

Timing of Nephrologist Referral and Arteriovenous Access Use: The CHOICE Study

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● Recent clinical practice guidelines recommend the creation of an arteriovenous (AV) vascular access (ie, native fistula or synthetic graft) before the start of chronic hemodialysis therapy to prevent the need for complication-prone dialysis catheters. We report on the association of referral to a nephrologist with duration of dialysis-catheter use and type of vascular access used in the first 6 months of hemodialysis therapy. The study population is a representative cohort of 356 patients with questionnaire, laboratory, and medical record data collected as part of the Choices for Healthy Outcomes in Caring for End-Stage Renal Disease Center Study. Patients who reported being seen by a nephrologist at least 1 month before starting hemodialysis therapy (75%) were more likely than those referred later to use an AV access at initiation (39% versus 10%; $P < 0.001$) and 6 months after starting hemodialysis therapy (74% versus 56%; $P < 0.01$). Patients referred within 1 month of initiating hemodialysis therapy used a dialysis catheter for a median of 202 days compared with 64, 67, and 19 days for patients referred 1 to 4, 4 to 12, and greater than 12 months before initiating hemodialysis therapy, respectively (P trend < 0.001). Patients referred at least 4 months before initiating hemodialysis therapy were more likely than patients referred later to use an AV fistula, rather than a synthetic graft, as their first AV access (45% versus 31%; $P < 0.01$). These associations remained after adjustment for age, sex, race, marital status, education, insurance coverage, comorbid disease status, albumin level, body mass index, and underlying renal diagnosis. These data show that late referral to a nephrologist substantially increases the likelihood of dialysis-catheter use at the initiation of hemodialysis therapy and is associated with prolonged catheter use. Regardless of the time of referral, only a minority of patients used an AV access at the initiation of treatment, and greater than 25% had not used an AV access 6 months after initiation. Thus, further efforts to improve both referral patterns and preparation for dialysis after referral are needed.

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INDEX WORDS: Vascular access; referral; hemodialysis (HD).

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ARTERIOVENOUS (AV) vascular accesses for hemodialysis (ie, native fistulae or synthetic grafts) provide greater blood flow rates than percutaneous dialysis catheters¹ and are associated with much lower rates of thrombosis,² infection,³ septicemia,^{4,5} and central venous stenosis.^{6,7} For these reasons, the National Kidney Foundation-Dialysis Outcomes Quality Initiative (DOQI) Clinical Practice Guidelines for Vascular Access recommend placement of an AV access before initiation of chronic hemodialysis therapy to avoid the use of a dialysis catheter.⁸ However, only one third of incident hemodialysis patients in the US Renal Data System in 1996 used an AV access at the initiation of hemodialysis therapy.⁹ Because most studies have found that AV fistulae have fewer complications than synthetic grafts, the DOQI guidelines further recommend fistulae over grafts.⁸ However, among incident hemodialysis patients in 1996, fewer than one third of the AV accesses in use 2 months after starting hemodialysis therapy were AV fistulae.⁹

Placement and adequate maturation of an AV access before the initiation of hemodialysis therapy requires timely patient education and

counseling, selection of the preferred renal replacement modality, selection of an access type and location, and creation of the access at least several weeks to months in advance of its expected need. Cross-sectional studies have found late referral to a nephrologist to be one important reason that many incident patients use a dialysis catheter at the start of chronic hemodialysis therapy.¹⁰ However, the duration of dialysis-catheter use associated with late referral to a nephrologist is unknown because few prospective data are available on the progression from dialysis catheters to AV accesses among incident patients after starting chronic hemodialysis therapy. Evidence is also lacking on the extent to which timing of referral to a nephrologist affects the eventual choice of initial AV-access type.

We conducted a prospective study to examine the association of timing of referral to a nephrologist, as well as other factors, with timing of first use of an AV access and type of access in use after initiation of chronic hemodialysis therapy in a nationally representative cohort of incident patients with kidney failure.

