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Article

Health Insurance in the First 3 Months of Hemodialysis and Early Vascular Access

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Abstract

Background and objectives Patients without Medicare who develop ESKD in the United States become Medicare eligible by their fourth dialysis month. Patients without insurance may experience delays in obtaining arteriovenous fistulas or grafts before obtaining Medicare coverage.

Design, setting, participants, & measurements In this retrospective cohort study, we used a national registry to compare uninsured patients starting in-center hemodialysis with a central venous catheter between 2010 and 2013 with similar patients with Medicare or Medicaid. We evaluated whether insurance status at dialysis start influenced the likelihoods of switching to dialysis through an arteriovenous fistula or graft and hospitalizations involving a vascular access infection. We used multivariable logistic and Cox regression models and transformed odds ratios to relative risks using marginal effects.

Results Patients with Medicare or Medicaid were more likely to switch to an arteriovenous fistula or graft by their fourth dialysis month versus uninsured patients (Medicare hazard ratio, 1.63; 95% confidence interval, 1.14 to 2.43; Medicaid hazard ratio, 1.23; 95% confidence interval, 1.12 to 1.38). There were no differences in rates of switching to arteriovenous fistulas or grafts after all patients obtained Medicare in their fourth dialysis month (Medicare hazard ratio, 1.17; 95% confidence interval, 0.97 to 1.42; Medicaid hazard ratio, 1.01; 95% confidence interval, 0.96 to 1.06). Patients with Medicare at dialysis start had fewer hospitalizations involving vascular access infection in dialysis months 4–12 (hazard ratio, 0.60; 95% confidence interval, 0.37 to 0.97).

Conclusions Insurance-related disparities in the use of arteriovenous fistulas and grafts persist through the fourth month of dialysis, may not fully correct after all patients obtain Medicare coverage, and may lead to more frequent vascular access infections.

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Introduction

More than 700,000 adults in the United States have ESKD, which is associated with high morbidity, mortality, and health care costs (1). Most patients with ESKD receive hemodialysis, which can be administered through an arteriovenous fistula (AVF), an arteriovenous graft (AVG), or a central venous catheter. Patients using an AVF or AVG are substantially less likely to be hospitalized for life-threatening infections (2–5) and experience improved survival compared with those using a central venous catheter (6–12).

National efforts to increase AVF use, including the Fistula First Initiative (13,14), led to substantial increases in AVF use. By 2014, >60% of United States patients on prevalent hemodialysis received dialysis through an AVF (15), a rate comparable with that in other developed countries (16). However, only 20% of United States patients initiate dialysis with an AVF or AVG, a lower proportion than in other developed countries (16,17). Lack of health insurance is an important barrier to early AVF or AVG use. Between 12% and 20% of United States adults <65 years old at the onset of ESKD are uninsured, and these patients are less likely to initiate dialysis with an AVF or AVG (1,17).

Patients without Medicare at the start of ESKD must wait 3 months before they become eligible for Medicare on the basis of having ESKD. Because nearly all United States patients qualify for Medicare by the first day of their fourth dialysis month regardless of age (18), most patients can receive outpatient dialysis, regardless of their health insurance, before developing ESKD. However, it is unknown whether this 3-month delay prolongs insurance-related disparities in AVF and AVG use. We examine whether uninsured patients at the start of dialysis experience persistent delays in AVF and AVG use.

Materials and Methods

Data Sources and Patient Selection

Data came from the US Renal Data System, a registry of all patients with Medicare Parts A and B and ESKD, the 2010 Census, and the 2012 American Community Survey.

We selected patients starting in-center hemodialysis with a central venous catheter between July 1, 2010

