Predictors of Delayed Transition From Central Venous Catheter Use to Permanent Vascular Access Among ESRD Patients

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Background: Early arteriovenous fistula (AVF) creation is necessary to curb the use of central venous catheters (CVCs) and reduce their complications. We sought to examine patient characteristics that may influence persistent CVC use 90 days after dialysis therapy initiation among patients using a CVC.

Methods: Data from the 1999 to 2003 Clinical Performance Measures Project was linked to the Centers for Medicare & Medicaid Services Medical Evidence (2728) form.

Results: Most patients (59.4%) starting dialysis with a CVC failed to transition to permanent access within 90 days, whereas 25.4% received a graft and only 15.2% received an AVF. Older patients (>75 years) were more than 2-fold more likely to remain CVC dependent at 90 days (P = 0.0.001) compared with those younger than 50 years. In addition, race and sex were highly predictive of CVC dependence at 90 days; black females, white females, and black males were 75% (P < 0.001), 61% (P < 0.001), and 35% (P = 0.023) more likely than white males to maintain CVC use, whereas patients with ischemic heart disease and peripheral vascular disease were 35% (P = 0.023) and 39% (P = 0.007) more likely to remain CVC dependent at 90 days, respectively.

Conclusion: Prolonged CVC dependence is more likely to occur among patients of older age, females, blacks, and those with cardiovascular comorbidity, suggesting inadequate or late access referral or greater primary access failure. Our findings suggest possible missed opportunities for early conversion of patients to permanent vascular access that may vary by race and sex.
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Placement and maintenance of an effective hemodialysis vascular access is essential for safe and adequate hemodialysis therapy, and access-related complications remain one of the most important sources of morbidity and cost among persons with end-stage renal disease (ESRD), with total annual costs exceeding $1 billion annually.[1-3] The National Kidney Foundation–Kidney Disease Outcomes Quality Initiative Clinical Practice Guidelines for Vascular Access recommend early placement and use of an autogenous arteriovenous fistula (AVF) among at least 50% of incident hemodialysis patients.[4] The AVF has longer patency and fewer infectious complications and is associated with lower all-cause mortality compared with a synthetic arteriovenous graft (AVG) or central venous catheter (CVC).[5-10]

Despite these recommendations, 15% of incident patients in the United States initiate dialysis therapy with an AVF, while greater than 60% do so using a CVC.[11,12] Few studies describe changes in vascular access type that might occur during the first several months after the initiation of dialysis therapy.[12,13] In addition, little is known regarding factors that may influence the placement of an AVF or AVG among patients initiating dialysis therapy with a CVC. Information about patient factors associated with early transition from CVC to AVF might identify opportuni-

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ties to increase AVF use. The purpose of this study is to identify patient characteristics associated with delayed transition to an AVF within 90 days after dialysis therapy initiation in a cohort of adult hemodialysis patients who began dialysis therapy using a CVC.

METHODS

Study Population and Data Collection

Information for this study was obtained from the Centers for Medicare & Medicaid Service ESRD Clinical Performance Measures Project (known before 1999 as the ESRD Core Indicators Project) and from selected US Renal Data System (USRDS) Standard Analytical Files for 1999 to 2003 (data collected during 1998 to 2002). Local institutional review board approval was obtained for this study.

Since 1994, the ESRD Clinical Performance Measures Project has collected data annually for a nationally representative random sample of prevalent adult (aged ≥ 18 years) patients with ESRD on hemodialysis therapy in the United States. Information about vascular access at hemodialysis therapy initiation has been collected since study year 1999. Patients are eligible for inclusion in the ESRD Clinical Performance Measures Project adult sample if they are 18 years or older and alive on the December 31 before the study year. Data are collected retrospectively for October to December of the year before the study year (ie, October to December 2002 for study year 2003). Patients are defined as incident for this study if onset of ESRD occurred on or between January 1 and August 31 of the year before the study year.