METHODS

Study Design and Population

Study subjects were a subpopulation of patients drawn from dialysis centers participating in the Choices for Healthy Outcomes in Caring for End-Stage Renal Disease (CHOICE) Cohort Study.¹¹ CHOICE is a national prospective cohort study of incident dialysis patients initiated in 1995 to investigate treatment choices of modality and dose and outcomes of dialysis care. From October 1995 to June 1998, a total of 1,041 patients were enrolled from 80 dialysis clinics associated with Dialysis Clinic, Incorporated (DCI; Nashville, TN), New Haven CAPD (New Haven, CT), and the Hospital of St Raphael (New Haven, CT). All patients were incident patients with kidney failure starting outpatient dialysis, aged older than 17 years, and spoke English or Spanish. All patients provided informed consent. Patients were enrolled a median of 45 days from initiation of chronic dialysis therapy (98% within 4 months). The present study was limited to patients who used hemodialysis as their initial renal replacement modality ($n = 762$), were enrolled at clinics associated with DCI ($n = 735$), and had records available at the time of review ($n = 706$).

Data Collection

Patients reported the date they were first seen by a nephrologist at enrollment into CHOICE. The time of first referral to a nephrologist relative to the initiation of chronic hemodialysis therapy was divided into four categories (<1,

1 to 4, 4 to 12, and >12 months). Self-reported education was categorized by whether the participant reported having completed high school. Demographic characteristics, insurance coverage at the initiation of chronic dialysis therapy, primary cause of renal failure, and date of first chronic dialysis were ascertained from the Health Care Financing Administration Medical Evidence Form (form 2728), completed at the initiation of chronic dialysis. Body mass index was calculated as height/weight² (in kilograms per square meter). Race was categorized as black or other. Insurance coverage was categorized as Medicare, Medicaid, other, or no insurance.

The Index of Coexistent Disease (ICED)^{12,13} was completed at enrollment by a trained research nurse based on medical records. The ICED is composed of the Index of Disease Severity (IDS) and Index of Physical Impairment (IPI). The IDS is a chart-based review of levels of severity of 19 medical conditions. The IPI is a chart-based assessment of 11 physical-impairment categories with three levels of severity. The IDS and IPI are compiled into a summary ICED score representing comorbid disease burden. The ICED score was categorized as mild (0 or 1), moderate (2), or severe (3). Specific comorbid conditions were also recorded. A patient was categorized as having a positive history of cardiovascular disease if any of the following conditions were noted: coronary artery disease, myocardial infarction, cerebrovascular disease, or transient ischemic attack. Diabetes mellitus was categorized as a secondary condition if a patient had diabetes mellitus but it was not the primary cause of renal disease. Blood laboratory values were obtained at the initiation of chronic dialysis as part of routine care. Serum albumin levels were categorized as greater or less than the mean of 3.6 g/dL.

Discharge summaries, dialysis flow sheets, and dialysis clinic progress notes were collected by clinic coordinators at each clinic at enrollment and annually. The type and date of first use of each vascular access used was abstracted from medical records by two investigators (B.C.A. and J.A.E.). Dialysis catheters were categorized as a tunneled cuffed catheter, percutaneous (nontunneled) catheter, or unspecified. A patient initially using a nontunneled catheter was categorized as using this until a tunneled catheter or AV access was used. A patient having used a tunneled catheter was categorized as using this until an AV access was used. A patient was considered to have used an AV access after a single hemodialysis session was completed using an AV access.

Statistical Analysis

Characteristics of patients using an AV access at the initiation of hemodialysis therapy were compared with the remaining patients in unadjusted analyses using *t*-tests for continuous variables, chi-squared tests for categorical variables, and chi-squared tests for trend for ordinal variables. Multivariate logistic regression was used to assess the independent predictors of using an AV access at initiation of chronic hemodialysis therapy. To account for possible correlation of outcomes within hemodialysis clinics, generalized estimating equations assuming an exchangeable correlation structure were used for all multivariate analyses.¹⁴ Similar

multivariate logistic regression models were used to assess the independent predictors of AV-fistula versus synthetic-graft use at the initiation of hemodialysis therapy, AV-access use by 6 months after initiation of hemodialysis therapy, and use of an AV fistula rather than a synthetic graft as the first type of AV access used. All terms were included in each of these models. Time to first use of an AV access was analyzed using Kaplan-Meier estimates and Wilcoxon's rank-sum tests.¹⁵ Cox proportional hazards models were used to examine the independent effects of referral status on AV-access use after adjustment for other patient characteristics.¹⁶ Dummy variables were used for patients with missing values for independent variables. Patients were censored at the time of death, renal transplantation, switch to peritoneal dialysis therapy, or last available follow-up information. Statistical analyses were performed using Stata statistical software (Stata Corp, College Station, TX).¹⁷

