Natural Resources for Human Health
eISSN: 2583-1194

Original Research

Received 13 May 2026
Revised 21 June 2026
Accepted 04 July 2026

Natural Resources for Human Health 2026, Vol. 6 (11s): 637–644

KEYWORDS:
arteriovenous fistula; central venous catheter; hemodialysis; vascular access; kidney failure; catheter dependence; Saudi Arabia

From Catheter Initiation to Arteriovenous Access: Transition Patterns and Factors Associated with Definitive Access Establishment among Adults Receiving Maintenance Hemodialysis in Saudi Arabia

Catheter-to-Arteriovenous Access Transition

Mohammed Yousef Almulhim, MD

Department of Internal Medicine, College of Medicine, King Faisal University, Al-Ahsa, Saudi Arabia, E-mail: malmulhim@kfu.edu.sa
Corresponding author: Mohammed Yousef Almulhim, MD; Department of Internal Medicine, College of Medicine, King Faisal University, Al-Ahsa, Saudi Arabia; E-mail: malmulhim@kfu.edu.sa

ABSTRACT:

Background: Persistent central venous catheter dependence after hemodialysis initiation is clinically important, but transition to definitive arteriovenous access is poorly characterized in Saudi Arabia.

Methods: We performed a retrospective multicenter secondary cohort analysis of adults receiving maintenance hemodialysis at two centers in Al-Ahsa. Patients whose first documented access was a permanent catheter were followed through recorded access history. The primary outcome was subsequent arteriovenous fistula or graft establishment. Modified Poisson regression with robust variance estimated adjusted risk ratios.

Results: Among 264 catheter-initiating patients, 144 (54.5%; 95% CI 48.5-60.4%) subsequently established arteriovenous access; 136 received fistulas and eight grafts. Median time to creation was 4.3 months (IQR 1.8-12.9). Cardiovascular comorbidity was independently associated with lower transition probability (aRR 0.60, 95% CI 0.42-0.84; p=0.003). Recent ESKD diagnosis, refusal, prior access failure, low ejection fraction, and surgical unsuitability were common barriers.

Conclusions: Nearly half of catheter-initiating patients lacked documented definitive arteriovenous access. Structured, individualized transition pathways may reduce avoidable catheter dependence.

INTRODUCTION

Hemodialysis vascular access is a central component of care for patients with kidney failure. Chronic kidney disease also constitutes a substantial health burden in Saudi Arabia, where recent population-based data have documented clinically important CKD prevalence and a steep increase with advancing age.1 For patients progressing to maintenance hemodialysis, vascular-access planning must balance immediate dialysis requirements with long-term access durability, complications, vascular anatomy, comorbidity, life expectancy, and individual preferences.

The 2019 Kidney Disease Outcomes Quality Initiative (KDOQI) guideline moved vascular-access practice away from a rigid "fistula first" strategy toward an individualized End-Stage Kidney Disease Life-Plan.2 Nevertheless, avoidable prolonged use

of central venous catheters remains undesirable. Observational evidence consistently associates catheter-based hemodialysis with greater infection and mortality risks than usable arteriovenous access, although part of this relationship reflects differences in underlying patient health and selection.3

Catheter initiation remains common internationally. Dialysis Outcomes and Practice Patterns Study data demonstrated substantial variation in vascular-access practice and showed that catheter use at dialysis initiation remains frequent even in healthcare systems with established predialysis nephrology services.4 Moreover, creation of an arteriovenous fistula (AVF) does not necessarily result in rapid catheter independence. International DOPPS data show marked variability in time from AVF creation to successful catheter-free dialysis, particularly when fistulas fail to mature or cannot be successfully cannulated.5

The clinically relevant question is therefore not simply which access a patient has at one point in time, but whether a patient who begins dialysis through a catheter subsequently progresses to usable definitive arteriovenous access. Previous studies suggest that successful conversion is associated with more favorable outcomes than continued catheter dependence.6-8 However, real-world data describing this transition are limited in Saudi Arabia.

