

Utilization, patency, and complications associated with vascular access for hemodialysis in the United States



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ABSTRACT

Background: This study examines the utilization and outcomes of vascular access for long-term hemodialysis in the United States and describes the impact of temporizing catheter use on outcomes. We aimed to evaluate the prevalence, patency, and associated patient survival for pre-emptively placed autogenous fistulas and prosthetic grafts; for autogenous fistulas and prosthetic grafts placed after a temporizing catheter; and for hemodialysis catheters that remained in use.

Methods: We performed a retrospective study of all patients who initiated hemodialysis in the United States during a 5-year period (2007-2011). The United States Renal Data System-Medicare matched national database was used to compare outcomes after pre-emptive autogenous fistulas, preemptive prosthetic grafts, autogenous fistula after temporizing catheter, prosthetic graft after temporizing catheter, and persistent catheter use. Outcomes were primary patency, primary assisted patency, secondary patency, maturation, catheter-free dialysis, severe access infection, and mortality.

Results: There were 73,884 (16%) patients who initiated hemodialysis with autogenous fistula, 16,533 (3%) who initiated hemodialysis with prosthetic grafts, 106,797 (22%) who temporized with hemodialysis catheter prior to autogenous fistula use, 32,890 (7%) who temporized with catheter prior to prosthetic graft use, and 246,822 (52%) patients who remained on the catheter. Maturation rate and median time to maturation were 79% vs 84% and 47 days vs 29 days for pre-emptively placed autogenous fistulas vs prosthetic grafts. Primary patency (adjusted hazard ratio [aHR], 1.26; 95% confidence interval [CI], 1.25-1.28; $P < .001$) and primary assisted patency (aHR, 1.36; 95% CI, 1.35-1.38; $P < .001$) were significantly higher for autogenous fistula compared with prosthetic grafts. Secondary patency was higher for autogenous fistulas beyond 2 months (aHR, 1.36; 95% CI, 1.32-1.40; $P < .001$). Severe infection (aHR, 9.6; 95% CI, 8.86-10.36; $P < .001$) and mortality (aHR, 1.29; 95% CI, 1.27-1.31; $P < .001$) were higher for prosthetic grafts compared with autogenous fistulas. Temporizing with a catheter was associated with a 51% increase in mortality (aHR, 1.51; 95% CI, 1.48-1.53; $P < .001$), 69% decrease in primary patency (aHR, 0.31; 95% CI, 0.31-0.32; $P < .001$), and 130% increase in severe infection (aHR, 2.3; 95% CI, 2.2-2.5; $P < .001$) compared to initiation with autogenous fistulas or prosthetic grafts. Mortality was 2.2 times higher for patients who remained on catheters compared to those who initiated hemodialysis with autogenous fistulas (aHR, 2.25; 95% CI, 2.21-2.28; $P < .001$).

Conclusions: Temporizing catheter use was associated with higher mortality, higher infection, and lower patency, thus undermining the highly prevalent approach of electively using catheters as a bridge to permanent access. Autogenous fistulas are associated with longer time to catheter-free dialysis but better patency, lower infection risk, and lower mortality compared with prosthetic grafts in the general population. (*J Vasc Surg* 2018;68:1166-74.)

Keywords: Hemodialysis access; Dialysis access; End-stage renal disease; Chronic kidney disease; Arteriovenous fistula; Arteriovenous graft; Autogenous fistula; Prosthetic graft; Hemodialysis catheter; Dialysis catheter; Permacath

National initiatives, such as Fistula First, and clinical guidelines, such as those promulgated by the Kidney Disease Outcomes Quality Initiative, have proliferated to minimize morbidity and to maximize the duration of access function for patients with end-stage renal disease

(ESRD).^{1,2} Accordingly, it has been recommended that autogenous fistulas be considered the preferred initial access for hemodialysis in patients with ESRD, followed by prosthetic grafts and finally by hemodialysis catheters.³ These recommendations stem from numerous studies that have demonstrated an increased risk of sepsis, hospitalization, central venous stenosis, and mortality with catheters as well as increased cost.⁴⁻¹⁰

The National Kidney Foundation recommends that patients with stage 4 chronic kidney disease undergo evaluation for permanent access placement 6 months before their anticipated dialysis start date.¹ This is to allow maturation, a process reported to be as long as 4 months for autogenous fistulas and 4 weeks for prosthetic grafts, and to avoid the need for a catheter as a bridge to maturation. Despite international recommendations and guidelines backed by strong evidence, 80% of incident hemodialysis patients initiate hemodialysis with a catheter rather than with an autogenous fistula or prosthetic graft in the United States.^{11,12} Indeed,

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in many countries, this trend may be increasing. For example, from 1996 to 2007, the proportion of hemodialysis patients using a catheter in Spain tripled.¹³ In France, it doubled.¹³ The need to reverse the high prevalence of catheter use, nationally and globally, remains urgent. The prompt creation of autogenous fistulas or prosthetic grafts after prior hemodialysis catheter placement is a rational step to limiting the risk associated with catheters. However, the risks attributable to prior catheter use on outcomes of autogenous fistulas and prosthetic grafts are largely unknown.