RESULTS

Patient Characteristics

The date of first referral to a nephrologist was available for 499 patients. Type of vascular access in use at initiation of hemodialysis therapy was available for 356 of these patients (71%). These patients were enrolled at 70 clinics. Patient characteristics are listed in Table 1. The mean age of these 356 patients was 2 years less than that of their 350 counterparts without complete information (58 versus 60 years; $P = 0.03$), but patients were similar in terms of sex, race, insurance coverage at initiation of hemodialysis therapy, and primary cause of kidney failure. No patients included on this study had acute renal failure or regained independent renal function.

Use of an AV Access at Initiation of Hemodialysis Therapy

At the initiation of hemodialysis therapy, 68% of patients used a dialysis catheter (49% tunneled, 15% nontunneled, and 4% unspecified) and 32% used an AV access (18% synthetic grafts and 14% AV fistulae; Fig 1). The proportion of patients using an AV access at the initiation of hemodialysis therapy increased with referral time from 10% for those referred less than 1 month to 32% for those referred 1 to 4 months, 28% for those referred 4 to 12 months, and 46% for those referred greater than 12 months before the initiation of hemodialysis therapy (P trend < 0.001). Earlier referral remained significantly associated with a greater likelihood of AV-access use at the initiation of hemodialysis therapy after adjustment for age, sex, race, body mass index,

Table 1. Selected Characteristics of 356 Incident Hemodialysis Patients Enrolled Into the CHOICE Study

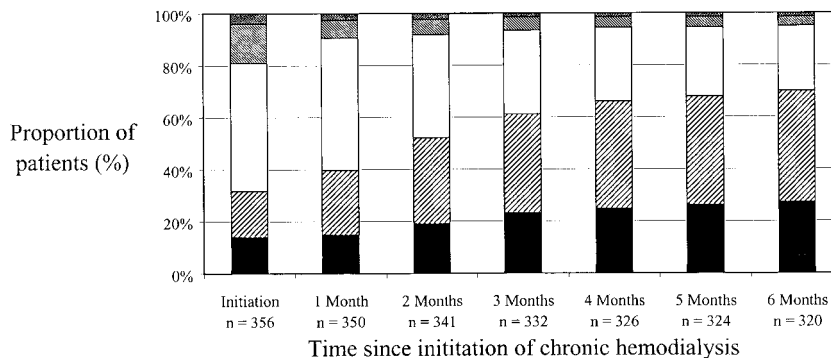
Patient Characteristic	No.	%
Age group (y)*		
<50	115	33.3
50-59	62	18.0
60-69	87	25.2
≥70	81	23.5
Women	152	42.7
Black†	108	32.0
High school graduate	252	70.8
Index of coexisting disease		
1 (mild)	102	28.7
2 (moderate)	145	40.7
3 (severe)	109	30.6
History of peripheral vascular disease	96	27.0
History of cardiovascular disease	179	50.3
Primary cause of kidney failure		
Diabetes mellitus	169	47.5
Hypertension	75	21.1
Glomerulonephritis	45	12.6
Other	67	18.8
Timing of first referral to a nephrologist (mon before initiation of hemodialysis)		
<1	89	25.0
1-4	53	14.9
4-12	61	17.1
>12	153	43.0
Use of an AV access at initiation of hemodialysis	113	31.7
First type of AV access used (n = 318)		
Native fistula	127	39.9
Synthetic graft	191	60.1

*Age was missing for 11 patients (n = 345).