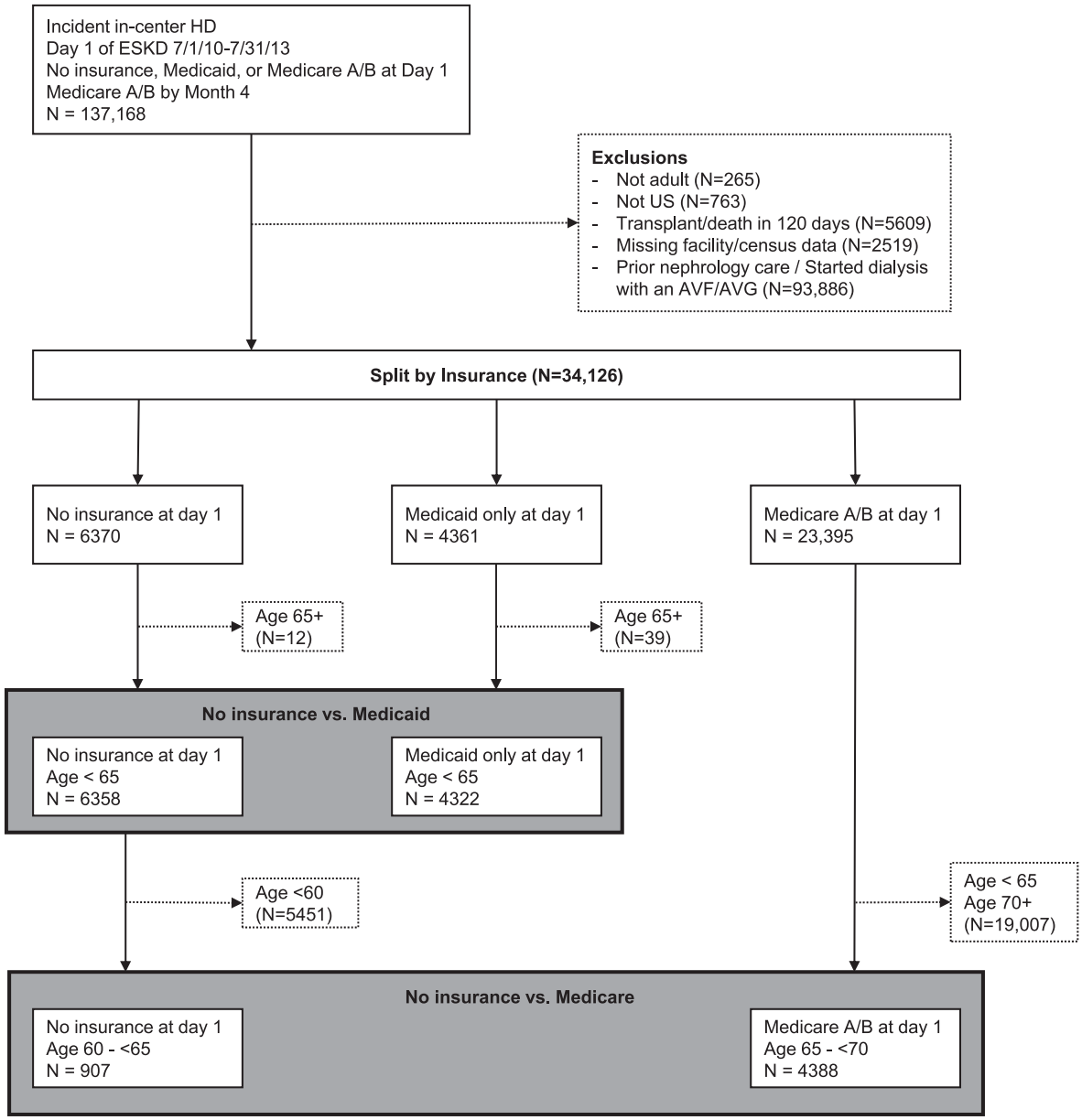

Figure 1. | Cohort selection from the United States Renal Data System. AVF, arteriovenous fistula; AVG, arteriovenous grant; HD, hemodialysis; US, United States.

and July 30, 2013. We limited our analysis to patients with Medicare Parts A and B by the fourth month of dialysis, because we relied on Medicare claims to identify outcomes. We excluded patients who died, recovered kidney function, changed to home dialysis, or received a kidney transplant in the first 120 days of dialysis.

Patients' health insurance before dialysis can affect their access to pre-ESKD nephrology care (19), which may increase the early placement of AVFs and AVGs. The focus of our study was on the effect that insurance has on AVF and AVG use after ESKD onset. Consequently, we excluded from our primary analyses patients with pre-ESKD nephrology care, for whom it is impossible to determine whether differences in early vascular access use reflect the effect of insurance before or after the onset of ESKD.

Comparison Groups and Study Exposure

We estimated the effect of insurance in the first 3 months of hemodialysis on the likelihood of switching to AVFs and AVGs by identifying two control groups that were similar to uninsured patients at ESKD onset (Figure 1). We first compared uninsured patients with patients with Medicare at dialysis start. Patients who have Medicare coverage at dialysis initiation are usually 65 years of age or older. To reduce bias due to age differences, we required that patients with Medicare were 65–69 years old and that uninsured patients were 60–64 years old.

A second analysis compared uninsured adults with those with Medicaid only at dialysis initiation. We excluded adults >65 years old, because <1% of patients in these groups were 65 years old or older. An advantage of

Table 1. Baseline characteristics of patients with Medicare versus no insurance at the start of dialysis ages 60–69 years old

Characteristic	No Insurance at Day 1, *n*=907		Medicare at Day 1, *n*=4388	
	N or Mean	Percent or SD	*N* or Mean	Percent or SD
Age, yr[a]	62	1.4	67	1.4
Sex				
Women	420	46%	2037	46%
Men	487	54%	2351	54%
Race				
White	611	67%	3090	70%
Black	249	28%	1126	26%
Other[b]	47	5%	172	4%
Ethnicity				
Hispanic[a,c]	237	26%	598	14%
Employed[a,d]	74	8%	165	4%
Dual eligible	0	0%	1225	28%
BMI, kg/m^2[a,e]				
<18.5	31	3%	167	4%
18.5 to <30	562	62%	2368	54%
30 to <40	243	27%	1321	30%
≥40	65	7%	499	12%
Albumin, g/dl[e]				
<2.5	153	23%	665	21%
2.5 to <3	163	25%	832	26%
3 to <3.5	172	26%	871	28%
≥3.5	167	26%	787	25%
Hemoglobin category, g/dl[a,e]				
<8	170	22%	568	15%
8 to <9	205	26%	912	24%
9 to <11	296	37%	1793	47%
≥11	120	15%	575	15%
Comorbidities				
Coronary artery disease[a]	109	12%	988	23%
Congestive heart failure[a]	233	26%	1614	37%
Cancer[a]	34	4%	418	10%
Hypertension	803	89%	3805	87%
Chronic obstructive pulmonary disease[a]	65	7%	664	15%
Diabetes mellitus[f]	500	55%	2688	61%
Peripheral vascular disease[a]	76	8%	701	16%
Prior stroke[a]	69	8%	535	12%
Drug dependence	31	3%	104	2%
Smoker[f]	91	10%	328	8%
Patient institutionalized[a]	26	3%	583	13%
Needs assistance with ADLs and/or inability to transfer[a]	77	9%	875	20%
Facility characteristics				
Large dialysis organization[f]	560	62%	2865	65%
Facility is for profit[f]	737	81%	3716	85%
Facility is hospital based[f]	105	12%	392	9%
Total facility patients per year[f]				
0–50	163	18%	926	21%
51–100	387	43%	1949	44%
101–150	216	24%	945	22%
>150	141	16%	568	13%
Full-time patient-to-nurse/technician ratio				
<7	473	52%	2396	55%
≥7	434	48%	1992	45%
Residence characteristics				
Urban[a]	675	74%	2948	67%
Poverty in zip code,[f] %				
<15	339	37%	1910	44%
15 to <25	314	35%	1451	33%
≥25	254	28%	1027	23%
Less than high school education in zip code,[a] %				
<15	346	38%	2016	46%
15 to <30	391	43%	1808	41%
≥30	170	19%	564	13%
Year of dialysis start				
2010	162	18%	737	17%
2011	301	33%	1475	34%
2012	290	32%	1395	32%
2013	154	17%	781	18%

