of access. This study aimed to comparatively analyze the use of central venous catheters (CVC) and AVFs in Brazil.

Materials and Methods: This is an ecological, descriptive, and cross-sectional study based on secondary data extracted from the Brazilian Unified Health System Outpatient Information System (SIA/SUS) through TabWin/DATASUS. Outpatient admissions for AVF creation between January 2008 and December 2024 were included. The analysis considered demographic, clinical, and transplant eligibility variables, as well as hospital mortality per admission (HMA).

Results: A total of 7,067,387 admissions were analyzed, with a predominance of males (58.5%). AVF was the most frequently used access (65.1%), associated with lower mortality rates (9.24 per thousand), while CVCs were linked to higher mortality. Advanced age (≥80 years) and early childhood (<1 year) were identified as high-risk groups, and comorbidities such as hypertension, diabetes, and neoplasms showed significant correlation with admissions and deaths.

Conclusion: AVF remains the safest and most effective form of vascular access, whereas catheters are associated with higher mortality, particularly in vulnerable populations with multiple comorbidities. A study limitation is the reliance on publicly available secondary data, which may be subject to underreporting.

Keywords: catheters; vascular access; arteriovenous fistulas

Introduction

Dialysis is a therapeutic alternative used in renal replacement therapy. It consists of an artificial extracorporeal device that performs the blood filtration previously performed by the kidneys, promoting the removal of solutes/toxins and excess fluids.1 Therefore, it is a procedure designed to maintain homeostasis in individuals who experience rapid renal functional loss, such as acute kidney injury (AKI), or prolonged loss, such as chronic kidney disease (CKD).[1]

In the current scenario, with the increasing global incidence of patients with kidney failure, the demand for dialysis has grown – especially due to limited organ availability, as it is a technique used as a transitional therapy during the kidney transplant waiting period.2,3 Therefore, hemodialysis represents the most common form of dialysis, used by 89% of patients, while peritoneal dialysis covers the remaining 11%.2 Currently, and worldwide, more than[2] million patients require hemodialysis (HD), which The procedure lasts approximately 3 to 4 hours

per day and is typically performed three times a week. In Brazil, in 2019, the total number of chronic dialysis patients was estimated at 139,691, of which 93.2% were undergoing hemodialysis, which requires the use of vascular access. [3,4,5]

Therefore, dialysis patients require functional vascular access (VA) capable of adequately meeting their therapeutic requirements. The main VA modalities for hemodialysis include tunneled or non-tunneled dialysis catheters (TDCs) and arteriovenous fistulas (AVFs) – autologous grafts obtained by anastomosis between a patient's own artery and vein.[6]

In this context, according to the 2019 update of the Kidney Disease Outcomes Quality Initiative (KDOQI) protocol, AVFs should be prioritized as initial and definitive vascular access. Furthermore, it highlights the increased morbidity and mortality in adult patients undergoing hemodialysis using a central venous catheter (CVC). However, although AVFs remain the most commonly used vascular access for hemodialysis, an increase in CVC use has been noted, even in light of the aforementioned recommendations that recommend using AVFs as the first choice.[7]

AVFs are considered the "gold standard" access for hemodialysis.8,9 Since the 1990s, major guidelines have encouraged the use of AVFs whenever possible in dialysis patients.10 Their main advantage over catheter placement lies in their autogenous nature, which substantially reduces the risk of infections.[8]

In contrast, CVCs are widely used because they offer immediate access, are less complex, and require less maturation time. However, it is clear that they are more susceptible to complications such as air embolism, occlusion, thrombosis, malfunction, and infection. Therefore, despite the practicality of CVCs, AVFs remain preferred when feasible, due to their long-term safety and efficacy.[7]

Despite the "fistula first" initiative developed by the KDOQI in its 2006 update, as well as the aforementioned information on AVFs and catheters, choosing a vascular access for hemodialysis remains a challenge, requiring an individualized approach based on each patient's characteristics. In this context, our study aims to reflect on the epidemiology of these accesses in Brazil.

Methodology

This is an ecological, descriptive, cross-sectional study with a quantitative approach, based on secondary data from public information systems. Outpatient admissions for AVF or CVC placement between January 2008 and December 2024 were analyzed.

