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Association of Initial Hemodialysis Vascular Access with Patient-Reported Health Status and Quality of Life

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Abstract

Background—Although the arteriovenous fistula (AVF) is the recommended form of vascular access for patients with ESRD, its impact on patient perception of health status, quality of life (QOL), or satisfaction is unknown.

Design, setting, participants, and measurements—This study compared patient-reported health status and QOL scores and vascular access type among a national random sample of 1563 patients at dialysis initiation and day 60 of ESRD during 1996 to 1997. Patients were stratified into five categories: AVF at first dialysis and day 60 of ESRD, arteriovenous graft (AVG) at first dialysis and day 60, central venous catheter (CVC) at first dialysis and AVF at day 60, CVC at first dialysis and AVG at day 60, and CVC at first dialysis and day 60.

Results—Ten percent (*n* = 154) of patients had an AVF, 21% (*n* = 326) had an AVG, and 69% (*n* = 1083) had a CVC at dialysis initiation; those who were most likely to use an AVF were white and male. After statistical adjustment, patients with persistent AVF use reported greater physical activity and energy, better emotional and social well-being, fewer symptoms, less effect of dialysis and burden of kidney disease, and better sleep compared with patients with persistent CVC use, whereas measures such as cognitive and sexual function did not differ by access type.

Conclusions—Compared with persistent CVC use, early persistent AVF use is associated with the perception of improved health status and QOL among patients with ESRD. Future longitudinal studies may help to clarify further the association between QOL and vascular access.

Studies among patients with ESRD demonstrate lower morbidity and mortality associated with arteriovenous fistula (AVF) use compared with an arteriovenous graft (AVG) or a central venous catheter (CVC) (1–6). Therefore, the National Kidney Foundation's Kidney Disease Outcomes Quality Initiative (NKF-K/DOQI) Clinical Practice Guidelines for Vascular Access recommend early placement and use of the AVF among at least 50% of incident hemodialysis (HD) patients (7,8). The AVF is considered the optimal form of vascular access for patients who have ESRD and receive HD. However, despite the increasing recognition of the importance of a patient's perception of health-related quality of life (QOL), no study has

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Disclosures

None.

evaluated the association of vascular access type with patient perception of health status and QOL. Investigating this association is important, because health-related QOL is a valuable indicator of quality of care.

The purpose of our study was to examine health status, QOL, and patient satisfaction reported early in the course of ESRD among patients with various vascular access types. We hypothesized that the initiation of dialysis with an AVF and its continued use early in ESRD would be associated with better patient-reported health and QOL compared with use of other vascular access types.

Materials and Methods

Data Collection

The Dialysis Mortality and Morbidity Study (DMMS) Wave 2 is a prospective study of dialysis patients (Medicare and non-Medicare) who initiated ESRD therapy in 1996 to 1997 (9). The 799 dialysis units that were included in the DMMS Wave 2 were a random selection of 25% of the units in the United States on the Master List of Medicare Approved Dialysis Facilities as of December 31, 1993; all new dialysis units that opened after January 1, 1994, were also included. The US Renal Data System (USRDS) Coordinating Center (then located at the University of Michigan) directed the study.

Inception Cohort and Eligibility Criteria

Incident patients were defined by receipt of in-center HD at least once weekly for the first time. Twenty percent of eligible HD patients were included by selection of only those with social security numbers that ended with 2 or 9. Patients were excluded when they were receiving intermittent dialysis treatment because of fluid overload or heart failure or when they were on home HD, had had a previous transplant, or were younger than 18 yr.

Of the 3601 patients in Wave 2, we identified 1715 who were white or black, received HD, were 18 yr or older, and responded to a patient questionnaire. Among these, 152 patients were excluded because they were missing vascular access type at either the initiation of (n = 46) or 60 d after the start of HD (n = 57), and 49 patients were excluded because they did not have one of the five vascular access combinations studied. A total of 1563 patients therefore were available for analysis.

All enrolled patients provided written informed consent. We used the DMMS Wave 2 data with updated patient characteristics available on the 2004 USRDS Core Standard Analysis File.