Table 1. (Continued)

Characteristic	No Insurance at Day 1, *n*=907		Medicare at Day 1, *n*=4388	
	N or Mean	Percent or SD	*N* or Mean	Percent or SD
Season of dialysis start				
Winter	256	28%	1175	27%
Spring	210	23%	1027	23%
Summer	235	26%	1174	27%
Fall	206	23%	1012	23%

BMI, body mass index; ADL, Activities of Daily Living.
[a]$P<0.001$.
[b]Other race includes Asian, Native American, Pacific Islander, and people with unknown or missing race.
[c]Hispanic ethnicity was determined using the Centers for Medicare and Medicaid Services-2728 (CMS-2728) form.
[d]Employment status was determined using the CMS-2728 form, and it included full-time and part-time employment. Patients who were retired, students, and homemakers were categorized as not employed.
[e]The following variables had missing values: body mass index (*n*=39, 1% missing), serum albumin (*n*=1485, 28% missing), and hemoglobin concentration (*n*=656, 12% missing).
[f]$P<0.05$.

this comparison is that patients were similar socioeconomically.

Study Outcomes

We had two primary outcomes. First, we studied the likelihood of AVF or AVG use using V codes on claims (20) (Supplemental Material) by the end of a patient's fourth month of hemodialysis, which is when Medicare claims appear for all patients in the cohort. Second, in patients still using a central venous catheter at the end of the fourth month, we examined the time to AVF or AVG use in the first year of dialysis.

We had three secondary outcomes. First, we examined time to first hospitalization involving a vascular access infection beginning in patients' fourth dialysis month, when all patients generated Medicare claims. Second, as a negative control, we analyzed time to first hospitalization with any infection (Supplemental Material). We used a previously described algorithm to isolate inpatient stays (21). Third, we examined the likelihood of using an AVF or AVG in the first year of dialysis.

Covariates

We controlled for sex, race, ethnicity, employment status, comorbid conditions, body mass index, albumin, and hemoglobin at dialysis start; dialysis facility characteristics; calendar year; season of dialysis start; population density; and local socioeconomics (listed in Tables 1 and 2). We used chained equations (ten imputations) to multiply impute missing values for serum albumin, hemoglobin, and body mass index (Supplemental Material has technical details, Tables 1 and 2 show the extent of missing data) (22).

Statistical Analyses

We used multivariable logistic regression to examine the associations between insurance and vascular access use at the end of dialysis month 4. To estimate the relative risk (RR) of AVF/AVG use associated with insurance, we calculated predicted probabilities from regression results with nonparametric bootstrapped 95% confidence intervals (95% CIs) (Supplemental Material has technical details).

We used multivariable Cox regression to study the association between insurance and time to the following events in dialysis months 4–12: switching to AVF or AVG use among patients using a catheter at month 4, hospitalization involving a vascular access infection, and hospitalization for any infection. We censored patients for death, change in dialysis modality, transplantation, loss of Medicare, or 3 consecutive months with no reported vascular access on claims. In the Medicare versus uninsured population, we censored 42% and 41% of patients, respectively. In the Medicaid versus uninsured population, we censored 37% and 35% of patients, respectively.

We combined the above logistic regression model with an exponential survival model to examine differences in AVF/AVG use through the first year of dialysis. This involved calculating the conditional probabilities of using a catheter at months 4 and 12 and multiplying the probabilities to estimate the 12-month probability of using a catheter. We used nonparametric bootstrapped 95% CIs. In all multivariable analyses, we controlled for the covariates described above (listed in Tables 1 and 2).

In sensitivity analyses, we tested the robustness of our primary results to a complete patient analysis, treating death as a competing risk (as opposed to a censoring event), including the likelihood of using an AVF/AVG at 6 months instead of 4 months (to account for longer AVF maturation times), and including patients with pre-ESKD nephrology care.

Results

Baseline Characteristics

The analysis comparing patients 65–69 years old with Medicare with uninsured patients 60–64 years old contained 5295 patients. The analysis comparing patients <65 years old with Medicaid with uninsured patients included 10,680 patients (Figure 1).

Tables 1 and 2 illustrate the baseline characteristics stratified by insurance. Compared with uninsured patients

Table 2. Baseline characteristics of patients with Medicaid versus no insurance at the start of dialysis