†Race was missing for 18 patients (n = 348).

marital status, education, insurance coverage at initiation of hemodialysis therapy, severity of comorbidity, history of peripheral vascular disease, history of cardiovascular disease, presence of diabetes mellitus, albumin level, and cause of kidney failure (Table 2, column 1). Moderate or severe comorbidity, compared with mild, was associated with an approximately 50% lower likelihood of using an AV access at initiation of hemodialysis therapy (adjusted odds ratio [OR], 0.48; 95% confidence interval [CI], 0.26 to 0.87), after adjustment. Patients with kidney failure caused by hypertension were less likely to use an AV access at the initiation of hemodialysis therapy than their counterparts with kidney failure caused by diabetes mellitus (adjusted OR, 0.40; 95% CI, 0.18 to 0.89). None of the other factors in Table 2

Fig 1. Type of vascular access in use among 356 incident hemodialysis patients enrolled onto the CHOICE Study by time since initiation of chronic hemodialysis therapy. (■) AV fistula; (▨) synthetic graft; (□) tunneled catheter; (▩) non-tunneled catheter; (■) unspecified catheter.



were significantly associated with AV-access use at the initiation of chronic hemodialysis therapy.

AV-Access Use During First 6 Months of Hemodialysis Therapy

By 6 months after the initiation of hemodialysis therapy, 224 of 320 patients (70%) with data available had used an AV access for at least one hemodialysis session. Of these, 87 accesses (39%) were AV fistulae and 137 accesses (61%) were synthetic grafts. Earlier referral was significantly associated with a greater likelihood of AV-access use by 6 months after the initiation of hemodialysis therapy (56% for those referred <1 month, 65% for those referred 1 to 4 months, 63% for those referred 4 to 12 months, and 82% for those referred >12 months before the initiation of hemodialysis therapy; P trend < 0.001). This association remained after adjustment for the other factors in Table 2 (adjusted OR for ≥ 4 months versus <4 months, 2.05; 95% CI, 1.20 to 3.50; Table 2, column 2). Moderate or severe comorbidity, compared with mild, remained associated with an approximately 50% lower likelihood of AV-access use by 6 months after initiation (adjusted OR, 0.47; 95% CI, 0.24 to 0.93).

Duration of Dialysis-Catheter Use

In Kaplan-Meier analysis, the median duration from starting hemodialysis therapy until the first use of an AV access was 57 days. The median duration of catheter use was 202 days among patients referred to a nephrologist less than 1 month before initiation of hemodialysis compared with medians of 67, 64, and 19 days among those referred 1 to 4, 4 to 12, and greater than 12 months before initiation, respectively (P trend < 0.001; Fig 2). Patients with moderate

or severe comorbidity had a median duration of 65 days compared with 41 days for patients with mild comorbidity (P < 0.01 by Wilcoxon's rank sum). Patients having completed high school had a median duration of 52 days compared with 92 days for their counterparts with less education (P < 0.05 by Wilcoxon's rank sum). The predicted median time to the first use of an AV access was 126 days for patients referred less than 1 month before the initiation of hemodialysis therapy after adjustment for mean level of education, severity of comorbidity, sex, race, and age. Median times for the other three categories of referral status did not change significantly after adjustment.

In a multivariate Cox proportional hazards model of the time to the first use of an AV access, referral status remained significantly associated with earlier use after adjustment for the other factors in Table 2 (P trend < 0.001). Age was also associated with a greater relative hazard (RH) of using an AV access (RH, 1.47 for age 50 to 59 compared with <50 years; 95% CI, 1.04 to 2.09; RH, 1.40 for age 60 to 69 years; 95% CI, 1.01 to 1.94; RH, 1.18 for age ≥ 70 years; 95% CI, 0.79 to 1.74).

Type of AV Access First Used

Among all patients who used an AV access at any time during follow-up ($n = 318$), 127 patients (40%) first used an AV fistula and 191 patients (60%) first used a synthetic graft. Patients referred 1 to 4 months before the initiation of hemodialysis therapy had the same likelihood of using an AV fistula, rather than a synthetic graft, as patients referred within 1 month (31%). Among patients referred 4 to 12 months and those referred greater than 12 months before the

Table 2. Adjusted OR of AV Access Use at Initiation and 6 Months After Initiation of Chronic Hemodialysis and Use of an AV Fistula as First Type of AV Access Among Incident Hemodialysis Patients Enrolled Onto the CHOICE Study