Saudi physicians have previously identified late nephrology referral, inadequate predialysis preparation, patient denial, fear of dialysis, and refusal of AVF surgery as important causes of delayed permanent access establishment.9 Understanding which patients remain catheter dependent and why may therefore provide a more actionable quality-of-care measure than simple cross-sectional vascular-access prevalence.

The underlying Al-Ahsa dataset has previously been used to describe overall vascular-access patterns, current access outcomes, and correlates of access failure.10 The present study addresses a distinct question by restricting analysis to patients whose first documented hemodialysis access was a catheter and reconstructing their subsequent trajectory toward AVF or arteriovenous graft (AVG) creation.

The objectives were to determine the proportion of catheter-initiating patients who subsequently established AVF/AVG access, characterize the timing and type of transition, describe barriers among patients without transition, and identify patient characteristics independently associated with definitive arteriovenous-access establishment.

METHODS

Study design and setting

This was a retrospective multicenter secondary cohort analysis of adults receiving maintenance hemodialysis at two dialysis centers in Al-Ahsa, Eastern Province, Saudi Arabia.

The underlying clinical data were collected during 2024 and contained demographic, clinical, dialysis, laboratory, cardiac, and vascular-access information. The present analysis was designed specifically to investigate the sequence from initial catheter use to subsequent arteriovenous-access establishment.

Reporting was guided by the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement.11

Source data and relationship to previous publication

The updated source files contained 381 patient records. A previous publication from the underlying cohort examined cross-sectional vascular-access patterns, access status, complications, and predictors of access failure.10

The present study used a distinct eligibility criterion, primary outcome, exposure framework, and statistical analysis. Specifically, only patients whose first documented dialysis access was a catheter were included, and subsequent establishment of AVF/AVG was reconstructed from the longitudinal access fields.

Participants

Patients were eligible if they were adults receiving maintenance hemodialysis for kidney failure; had an internal jugular or femoral permanent catheter documented as their first dialysis access; and had sufficient subsequent access information to determine whether AVF or AVG creation occurred. Patients whose first documented access was already an AVF or AVG were excluded because they were not at risk for the transition of interest. A total of 264 patients satisfied the eligibility criteria.

Outcome definitions

Primary outcome. The primary outcome was establishment of definitive arteriovenous access, defined as subsequent documentation of an AVF or AVG after initial dialysis through a catheter. Patients were categorized as transitioned when a subsequent AVF or AVG was documented, or as having no documented transition when no subsequent AVF or AVG was recorded.

Functional transition. A secondary outcome required both AVF/AVG establishment and documentation that the access was well functioning at the time of assessment.

Time to access creation. For patients with valid dates for both catheter initiation and AVF/AVG creation, elapsed time was calculated in months using the difference between the two recorded dates divided by 30.44 days.

Candidate explanatory variables

Variables considered for the primary adjusted model were chosen a priori on the basis of clinical relevance, temporal interpretability, and data completeness: age, sex, dialysis center, diabetes mellitus as the primary etiology of ESKD, and cardiovascular comorbidity.

Cardiovascular comorbidity was defined by documented ischemic heart disease, coronary disease, congestive heart failure, dilated or ischemic cardiomyopathy, or equivalent clinically significant cardiac disease.

Body mass index, smoking, laboratory results, and ejection fraction were not included in the primary adjusted etiologic model because missingness was substantial for some variables or the dataset could not consistently establish that measurement preceded AV-access creation.

Barriers to arteriovenous access

For patients without AVF/AVG transition, free-text reasons were harmonized into clinically meaningful categories: recent/new ESKD diagnosis; patient refusal; previous access failure; reduced ejection fraction; not a surgical candidate; technical difficulty; peripheral arterial disease; superior vena cava syndrome; unclear diagnosis; unknown/unspecified; and no reason documented. Future AV-access plans were also summarized.

Statistical analysis

Continuous variables were summarized as mean ± standard deviation when appropriate and as median with interquartile range (IQR) when distributions were skewed. Categorical variables were presented as frequencies and percentages. The primary transition proportion was accompanied by a Wilson 95% confidence interval.

Because the primary outcome occurred in more than half of the cohort and was therefore not rare, modified Poisson regression with robust sandwich variance was used to directly estimate adjusted risk ratios (aRRs) and 95% confidence intervals.12 Age was modeled continuously per 10-year increase. Female sex, treatment center, diabetes as ESKD etiology, and cardiovascular comorbidity were entered as binary covariates.