In the past, there was no reimbursement from the Centers for Medicare and Medicaid Services (CMS) for the creation of autogenous fistulas or prosthetic grafts until at least 30 days after the diagnosis of ESRD. This practice changed through the extensive efforts of the leadership of the Fistula First Initiative, among others.¹⁴ Changes in payment policies for hemodialysis-related care that incentivize efficiency, durability, and low cost have also recently been made by the CMS.¹⁵ These necessitate objective examination of the performance and durability of hemodialysis access alternatives.

In this study, we performed a 5-year audit of hemodialysis access in the United States. Our objective was to compare patterns of utilization of autogenous fistulas and prosthetic grafts or catheters for hemodialysis, access maturation, attainment of catheter-free dialysis, patency, imaging, and mortality in a population-based cohort of patients. We also estimate the risks attributable to prior and persistent use of hemodialysis catheters.

METHODS

A retrospective analysis of all patients in the United States Renal Data System (USRDS) who initiated hemodialysis between January 1, 2007, and December 31, 2011, was performed. The USRDS maintains a prospective database of all ESRD patients receiving renal replacement therapy in the United States. Annual reports published since 1988 appear at usrds.org and provide information on epidemiology and mortality among other parameters.¹⁶ The USRDS maintains a robust database of every ESRD patient by integrating patient-specific data on hospitalization and costs from the CMS, Centers for Disease Control and Prevention, United Network for Organ Sharing, and ESRD networks. The Johns Hopkins Institutional Review Board approved this study, and the need for consent of the individual patient was waived.

The USRDS database contains data on patients' initial hemodialysis access type and demographic and medical characteristics obtained through CMS Form 2728, End Stage Renal Disease Medical Evidence Report. This form is filled out at the treatment facility by trained medical personnel. Data on arteriovenous access creation, interventions, and complications such as stenosis, thrombosis, and infection necessitating excision in predialysis patients were obtained from a cohort of Medicare beneficiaries

ARTICLE HIGHLIGHTS

- **Type of Research:** Retrospective study of data from the United States Renal Data System-Medicare matched national database
- **Take Home Message:** In over 470,000 patients who initiated hemodialysis, catheter use as a bridge to permanent access was associated with higher mortality, higher infection, and lower patency. Initiating hemodialysis with autogenous fistula was associated with better patency and survival and lower infection rate.
- **Recommendation:** Whenever possible, the authors recommend initiating hemodialysis with autogenous fistula and abandoning the approach of electively temporizing with hemodialysis catheters.

who progressed to ESRD and were subsequently captured in the USRDS database. Follow-up data were obtained from the linked Medicare claims database. The USRDS database also contains data on the death of patients, collected from CMS Form 2746, ESRD Death Notification Form, that is filled out by providers to notify Medicare whenever an ESRD patient dies and matched with the Social Security Death Index. The cohort was divided into patients who initiated hemodialysis with autogenous fistula, prosthetic grafts, or hemodialysis catheters. Patients who initiated hemodialysis with a catheter were further stratified into those who converted from catheter to fistula or graft (converts) and those who persisted on catheters for hemodialysis. The type of arteriovenous access created after initiation with a catheter was identified by *Current Procedural Terminology* (CPT) codes for autogenous fistulas (36818, 36819, 36820, 36821, and 36825) and prosthetic grafts (36830).

Among patients who initiated hemodialysis with a catheter, the total duration of catheter exposure was computed as the interval between catheter placement (CPT code: 36557, 36558) and removal (CPT code: 36589). The time to catheter-free dialysis was computed as the interval between autogenous fistula or prosthetic graft placement and catheter removal in a patient who initiated hemodialysis with a catheter. The ends of these intervals were identified by catheter removal not associated with a new catheter placement within 7 days and preceded by autogenous fistula or prosthetic graft placement, thus incorporating all catheter exchanges within the interval. Primary patency, primary assisted patency, and secondary patency were defined in accordance with published standards.¹⁷ The following interventions signified the event times used for computing patencies: angioplasty (CPT code: 35476), stenting (CPT code: 37205, 75960), thrombectomy (CPT code: 36831, 36870), and surgical revision (CPT code: 36832, 36833). The incidence of severe infection necessitating arteriovenous

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