Variation in Nephrologist Visits to Patients on Hemodialysis across Dialysis Facilities and Geographic Locations

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Summary

Background and objectives Geographic and other variations in medical practices lead to differences in medical costs, often without a clear link to health outcomes. This work examined variation in the frequency of physician visits to patients receiving hemodialysis to measure the relative importance of provider practice patterns (including those patterns linked to geographic region) and patient health in determining visit frequency.

Design, setting, participants, & measurements This work analyzed a nationally representative 2006 database of patients receiving hemodialysis in the United States. A variation decomposition analysis of the relative importance of facility, geographic region, and patient characteristics—including demographics, socioeconomic status, and indicators of health status—in explaining physician visit frequency variation was conducted. Finally, the associations between facility, geographic and patient characteristics, and provider visit frequency were measured using multivariable regression.

Results Patient characteristics accounted for only 0.9% of the total visit frequency variation. Accounting for case-mix differences, patients' hemodialysis facilities explained about 24.9% of visit frequency variation, of which 9.3% was explained by geographic region. Visit frequency was more closely associated with many facility and geographic characteristics than indicators of health status. More recent dialysis initiation and recent hospitalization were associated with decreased visit frequency.

Conclusions In hemodialysis, provider visit frequency depends more on geography and facility location and characteristics than patients' health status or acuity of illness. The magnitude of variation unrelated to patient health suggests that provider visit frequency practices do not reflect optimal management of patients on dialysis.

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Introduction

Variation in medical practices leads to a wide range in health care costs, often without a clear link to health outcomes (1,2). Because of high morbidity and mortality in patients with ESRD and because the ESRD program comprises a large share of overall costs to Medicare (nearly 6% of the Medicare budget in 2009) (3), observed variation in ESRD care (4,5) has the potential to translate into large differences in patient outcomes and health care costs.

Past surveys of dialysis facilities found that 15%–36% of patients on hemodialysis were seen by a physician or advanced practitioner at least one time per week, whereas 21% of patients were seen monthly or less (6,7). This variation could reflect differences across facilities in the perceived need for patient visits; patients who are sicker might require more frequent visits to modify the dialysis prescription, target weight, or medication regimen. Alternatively, variation could be driven by differences in provider practice patterns unrelated to patient acuity.

In 2004, the Centers for Medicare and Medicaid Services (CMS), in an effort to alter economic incentives, instituted a direct link between visit frequency and physician reimbursement through a tiered fee-for-service system referred to as G-code reimbursement (8). On average, in 2010, CMS reimbursed providers 72% more on a per-patient basis if the patient was seen four times per month relative to if a patient was seen one time per month (9). A survey of dialysis facilities suggested that providers responded promptly to this economic incentive (10–13). The amount of geographic variation in visit frequency after this economic incentive was introduced has not been described.

This study examines variation in nephrologist visit frequency across dialysis facilities and geographic regions. We use both variation decomposition and multivariable regression analyses to test the hypothesis that provider practice patterns (including those patterns linked to geographic region) were stronger determinants of visit frequency than patient characteristics, including indicators of health status.

Materials and Methods

Data and Patient Selection

We selected a cohort of patients receiving hemodialysis in the United States during 2006. We chose this year because of the availability of census-based categories for population density, information on the number of nephrologists practicing in geographic regions (nephrologist density), and allowance of sufficient time for providers to respond to the economic incentive put in place by the 2004 G-code reimbursement reform. Patients were included in the analysis if they received in-center hemodialysis during 1 or more months in 2006 while being covered by Medicare Parts A & B as their primary payer. Patients were eligible only if they had ESRD and were covered by Medicare Parts A & B for at least 6 months; this parameter allowed sufficient patient-months to identify comorbidities through medical claims.

We obtained data on patient and facility characteristics from the United States Renal Data System; we only considered patient-time with Medicare Parts A & B as primary payer for the current analysis. We determined whether comorbid conditions were present or absent based on 6 prior months of Medicare claims. We calculated a modified Charlson comorbidity score adapted for patients with ESRD (14). We obtained data linking population density to facility zip code from census-based Rural Urban Commuting Area codes (15). We obtained data on the number of nephrologists practicing in a hospital referral region from the Dartmouth Atlas of Health Care (16).