Demographic and comorbid characteristics used in our analysis include race (black, white); sex; tobacco use (yes, no); age (<54.6, 54.6 to <65.8, 65.8 to <74.5, and ≥74.5 years); body mass index (BMI) classified according to the World Health Organization classification system as underweight (BMI < 18.5 kg/m^2), normal (BMI, 18.5 to <25 kg/m^2), overweight (BMI, 25 to <30 kg/m^2), and obese (BMI ≥ 30 kg/m^2); diabetes (yes, no); hypertension (yes, no); ischemic heart disease (yes, no); myocardial infarction (yes, no); peripheral vascular disease (yes, no); inability to ambulate (yes, no); pre-ESRD erythropoietin use (yes, no); pre-ESRD albumin level (<3.5 or ≥ 3.5 g/dL [<35 or ≥ 35 g/L]); pre-ESRD hemoglobin level (<11 or ≥ 11 g/dL [<110 or ≥ 110 g/L]); pre-ESRD medical coverage (yes, no); and year of incidence (1998 to 2002).

Statistical Analysis

Chi-square tests and Mantel-Haenszel odds ratios (ORs) were used to examine crude associations between patient characteristics and vascular access at 90 days. Adjusted analyses were performed using polytomous logistic regression to compare AVFs and AVGs with CVCs as the reference group. Among patients with a permanent vascular access at 90 days, logistic regression was used to compare AVFs with AVGs. All variables were included in the multivariable models. Interaction between BMI, race, and sex was assessed by using stratified analysis and cross-product terms in multivariable models.

RESULTS

There were 5,042 incident patients in the sample for analysis. Of 4,200 patients with vascular access information available for both hemodialysis therapy initiation and 90 days after initiation, 1,562 were excluded because of missing covariate data (302 missing pre-ESRD comorbidities or BMI, 1,260 missing serum albumin or hemoglobin values). At hemodialysis therapy initiation, 1,880 patients (71%) were dialyzed using a CVC; 343 (13%), with an AVF; and 415 (16%) with an AVG (Fig 1), and at 90 days after dialysis therapy initiation, 1,154 patients (44%) used a CVC, 605 (23%) used an AVF, and 879 (33%) used an AVG. Of patients dialyzed with a CVC at dialysis therapy initiation, 1,117 (59.4%) continued to dialyze with a CVC at 90 days after dialysis therapy initiation, whereas 286 (15.2%) had transitioned to an AVF, and 477 (25.4%), to an AVG.

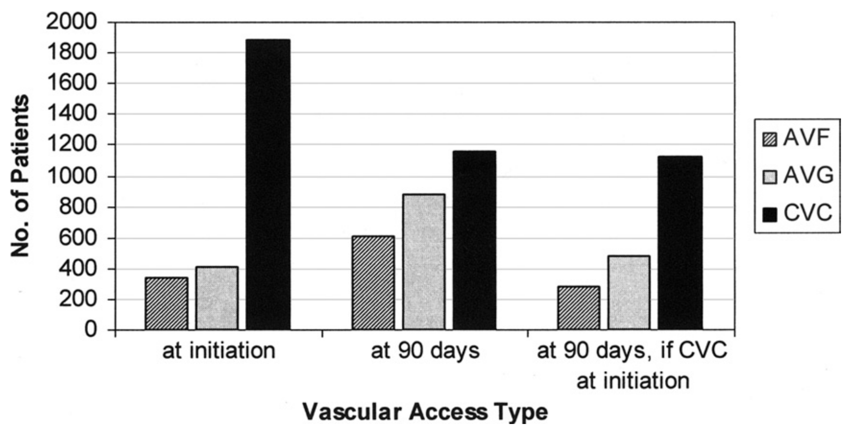

Figure 1. Vascular access type at dialysis therapy initiation and at 90 days.