As a sensitivity analysis, multivariable logistic regression was performed using the same predictors. A second modified Poisson model used well-functioning AV-access transition as the outcome. Complete-case analysis was used for the primary model because the included covariates had complete information in the analytic cohort. No statistical imputation was performed. Two-sided $p<0.05$ was considered statistically significant, with interpretation emphasizing effect estimates and confidence intervals.

RESULTS

Cohort characteristics

A total of 264 patients had initiated hemodialysis through an internal jugular or femoral catheter and comprised the analytic cohort.

Mean age was 55.7 ± 16.8 years, and median age was 59 years (IQR 42-69). Ninety-seven patients (36.7%) were women. Diabetes mellitus was the documented primary etiology of ESKD in 181 (68.6%), and 67 (25.4%) had cardiovascular comorbidity.

Forty-three patients were treated at one participating center and 221 at the second center. Internal jugular access represented the first catheter site in 250 patients (94.7%) and femoral access in 14 (5.3%).

Table 1. Characteristics according to subsequent arteriovenous-access establishment

Characteristic	Transitioned n=144	No transition n=120
Age, mean ± SD, years	55.1 ± 16.5	56.4 ± 17.1
Age, median (IQR), years	56.5 (42.0-68.0)	59.0 (40.8-69.0)
Female sex	55 (38.2%)	42 (35.0%)
Diabetes as primary ESKD etiology	98 (68.1%)	83 (69.2%)
Cardiovascular comorbidity	24 (16.7%)	43 (35.8%)
Center 1	19 (13.2%)	24 (20.0%)
Femoral initial catheter	7 (4.9%)	7 (5.8%)

Abbreviations: ESKD, end-stage kidney disease; IQR, interquartile range; SD, standard deviation.

Transition to definitive arteriovenous access

Of the 264 catheter-initiating patients, 144 subsequently established an AVF or AVG, corresponding to a transition proportion of 54.5% (95% CI 48.5-60.4%). The remaining 120 patients (45.5%) had no subsequent definitive arteriovenous access documented.

Among patients who transitioned, 136 (94.4%) received an AVF and 8 (5.6%) received an AVG. A well-functioning AVF/AVG was documented in 139 patients, representing 96.5% of those who transitioned and 52.7% (95% CI 46.6-58.6%) of the total catheter-initiating cohort.

Among 132 transitioned patients with complete dates, median time from initial catheter access to AVF/AVG creation was 4.3 months (IQR 1.8-12.9 months). Fifty-five of 132 patients (41.7%) had access creation within 3 months, 76 (57.6%) within 6 months, and 96 (72.7%) within 12 months.

Table 2. Catheter-to-arteriovenous-access transition outcomes

Outcome	n (%) or summary
Catheter-initiating cohort	264
Subsequent AVF/AVG	144 (54.5%)
No documented AVF/AVG	120 (45.5%)
AVF among transitioned patients	136 (94.4%)
AVG among transitioned patients	8 (5.6%)
Well-functioning AVF/AVG	139/144 (96.5%)
Functional transition, total cohort	139/264 (52.7%)
Complete transition dates	132
Time to AVF/AVG creation, median (IQR)	4.3 (1.8-12.9) months

Barriers among patients without transition

Among 120 patients without documented AVF/AVG transition, the most frequent recorded category was an unknown or unspecified reason (21.7%). A recent diagnosis of ESKD was recorded in 20.8%, patient refusal in 13.3%, previous access failure in 12.5%, low ejection fraction in 10.8%, and lack of surgical candidacy in 8.3%.

Twenty-nine patients (24.2%) had a documented future plan to pursue AV access, whereas 17 (14.2%) had a documented plan not to pursue AV access. Future plans were unknown or unrecorded in the remainder.