Data were extracted from the SUS Outpatient Information System (SIA/SUS), accessed through the TabWin tabulator, provided by the SUS Information Technology Department (DATASUS). Data collection was conducted using the "APAC – Arteriovenous Fistula Creation" topic, which gathers outpatient records related to the vascular access implantation procedure.

The database included the following variables: type of vascular access (arteriovenous fistula, short-term catheter, and long-term catheter), sex, age group, patient eligibility status for kidney transplant (eligible, unsuitable, refusal, or new case with less than 90 days of treatment), number of hospitalizations, and number of deaths. The hospital mortality rate (HMR) per admission was calculated by the ratio of the number of deaths to the total number of hospitalizations, multiplied by 1,000. Based on this ratio, the HMR rate was stratified by the presence of comorbidities such as obesity, hypertension, diabetes mellitus, and neoplasms.

Microsoft Excel (version 365) and Jamovi (version 2.6) software were used for statistical analysis. Categorical variables were described as absolute and relative frequencies. The distribution of quantitative variables was assessed using the Shapiro-Wilk normality test. For normally distributed variables, Pearson's correlation coefficient was applied; In cases of asymmetric distribution, Spearman's correlation coefficient was used. Correlations between the number of hospitalizations and MHI per hospitalization with comorbidities were performed separately, and the results are presented in specific tables.

This study did not require submission to the Research Ethics Committee because it used exclusively public domain data, as established in Resolution No. 510/2016 of the National Health Council. Nevertheless, all methodological procedures respected the ethical principles set forth in Resolution No. 466/2012, ensuring confidentiality and responsible use of the information obtained.

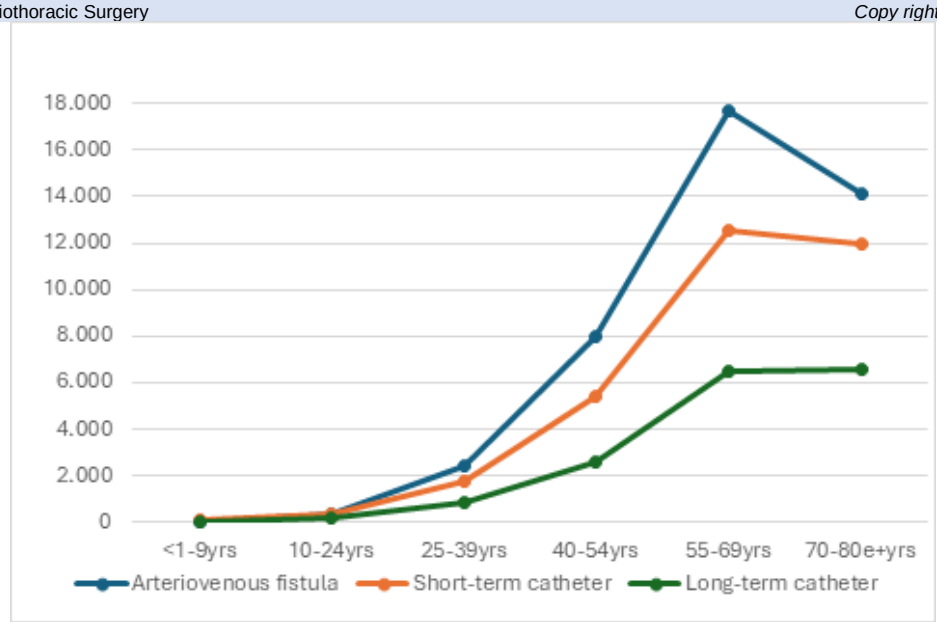
Results

The analysis covered a total of 7,067,387 hospitalizations, with a predominance of males (58.5%). The most commonly used vascular access method was the arteriovenous fistula (AVF), accounting for 65.1% of cases, followed by short-term (19.9%) and long-term (14.9%) catheters. The overall mortality rate observed was 12.93 per thousand patients, being considerably lower among AVF users (9.24 per thousand) compared to short-term (22.76 per thousand) and long-term (15.91 per thousand) catheters. This trend continued between genders, with slight percentage variations.