We tracked comorbid conditions and recent hospitalizations for each month during which a patient received hemodialysis. We excluded patient-months during which patients (*1*) were hospitalized for more than 2 days; (*2*) started dialysis, ended dialysis, or ended Medicare coverage; and/or (*3*) died. Additionally, we excluded 14 dialysis facilities in which no visits were recorded. We censored data on patients after they changed to peritoneal dialysis, moved to another dialysis facility, or received a kidney transplant.

Study Design and Statistical Methods

Our primary outcome of interest was whether a patient was seen four or more times in 1 month. To describe baseline characteristics in the population, we ranked patients by their proportion of months with four or more visits during 2006 and separated patients into quintiles of visit frequency. We aggregated patient, facility, and geographic characteristics for all patient-months in 2006 by patient visit frequency quintile. Because of the large population size, we used 10% standardized difference as a marker of heterogeneity between groups (17).

We conducted a variation decomposition analysis for each calendar month in 2006 to determine whether dialysis facility location and geographic region (represented by hospital referral region) explain more of the total variation in physician visit frequency than patient characteristics. Specifically, we used a multilevel model of determinants of visit frequency to partition variation in visit frequency into components explained by dialysis facility location and geographic region (represented by random facility or hospital referral region effects) and selected patient characteristics (listed in Table 1) using a method described by Brookhart *et al.* (18). Visit frequency in each month was represented by a dichotomous variable describing whether a patient was seen four or more times. By using dialysis facility and geographic random effects, this model quantifies variation explained by both observed and unobserved facility and geographic characteristics. By contrast, we only included observed patient characteristics in the variation decomposition. After adjusting for differences in case mix (*i.e.*, age, sex, race, and ethnicity) across dialysis facility location and geographic regions, total variation explained by dialysis facility and geographic locations was compared with total variation explained by patient characteristics, including health status (detailed methods in Supplemental Material).

To illustrate the amount of unexplained variation across geographic regions, we used data for all patient-months in 2006 to plot geographic variation in visit frequency after categorizing hospital referral regions into low-, medium-, or high-visit frequency regions. Visit frequency categories were based on the difference between the actual and predicted proportions of patient-months with four or more visits after adjusting for patient and facility characteristics. We used a 10% deviation from expected to define low- and high-visit regions.

We then used data for all patient-months in 2006 in a multivariable logistic regression model to compare the relative importance of facility, geographic, and patient characteristics, including indicators of patient health status, in their association with physician visit frequency. Facility and geographic characteristics studied included dialysis facility size, population density around dialysis facilities, profit status of facilities, nephrologists per 100,000 population, and part- or full-time advanced practitioners working at a facility. Indicators of patient health status included comorbidity burden, days spent in the hospital over the past 6 months, and being in the first year of hemodialysis. We used cluster-robust standard errors to account for the possibility of correlated errors within facilities, geographic regions, and patients (19,20). To facilitate interpretation of our results, we calculated predicted probabilities—based on the logistic regression model—and computed differences in the absolute probability of four or more visits associated with counterfactual scenarios where indicators of patient health status and selected facility and geographic characteristics varied.

This project was approved by the institutional review board of Stanford University School of Medicine.

Results

Baseline Characteristics

After excluding 10.3% of patient-months because of missing patient or geographic data, a total of 218,058 patients in 4757 hemodialysis facilities met inclusion criteria for the variation decomposition analysis (yielding a total of 1,809,601 patient-months). An additional 2.7% of patients-months were excluded from the multivariable regression analysis because of missing facility characteristics. Patients were seen four or more times during 69% of all patient-months in 2006.