Characteristic	No Insurance at Day 1, *n*=6358		Medicaid at Day 1, *n*=4322	
	N or Mean	Percent or SD	*N* or Mean	Percent or SD
Age, yr[a]	48	11	48	11
Sex[b]				
Women	2105	33%	1878	44%
Men	4253	67%	2444	57%
Race[b]				
White	3571	56%	2396	55%
Black	2518	40%	1649	38%
Other[c]	269	4%	277	6%
Ethnicity				
Hispanic[d]	1521	24%	1039	24%
Employed[b,e]	1021	16%	374	9%
BMI, kg/m^2[f]				
<18.5	189	3%	126	3%
18.5 to <30	3607	57%	2410	56%
30 to <40	1831	29%	1222	29%
≥40	677	11%	523	12%
Albumin, g/dl[a,f]				
<2.5	1072	23%	797	26%
2.5 to <3	1170	26%	761	25%
3 to <3.5	1202	26%	724	23%
≥3.5	1133	25%	807	26%
Hemoglobin category, g/dl[b,f]				
<8	1363	25%	769	20%
8 to <9	1356	24%	874	23%
9 to <11	2086	38%	1598	42%
≥11	744	13%	548	15%
Comorbidities				
Coronary artery disease[b]	424	7%	420	10%
Congestive heart failure[b]	1280	20%	1107	26%
Cancer[b]	121	2%	132	3%
Hypertension[a]	5614	88%	3721	86%
Chronic obstructive pulmonary disease[b]	231	4%	286	7%
Diabetes mellitus[b]	2894	46%	2366	55%
Peripheral vascular disease[b]	323	5%	382	9%
Prior stroke[b]	277	4%	308	7%
Drug dependence[a]	401	6%	340	8%
Smoker	785	12%	510	12%
Patient institutionalized[b]	95	2%	246	6%
Needs assistance with ADLs and/or inability to transfer[b]	303	5%	483	11%
Facility characteristics				
Large dialysis organization	4172	66%	2869	66%
Facility is for profit[a]	5331	84%	3693	85%
Facility is hospital based[b]	625	10%	291	7%
Total facility patients per year[b]				
0–50	1114	18%	693	16%
51–100	2726	43%	1708	40%
101–150	1509	24%	1124	26%
>150	1009	16%	797	18%
Full-time patient-to-nurse/technician ratio[b]				
<7	3368	53%	2089	48%
≥7	2990	47%	2233	52%
Residence characteristics				
Urban	4762	75%	3234	75%
Poverty in zip code,[b] %				
<15	2143	34%	1274	30%
15 to <25	2244	35%	1603	37%
≥25	1971	31%	1445	33%
Less than high school education in zip code,[b] %				
<15	2354	37%	1450	34%
15 to <30	2869	45%	1985	46%
≥30	1135	18%	887	21%
Year of dialysis start				
2010	1127	18%	770	18%
2011	2223	35%	1430	33%
2012	1852	29%	1358	31%
2013	1156	18%	764	18%

Table 2. (Continued)

Characteristic	No Insurance at Day 1, *n*=6358		Medicaid at Day 1, *n*=4322	
	N or Mean	Percent or SD	*N* or Mean	Percent or SD
Season of dialysis start[a]				
Winter	1773	28%	1126	26%
Spring	1511	24%	1132	26%
Summer	1532	24%	1033	24%
Fall	1542	24%	1031	24%

BMI, body mass index; ADL, Activities of Daily Living.
[a]$P<0.05$.
[b]$P<0.001$.
[c]Other race includes Asian, Native American, Pacific Islander, and people with unknown or missing race.
[d]Hispanic ethnicity was determined using the Centers for Medicare and Medicaid Services-2728 (CMS-2728) form.
[e]Employment status was determined using the CMS-2728 form and included full-time and part-time employment. Patients who were retired, students, and homemakers were categorized as not employed.
[f]The following variables had missing values: body mass index (*n*=95, 1% missing), serum albumin (*n*=3014, 28% missing), and hemoglobin concentration (*n*=1342, 13% missing).

60–64 years old, patients 65–69 years old with Medicare were less likely to be Hispanic and more likely to have higher hemoglobin, be unemployed, live in more affluent counties, and have more comorbidities.

Compared with uninsured patients <65 years old, patients with Medicaid were more likely to be women, be unemployed, live in poorer counties, have higher starting hemoglobin, have lower serum albumin, and have more comorbidities (Supplemental Tables 1 and 2).

Primary Outcomes

Medicare Versus Uninsured. In unadjusted analysis, patients 65–69 years old with Medicare who initiated dialysis using a central venous catheter were more likely to use an AVF or AVG by their fourth dialysis month than uninsured patients 60–64 years old: 16% versus 11%, respectively ($P<0.001$) (Figure 2[a], Table 3). When we adjusted for covariates (all coefficients are in Supplemental Table 3), patients with Medicare had a 63% higher RR (95% CI, 14% to 143%) of AVF or AVG use at month 4 (Figure 3).

Among patients still receiving dialysis through a central venous catheter at the end of their fourth dialysis month, there was no significant difference in the unadjusted time to switching to an AVF or AVG, with 72% of patients with Medicare and 77% of uninsured patients switching (two-sided log rank test, $P=0.20$) (Figure 2[b]). This finding did not change after covariate adjustment, with a hazard ratio (HR) for Medicare versus no insurance of 1.17 (95% CI, 0.97 to 1.42) (Figure 3, Supplemental Table 5).

Medicaid Versus No Insurance. In unadjusted analyses of patients <65 years old, those with Medicaid who initiated dialysis using a central venous catheter were more likely to use an AVF or AVG by their fourth month of dialysis than uninsured patients: 15% versus 13%, respectively ($P<0.001$) (Figure 2[c], Table 3). After we adjusted for covariates (coefficients are in Supplemental Table 4), patients with Medicaid had a 23% higher RR (95% CI, 12% to 38%) of AVF or AVG use at month 4 (Figure 3).

Among patients still receiving dialysis through a central venous catheter at the end of their fourth dialysis month, there was no significant difference in the unadjusted time to switching to an AVF or AVG, with 77% of patients with Medicaid and 80% of uninsured patients switching (two-sided log rank test, $P=0.07$) (Figure 2[d]). Adjusting for covariates did not change this result, with an HR for Medicaid versus no insurance of 1.01 (95% CI, 0.96 to 1.06) (Figure 3, Supplemental Table 6).

Secondary Outcomes

Compared with patients who were uninsured at the start of dialysis, patients with Medicare experienced a lower likelihood of hospitalization involving a vascular access infection between dialysis months 4 and 12 (HR, 0.60; 95% CI, 0.37 to 0.97; $P=0.04$). In contrast, there was no statistically significant difference in likelihood of hospitalization with any infection between the groups (HR, 0.91; 95% CI, 0.70 to 1.19; $P=0.49$) (Figure 3, Supplemental Tables 7 and 9). Our comparison of patients with Medicaid with uninsured patients did not find a statistically significant difference in likelihood of hospitalization involving a vascular access infection (HR, 1.10; 95% CI, 0.99 to 1.23; $P=0.08$). However, patients with Medicaid were significantly more likely to be hospitalized with any infection than uninsured patients (HR, 1.21; 95% CI, 1.13 to 1.30; $P<0.001$).