Measures and Data Collection

DMMS Wave 2 data collection instruments are available in the Researcher's Guide to the USRDS Database (10). A medical questionnaire was completed by dialysis unit personnel who abstracted data from medical records, billing records, dialysis logs, patient rosters, hospital records, and personal physician records as information sources; for ascertainment of race and other information, the patient was also a source of information. Data for the medical questionnaire was obtained up to 3 mo before study start date or within 30 d after study start. A patient questionnaire that was distributed to enrolled patients requested information about medical care before long-term dialysis and current employment status and included scales from the Kidney Disease Quality of Life-Short Form (KDQOL-SF) instrument (11). Patients were asked to complete the questionnaire within 30 d of the study start date (*i.e.*, the date that treatment modality was defined at approximately day 60 of ESRD) and to return the questionnaire in a sealed envelope identified only by study ID number. The protocol specified that patients be asked to self-complete the patient questionnaire at the dialysis unit whenever possible but also indicated that patients who were unable to complete the questionnaire because of their level of education or because of a physical disability such as impaired vision could receive assistance from a dialysis unit staff member or a family member.

Cardiovascular comorbidity was defined by documentation of any of the following conditions in the patient's medical records: Coronary heart disease/coronary artery disease, acute myocardial infarction, cardiac arrest, cerebrovascular accident/stroke, peripheral vascular disease, or congestive heart failure. Early referral for pre-ESRD care by a nephrologist was defined as 4 mo or more before dialysis treatment start, consistent with previous studies (12).

Reliability and validity have been demonstrated for the KDQOL-SF instrument (13). The KDQOL-SF includes eight generic measures of health status (14) and multiple disease-specific QOL scales. The instrument also includes two scales that focus on the patient's assessment of dialysis care. Each scale is scored 0 to 100, with a higher score indicating a better rating (11). Summary health status scores, a Physical Component Summary score, and a Mental Component Summary score, were calculated from the eight generic measures using the scoring method developed by Ware *et al.* and recommended by Hays (R.D. Hays, UCLA Department of Medicine, Los Angeles, CA; personal communication, November 16, 2004) (11,15). The Physical Component Summary and Mental Component Summary are normalized to a general population mean of 50 and an SD of 10.

Internal consistency reliability estimates were ≥0.7 for all health status, QOL, and dialysis care scales, indicating adequate reliability in the DMMS Wave 2 study population. Thus, items in each scale were sufficiently intercorrelated to indicate that they were measuring the same domain. Minor modifications in wording of the effects of kidney disease, social support satisfaction, sleep, sexual function, staff encouragement, and patient satisfaction scales that were used in the DMMS Wave 2 did not compromise construct validity of these measures.

Statistical Analyses

KDQOL-SF data were collected in a cross-sectional manner and do not evaluate the effect of change over time. Rather, we combined vascular access information at dialysis initiation and at day 60 of ESRD to create five categories that are the focus of analysis. Patients were classified by type of vascular access in use at the initiation of dialysis and at day 60 of ESRD: AVF, AVG (polytetrafluoroethylene or bovine), or CVC (permanent or temporary). Five categories accounted for 97% of patients and were defined as AVF at first dialysis and day 60 of ESRD, AVG at first dialysis and day 60 of ESRD, CVC at first dialysis and AVF at day 60 of ESRD, CVC at first dialysis and AVG at day 60 of ESRD, and CVC at first dialysis and at day 60 of ESRD. Sociodemographic and clinical characteristics of patients in the five vascular access categories (n = 1563) were compared using ANOVA for continuous variables and χ^2 test for categorical variables. In these analyses, the five vascular access categories entered the models as four indicators with persistent CVC used as the reference, along with adjusting covariates race, gender, age, education, household status, vintage, albumin, creatinine, phosphorus, hemoglobin, receipt of erythropoietin (EPO) during first 60 d of dialysis, predialysis systolic BP, body mass index, Kt/V, diabetic ESRD, cardiovascular comorbidity, and pre-ESRD care. Statistical analyses were performed using SAS version 9.1 (SAS Institute, Cary, NC).