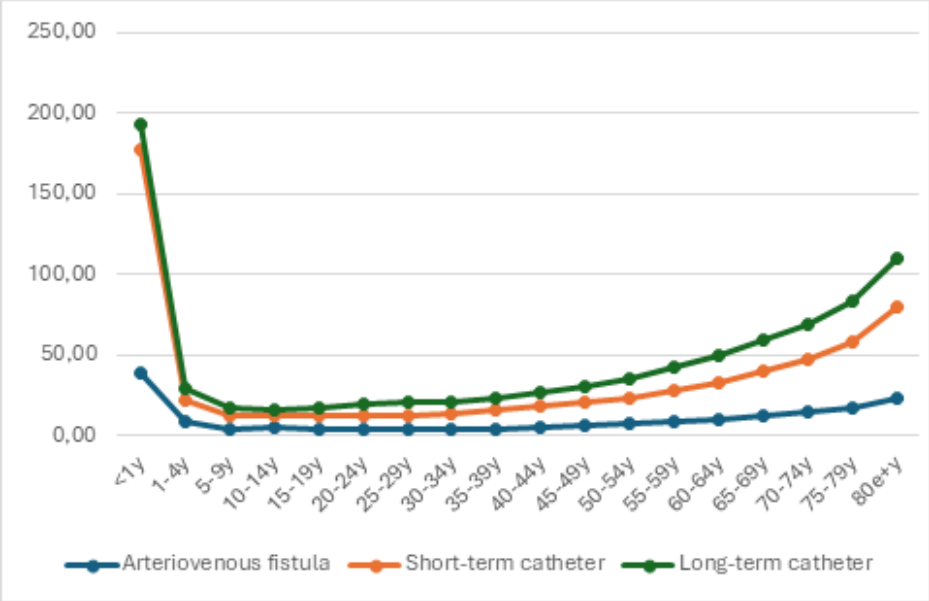
The age distribution showed a higher concentration of patients between 50 and 64 years old, representing the age group with the highest absolute number of vascular access procedures. Analysis by age group also revealed a progressive increase in mortality rates with advancing age, reaching the highest values in patients aged 80 years and older (31.16 per thousand), as well as an early peak in those under 1 year of age (55.21 per thousand), suggesting greater clinical vulnerability at the extremes of age.

Regarding eligibility for kidney transplantation, 33.7% of patients were considered eligible, 29.7% were unsuitable, 5% refused the procedure, and 31.6% were classified as new cases, with less than 90 days of treatment. AVF was the preferred access method among those eligible for transplantation (73% of cases), while catheter use was more prevalent among unsuitable patients, refusals, and new cases, possibly reflecting both clinical severity and the reduced time of exposure to dialysis therapy in these populations.

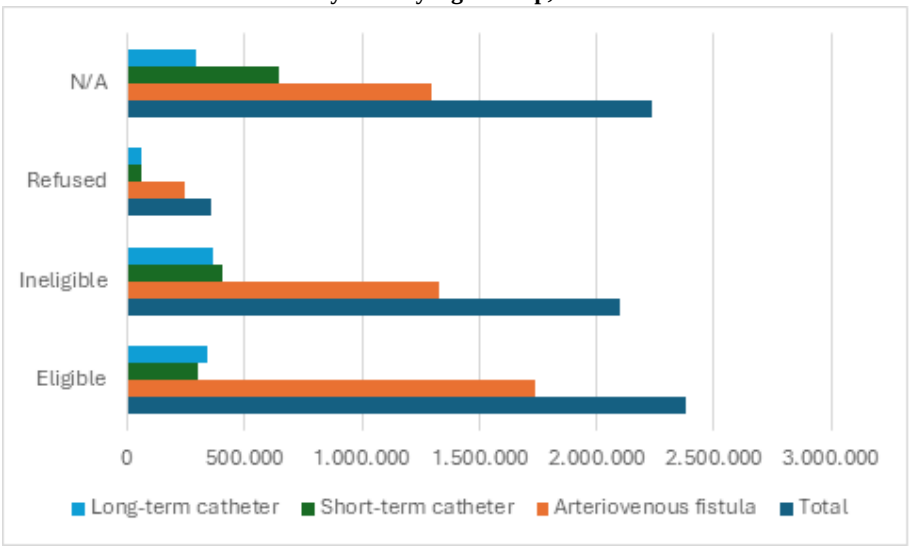
Correlation analyses were performed between comorbidities (obesity, hypertension, diabetes mellitus, and neoplasms) and the outcomes number of hospitalizations due to central access and associated mortality rate. The correlations demonstrated statistically significant results and are detailed in the respective tables, highlighting the strong positive associations between hypertension, diabetes, and neoplasms and the frequency of hospitalizations due to central access. The correlation with mortality was also significant for hypertension and diabetes, suggesting a significant clinical impact of these conditions on the severity of hospitalizations