Table 1. Patient, facility, and geographic characteristics in patients stratified by percentage of months with four or more provider visits

	Quintile of Mean Visit Frequency				Total Population
	First	Second	Third	Fourth and Fifth	
Patient-months with four or more visits (%)[a]	4.4	58.0	87.1	100.0	68.8
Demographic					
Men (%)	44.3	46.2	46.4	45.6	45.7
Age (yr; %)					
Under 50	20.6	23.2	19.6	17.9	20.0
50–75	54.6	54.9	57.1	57.0	56.1
Over 75	24.8	22.0	23.3	25.1	23.9
Race (%)					
American Indian[a]	2.9	1.6	1.3	1.2	1.7
Black[a]	30.2	41.1	42.7	41.3	39.5
White[a]	61.0	53.2	52.3	53.4	54.5
Other race[b]	5.9	4.1	3.6	4.0	4.3
Hispanic ethnicity	13.5	13.2	12.7	13.0	13.1
Socioeconomic (%)					
Drug or alcohol abuse	3.3	4.0	2.8	2.5	3.1
Medicaid coverage	43.7	46.8	45.4	45.3	45.4
Hospitalizations and comorbidities					
Comorbidity score by quintile (%)[c]					
First (0–1 points)[a]	25.8	23.8	23.6	21.5	23.4
Second (2 points)	20.2	19.4	19.7	19.4	19.6
Third (3–4 points)	21.8	21.7	22.7	22.6	22.2
Fourth (5–6 points)	17.1	17.7	18.1	18.9	18.1
Fifth (over 6 points)	15.1	17.4	15.8	17.6	16.6
Days hospitalized in past 6 months by quintile (%)					
First, second, and third (0 d)	61.1	58.0	61.3	60.3	60.2
Fourth (1–6 days)	19.5	21.4	21.1	19.2	20.2
Fifth (over 6 days)	19.4	20.6	17.7	20.5	19.6
First year of ESRD	11.7	10.4	6.9	11.5	10.2
Facility and geographic					
Facility size by quintile (%)					
First (under 49 patients)[a]	27.2	20.5	18.2	17.3	20.2
Second (49–74 patients)	22.0	21.3	19.5	18.3	20.0
Third (75–101 patients)[a]	17.2	20.2	21.6	21.7	20.5
Fourth (102–140 patients)	17.8	19.2	20.5	20.6	19.7
Fifth (over 140 patients)[a]	15.7	18.8	20.1	22.0	19.6
Nonprofit facility (%)	27.0	23.0	22.9	24.9	24.3
Advanced practitioners in a facility, mean (SD)	0.06	0.06	0.07	0.08	0.07 (0.4)
Nephrologists per 100,000 population, mean (SD)[a]	2.0	2.1	2.1	2.2	2.1 (0.7)
Rural/small town (%)[a]	8.2	5.3	5.1	4.6	5.5

[a]Greater than 10% standardized difference between lowest and highest quintiles of visit frequency.
[b]Other race includes Asian, Pacific Islander, Mideast, Indian subcontinent, multiracial, and unknown.
[c]Based on a Modified Charlson Comorbidity Score (points for renal disease not included) (14).

After stratifying patients into visit frequency quintiles according the proportion of months that a patient was seen four or more times in 2006, we compared characteristics of patient-months in the lowest- and highest-visit frequency quintiles; 4.4% of patient-months in the lowest-visit frequency quintile had four or more visits compared with 100% of patient-months in the two highest-visit frequency quintiles. Patient-months in the lowest- and highest-visit frequency quintiles differed in most race categories, with a larger percentage of whites and American Indians in the lowest-visit frequency quintile and more blacks in the highest-visit frequency quintiles. The lowest-visit frequency quintile had a larger percentage of patient-months with fewer than two comorbidities and a larger percentage of patients dialyzing in small towns/rural areas, whereas there were more nephrologists per capita in patient-months in the highest-visit frequency quintiles. The lowest-visit frequency quintile had a larger percentage of facilities with fewer than 49 patients, whereas there were larger percentages of facilities with 75–101 and over 140 patients in the highest-visit frequency quintiles (Table 1).

Variation Decomposition Analysis

The fraction of overall variation per month explained by dialysis facility ranged from 24.9% to 26.4%. This fraction decreased slightly to 24.3%–25.7% (average=24.9%) after adjusting for differences in case mix among facilities. The fraction explained by geographic region ranged from 9.2% to 10.5% and from 8.6% to 9.8% (average=9.3%) after adjusting for differences in case mix among regions. In contrast, the fraction of overall variation per month explained by patient characteristics was only 0.7%–1.0%. The amount of total variation explained by facility location, geographic region, and patient characteristics ranged from 25.1% to 26.3% (Supplemental Figure 1 and Supplemental Table 1).