Results

Sociodemographic Characteristics of the Study Cohort

The demographic characteristics and vascular access type at dialysis initiation and 60 d later are shown in Table 1. Overall, at dialysis initiation, 9.8% of patients used an AVF, 20.9% used an AVG, and 69.3% used a CVC. Among the cohort that initiated dialysis with a CVC, 60 d later, 13.4% had converted to AVF use, 41.1% had converted to AVG use, and 45.5% remained CVC dependent. There were significant differences in race and gender across vascular access categories. Patients who initiated and maintained an AVF at 60 d or who started with a CVC and transitioned to an AVF were more likely to be white and male. The mean age at enrollment was greater among patients who initiated dialysis and maintained AVG use, whereas it was lower among patients who initiated dialysis with a CVC and transitioned to AVF use at 60 d. Educational status was significantly different among access categories. Patients who started with and maintained an AVF and patients who started with a CVC and transitioned to an AVF were more likely to have completed some college or higher education. There were no significant differences in household status or months on dialysis by access type.

Baseline Clinical Characteristics of the Study Cohort

The mean levels of albumin, creatinine and hemoglobin were significantly different among access categories ($P < 0.0001$, $P = 0.006$, and $P = 0.007$, respectively), with the highest levels of albumin and hemoglobin in the group that initiated dialysis with persistent AVF use, whereas lower levels were found among patients with persistent CVC use (Table 2). Body mass index was significantly different across access categories ($P = 0.0008$) and lowest among patients with persistent CVC use. ESRD as a result of diabetes ($P < 0.0001$), congestive heart failure ($P = 0.003$), combined cardiovascular disease ($P = 0.009$), and pre-ESRD referral time ($P < 0.0001$) were significantly different among access categories, with early referral found to be greatest among patients with persistent AVF use. Phosphorus level, EPO use in the first 60 d, predialysis systolic BP, coronary heart disease, cerebrovascular disease, peripheral vasculopathy, lung disease, cancer, and HIV status did not differ by access type.

Patient-Reported Health Status, QOL, and Dialysis Care at Treatment Start

Patients with continuous AVF use rated their health status and QOL significantly higher in several domains, compared with patients with other access types. After statistical adjustment, ratings of general health perception, emotional well-being, social functioning, energy/fatigue, the physical composite score, symptoms/problems, effects of dialysis on daily life, burden of kidney disease, and sleep were significantly higher among patients with persistent AVF use compared with patients with persistent CVC use (Table 3). In addition, patients with continuous AVG use reported feeling significantly more energy, less fatigue, and less burden of their kidney disease on daily life compared with patients who had continuous CVC use.

Patient satisfaction with care was significantly lower among patients who initiated dialysis with a CVC and later converted to a permanent access, compared with patients who maintained a CVC from the start of dialysis; perception of encouragement from staff did not differ between categories (Table 3). Measures of physical function, emotional role limitation, bodily pain, physical role limitation, the mental composite score, satisfaction with social support, cognitive function, and sexual function did not differ by access use category.

Discussion

In a national cohort of incident HD patients, continuous AVF use early in the course of ESRD was associated with the perception of greater health status and QOL, compared with continuous CVC use. Patients with early, persistent use of an AVF were significantly more likely to report greater general health, emotional well-being, social functioning, energy level, and physical functioning; fewer symptoms or problems; less effect of kidney disease on daily life; and better quality of sleep compared with patients with early CVC use.

To our knowledge, our study is the first to report the association of HD vascular access type with patient perceptions of health status and QOL. The AVF is recognized as the optimal type of HD vascular access for its longer patency, fewer infectious complications, and association with lower all-cause mortality compared with the AVG or the CVC (6,16–18). Therefore, it is plausible that these benefits would translate into better perceived health status and QOL among patients with persistent AVF use, compared with patients who use an AVG or a CVC. Conversely, it is possible that vascular access-related morbidity that is experienced by patients with an AVG or a CVC contributed to a poorer perception of health status and QOL among these patients.

Patient-rated physical functioning scores were greatest among those with persistent AVF use, reflecting fewer health-related limitations on physical activity and greater exercise capacity. This finding is supported by Dhingra *et al.* (2), who reported that prevalent patients who had ESRD and used an AVF were more likely to be ambulatory than patients who used a CVC. Factors that contribute to reduced physical activity among dialysis patients include uremic myopathy and anemia of chronic disease (19). Better dialysis adequacy, conferred by AVF use, may lead to greater uremia reduction and reduced anemia compared with CVC use (20, 21). Recirculation, reduced blood flow, and catheter thrombosis may reduce dialysis adequacy among CVC patients, whereas anemia and EPO resistance may contribute to decreased energy and exercise capacity (22,23). Our analyses were adjusted for Kt/V, but laboratory and QOL data were not obtained at precisely the same time point, and it is possible that patient ratings reflect unmeasured differences in achieved Kt/V. Similarly, AVF use was associated with the perception of greater overall general health. Reporting of better emotional well-being and social functioning, improved energy, fewer symptoms, and better quality of sleep likely combine to form the overall perception of greater general health among AVF patients compared with CVC patients.