Patient Characteristic	AV Access v Dialysis Catheter		AV Fistula v Synthetic Graft as First Type of AV Access Used (n = 318)
	Initiation of Chronic Hemodialysis (n = 356)	6 Months After Initiation of Hemodialysis (n = 320)	Adjusted* OR (95% CI)
Timing of first referral to a nephrologist (mon before initiation of hemodialysis)			
<1	1.00 (referent)	1.00 (referent)	1.00 (referent)
1-4	5.14 (1.99-13.26)†	1.63 (0.71-3.73)†	1.11 (0.46-2.67)
4-12	3.22 (1.24-8.37)†	1.28 (0.59-2.74)†	2.18 (0.95-5.00)
>12	8.88 (3.90-20.23)†	3.56 (1.80-7.04)†	1.76 (0.87-3.56)
Age group			
<50	1.00 (referent)	1.00 (referent)	1.00 (referent)
50-59	2.22 (0.99-4.85)	2.36 (1.01-5.53)	0.46 (0.21-1.01)‡
60-69	1.44 (0.70-2.99)	1.85 (0.84-4.06)	0.44 (0.21-0.92)‡
≥70	2.02 (0.91-4.48)	1.00 (0.44-2.24)	0.39 (0.17-0.85)‡
Men	1.00 (referent)	1.00 (referent)	1.00 (referent)
Women	1.01 (0.58-1.77)	1.33 (0.74-2.39)	0.34 (0.19-0.61)§
Nonblack	1.00 (referent)	1.00 (referent)	1.00 (referent)
Black	1.57 (0.85-2.91)	1.00 (0.56-1.78)	0.42 (0.22-0.80)
Not high school graduate	1.00 (referent)	1.00 (referent)	1.00 (referent)
High school graduate	1.61 (0.89-2.93)	1.19 (0.68-2.08)	0.62 (0.34-1.14)
Index of coexistent disease			
1 (mild)	1.00 (referent)	1.00 (referent)	1.00 (referent)
2 (moderate)	0.57 (0.30-1.07)‡	0.43 (0.21-0.86)¶	0.84 (0.44-1.59)
3 (severe)	0.36 (0.18-0.75)‡	0.46 (0.21-0.98)¶	0.63 (0.31-1.29)
Primary cause of kidney failure			
Diabetes mellitus	1.00 (referent)	1.00 (referent)	1.00 (referent)
Hypertension	0.40 (0.18-0.89)#	1.23 (0.57-2.66)	1.19 (0.56-2.52)
Glomerulonephritis	1.07 (0.45-2.56)	1.85 (0.68-5.07)	0.87 (0.36-2.11)
Other	0.70 (0.33-1.46)	0.51 (0.25-1.06)	0.96 (0.45-2.05)

*Adjusted for body mass index, marital status, insurance coverage at initiation of chronic hemodialysis, history of peripheral vascular disease, history of cardiovascular disease, diabetes mellitus as a secondary condition, and low albumin level (<3.6 mg/dL).

†*P* trend < 0.001.

‡*P* trend < 0.01.

§*P* < 0.001.

||*P* < 0.01.

¶*P* trend < 0.05.

#*P* < 0.05.

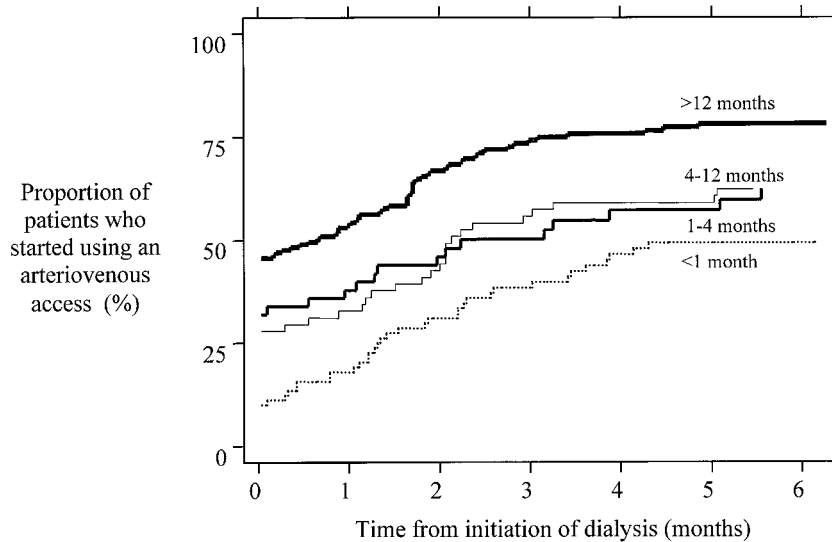
initiation of hemodialysis therapy, 45% used an AV fistula as their first AV access (*P* = 0.01 for ≥4 versus <4 months). The proportion of patients using an AV fistula as their first AV access was twice as high among men as women (50% versus 24%; *P* < 0.001) and higher among patients without than with diabetes mellitus (45% versus 33%; *P* = 0.07) and younger than older patients (52% of patients aged <50 years, 41% of patients aged 50 to 59 years, 29% of patients aged 60 to 69 years, and 35% of patients aged