Figure 1 illustrates variation in visit frequency across geographic regions after adjusting for differences in case mix. High-visit frequency regions were clustered near the coasts, the Great Lakes region, and south-central United States.

Analysis of Specific Facility, Geographic, and Patient Characteristics

A comparison of regression coefficients indicates that many facility and geographic characteristics were more strongly associated with provider visit frequency than indicators of patient health status. The odds of four or more visits were 56% (52%–60%) higher in facilities with more than 140 patients compared with facilities with fewer than 49 patients, whereas the odds of four or more visits were 18% (15%–21%) lower in more remote facilities (facilities in small towns and rural areas) compared with facilities located in urban areas and large towns. An increased number of nephrologists (odds ratio [OR]=1.27; 95% confidence interval [95% CI]=1.25–1.28 per nephrologist) practicing in an area and more advanced practitioners (who can bill for all but one monthly visit) working at a dialysis facility (OR=1.16; 95% CI=1.14–1.19 per practitioner) were associated with higher odds of four or more visits, whereas nonprofit facilities (OR=0.96; 95% CI=0.94–0.97) were associated with fewer visits.

Although the odds of four or more visits associated with the highest quintile of comorbidity score (over six points) were 17% higher compared with the lowest quintile of comorbidity score (zero to one points), other indicators of patient health status were associated with only a small increase—or decrease—in the odds of four or more visits. Patients in their first year of hemodialysis or patients who spent more than 6 days in the hospital in the past 6 months had 9% and 10% lower odds of more frequent visits, respectively. Black race was associated with a 21% increase in the odds of four or more visits after adjusting for observed patient, geographic, and facility characteristics (Table 2). For selected subpopulations, the predicted probability of more frequent visits was also more closely associated with geographic and facility characteristics than indicators of patient health status (Figure 2).

Discussion

Although most patients on hemodialysis in the United States are seen by their nephrologist or a nephrologist surrogate (*e.g.*, Nurse Practitioner or Physician Assistant) four or more times per month, provider visit frequency varies substantially across dialysis facilities and geographic region. Dialysis facility and geographic location explain substantially more of the variation in provider visit frequency than observed patient characteristics. Additionally, indicators of patient health status, including the burden of comorbidities, recent hospitalization, and