Number of Deaths by Age Group, 2008–2024



Mortality Rate by Age Group, 2008–2024



Frequency by Transplant Status According to Vascular Access

Comorbidities	Correlation Type	Coefficient (r or ρ)	p-value
Obesidade	Spearman	0.525	0.025
Hypertension	Spearman	0.864	<.001
Neoplasias	Spearman	0.975	<.001
DM	Spearman	0.936	<.001

Table X. Correlation between hospitalizations for central access and comorbidities

Comorbidities	Correlation Type	Coefficient (r or ρ)	p-value
Obesidade	**Spearman**	**-0.292**	**0.24**
Hypertension	**Spearman**	**0.6**	**0.009**
Neoplasia	**Spearman**	**0.42**	**0.083**
DM	**Spearman**	**0.488**	**0.04**

Correlation between the morbidity of central venous access-related hospitalizations, comorbidities, and hospitalization frequency.

Discussion

The most commonly used vascular access in Brazil was the AVF, followed by short-term (SPC) and long-term (LTC) catheters. This trend remained consistent across genders, with slight percentage variations. Therefore, there is alignment with key international recommendations in nephrology, such as the KDOQI guidelines, which recognize the AVF as a priority vascular access and the gold standard for hemodialysis. This is primarily due to its autogenous nature, which significantly reduces the risk of infection and hospitalizations compared to CVCs. However, CVC implantation is an outpatient procedure, and these patients are most likely not registered as inpatients, but rather as outpatients, which may distort the reality in Brazil.

Thus, analyzing the data related to mortality, a considerably lower number is found in AVF users (9.24 per thousand patients) when compared to short-term (22.76 per thousand) and long-term (15.91 per thousand) catheters. These data reinforce the safety and efficacy of AVFs, in accordance with the findings of large multicenter studies such as that of Ravani et al. (2013), in which a meta-analysis of 62 cohorts with more than 500,000 patients demonstrated that the use of a central catheter is associated with a 1.53-fold higher risk of mortality than the use of a fistula (95% CI 1.40–1.67). In absolute terms, this represents approximately 106 additional deaths per 1,000 patient-years.[9,10,11,12]

Despite the convenience of central venous catheters (CVCs) because they offer less complex and immediate access, they are more susceptible to complications, such as air embolism, occlusion, malfunction, and infection. Studies show that the use of CVCs increases the risk of bloodstream infections by up to 11.2 times compared to AVFs.[13]

The document released by K/DOQI highlights the increased morbidity and mortality in adult patients undergoing hemodialysis using CVCs. Therefore, despite the convenience of CVCs, AVFs remain preferred whenever possible due to their greater safety and long-term efficacy. However, even though it is the gold standard, AVF is not exempt from complications, the most common of which are infections, aneurysms, stenosis, congestive heart failure, steal syndrome, angiodysplasia, ischemic neuropathy, and thrombosis. These complications require constant monitoring to detect potential changes early.

When analyzing mortality by age group, a bimodal risk pattern was found: peak mortality rates in children under 1 year of age and patients 80 years of age or older. This pattern is consistent with the literature, which highlights greater vulnerability at the extremes of age.

In individuals under 1 year of age, the mortality rate was 55.21 per thousand patients, primarily due to low immunity and possible renal and circulatory malformations. The review "Long-term outcome of chronic dialysis in children" confirms the high risk for these individuals, demonstrating that the risk of death in infants is four times higher compared to children aged 15-19, in addition to the 5-year survival rate for infants being 73%, while the remaining population on renal replacement therapy has 86%.15 These data demonstrate the influence of the period of initiation of renal replacement therapy on the prognosis of patients.