Table 3. Documented barriers to AVF/AVG establishment among patients without transition (n=120)

Barrier	n (%)
Unknown/unspecified	26 (21.7)
Recent/new ESKD diagnosis	25 (20.8)
Patient refusal	16 (13.3)
Previous access failure	15 (12.5)
Low ejection fraction	13 (10.8)
Not a surgical candidate	10 (8.3)
No barrier documented	9 (7.5)
Technical difficulty	3 (2.5)
Peripheral arterial disease	1 (0.8)
Superior vena cava syndrome	1 (0.8)
Unclear diagnosis	1 (0.8)

Factors associated with transition

In modified Poisson regression, cardiovascular comorbidity was independently associated with a lower probability of AVF/AVG establishment. After adjustment for age, sex, treatment center, and diabetes as ESKD etiology, patients with cardiovascular comorbidity had an approximately 40% lower probability of transition than patients without documented cardiovascular disease (aRR 0.60, 95% CI 0.42-0.84; p=0.003). Age, sex, treatment center, and diabetic ESKD were not independently associated with transition.

Table 4. Multivariable model for subsequent AVF/AVG establishment

Predictor	Adjusted risk ratio	95% CI	p-value
Age, per 10-year increase	1.00	0.93-1.08	0.921
Female sex	1.09	0.86-1.37	0.477
Center 1 vs Center 2	0.89	0.61-1.30	0.552
Diabetes as ESKD etiology	1.04	0.81-1.34	0.739
Cardiovascular comorbidity	0.60	0.42-0.84	0.003

The sensitivity logistic-regression model yielded the same substantive conclusion. Cardiovascular comorbidity remained independently associated with reduced odds of transition (adjusted OR 0.37, 95% CI 0.20-0.67; p=0.001). Similarly, when the secondary outcome was restricted to a well-functioning AVF/AVG, cardiovascular comorbidity remained independently associated with lower functional-transition probability (aRR 0.60, 95% CI 0.42-0.87; p=0.007).

DISCUSSION

Principal findings

This multicenter study examined vascular access as a clinical trajectory rather than as a cross-sectional access category. Only slightly more than half of adults who began maintenance hemodialysis through a catheter subsequently had an AVF or AVG documented, while 45.5% remained without documented definitive arteriovenous access. Among patients who did transition, AVF predominated and functional status was favorable. However, median time to access creation exceeded four months, and more than one quarter of patients with complete dates had not undergone AV-access creation within the first year. The most important patient-level finding was the association between cardiovascular comorbidity and transition. After adjustment, cardiovascular disease was associated with approximately 40% lower probability of definitive arteriovenous-access establishment.

Catheter dependence as a care pathway

The findings add a different perspective to conventional vascular-access prevalence studies. International data have demonstrated that catheter initiation remains frequent and that subsequent catheter dependence can persist even after an AVF has been created.4,5 In the French REIN registry, a substantial proportion of patients beginning hemodialysis with nonfunctional arteriovenous access never achieved successful conversion during follow-up.7 Conversely, patients who eventually converted to functional access had outcomes more similar to patients who started with functional arteriovenous access than to those who remained catheter dependent. Gan et al. likewise reported clinically important differences between early catheter-to-AVF conversion and persistent catheter use among incident hemodialysis patients.8 These observations support evaluating time to catheter independence and transition success as meaningful dialysis-quality measures. The 54.5% transition proportion in our study should not, however, be interpreted as evidence that every remaining patient necessarily represented inappropriate catheter use. Contemporary KDOQI guidance explicitly recognizes that vascular-access choice must be individualized according to the patient's ESKD Life-Plan, comorbidity, vascular anatomy, prognosis, and treatment preferences.2

Cardiovascular disease and access transition

Cardiovascular comorbidity emerged as the clearest marker of non-transition. This finding is clinically plausible because substantial ischemic heart disease, heart failure, or cardiomyopathy may complicate arteriovenous-access planning and alter the balance between the expected benefit of catheter avoidance and the hemodynamic consequences of AV-access creation. Importantly, the finding should not be interpreted as evidence that cardiovascular disease is itself a contraindication to AVF or AVG creation. Rather, it identifies a group that may benefit from earlier multidisciplinary evaluation involving nephrology, vascular-access specialists and, where appropriate, cardiology. The barrier analysis supports this interpretation: reduced ejection fraction and designation as not being a surgical candidate together accounted for almost one fifth of patients without transition.