Patient characteristics associated with transitioning to an AVF/AVG within 90 days after dialysis therapy initiation included sex, with women 60% less likely than men to have an AVF (OR, 0.40; 95% confidence interval [CI], 0.30 to 0.53), but as likely as men to have an AVG (OR, 1.14; 95% CI, 0.92 to 1.42; Table 1). Younger patients were twice as likely to transition to an AVF (OR, 2.14; 95% CI, 1.46 to 3.16), whereas older patients were 53% more likely to receive an AVG (OR, 1.53; 95% CI, 1.12 to 2.09; Table 1).

Patients with a BMI of 30 kg/m^2 or greater were more likely to transition to an AVG than maintain a CVC compared with patients with normal BMI (OR, 1.35; 95% CI, 1.04 to 1.77; Table 1). Patients with diabetes (OR, 1.36; 95% CI, 1.10 to 1.69; $P = 0.018$) were more likely to convert to an AVG at 90 days than to maintain use of a CVC.

Conversely, baseline smoking status, anemia, and predialysis erythropoietin administration were not associated with a transition to AVF or AVG use, whereas low albumin level resulted in a 30% greater likelihood of AVG use at 90 days (OR, 1.30; 95% CI, 1.01 to 1.66) compared with continued use of a CVC (Table 1).

Patients with either ischemic heart disease or peripheral vascular disease were 31% and 34% more likely to continue CVC use than transition to an AVF or AVG, respectively: (OR, 0.69; 95% CI, 0.50 to 0.85) for ischemic heart disease and (OR, 0.64; 95% CI, 0.46 to 0.89) for peripheral vascular disease.

With respect to early transition to an AVF, there were substantial differences in the likelihood of transition to an AVF among different race-sex groups. Black females were 63% less likely to transition to an AVF (OR, 0.37; 95% CI, 0.22 to 0.63) compared with black males (Table 2). Similarly, white females were 58% less likely to have an AVF (OR, 0.42; 95% CI, 0.30 to 0.58) compared with white males. Race and sex were highly predictive of transition to AVF use at 90 days. Black females (OR, 0.25; 95% CI, 0.15 to 0.42), white females (OR, 0.39; 95% CI, 0.28 to 0.54), and black males (OR, 0.65; 95% CI, 0.50 to 0.95) were significantly less likely to transition to AVF use at 90 days compared with white males (Table 3).

With respect to early transition to an AVG, black females were 63% more likely to have an AVG (OR, 1.63; 95% CI, 1.14 to 2.34) than continue with a CVC compared with black males, whereas white females were as likely to have an AVG as continue with a CVC compared with white males (Table 2). Black females were 54% more likely than white males to transition to an AVG (OR, 1.54; 95% CI, 1.12 to 2.11) at 90 days, whereas there were no significant differences in the use of an AVG versus CVC among white females, black males, and white males (Table 3).

After adjusting for demographic and comorbid conditions, characteristics associated with transition from a CVC at dialysis therapy initiation to an AVF or AVG after 90 days included age, sex, race, and cardiovascular comorbidity. Individuals younger than 50 years had a 2.14-fold increased likelihood of converting to AVF use compared with patients older than 75 years (OR, 2.14; 95% CI, 1.40 to 3.28), whereas patients between 65 and 74 years of age were 39% more likely to convert to AVG use than continue to use a CVC compared with patients older than 75 years (OR, 1.39; 95% CI, 1.01 to 1.92; Table 3).

In addition, after controlling for other patient characteristics, cardiovascular comorbidity was associated with prolonged CVC use. Patients with ischemic heart disease were 35% less likely to transition to AVF use at 90 days (OR, 0.65; 95% CI, 0.45 to 0.96), and patients with peripheral vascular disease were 39% less likely to use an AVG (OR, 0.61; 95% CI, 0.43 to 0.88). BMI, smoking history, serum albumin level, anemia, pre-ESRD erythropoietin use, diabetes, hypertension, and history of myocardial infarction were not associated with transition to either AVF or AVG use at 90 days. There was no significant 2- or 3-way interaction or effect modification between BMI class, race, and sex in the multivariable models.