Patients with Medicare at the start of dialysis had a higher probability of using an AVF or AVG by the end of month 12 than uninsured patients (RR, 1.11; 95% CI, 1.01 to 1.22; $P=0.04$). Conversely, there was no significant difference between patients with Medicaid at the start of dialysis and uninsured patients (RR, 1.01; 95% CI, 1.00 to 1.04; $P=0.20$) (Figure 3, Supplemental Tables 8 and 10).

Sensitivity Analyses

In sensitivity analysis, we found that patients with insurance were also more likely to use an AVF or AVG at the end of month 6 (Medicare RR, 1.54; 95% CI, 1.10 to 2.18; Medicaid RR, 1.24; 95% CI, 1.13 to 1.35), suggesting that longer AVF maturation times did not influence our results (Supplemental Table 11).

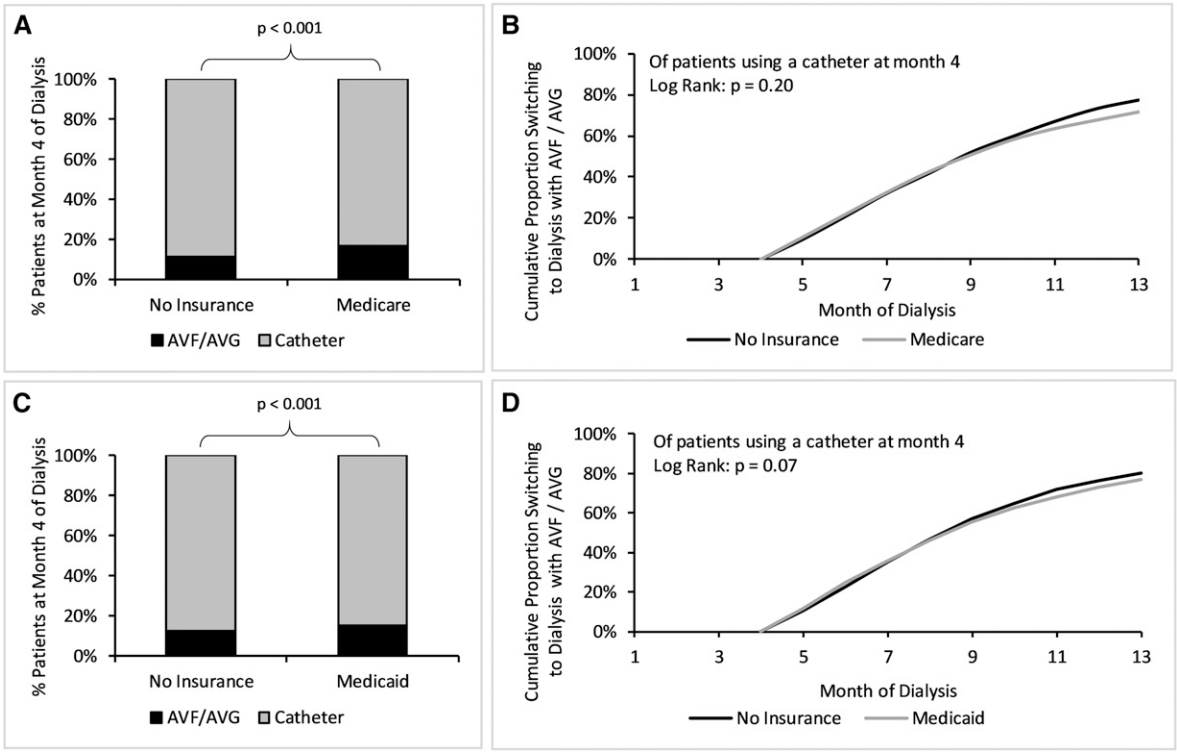

Figure 2. | Greater unadjusted arteriovenous fistula (AVF) or arteriovenous graft (AVG) use at month 4 by patients with Medicare and Medicaid with no difference in cumulative incidence afterward. In unadjusted analysis (unpaired *t* test), patients with Medicare (A) and Medicaid (C) were significantly more likely to use an AVF or AVG than patients with no insurance. When examining patients still using a catheter at month 4, there was no significant difference in the likelihood of obtaining an AVF or AVG in the Medicare versus no insurance (B) or the Medicaid versus no insurance (D) comparisons. Cumulative incidence was derived using the Kaplan–Meier method. (A and C) In the comparison of patients with Medicare versus no insurance, a total of 42% of patients were censored from the Medicare population (9.9% censored for death). The uninsured population had a total of 41% of patients censored (4.5% censored for death). (B and D) In the comparison of patients with Medicaid versus no insurance, a total of 37% of patients were censored from the Medicaid population (3.9% for death). The uninsured population had a total of 35% of patients censored (2.4% for death).

We tested the sensitivity of excluding patients with pre-ESKD care by including these patients in our primary models along with a covariate denoting pre-ESKD care in the multivariable regression analyses. Our findings were robust to this sensitivity analysis, with one exception: the Medicaid population had a 5% higher probability of using an AVF or AVG by the end of month 12 than uninsured patients (95% CI, 3% to 7%; $P<0.001$).

We found no material change in our results on complete patient analysis or when treating death as a competing risk.

Discussion

We found that insurance-related barriers to AVF or AVG use persist into the early dialysis period. In patients initiating dialysis with a central venous catheter, health insurance during the first 3 months of dialysis was associated with greater AVF or AVG use by the end of month 4. The relative magnitude of this difference was substantial. Patients with Medicare or Medicaid at the start of dialysis had 60% and 20%, respectively, higher likelihoods of switching to AVF or AVG use compared with uninsured patients. Although the absolute differences in early AVF and AVG use were modest (5% and 2% unadjusted in the Medicare and Medicaid comparisons, respectively), the relative increases could translate into more substantial gains in younger populations more likely to receive AVF and AVGs.