≥70 years; *P* trend < 0.01). The associations of referral 4 months or greater before the initiation of hemodialysis therapy (adjusted OR, 1.85; 95% CI, 1.06 to 3.21), male sex, and younger age with use of an AV fistula as the first AV access remained after adjustment (Table 2, column 3).

DISCUSSION

Our results show that patients referred to a nephrologist at least 1 month before the initiation of chronic hemodialysis therapy are more than

Fig 2. Proportion of living patients who started using an AV access by timing of first referral to a nephrologist (<1, 1 to 4, 4 to 12 months, and >12 months before the initiation of hemodialysis therapy) among 356 incident hemodialysis patients enrolled onto the CHOICE Study.



three times as likely to use an AV access as opposed to a dialysis catheter for their first dialysis session than patients referred later. Early referral also showed a strong dose response with duration of dialysis-catheter use. Patients referred early were also more likely to use an AV fistula, rather than synthetic graft, as their first AV access than patients referred late. Characteristics of patients on this study and the distribution of vascular-access types are similar to those in other national samples of dialysis patients (eg, Waves 1 and 2 of the Dialysis Morbidity and Mortality Study).^{18,19}

Previous cross-sectional studies have reported the association between early referral to a nephrologist and greater AV-access use at the initiation of chronic hemodialysis therapy.^{9,20,21} Woods et al²¹ reported that 37% of a sample of patients starting hemodialysis therapy in 1996 used an AV access at their first dialysis session, with a 79% greater odds of using an AV access among patients referred to a nephrologist 4 or more months in advance of the initiation of therapy. In the same population, Stehman-Breen et al⁹ found that patients told they had renal disease more than 1 year before the start of hemodialysis therapy were nearly three times more likely to have an AV access in use at the start of hemodialysis therapy than those told 1 to 4 weeks before the start of hemodialysis therapy. Arora et al²⁰ found that 48% of 86 patients referred to a tertiary-care center at least 4 months before the start of chronic hemodialysis therapy used an AV

access for their first dialysis session compared with 4% of 28 patients referred later.

The present study not only confirms the association between early referral and AV-access use at the initiation of hemodialysis therapy, but also extends these results by quantifying the excess duration of dialysis-catheter use associated with late referral in a representative population of incident hemodialysis patients. Because dialysis catheters are often used while an AV access is maturing, examining only the type of vascular access in use at the first hemodialysis session may underestimate the use of AV accesses in the first few months of hemodialysis therapy and therefore overestimate the impact of late referral. Results show that the association between timing of referral to a nephrologist and type of access in use persists well beyond the initiation of chronic hemodialysis therapy. The median duration of dialysis-catheter use among patients referred greater than 12 months before the initiation of hemodialysis therapy was 19 days, whereas the median duration of catheter use was 64, 67, and 202 days for patients referred 4 to 12, 1 to 4, and less than 1 month before initiation, respectively. The burden of morbidity may be substantial because of the much greater complication rates associated with dialysis catheters and the longer period of vulnerability to complications.⁷ Decreasing the prevalence or duration of use of dialysis catheters in the initial period of hemodialysis therapy might decrease the incidence of complications associated with their use.