Patient and system barriers

Several potentially modifiable barriers were also evident. Recent diagnosis of ESKD accounted for approximately one fifth of non-transition cases. This may reflect late presentation, rapid deterioration of kidney function, or insufficient time for predialysis access planning. Saudi nephrologists have previously identified late referral and inadequate predialysis preparation as important contributors to delayed permanent access creation.9 Patient refusal was documented in 13.3%. Effective counseling should therefore go beyond simply recommending a fistula and should provide balanced information about catheter risks, AVF maturation, potential interventions, and alternatives. Such shared decision-making is consistent with the individualized approach advocated by KDOQI.2 Previous access failure represented another clinically important group. These patients may require accelerated vascular mapping, alternative access configurations, endovascular or surgical reassessment, or individualized consideration of graft access rather than repeated unsuccessful fistula attempts. A further quality concern was documentation. Almost 30% of non-transition cases had either an unknown/unspecified reason or no recorded reason at all. Without a clearly documented rationale, it is difficult to distinguish appropriate long-term catheter use from potentially correctable delay.

Clinical implications

A practical implication is that dialysis programs should monitor not only prevalent catheter rates but the trajectory of every patient who initiates dialysis through a catheter. A catheter-transition pathway could include documentation of the reason for catheter initiation; an individualized ESKD Life-Plan; vascular assessment and mapping when appropriate; explicit documentation of surgical or cardiac contraindications; patient-centered counseling when refusal occurs; a scheduled date for access reassessment; and continued follow-up until catheter removal or a documented decision for long-term catheter management is reached. Such an approach would distinguish unavoidable catheter use from potentially remediable catheter dependence.

Strengths and limitations

The study has several strengths. It uses data from two dialysis centers and examines a clinically meaningful sequence from first access to subsequent AVF/AVG creation. The primary denominator is clearly defined, and the main outcome is distinct from previously reported cross-sectional access-patency analyses. The use of adjusted risk ratios also provides a directly interpretable measure for a common outcome. Several limitations require consideration. First, the retrospective design prevents causal inference. Associations should therefore be interpreted as markers of transition probability rather than causal determinants. Second, the recorded date of AVF/AVG creation does not necessarily represent the date of successful cannulation or catheter removal. Accordingly, the primary outcome represents establishment of definitive arteriovenous access, not confirmed catheter-free survival. Third, time-to-event methods accounting for competing risks could not be performed because complete dates of death, transplantation, transfer, recovery of kidney function, and catheter removal were unavailable. Fourth, some clinically important factors—including vessel diameter, vascular mapping findings, previous central venous procedures, detailed peripheral vascular disease, surgeon-related factors, and repeated cannulation attempts—were not available. Fifth, cardiovascular disease was derived from clinical documentation and represents a heterogeneous group of conditions. Sixth, reasons for non-transition were retrospectively recorded and may be susceptible to documentation bias. Finally, both centers were located in Al-Ahsa. The findings therefore require external validation before being generalized to the wider Saudi dialysis population.

CONCLUSIONS

Among adults initiating maintenance hemodialysis through a catheter in two centers in Al-Ahsa, only 54.5% subsequently established an AVF or AVG, and approximately one half of the total cohort ultimately had a documented well-functioning arteriovenous access.

Cardiovascular comorbidity was independently associated with substantially lower transition probability, while recent ESKD diagnosis, patient refusal, previous access failure, low ejection fraction, and surgical unsuitability represented important barriers.

These findings support moving beyond simple catheter-prevalence measures toward a structured catheter-to-definitive-access pathway in which every catheter-initiating patient has a documented rationale, individualized access plan, scheduled reassessment, and explicit follow-up until catheter independence or an appropriately documented long-term catheter strategy is achieved.

DECLARATIONS

Ethics approval and consent to participate

The present secondary analysis was approved by the Research Ethics Committee of King Faisal University, Al-Ahsa, Saudi Arabia. The source clinical data were collected under institutional ethical authorization. Because the present study involved retrospective analysis of de-identified clinical information without direct participant contact, the requirement for individual informed consent was waived where permitted by the approving ethics committees. All procedures were conducted in accordance with applicable institutional requirements and the principles of the Declaration of Helsinki.