We also found that insurance-related differences in vascular access use are not necessarily short lived. After obtaining Medicare coverage in the fourth month of dialysis, uninsured patients at the start of dialysis had the same likelihood of switching from a central venous catheter to an AVF or AVG as those with Medicare or Medicaid at dialysis start. Consequently, patients starting dialysis on Medicare were still significantly more likely to use an AVF or AVG by their 12th month than uninsured patients. Our findings are consistent with prior literature showing that patients without health insurance experience substantial barriers to chronic disease care and suggest that this may contribute to long-term disparities in vascular access.

The persistence of insurance-related disparities in vascular access use may be related to inertia. Patients receiving dialysis through a central venous catheter for longer periods of time are less likely to transition to an AVF or AVG, perhaps due to comfort with a catheter (23–25). Additionally, prolonged catheter use is associated with a higher risk for central vein stenosis, complicating future

Table 3. Unadjusted numbers of arteriovenous fistulas and grafts placed over time

Vascular Access by Population	Month 4	Month 8	Month 12
Medicare versus uninsured			
Medicare			
AVF	481	1521	1958
AVG	239	470	566
Permanent accesses that are AVFs, %	67	76	78
Uninsured			
AVF	72	309	458
AVG	29	81	101
Permanent accesses that are AVFs, %	71	79	82
Medicaid versus uninsured			
Medicaid			
AVF	478	1768	2371
AVG	171	421	525
Permanent accesses that are AVFs, %	74	81	82
Uninsured			
AVF	626	2652	3698
AVG	168	465	581
Permanent accesses that are AVFs, %	79	85	86

AVF, arteriovenous fistula; AVG, arteriovenous graft.

AVF or AVG placement (26). It is unlikely that differences in surgical candidacy explain this disparity, because patients with Medicare or Medicaid at the start of dialysis appeared less healthy, likely making them worse surgical candidates (Tables 1 and 2). Furthermore, patients with Medicaid were more likely than uninsured patients to use an AVF or AVG by month 4, despite being comparable socioeconomically, suggesting that socioeconomic differences do not fully explain differences in vascular access use.

Patients with Medicare experienced fewer hospitalizations involving vascular access infections between dialysis months 4–12. Delayed AVF and AVG use in uninsured patients might explain the relatively higher risk for hospitalizations, consistent with a large body of evidence showing improved health outcomes and lower costs associated with AVF and AVG use compared with catheters (2–11). Although we did not observe a similar difference in hospitalizations involving vascular access infections when comparing patients with Medicaid with uninsured patients, this comparison may also have been confounded by differences in the underlying health of the two populations. Despite our efforts to identify comparison groups as similar as possible, a comparison of observed comorbidities suggests that both the Medicare and Medicaid populations were sicker than the uninsured populations. When comparing patients with Medicare with those without insurance, these differences in underlying health may have led us to underestimate the true association between insurance and hospitalization involving vascular access infections. Because the magnitude of the observed difference in AVF or AVG use among patients with Medicaid versus the uninsured after 3 dialysis months was smaller, it is possible that relative increases in hospitalizations due to prolonged central venous catheter in uninsured patients were too small to offset lower baseline rates of hospitalization resulting from differences in underlying health.

Helping uninsured patients obtain an AVF or AVG earlier could yield substantial gains in health and health care savings and improve systemic disparities faced by uninsured patients. One way to address this opportunity for improvement is to extend Medicare eligibility to the first day of in-center hemodialysis (27). Although this solution would likely face fierce political opposition if it were viewed as an expansion of a federal entitlement program, a similar policy is already in place for patients undergoing home dialysis. Extending Medicare eligibility for vascular access care to the first day of in-center hemodialysis may be more appropriately viewed as a refinement to Medicare's existing ESKD program. Although such a policy might increase initial upstream costs, it could yield downstream Medicare savings by preventing complications associated with central venous catheters. The Affordable Care Act may have partially addressed this issue through expanding Medicaid, making insurance accessible for many uninsured patients. However, many states have opted out of Medicaid expansion, leaving their patients vulnerable.

Earlier AVF or AVG placements could also reduce undue financial pressure exerted by the Quality Incentive Program (QIP) on providers that care for a large share of uninsured patients. The QIP penalizes dialysis facilities with high proportions of patients using central venous catheters after the first 90 days of dialysis. Although this 90-day grace period gives providers time to help patients obtain an AVF or AVG, our findings suggest that insurance status in the first 3 months of dialysis may contribute to long-term differences in catheter use with associated financial ramifications for dialysis facilities. Additionally, we found that a nontrivial proportion of uninsured patients used an AVF or AVG at month 4 of dialysis, suggesting that providers likely subsidized access placements, either directly through donated care or indirectly through charity, taxes, and government assistance. A policy extending insurance coverage could alleviate financial pressure on these providers.