DISCUSSION

Our main finding is that a majority (59.4%) of individuals in a national random sample of incident patients initiating hemodialysis therapy with a CVC remain CVC dependent 90 days after starting dialysis therapy. Among those who transitioned to a permanent vascular access, the majority received a synthetic AVG (25.4%), whereas only 15.2% had a functioning AVF. Patient characteristics independently associated with failure

Table 1. Univariate Associations Between AVF or AVG Use and Patient Characteristics, With CVC as Reference

Patient Characteristics	Vascular Access at 90 d			Chi-Square		
	AVF (n = 286)	AVG (n = 477)	CVC (n = 1,117)	*P*	AVF *v* CVC	AVG *v* CVC
Age (y)						
Q4 (≥75.4)	46 (16.1)	91 (19.1)	279 (25.0)		Reference	Reference
Q3 (65.4 to <75.4)	75 (26.2)	140 (29.4)	280 (25.1)		1.62 (1.09-2.43)	1.53 (1.12-2.09)
Q2 (50 to <65.4)	66 (23.1)	133 (27.9)	278 (24.9)		1.44 (0.95-2.17)	1.47 (1.07-2.01)
Q1 (<50)	99 (34.6)	113 (23.7)	280 (25.1)	0.001	2.14 (1.46-3.16)	1.24 (0.90-1.71)
Sex						
Female	84 (29.4)	258 (54.1)	567 (50.8)		0.40 (0.30-0.53)	1.14 (0.92-1.42)
Male	202 (70.6)	219 (45.9)	550 (49.2)	<0.001	Reference	Reference
Race						
Black	81 (28.3)	191 (40.0)	356 (31.9)		0.84 (0.63-1.12)	1.43 (1.14-1.78)
White	205 (71.7)	286 (60.0)	761 (68.1)	<0.001	Reference	Reference
Race-sex						
Black female	22 (7.7)	119 (25.0)	179 (16.0)		0.32 (0.20-0.52)	1.69 (1.25-2.28)
White female	62 (21.7)	139 (29.1)	388 (34.7)		0.42 (0.30-0.58)	0.91 (0.69-1.19)
Black male	59 (20.6)	72 (15.1)	177 (15.9)		0.87 (0.61-1.24)	1.03 (0.74-1.44)
White male	143 (50.0)	147 (30.8)	373 (33.4)	<0.001	Reference	Reference
BMI class (kg/m^2)						
Underweight (<18.5)	13 (4.6)	28 (5.9)	74 (6.6)		0.70 (0.38-1.31)	1.04 (0.65-1.67)
Normal (18.5 to <25)	114 (39.9)	166 (34.8)	457 (40.9)		Reference	Reference
Overweight (25 to <30)	82 (28.7)	140 (29.4)	295 (26.4)		1.11 (0.81-1.53)	1.31 (1.00-1.71)
Obese (≥30)	77 (26.9)	143 (30.0)	291 (26.1)	0.237	1.06 (0.77-1.47)	1.35 (1.04-1.77)
Smoke						
Yes	20 (7.0)	33 (6.9)	60 (5.4)		0.32 (0.78-2.24)	1.31 (0.84-2.03)
No	266 (93.0)	444 (93.1)	1,057 (94.6)	0.369	Reference	Reference
Albumin (g/dL)						
Low (<3.5)	213 (74.5)	360 (75.5)	786 (70.4)		1.23 (0.91-1.65)	1.30 (1.01-1.66)
Normal (≥3.5)	73 (25.5)	117 (24.5)	331 (29.6)	0.076	Reference	Reference
Hemoglobin (g/dL)						
Low (<11)	229 (80.1)	389 (81.6)	899 (80.5)		0.97 (0.70-1.35)	1.07 (0.81-1.41)
Normal (≥11)	57 (19.9)	88 (18.4)	218 (19.5)	0.849	Reference	Reference
Erythropoietin administered pre-ESRD						
Yes	77 (26.9)	123 (25.8)	319 (28.6)		0.92 (0.69-1.23)	0.87 (0.68-1.11)
No	209 (73.1)	354 (74.2)	798 (71.4)	0.506	Reference	Reference
Diabetes						
Yes	137 (47.9)	260 (54.5)	523 (46.8)		1.04 (0.81-1.35)	1.36 (1.10-1.69)
No	149 (52.1)	217 (45.6)	594 (53.2)	0.018	Reference	Reference
Hypertension						
Yes	225 (78.7)	391 (82.0)	867 (77.6)		1.06 (0.78-1.46)	1.31 (1.00-1.72)
No	61 (21.3)	86 (18.0)	250 (22.4)	0.149	Reference	Reference
Ischemic heart disease						
Yes	58 (20.3)	121 (25.4)	301 (27.0)		0.69 (0.50-0.85)	0.92 (0.72-1.78)
No	228 (79.7)	356 (74.6)	816 (73.0)	0.070	Reference	Reference
Myocardial infarction						
Yes	21 (7.3)	43 (9.0)	107 (9.6)		0.75 (0.46-1.22)	0.94 (0.65-1.36)
No	265 (92.7)	434 (91.0)	1,010 (90.4)	0.501	Reference	Reference
Peripheral vascular disease						
Yes	40 (14.0)	50 (10.5)	173 (15.5)		0.89 (0.61-1.29)	0.64 (0.46-0.89)
No	246 (86.0)	427 (89.5)	944 (84.5)	0.031	Reference	Reference