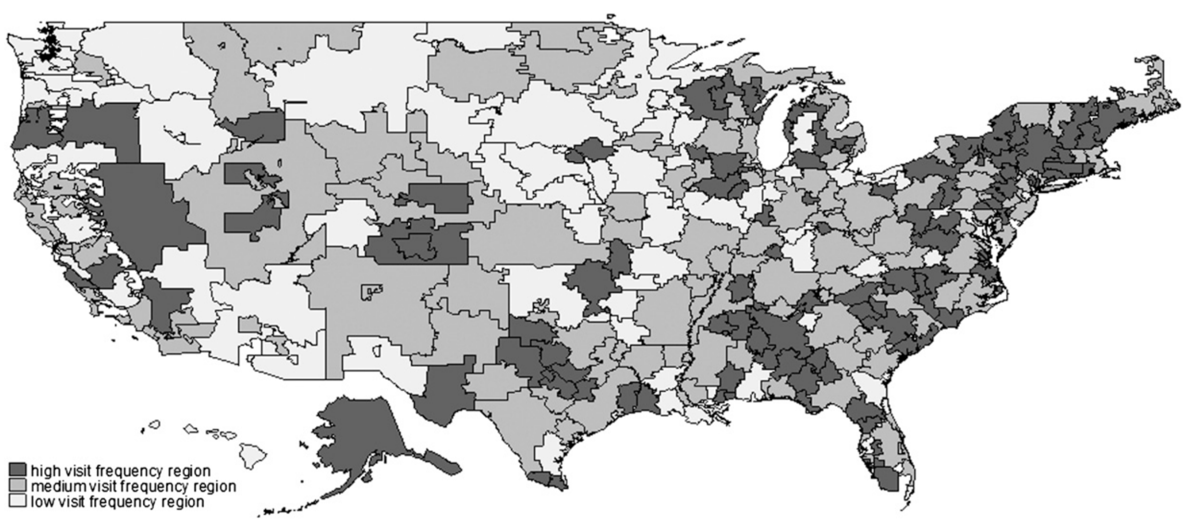

Figure 1. | Geographic variation in the percentage of patients seen four or more times by their provider. Geographic boundaries are defined by the hospital referral region (HRR) obtained from the Dartmouth Atlas of Health Care (16). Low-visit frequency regions included 21.9% of HRRs, medium-visit frequency regions included 42.5% of HRRs, and high-visit frequency regions included 35.6% of HRRs. Visit frequency adjusted for patient (sex, age, race, ethnicity, drug or alcohol use, Medicaid coverage, quintile of hospitalizations, quintile of comorbidity score, and first year of dialysis), facility (quintile of facility size, for-profit status, and advanced practitioners in a facility), and geographic (nephrologists per 100,000 population and rural/small town) characteristics using predicted probabilities of four or more visits from logistic regression.

Table 2. Logistic regression results comparing the association between patient, facility, and geographic characteristics with the odds of four or more provider visits

Variable	Odds Ratio	LCI	UCI	*P* Value
Men	0.99	0.98	1.01	0.32
Age (yr)				
Under 50		Reference		
50–75	1.14	1.12	1.17	<0.001
Over 75	1.17	1.14	1.20	<0.001
Race				
White		Reference		
American Indian	0.68	0.64	0.72	<0.001
Black	1.21	1.19	1.23	<0.001
Other[a]	0.73	0.70	0.76	<0.001
Hispanic ethnicity	0.95	0.92	0.97	<0.001
Drugs or alcohol abuse	0.78	0.75	0.81	<0.001
Medicaid coverage	1.01	0.99	1.03	0.21
Comorbidity score by quintile				
First (score 0–1)		Reference		
Second (score 2)	1.09	1.06	1.11	<0.001
Third (score 3–4)	1.13	1.10	1.16	<0.001
Fourth (score 5–6)	1.17	1.14	1.20	<0.001
Fifth (score over 6)	1.17	1.14	1.20	<0.001
Recent hospitalizations by quintile[b]				
First, second, and third (0 d)		Reference		
Fourth (1–6 d)	0.95	0.94	0.97	<0.001
Fifth (over 6 d)	0.90	0.89	0.92	<0.001
First year of dialysis	0.91	0.89	0.92	<0.001
Facility size by quintile				
First (under 49 patients)		Reference		
Second (49–74 patients)	1.19	1.16	1.22	<0.001
Third (75–101 patients)	1.49	1.45	1.53	<0.001
Fourth (102–140 patients)	1.40	1.37	1.44	<0.001
Fifth (over 140 patients)	1.56	1.52	1.60	<0.001
Nonprofit facility	0.96	0.94	0.97	<0.001
One additional advanced practitioner in facility	1.16	1.14	1.19	<0.001
One additional nephrologist in area	1.27	1.25	1.28	<0.001
Facility in small town or rural area	0.82	0.79	0.85	<0.001

[a]Other race includes Asian, Pacific Islander, Mideast, Indian subcontinent, multiracial, and unknown.
[b]Hospitalizations in the past 6 months. Wald tests comparing absolute regression coefficient size for the most significant indicator of patient acuity (fifth quintile of comorbidity index) with coefficients for facility and geographic characteristics show significantly larger ($P<0.001$) associations for all facility and geographic coefficients except for nonprofit and advanced practitioners. Supplemental Material (Supplemental Table 3) shows a linear probability model exploring the negative association between hospitalizations and visit frequency. LCI, lower 95% confidence interval; UCI, upper 95% confidence interval.

vintage of 1 year or less, were associated with only a slight increase or decrease in the probability of four or more visits, whereas several facility and geographic characteristics had associations with visit frequency of much larger magnitude. Black race was independently associated with a 21% increase in the odds of four or more visits. These findings suggest that the frequency with which providers see patients on hemodialysis depends primarily on provider practice patterns rather than how sick patients are; some providers tend to see patients four or more times per month, whereas others do not.