Our study had some limitations. A relatively small sample size limited statistical power. Data on vascular access use were only available at the monthly level, and we could not compare changes in vascular access type in the first 3 months of dialysis. Additionally, the Medicare population was categorically older than the uninsured population. Although we restricted the Medicare population to 65–69 years of age and the uninsured group to 60–64 years of age, it is possible that small age-related biases persisted. Our results may have also been confounded by unobserved characteristics given the observational nature of our study. Patients without insurance had fewer comorbidities at hemodialysis start, which could reflect an under-reporting of known conditions and may have affected our multivariable regression analyses. We attempted to mitigate some of these concerns by excluding patients with access to pre-ESKD care. However, this exclusion may have led to the selection of a sicker patients

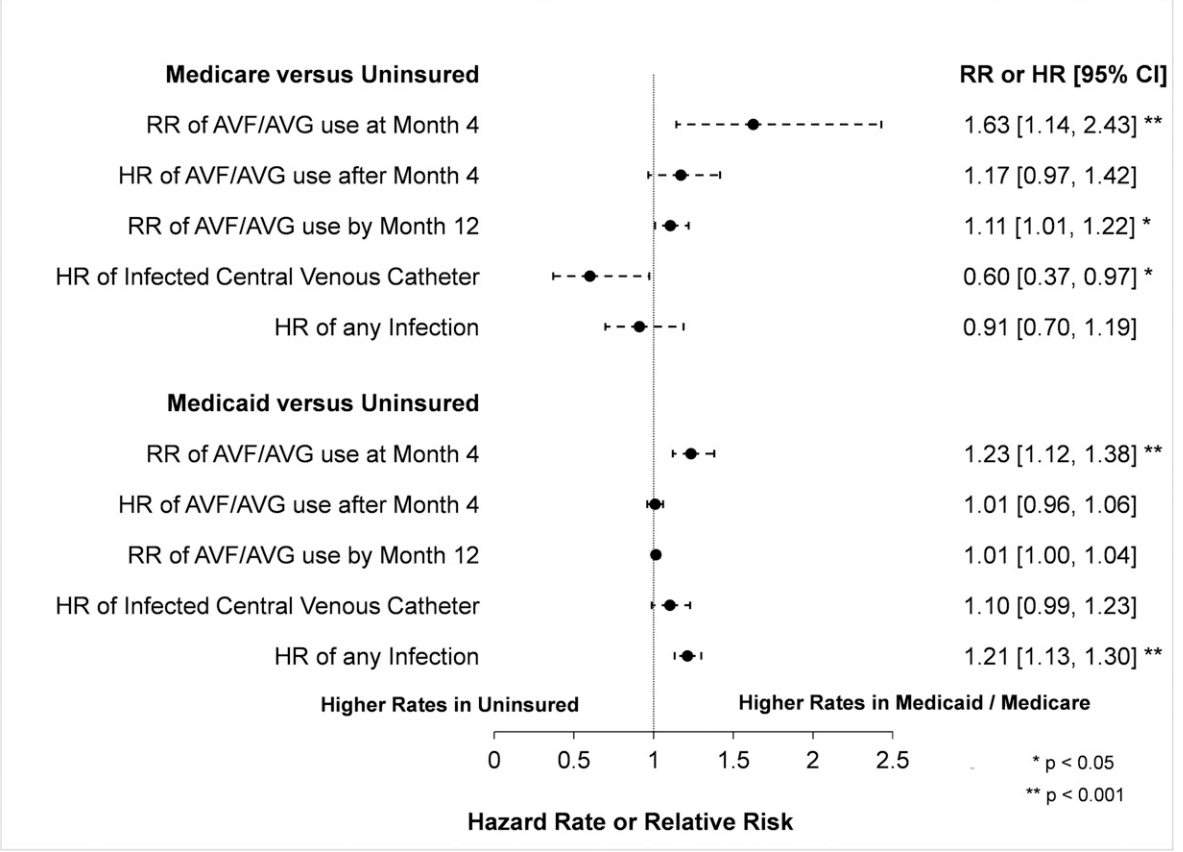

Figure 3. | Greater arteriovenous fistula (AVF) or arteriovenous graft (AVG) use by patients Medicare and Medicaid, with fewer catheter-associated infections in Medicaid patients. Results from multivariable regression models. The reference in all comparisons is the uninsured group. We show the relative risk (RR) of arteriovenous fistula (AVF) or arteriovenous graft (AVG) use at month 4 of dialysis in the entire population estimated from multivariable logistic regression. After excluding patients who were already using an AVF/AVG at month 4, we estimated the hazard ratio (HR) of AVF/AVG use in patients using a central venous catheter after month 4 using multivariable Cox proportional hazard models. We estimated the HR of infections using multivariable Cox proportional hazard models in the entire population. RR of AVF/AVG use at month 13 was determined using a parametric survival model assuming an exponential survival function in the entire population. All models were adjusted for age, sex, race, ethnicity, employment, dual eligibility if applicable, body mass index, albumin, hemoglobin, comorbidities, facility type, number of patients in facility, patient-to-nurse/technician ratio, census characteristics, and year and season of dialysis start (Supplemental Tables 3–10 have coefficients from regressions). 95% CI, 95% confidence interval.

in the Medicare and Medicaid cohorts who had access to but did not use pre-ESKD care before starting dialysis.

In summary, insurance-related barriers to AVF or AVG use persist after patients start dialysis and do not seem to correct through the first year of dialysis. These barriers may translate into a higher likelihood of hospitalizations involving vascular access infections in some patients. Coverage for vascular access care among the uninsured population before the fourth month of dialysis could yield increased AVF and AVG use and lead to improvements in patient health and health care costs.

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Disclosures

None.