Patients with persistent AVF use reported fewer symptoms and problems, such as muscle soreness, cramps, itchy or dry skin, shortness of breath, decreased appetite, and nausea. This finding is likely attributable to greater adequacy of dialysis, less recirculation, and more stable hemoglobin level among AVF patients. Patients with CVC may experience greater variation in hemoglobin levels and EPO dosing, as reported by Chand *et al.* (22). Hemoglobin levels among AVF patients were consistently greater over 24 mo than among CVC patients (22). Similarly, patients with CVC had lower levels of hemoglobin and required more EPO for every CVC insertion and infection compared with patients with no history of a CVC (24). Although we controlled for hemoglobin, we were not able to capture changes in hemoglobin over time. The association of AVF use with fewer patient-reported symptoms and problems is important, because the degree of physical symptom burden is associated with reduced QOL and depression among prevalent HD patients (25).

Patients with chronic AVF use reported a lower burden of kidney disease on daily life when asked about time spent dealing with kidney disease, frustration level, and the burden imposed on family. AVF patients are less likely to experience vascular access morbidity, whereas CVC patients experience the daily challenge of keeping the CVC site dry, the cosmetic effect and imposition of the catheter, and greater CVC-related morbidity (16,17,26).

Poor nocturnal sleep and daytime sleepiness are prevalent in the HD population and have been associated with reduced QOL (27–33). Patients with persistent AVF use reported better quality of sleep compared with CVC patients. This finding may be due to better adequacy of dialysis among AVF patients, because reports suggest that itching and metabolic factors such as subclinical uremic encephalopathy, anemia and iron deficiency associated with restless legs syndrome, and hyperphosphatemia may contribute to increased sleepiness and poor quality of sleep (30,31,34–38).

When asked to rate the level of satisfaction with care and the friendliness and interest exhibited to them by dialysis unit personnel, patients with continual AVF and CVC use had similar ratings. However, those who initiated dialysis with a CVC and subsequently converted to either AVF or AVG use reported less satisfaction than those with long-term CVC use. Initially, patients who start dialysis with a CVC are free of the discomfort of cannulation, risk for infiltration, and access hemostasis after dialysis that may be experienced once they convert to permanent AV access use and may result in dissatisfaction with dialytic care. In addition, changes in access type may be more likely to occur among patients who undergo dialysis in units with high staff turnover and inexperienced personnel, where staff may have difficulty with AV access cannulation, and may express reluctance toward patients who are viewed as difficult to cannulate. These are important questions for further study.

This study has several limitations. Given the observational nature of our study, there is the potential for confounding by severity of illness. We minimized this bias by controlling for comorbid conditions that may influence the choice of vascular access type; however, we acknowledge that additional unmeasured variables were not accounted for in this study. Our findings reflect patient-reported QOL early in dialysis, because our data are cross-sectional, and therefore may not reflect future assessment of QOL as patients adapt to dialysis and experience vascular access-related complications (stenosis, aneurysms, and central venous stenosis) and events related to comorbid conditions. Longitudinal data are needed to address this question further. Although the USRDS Wave II data reflect a less contemporary patient cohort, the distribution of vascular access type is similar to more recent US Clinical Performance Measures data (1999 to 2003), in which at HD initiation, 71% patients underwent dialysis *via* a CVC, 13% with an AVF, and 16% with an AVG (39). We cannot exclude the possibility of response bias. However, there was no significant difference in the percentage of patients who were questionnaire respondents and nonrespondents in any of the five access categories ($P = 0.26$, by χ^2 analysis). Overall, patients who responded to the questionnaire, compared with nonrespondents, were less likely to have diabetic ESRD and were more likely to have completed a higher level of education, but there were no significant differences between respondents and nonrespondents in race, gender, age, or cardiovascular comorbidity.