The optimal number of physician (or advanced practitioner) encounters per month to patients on hemodialysis is unknown. CMS enacted G-code reimbursement, despite conflicting results regarding the optimal number of visits from several epidemiologic studies (6,7,21). Although we did not study how visit frequency and patient outcomes changed as a result of reimbursement reform, a previous analysis observed a large response in the number of visits after the reform and no improvement in major health outcomes (13). However, more frequent physician visits may lead to improvement in patient outcomes other than mortality, such as decreased use of dialysis catheters, lower transplantation waiting times, and improved patient satisfaction at an acceptable cost. If this finding is true, then the magnitude of variation in practice patterns and differences by race suggests that efforts to promote more frequent visits could generate substantial improvements in the care of patients on hemodialysis. Alternatively, if more frequent provider visits are not associated with improved outcomes, then the magnitude of variability across dialysis providers highlights an area where

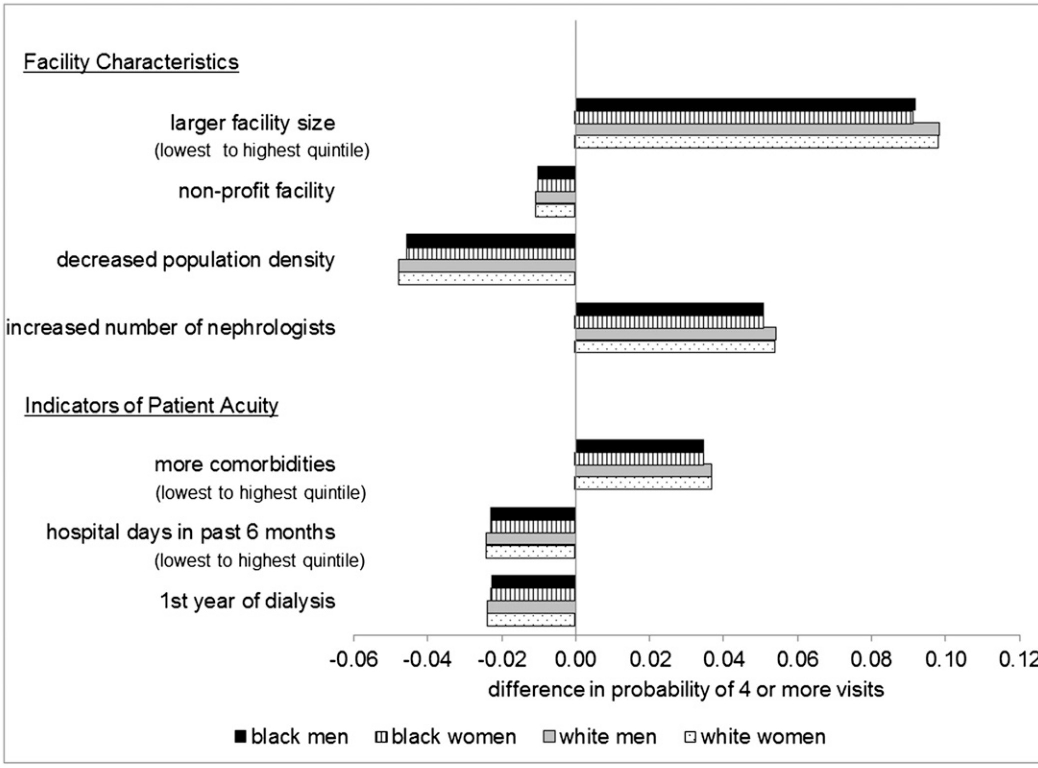

Figure 2. | Comparing the association between facility, geographic, and patient characteristics with the absolute probability of four or more visits in selected patient cohorts. Decreased population density compares rural/small town with urban/large town; increased number of nephrologists compares one additional nephrologist per 100,000 population. Hospital days in past 6 months compares greater than 6 days in the hospital with no hospitalizations. Predicted probabilities are otherwise calculated for a typical hemodialysis patient with common categorical patient, facility, and geographic characteristics and median values for all continuous characteristics. Specifically, in the reference case, the patient is 50–75 years old, non-Hispanic, and not in the first year of hemodialysis with no hospitalizations in the past 6 months, the lowest quintile of comorbidity score, no drug or alcohol use, and dialysis in a for-profit center in the lowest facility size quintile (<49 patients) in an urban area or large town with 0 advanced practitioners and 2.09 nephrologists per 100,000 population.

unnecessary and costly medical care should no longer be incentivized.