Note: Values expressed as mean and number (percent) or OR (95% CI). To convert albumin and hemoglobin in g/dL to g/L, multiply by 10.

Table 2. Crude Interaction Between Race and Sex

Patient Characteristics	Vascular Access at 90 d AVF (n = 286)	AVG (n = 477)	CVC (n = 1,117)	Chi-Square *P*	AVF *v* CVC	AVG *v* CVC
Race = black						
Sex						
Female	22 (27.2)	119 (62.3)	179 (50.3)		0.37 (0.22-0.63)	1.63 (1.14-2.34)
Male	59 (72.8)	72 (37.7)	177 (49.7)	<0.001	Reference	Reference
Race = white						
Sex						
Female	62 (30.2)	139 (48.6)	388 (51.0)		0.42 (0.30-0.58)	0.91 (0.69-1.19)
Male	143 (69.8)	147 (51.4)	373 (49.0)	<0.001	Reference	Reference

Note: Values expressed as mean and number (percent) or OR (95% CI).

to transition from a CVC included older age, black race, female sex, and cardiovascular comorbidity. Patients of black race and female sex were significantly more likely to maintain CVC use at 90 days than white males, whereas patients with ischemic heart disease and peripheral vascular disease were more likely to remain catheter dependent compared with patients without cardiovascular comorbidity. Indicators of adequate predialysis care were not associated with permanent access placement at 90 days.

Our report describes predictors of failure to transition to use of permanent vascular access among a contemporary cohort of patients initiating dialysis therapy using a CVC and is consistent with a report finding that a majority of patients who initiated dialysis therapy with a CVC remained catheter dependent 60 days after the start of dialysis therapy.[12] Fifty-nine percent of incident patients remained CVC dependent after 90 days, whereas 25% converted to an AVG.