Finally, although we acknowledge our study limitations, our findings reflect a difference of patient-reported QOL by vascular access type and extend the data that support AVF use for reasons other than reduced vascular access–related sepsis and mortality (2,5,18). Furthermore, we found that early nephrology referral was greatest among patients with persistent AVF use, suggesting that early referral leads to more common AVF use and may improve QOL measures. It would be of interest to investigate QOL as measured by questions such as those used by Bay *et al.* (40) to identify what patients liked and were most concerned with about their own vascular access. Finally, our study uses a population-based, large, random sample of incident dialysis patients, which allows generalizability to the adult dialysis population.

Conclusion

In this study, we found that patients who experienced uninterrupted use of an AVF early in the course of HD were more likely to report better health status and QOL than were patients with long-term CVC use, whereas those who converted from a CVC to permanent AV access had a poorer perception of dialysis care compared with patients with early, long-term CVC use. Not only were patients with early nephrology referral more likely to experience early persistent AVF use, but also vascular access type was associated with patient perceptions of their own health status and QOL, which serve as important indicators of quality of care. Future outcome studies may help to clarify further the association between QOL and vascular access.

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Table 1

Sociodemographic characteristics and months receiving dialysis, by vascular access at first dialysis and day 60 of ESRD: DMMS Wave 2 HD patients[a]

Characteristic	AVF at First Dialysis and Day 60 of ESRD (*n* = 154)	AVG at First Dialysis and Day 60 of ESRD (*n* = 326)	CVC at First Dialysis, AVF at Day 60 of ESRD (*n* = 145)	CVC at First Dialysis, AVG at Day 60 of ESRD (*n* = 445)	CVC at First Dialysis and Day 60 of ESRD (*n* = 493)	P^b
Race/gender (%)						<0.0001
black male	21.4	16.0	21.4	18.9	17.7	
black female	8.4	27.3	8.3	18.4	16.6	
white male	48.1	28.2	51.7	32.1	32.3	
white female	22.1	28.5	18.6	30.6	33.4	
Age at enrollment (yr; mean)	60.5 (15.4)	63.1 (14.2)	58.1 (16.3)	62.5 (14.7)	60.9 (16.6)	0.009
Age (%)						0.03
18 to 64	51.3	49.1	62.8	47.6	52.1	
≥65	48.7	50.9	37.2	52.4	47.9	
Educational status (%)						0.0009
<12 yr	30.6	44.8	35.2	45.4	43.0	
high school graduate	32.9	35.9	31.2	30.1	35.2	
some college or more	36.5	19.3	33.6	24.5	21.8	
Household status (%)						0.01
living alone	22.5	21.5	18.9	15.1	14.6	
living with others	73.5	70.5	78.3	76.1	74.3	
nursing home	4.0	8.0	2.8	8.3	10.5	
homeless	0	0	0	0.5	0.6	
Months on dialysis (mean)	2.2 (0.7)	2.3 (0.8)	2.4 (1.3)	2.2 (0.5)	2.3 (1.0)	0.08

[a] AVF, arteriovenous fistula; AVG, atriovenous graft; CVC, central venous catheter; DMMS, Dialysis Morbidity and Mortality Study; HD, hemodialysis.

[b] Differences among vascular access categories using ANOVA to compare means and χ^2 tests to compare proportions.

Table 2

Treatment/laboratory variables, comorbidities, and pre-ESRD care, by vascular access at first dialysis and day 60 of ESRD: DMMS Wave 2 HD patients[a]