Uncertainty about the true relation between provider visit frequency and patient outcomes may occur, because only a subset of patients benefit from more frequent visits. In other chronic disease settings, improvement in patient health outcomes from more frequent provider encounters has been shown primarily in sicker patients. For instance, closer follow-up was associated with reduced rates of rehospitalization in patients recently hospitalized for chronic obstructive pulmonary disease exacerbations (22), whereas a multidisciplinary intervention, including more frequent provider visits, prevented rehospitalization in patients recently hospitalized for heart failure (23). Additionally, more frequent ambulatory visits were found to be beneficial in patients with uncontrolled diabetes (24). If a similar pattern holds true for patients on hemodialysis (*i.e.*, sicker patients benefit from more frequent encounters with their provider), our finding that certain subsets of sicker or more vulnerable patients on hemodialysis (*e.g.*, patients recently started or hospitalized) are not seen as frequently as more stable patients highlights a potential area for improved care in this population.

Underlying economic incentives faced by dialysis care providers in the period after G-code provider reimbursement reform can explain the observed associations between facility characteristics and visit frequency. For example, if the cost of travel to dialysis facilities in more remote locations is, on average, higher—both in travel expense and opportunity cost (*i.e.*, the time that the provider could spend doing other profitable activities, such as working in an office practice or seeing more patients in the hospital)—then there is a disincentive to visit patients dialyzing in remote facilities more frequently. This potential disincentive to seeing patients in remote dialysis facilities was highlighted several times in the discourse leading up to enactment of G-codes (12,25). Because fixed travel costs to a dialysis facility are distributed among all of the patients who are seen on a provider's visit to a given facility, fixed travel costs are distributed over fewer patients in smaller facilities, which creates an economic disincentive to see patients at smaller facilities because of the increased per patient cost (in terms of time spent traveling) of a visit. Finally, more competition among providers in areas with more nephrologists and advanced practitioners per capita may decrease the net income threshold that providers require to see patients more times per month, leading to the observed increase in visit frequency in areas with more providers. Because providers were responsive to the economic incentive put in place by G-code reimbursement in 2004 (10–13), it is not surprising that economic incentives (or disincentives) continue to play a significant role in determining provider practices.

This study has several limitations. First, we use dialysis facility as a proxy for dialysis care provider practice patterns. In reality, a dialysis facility frequently services several care providers, and a given care provider often operates at several facilities. The interdigitation of nephrologists and facilities suggests that we are underestimating the actual amount of variation explained by differences in care provider practices. The 73.7%–74.9% of total visit frequency variation unexplained by our model likely reflects this underestimation along with underlying randomness in provider–patient interactions. Second, despite the availability of a rich administrative database, we are unable to observe all patient characteristics. Although the patient characteristics that we included explained only a small fraction of the variability in visit frequency across dialysis facilities, there remains the possibility that an additional small share of the variation explained by dialysis facilities is actually caused by clustering of unobserved patient characteristics within facilities. Third, in our variation decomposition analysis, we used a method of partitioning variation that is only an approximation. Fourth, because billing codes do not allow us to distinguish between two and three visits per month, we describe visit frequency variation by the fraction of months with four or more visits. This description may have obscured subtle differences in practice. However, we do not believe that an alternative method of characterizing visit frequency (*e.g.*, total visits by week, month, or year) would have materially influenced our qualitative results.

After the enactment of G-code reimbursement, there continues to be significant variability in the frequency of practitioner visits to patients on hemodialysis, although two thirds of patients are seen four or more times per calendar month. Facility and geographic location explain more of the variation in visit frequency than patient characteristics, whereas many facility and geographic characteristics are more strongly associated with visit frequency than patient health status. These findings suggest that current payment incentives to augment hemodialysis visit frequency have led to an environment where underlying economic incentives and provider practice patterns determine visit frequency rather than the level of illness of the patients. Understanding how more frequent provider visits might result in a reduction in ESRD-related complications and how to appropriately align remuneration with optimal visit frequency could result in improved hemodialysis care at significantly lower cost.

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Disclosures

G.M.C. serves on the Board of Directors at Satellite Healthcare, Inc. and is on the Scientific Advisory Board of DaVita Clinical Research.

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