Consent for publication

Not applicable.

Data availability

Patient-level clinical data are not publicly available because of confidentiality and institutional data-governance requirements. De-identified data may be available from the corresponding author upon reasonable request and following the necessary institutional and ethical approvals.

Author contribution

Mohammed Yousef Almulhim: Conceptualization, methodology, investigation, data curation, formal analysis, interpretation, supervision, writing-original draft, writing-review and editing, and final approval of the manuscript.

REFERENCES

[1] Alshehri MA, Alkhlady HY, Awan ZA, et al. Prevalence of chronic kidney disease in Saudi Arabia: an epidemiological population-based study. BMC Nephrol. 2025;26(1):37. doi:10.1186/s12882-025-03954-2. PMID: 39849386.

[2] Lok CE, Huber TS, Lee T, et al; National Kidney Foundation. KDOQI Clinical Practice Guideline for Vascular Access: 2019 Update. Am J Kidney Dis. 2020;75(4 Suppl 2):S1-S164. doi:10.1053/j.ajkd.2019.12.001. PMID: 32778223.

[3] Ravani P, Palmer SC, Oliver MJ, et al. Associations between hemodialysis access type and clinical outcomes: a systematic review. J Am Soc Nephrol. 2013;24(3):465-473. doi:10.1681/ASN.2012070643. PMID: 23431075.

[4] Pisoni RL, Zepel L, Port FK, Robinson BM. Trends in US vascular access use, patient preferences, and related practices: an update from the US DOPPS Practice Monitor with international comparisons. Am J Kidney Dis. 2015;65(6):905-915. doi:10.1053/j.ajkd.2014.12.014. PMID: 25662834.

[5] Pisoni RL, Zepel L, Zhao J, et al. International comparisons of native arteriovenous fistula patency and time to becoming catheter-free: findings from the Dialysis Outcomes and Practice Patterns Study (DOPPS). Am J Kidney Dis. 2021;77(2):245-254. doi:10.1053/j.ajkd.2020.06.020. PMID: 32971192.

[6] Lyu B, Chan MR, Yevzlin AS, Astor BC. Catheter dependence after arteriovenous fistula or graft placement among elderly patients on hemodialysis. Am J Kidney Dis. 2021;78(3):399-408.e1. doi:10.1053/j.ajkd.2020.12.019. PMID: 33582176.

[7] Alencar de Pinho N, Coscas R, Metzger M, et al. Vascular access conversion and patient outcome after hemodialysis initiation with a nonfunctional arteriovenous access: a prospective registry-based study. BMC Nephrol. 2017;18(1):74. doi:10.1186/s12882-017-0492-y. PMID: 28222688.

[8] Gan W, Zhu F, Mao H, Xiao W, Chen W, Zeng X. The effect of early conversion from central venous catheter to arteriovenous fistula on hospitalization and mortality in incident haemodialysis patients. J Vasc Access. 2024;25(6):1967-1974. doi:10.1177/11297298231196267. PMID: 37638715.

[9] Alfarhan MA, Almatrafi SA, Alqaseer SM, Albkiry YA. Causes of the delay in creating permanent vascular access in hemodialysis patients. Saudi J Kidney Dis Transpl. 2020;31(6):1217-1224. doi:10.4103/1319-2442.308330. PMID: 33565433.

[10] Alhubail FM, Al Mousa AM, Alhassan GM, et al. Patterns and outcomes of permanent vascular access in end-stage kidney disease: a multicenter experience. Cureus. 2025;17(10):e94950. doi:10.7759/cureus.94950. PMID: 41267729.

[11] von Elm E, Altman DG, Egger M, Pocock SJ, Gøtzsche PC, Vandenbroucke JP; STROBE Initiative. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies. J Clin Epidemiol. 2008;61(4):344-349. doi:10.1016/j.jclinepi.2007.11.008. PMID: 18313558.

[12] Zou G. A modified Poisson regression approach to prospective studies with binary data. Am J Epidemiol. 2004;159(7):702-706. doi:10.1093/aje/kwh090. PMID: 15033648.