Parameter	AVF at First Dialysis and Day 60 of ESRD	AVG at First Dialysis and Day 60 of ESRD	CVC at First Dialysis, AVF at Day 60 of ESRD	CVC at First Dialysis, AVG at Day 60 of ESRD	CVC at First Dialysis and Day 60 of ESRD	P^b
Treatment/laboratory variables						
albumin (g/dl)	3.7 ± 0.5	3.6 ± 0.6	3.6 ± 0.5	3.5 ± 0.6	3.4 ± 0.6	<0.0001
creatinine (mg/dl)	8.6 ± 3.7	7.3 ± 2.6	8.7 ± 5.7	7.6 ± 3.3	7.7 ± 6.0	0.006
phosphorus (mg/dl)	5.7 ± 2.1	5.6 ± 1.8	5.6 ± 1.9	5.8 ± 3.8	5.6 ± 4.0	0.93
hemoglobin (g/dl)	11.2 ± 6.9	10.2 ± 2.9	10.8 ± 7.6	9.9 ± 2.6	10.1 ± 3.5	0.007
taking EPO in first 60 d[b] (%)	94.6	95.9	95.7	95.8	96.3	0.94
predialysis systolic BP (mmHg)	151.7 ± 21.2	151.8 ± 20.0	154.9 ± 20.5	151.1 ± 21.3	148.9 ± 21.9	0.04
body mass index	25.8 ± 6.1	27.8 ± 12.8	26.1 ± 7.5	26.3 ± 9.3	24.3 ± 6.4	0.0008
Kt/V	1.2 ± 0.4	1.3 ± 0.4	1.1 ± 0.4	1.3 ± 0.4	1.2 ± 0.4	<0.0001
Diabetic ESRD (%)	34.0	53.7	35.4	43.2	39.1	<0.0001
Comorbidities (%)						
coronary heart disease	34.7	42.9	37.8	40.9	40.1	0.52
congestive heart failure	28.2	42.4	33.8	43.5	44.3	0.003
cerebrovascular disease	15.1	19.9	13.6	18.6	19.0	0.49
peripheral vasculopathy	17.9	25.0	15.4	22.8	23.3	0.14
combined cardiovascular[c]	56.9	72.3	61.2	66.7	69.5	0.009
lung disease	14.2	9.4	14.3	12.4	15.9	0.11
cancer, excluding skin	8.9	10.5	7.3	13.0	13.3	0.19
HIV	2.1	0.0	2.1	5.6	4.7	0.11
Pre-ESRD care (%)						<0.0001
early referral (≥4 mo pre-ESRD)	82.1	69.7	62.0	51.5	51.2	
late referral (<4 mo pre-ESRD)	17.9	30.3	38.0	48.5	48.8	

[a]EPO, erythropoietin.

[b]Differences among vascular access categories using ANOVA to compare means and χ^2 tests to compare proportions.

[c]One or more of the following: Coronary heart disease, congestive heart failure, cerebrovascular disease, peripheral vasculopathy, coronary artery disease, acute myocardial infarction, or cardiac arrest.

Table 3

Adjusted mean (SE) health status, quality-of-life, and dialysis care scores by vascular access category[a]

QOL Variables	FF (*n* = 154)	GG (*n* = 326)	CF (*n* = 145)	CG (*n* = 445)	CC (*n* = 493)
Health status					
physical function	42.6	36.6	38.7	38.3	35.1
role limitation, emotional	50.2	47.5	45.2	44.5	48.6
bodily pain	60.7	58.2	54.7	58.2	53.5
general health perceptions	42.2[b]	39.0	37.7	37.8	35.3
emotional well-being	70.1[b]	65.4	62.3	63.2	63.3
role limitation, physical	24.7	20.7	21.6	18.2	18.1
social functioning	64.5[c]	57.6	53.7	49.5	52.2
vitality	46.1[c]	42.5[b]	40.7	37.6	36.8
Physical Component Summary	33.0[b]	31.1	31.1	31.4	30.0
Mental Component Summary	47.7	45.8	44.3	43.4	44.4
Quality of life					
symptoms/problems	75.2[c]	70.9	67.7	71.3	68.4
effects of daily life	66.8[c]	58.1	56.6	56.3	54.8
burden of kidney disease	48.7[c]	45.8[c]	37.1	38.0	35.9
social support satisfaction	70.8	68.1	72.9	66.3	68.7
cognitive function	81.8	75.8	72.3	75.6	75.6
sleep	64.4[b]	61.1	58.4	58.1	55.5
sexual function	55.6	60.7	51.3	59.1	54.6
Dialysis care					
patient satisfaction	79.2	79.1	72.7[c]	75.8[c]	81.4
staff encouragement	84.6	83.8	81.1	80.4	79.4

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[a]FF, patients who had an AVF from dialysis start; GG, patients who had an AVG from dialysis start; CF, patients who had a CVC at first dialysis and an AVF at 60 d; CG, patients who had a CVC at first dialysis and an AVG at 60 d; CC, patients who had a CVC from dialysis start.

[b]$P < 0.05$; significantly different from the reference category CC.

[c]$P < 0.005$; significantly different from the reference category CC.