Our findings are consistent with prior studies that show a high rate of CVC use among patients initiating hemodialysis therapy.[7,12,13] Stehman-Breen et al[12] reported that 66% of patients in the USRDS Wave II cohort used a CVC at dialysis therapy initiation, whereas Astor et al[13] found that 68% of patients in their patient cohort initiated dialysis therapy using a CVC. Lorenzo et al[7] found that 70% of incident dialysis patients with late nephrology referral used a CVC at dialysis initiation. The most recent national data published in the USRDS 2005 Annual Report indicates that catheter use among incident hemodialysis patients is increasing as AVF creation increases, possibly related to prolonged AVF maturation.[14] We found greater prolonged CVC dependence than previously reported among patients from 1996 (46%) and lower conversion to an AVG than previously noted (40%), suggesting a possible trend toward CVC use as a bridge to AVF maturation.[12] The increasing CVC maintenance is concerning given the host of complications related to CVC use, such as bacteremia, metastatic infection, central vein stenosis, and increased mortality.[6,10,15-18]

Characteristics associated with a lower likelihood of AVF use 90 days after dialysis therapy initiation among patients starting with a CVC were older age (>75 years), female sex, black race, and the presence of ischemic heart disease. There was no association of AVF use with body mass, smoking, albumin level, anemia, pre-ESRD erythropoietin use, diabetes, hypertension, or history of myocardial infarction. Our findings differ from previous reports that found a decreased likelihood of AVF use 30 to 60 days after dialysis therapy initiation among patients with diabetic nephropathy and larger body mass.[12,19]

Although several reports described an association between older age and less AVF use, the underlying reasons for this observation are unclear.[11] Successful creation of an AVF requires suitable vasculature. Vein distensibility may be affected by a greater prevalence of vascular disease among the elderly, which is supported by the greater risk of AVF failure found among older dialysis patients.[20-22] Female patients also were less likely to use an AVF after 90 days, possibly reflecting small vein diameter. Specific attributes of vessels used for AVF construction appear to have a key role in subsequent success.

Table 3. Multivariate-Adjusted Associations Between AVF or AVG Use and Patient Characteristics Compared With CVC

Patient Characteristics	AVF *v* CVC	*P*	AVG *v* CVC	*P*
Age (y)				
Q4 (≥75.4)	Reference		Reference	
Q3 (65.4 to <75.4)	1.62 (1.07-2.45)	0.024	1.39 (1.01-1.92)	0.043
Q2 (50 to <65.4)	1.44 (0.93-2.22)	0.104	1.20 (0.86-1.68)	0.285
Q1 (<50)	2.14 (1.40-3.28)	0.001	1.00 (0.70-1.42)	0.990
Race-sex				
Black female	0.25 (0.15-0.42)	<0.001	1.54 (1.12-2.11)	0.008
White female	0.39 (0.28-0.54)	<0.001	0.89 (0.67-1.17)	0.403
Black male	0.65 (0.50-0.95)	0.023	0.99 (0.69-1.41)	0.947
White male	Reference		Reference	
BMI class(kg/m^2)				
Underweight (<18.5)	0.78 (0.41-1.48)	0.444	1.08 (0.67-1.75)	0.750
Normal (18.5 to <25)	Reference		Reference	
Overweight (25 to <30)	1.10 (0.79-1.53)	0.561	1.22 (0.93-1.61)	0.155
Obese (≥30)	1.08 (0.77-1.52)	0.665	1.19 (0.90-1.58)	0.230
Smoker				
Yes	1.12 (0.65-1.92)	0.688	1.39 (0.89-2.19)	0.150
No	Reference		Reference	
Albumin (g/dL)				
Low (<3.5)	1.22 (0.90-1.66)	0.205	1.25 (0.98-1.61)	0.078
Normal (≥3.5)	Reference		Reference	
Hemoglobin (g/dL)				
Low (<11)	0.90 (0.64-1.26)	0.538	1.01 (0.76-1.34)	0.948
Normal (≥11)	Reference		Reference	
Erythropoietin administered pre-ESRD				
Yes	0.96 (0.71-1.30)	0.774	0.88 (0.68-1.13)	
No	Reference		Reference	0.302
Diabetes				
Yes	1.10 (0.83-1.47)	0.499	1.23 (0.97-1.56)	0.089
No	Reference		Reference	
Hypertension				
Yes	1.13 (0.81-1.56)	0.482	1.22 (0.92-1.61)	0.174
No	Reference		Reference	
Ischemic heart disease				
Yes	0.65 (0.45-0.96)	0.023	0.99 (0.74-1.32)	0.942
No	Reference		Reference	
Myocardial infarction				
Yes	0.84 (0.49-1.44)	0.526	0.99 (0.65-1.50)	0.964
No	Reference		Reference	
Peripheral vascular disease				
Yes	1.05 (0.70-1.66)	0.810	0.61 (0.43-0.88)	0.007
No	Reference		Reference	