The other peak increase in mortality rates was 31.16 per thousand and occurred in individuals aged 80 years or older. Some factors that may explain these data are related to the frailty of these patients and the combined conditions that many present (such as diabetes mellitus and hypertension). Furthermore, studies—such as the review by Song Y. et al.—show that cognitive impairment in elderly hemodialysis patients is positively correlated with mortality. 16 Thus, cognitive impairment is not uncommon among patients in this age group; diseases such as Alzheimer's and dementia are correlated with an increased risk of mortality and treatment abandonment in individuals over 75 years of age.[14,15,16]

Furthermore, the data obtained reveal a correlation between eligibility for kidney transplantation and the predominant vascular access. It is notable that among patients eligible for transplantation (33.7%), there is a preference for AVF (73%), highlighting that this access is the gold standard, as it is associated with a lower risk of infection when compared to CVCs. Therefore, better long-term results are obtained, which is essential for patients preparing for kidney transplantation. However, in patients who are unfit (27.7%), refused treatment (5%), or were classified as new cases (31.6%), with less than 90 days of treatment, the most commonly used access is the CVC. This is due to factors such as the urgency of the clinical condition, the presence of significant comorbidities, and the early stage of dialysis therapy. Newly diagnosed patients generally require rapid-initiation access, making the catheter a temporary alternative until the fistula matures. In the case of unfit patients, the choice of CVC suggests a clinically severe condition, precluding the creation of an AVF. This context reinforces that the choice of vascular access must consider the clinical particularities of each patient, highlighting the importance of individualized approaches in the treatment of dialysis patients, as Allon et al.

The correlation between comorbidities and the hospitalization and mortality patterns analyzed highlighted the strong association between hypertension (HTN), diabetes, and neoplasms with increased negative outcomes; therefore, this association is also found in the literature. Studies such as that by Sousa et al. demonstrate that individuals with hypertension and diabetes have an increased risk of cardiovascular events by up to 12

times, when compared to individuals with diabetes. 20 In larger cohorts, such as that conducted by Tu Q. and colleagues in China, the combination of hypertension and diabetes doubled the risk of mortality and cardiovascular events in patients, demonstrating how these comorbidities impair individual prognosis. 21 These findings reinforce the need for frequent glycemic and blood pressure control in dialysis patients, given the notable reduction in complications related to vascular access during treatment.

Therefore, despite the "fistula first" guideline established by K/DOQI, as well as the aforementioned information on AVF and CVC, the choice of vascular access remains a challenge in Brazil, requiring an individualized approach based on the characteristics of each patient.[17] This is due, in part, to the fact that simply increasing the number of AVFs, although encouraged by the guidelines, does not necessarily translate into better outcomes. Such accesses are subject to high primary failure rates and long maturation periods. Consequently, an undesirable increase in catheter dependence may be observed, contradicting the initial goals, especially in cases where the fistula does not achieve adequate patency, compromising the initiation of dialysis therapy.[18,19,20]

Because this is an ecological and descriptive study based on population-based data, it has limitations: it is not possible to establish direct causal inferences about individual patient risk. The use of secondary data from the SIA/SUS, although extensive, may be subject to biases and recording inconsistencies, potentially affecting the accuracy of the results. Furthermore, the cross-sectional nature of the analysis prevents longitudinal follow-up of patients, limiting the assessment of relevant clinical outcomes, such as primary arteriovenous fistula failure or the transition from catheter to fistula. Potential confounding factors, such as dialysis duration, nutritional status, and severity of kidney disease, were not considered, which could influence both the choice of vascular access and the observed outcomes. It is important to consider that the research method was based on outpatients, but hospitalized patients who also underwent vascular access for hemodialysis may not have been registered in this database, reflecting underreporting.

Conclusion

The use of catheters was prevalent in patients with contraindications for kidney transplantation, those newly diagnosed, or those who refused fistula, reflecting both the severity of the clinical condition and the intensity of the comorbidities involved. Patient age is an influential factor, with higher mortality rates in extreme groups: those under 1 year old and those aged 80 or older. Hypertension, diabetes, neoplasms, and obesity demonstrate a correlation with hospitalization and the number of deaths, reinforcing the need for rigorous management of comorbidities. These findings reinforce the importance of individualized care, focusing on prior preparation regarding the choice of vascular access and a multidisciplinary approach to the patient, aiming to reduce potential complications, improve quality of life, and minimize mortality in patients undergoing dialysis.

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