References

1. United States Renal Data System: *2017 USRDS Annual Data Report: Epidemiology of Kidney Disease in the United States,*

Bethesda, MD, National Institutes of Health, National Institute of Diabetes and Digestive and Kidney Diseases, 2017
2. Dalrymple LS, Mu Y, Romano PS, Nguyen DV, Chertow GM, Delgado C, Grimes B, Kaysen GA, Johansen KL: Outcomes of infection-related hospitalization in Medicare beneficiaries receiving in-center hemodialysis. *Am J Kidney Dis* 65: 754–762, 2015
3. Metcalfe W, Khan IH, Prescott GJ, Simpson K, Macleod AM: Hospitalization in the first year of renal replacement therapy for end-stage renal disease. *QJM* 96: 899–909, 2003
4. Rayner HC, Pisoni RL, Bommer J, Canaud B, Hecking E, Locatelli F, Piera L, Bragg-Gresham JL, Feldman HI, Goodkin DA, Gillespie B, Wolfe RA, Held PJ, Port FK: Mortality and hospitalization in haemodialysis patients in five European countries: Results from the Dialysis Outcomes and Practice Patterns Study (DOPPS). *Nephrol Dial Transplant* 19: 108–120, 2004
5. O'Connor AS, Wish JB, Sehgal AR: The morbidity and cost implications of hemodialysis clinical performance measures. *Hemodial Int* 9: 349–361, 2005
6. Dixon BS, Novak L, Fangman J: Hemodialysis vascular access survival: Upper-arm native arteriovenous fistula. *Am J Kidney Dis* 39: 92–101, 2002
7. Astor BC, Eustace JA, Powe NR, Klag MJ, Fink NE, Coresh J; CHOICE Study: Type of vascular access and survival among incident hemodialysis patients: The Choices for Healthy Outcomes in Caring for ESRD (CHOICE) Study. *J Am Soc Nephrol* 16: 1449–1455, 2005
8. Dhingra RK, Young EW, Hulbert-Shearon TE, Leavey SF, Port FK: Type of vascular access and mortality in U.S. hemodialysis patients. *Kidney Int* 60: 1443–1451, 2001
9. Pastan S, Soucie JM, McClellan WM: Vascular access and increased risk of death among hemodialysis patients. *Kidney Int* 62: 620–626, 2002
10. Pisoni RL, Arrington CJ, Albert JM, Ethier J, Kimata N, Krishnan M, Rayner HC, Saito A, Sands JJ, Saran R, Gillespie B, Wolfe RA, Port FK: Facility hemodialysis vascular access use and mortality in countries participating in DOPPS: An instrumental variable analysis. *Am J Kidney Dis* 53: 475–491, 2009
11. Polkinghorne KR, McDonald SP, Atkins RC, Kerr PG: Vascular access and all-cause mortality: A propensity score analysis. *J Am Soc Nephrol* 15: 477–486, 2004
12. Quinn RR, Oliver MJ, Devoe D, Poinen K, Kabani R, Kamar F, Mysore P, Lewin AM, Hiremath S, MacRae J, James MT, Miller L, Hemmelgarn BR, Moist LM, Garg AX, Chowdhury TT, Ravani P: The effect of predialysis fistula attempt on risk of all-cause and access-related death. *J Am Soc Nephrol* 28: 613–620, 2017
13. Peters VJ, Clemons G, Augustine B: "Fistula First" as a CMS breakthrough initiative: Improving vascular access through collaboration. *Nephrol Nurs J* 32: 686–687, 2005
14. National Kidney Foundation-Dialysis Outcomes Quality Initiative: NKF-DOQI clinical practice guidelines for vascular access. *Am J Kidney Dis* 30[Suppl 3]: S150–S191, 1997
15. Monitor DP: *Vascular Access in Use: National Sample*, Ann Arbor, MI, Arbor Research Collaborative for Health, 2015
16. Pisoni RL, Zepel L, Port FK, Robinson BM: Trends in US vascular access use, patient preferences, and related practices: An update from the US DOPPS practice monitor with international comparisons. *Am J Kidney Dis* 65: 905–915, 2015
17. Zarkowsky DS, Arhuidese IJ, Hicks CW, Canner JK, Qazi U, Obeid T, Schneider E, Abularrage CJ, Freischlag JA, Malas MB: Racial/ethnic disparities associated with initial hemodialysis access. *JAMA Surg* 150: 529–536, 2015
18. 92nd Congress: Social Security Amendments of 1972. 1972. United States Code, Public Law 92-603. *86 Stat* 1329–1491. Available at: https://www.gpo.gov/fdsys/pkg/STATUTE-86/pdf/STATUTE-86-Pg1329.pdf. Accessed September 17, 2018.
19. Gillespie BW, Morgenstern H, Hedgeman E, Tilea A, Scholz N, Shearon T, Burrows NR, Shahinian VB, Yee J, Plantinga L, Powe NR, McClellan W, Robinson B, Williams DE, Saran R: Nephrology care prior to end-stage renal disease and outcomes among new ESRD patients in the USA. *Clin Kidney J* 8: 772–780, 2015
20. Noridian Healthcare Solutions: *Modifiers*, Fargo, ND, Noridian Healthcare Solutions, 2018
21. Lin E, Kurella Tamura M, Montez-Rath ME, Chertow GM: Re-evaluation of re-hospitalization and rehabilitation in renal research. *Hemodial Int* 21: 422–429, 2017
22. WWAMI: *Rural-Urban Commuting Area Codes (RUCA)*, Grand Forks, ND, WWAMI Rural Health Research Center, 2005
23. Lee T, Barker J, Allon M: Tunneled catheters in hemodialysis patients: Reasons and subsequent outcomes. *Am J Kidney Dis* 46: 501–508, 2005
24. Asif A, Cherla G, Merrill D, Cipleu CD, Briones P, Pennell P: Conversion of tunneled hemodialysis catheter-consigned patients to arteriovenous fistula. *Kidney Int* 67: 2399–2406, 2005
25. Astor BC, Eustace JA, Powe NR, Klag MJ, Sadler JH, Fink NE, Coresh J: Timing of nephrologist referral and arteriovenous access use: The CHOICE Study. *Am J Kidney Dis* 38: 494–501, 2001
26. MacRae JM, Ahmed A, Johnson N, Levin A, Kiaii M: Central vein stenosis: A common problem in patients on hemodialysis. *ASAIO J* 51: 77–81, 2005
27. Allon M, Dinwiddie L, Lacson E Jr., Latos DL, Lok CE, Steinman T, Weiner DE: Medicare reimbursement policies and hemodialysis vascular access outcomes: A need for change. *J Am Soc Nephrol* 22: 426–430, 2011

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