Note: Values expressed as OR (95% CI). To convert albumin and hemoglobin in g/dL to g/L, multiply by 10.

While reports indicate the importance of adequate vein caliber in the creation of a functioning AVF, it is unknown whether females have smaller vein caliber and if this may account for some portion of the disparity found in AVF use and survival.[23-27] Should this be the case, efforts at preoperative ultrasound examination to find adequately sized veins and/or the proximal placement of AVFs may be important in increasing AVF survival in these patients.

Our data show a strong race-sex relationship with vascular access type 90 days after dialysis therapy initiation. We found that black women were 75% less likely than white men to use an AVF at 90 days, whereas white women were 61% less likely and black men were 35% less likely to use an AVF at 90 days compared with white men. This finding is concerning because blacks appear to be equally suited for AVF creation based on known vascular anatomy and should have similar rates of AVF placement compared with whites. Instead, we found that black women in particular were 54% more likely to use an AVG after 90 days than white males.

Speckman et al (unpublished data) and Avorn et al[28] reported that black patients were more likely to have a permanent vascular access in place at dialysis therapy initiation, specifically an AVG. However, our findings suggest that when black patients and women initiate dialysis therapy using a CVC, they are less likely to have a permanent access in use 90 days after dialysis therapy initiation. Although use of an AVG at dialysis therapy initiation among blacks may suggest adequate predialysis care, it may reflect late referral to a nephrologist.[13] Late referral to a nephrologist was suggested as a primary reason for lack of permanent access at the initiation of dialysis therapy. Astor et al[13] reported that the earlier a patient was referred to a nephrologist, the more likely the patient was to have permanent access placement 6 months after dialysis therapy initiation. Therefore, our findings suggest the possibility that a missed opportunity for vascular access placement before initiation of dialysis therapy is corrected to a greater extent among white patients than black patients, leading to greater rates of CVC use in blacks compared with whites at 90 days. It also suggests the possibility of greater AVF failure among blacks. Our data support the role of early AVF placement, particularly among female and black patients with chronic kidney disease, who comprise an increasing proportion of the ESRD population, and regular access inspection to determine AVF maturation.

This study has several limitations. Data were not available regarding time of referral to a nephrologist; therefore, we cannot comment on the role that late referral may have had on our cohort. In addition, our data are from 1999 to 2003 and may not represent current trends in vascular access use at dialysis therapy initiation and later. From the available data, we were not able to ascertain attempts at AVF placement or AVF failure, which may help explain the disparities observed among women and blacks in our study. Although this study has limitations, it examines a nationally representative cohort of incident hemodialysis patients and is generalizable to the US adult hemodialysis population.

Among a nationwide contemporary cohort of patients initiating hemodialysis therapy using a CVC, we identify factors predictive of the type of vascular access in use 90 days after the initiation of dialysis therapy. Protracted CVC use was observed among a majority of subjects, particularly female and black patients, and we speculate that this may be caused by inadequate or late referral for permanent access placement or greater primary access failure among these groups. Additional studies are needed to discern reasons for prolonged CVC use among these groups, and interventions are needed to increase both predialysis and postdialysis permanent access placement.

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