Dialysis catheters may be used as a bridge to provide dialysis during the longer maturation time required by AV fistulae. The risks to incident hemodialysis patients associated with the temporary use of these catheters may be more than offset by the advantage of having a mature native AV fistula for long-term use because previous studies have shown that AV fistulae have superior outcomes compared with synthetic grafts.^{8,22} Therefore, AV-access use at the initiation of hemodialysis therapy may not be an indicator of optimal care for patients referred late. However, patients referred less than 4 months before the initiation of hemodialysis therapy also were less likely than patients referred earlier to receive a native fistula as their first AV access. The DOQI guidelines specify early referral to a nephrologist and determination of the patient's preferred dialysis modality as the best means of increasing the percentage of AV fistulae among incident hemodialysis patients.⁸ Although other factors likely are associated with the use of synthetic grafts, such as suboptimal vessel anatomy, our results support this recommendation. However, no difference in the proportion of patients using an AV fistula was observed between those referred less than 1 month and those referred 1 to 4 months before the initiation of hemodialysis therapy. This result suggests that referral within a few months of the anticipated need for dialysis frequently provides insufficient time for adequate vascular-access preparation and shows the need for much earlier referral to a nephrologist.

Although use of an AV access at the initiation of hemodialysis therapy was much more common in patients referred early than in patients referred late, vascular-access experiences of patients referred early also were suboptimal. A majority of patients referred more than 1 year before the initiation of hemodialysis therapy did not use an AV access for their first hemodialysis session. Factors other than timing of referral to a nephrologist, such as reluctance of the patient to accept and plan for renal replacement therapy or failures in the processes of care after referral to a nephrologist, may also have a significant impact on the lack of timely AV-access creation in patients starting hemodialysis therapy. If such factors prove to be important, efforts to improve the

preparation of patients with severe chronic kidney disease should focus not only on referring physicians, but should include the practices of nephrologists and other health professionals involved in predialysis care and the education and counseling of patients.

Patients with moderate or severe comorbid disease were significantly more likely than their counterparts with mild comorbid disease to use a dialysis catheter at the initiation of hemodialysis therapy. More severe comorbid disease was also associated with a longer duration of dialysis-catheter use. These associations may be caused by the lack of suitable vessels for creation of an AV access in these patients or the need for an AV access or ability to create it may be outweighed by other health concerns in very ill patients. However, such patients may be least able to tolerate the increased rate of complications, lower dialysis dose, and greater disruption of the dialysis schedule associated with dialysis catheters compared with AV accesses.

There are several limitations to this study. The time of the first referral to a nephrologist was self-reported. However, categorizing referral time into four groups should reduce the misclassification associated with inaccurate responses. We also do not know whether a nephrologist actively followed up a patient after the first encounter, what recommendations were made, or if they were followed. Thus, the impact of specific changes in the practices of nephrologists cannot be predicted from these results. We also cannot determine the extent to which the failure of some AV fistulae to adequately mature after creation impacts on the prevalence or duration of use of dialysis catheters in the early phase of hemodialysis therapy. Data on the first use of each vascular-access type were abstracted retrospectively from medical records; therefore, some changes in type of access in use may have been missed. The number of patients reported on this study as having ever used an AV access overestimates the number of patients actually using an AV access because some are likely to have failed after their initial use. However, ratios of AV accesses to dialysis catheters and of synthetic grafts to AV fistulae at 1 and 2 months reported in the present study are similar to those from other representative populations,^{9,18} and the relative proportions

at 6 months are similar to reports from prevalent hemodialysis patients.^{18,19}

In summary, this prospective study of a nationally representative population of patients starting chronic hemodialysis therapy describes types of vascular accesses in use during the first 6 months of hemodialysis therapy and shows that patients referred to a nephrologist early experience better vascular-access preparation than patients referred later. These results also show that the duration of dialysis-catheter use associated with late referral to a nephrologist is substantial. However, rates of AV-access use and, more specifically, AV-fistula use among patients referred to a nephrologist well in advance of the need for chronic hemodialysis therapy were suboptimal. This suggests that late referral to a nephrologist is not the only factor contributing to the high rate of dialysis-catheter use and the low rate of AV-fistula use. Efforts to improve the vascular-access experience of patients in the initial stages of hemodialysis therapy need to focus on all persons involved in predialysis care, including patients, referring physicians, surgeons, and nephrologists. These data also provide benchmarks against which this improvement can be measured.

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