Medicare's New Prospective Payment System on Facility Provision of Peritoneal Dialysis

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Abstract

Background and objectives Peritoneal dialysis is a self-administered, home-based treatment for ESKD associated with equivalent mortality, higher quality of life, and lower costs compared with hemodialysis. In 2011, Medicare implemented a comprehensive prospective payment system that makes a single payment for all dialysis, medication, and ancillary services. We examined whether the prospective payment system increased dialysis facility provision of peritoneal dialysis services and whether changes in peritoneal dialysis provision were more common among dialysis facilities that are chain affiliated, located in nonurban areas, and in regions with high dialysis market competition.

Design, setting, participants, & measurements We conducted a longitudinal retrospective cohort study of n=6433 United States nonfederal dialysis facilities before (2006–2010) and after (2011–2013) the prospective payment system using data from the US Renal Data System, Medicare, and Area Health Resource Files. The outcomes of interest were a dichotomous indicator of peritoneal dialysis service availability and a discrete count variable of dialysis facility peritoneal dialysis program size defined as the annual number of patients on peritoneal dialysis in a facility. We used general estimating equation models to examine changes in peritoneal dialysis service offerings and peritoneal dialysis program size by a pre– versus post-prospective payment system effect and whether changes differed by chain affiliation, urban location, facility size, or market competition, adjusting for 1-year lagged facility–, patient with ESKD–, and region-level demographic characteristics.

Results We found a modest increase in observed facility provision of peritoneal dialysis and peritoneal dialysis program size after the prospective payment system (36% and 5.7 patients in 2006 to 42% and 6.9 patients in 2013, respectively). There was a positive association of the prospective payment system with peritoneal dialysis provision (odds ratio, 1.20; 95% confidence interval, 1.13 to 1.18) and PD program size (incidence rate ratio, 1.27; 95% confidence interval, 1.22 to 1.33). Post-prospective payment system change in peritoneal dialysis provision was greater among nonurban (P<0.001), chain-affiliated (P=0.002), and larger-sized facilities (P<0.001), and there were higher rates of peritoneal dialysis program size growth in nonurban facilities (P<0.001).

Conclusions Medicare's 2011 prospective payment system was associated with more facilities' availability of peritoneal dialysis and modest growth in facility peritoneal dialysis program size.

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Introduction

Peritoneal dialysis (PD) is a clinically equivalent and convenient alternative to hemodialysis (HD) (1–5) that is often preferred by patients with ESKD (6–8). Nephrologists report that PD is an appropriate therapy for roughly one half of their patients (9,10), and PD is less costly than HD (11–15). Medicare policies promote PD utilization among patients (*e.g.*, waiving the 90-day enrollment period) and physicians (*e.g.*, monthly capitated payment for visits). However, PD use in the United States is low compared with use in other industrialized nations; PD incidence peaked at 14% in 1985 and fell to 6% in 2010 (16). Much of the empirical evidence for the low and declining use of PD has focused on patient and physician determinants that have not fully explained declining trends (7,17–19), suggesting that other nonmedical factors in the health care delivery system for dialysis are associated with PD's limited use (2,20–23).

In 2011, Medicare implemented a new comprehensive prospective payment system (PPS) that makes a single payment for all dialysis, medication, and ancillary services. By bundling previously separately billable medication and ancillary services, which made HD a more profitable therapy, the new PPS leveled payment between PD and HD treatment (22,24–27). PD requires lower facility overhead costs in equipment and staffing (28,29), and therefore, the new PPS was projected to increase PD operating margins from $185 to $201 per patient-month (30), which was expected to induce greater PD service provision in dialysis facilities or increase PD program size.

Recent work has shown upward trends in patient demand for PD (31–34), with little consideration of changes in facility supply of PD that underlie these patient-level trends. Dialysis facility response to PPS is an important factor in these changes, because payment reform is designed to drive supply-side change in dialysis modality and PD provision.

In this study, we examined whether PPS increased dialysis facility provision of PD services and whether certain types of dialysis facilities were more responsive than others. PD availability was declining for years leading up to PPS implementation, with PD more likely to be offered by facilities unaffiliated with chain organizations, in urban locations, and in uncompetitive dialysis markets (35–37). We expected an increase in PD provision after implementation of PPS and that the increase would occur primarily among the types of facilities "at risk" for developing and expanding PD programs, namely those that are chain affiliated, located in nonurban areas, and in regions with high dialysis market competition where PD services were not offered in the pre-PPS era. Findings from this study contribute to identifying meaningful responses to the Medicare ESKD PPS in terms of provider practice patterns, which are a critical component in evaluating the effectiveness of Medicare's payment reform.

Materials and Methods

Study Design, Population, and Data

We conducted a retrospective study of all nonfederal outpatient ESKD dialysis facilities before (2006–2010) and after (2011–2013) the implementation of PPS. The sample excluded facilities that only provided transplant services, never reported dialysis services, and had invalid zip code or nonmatching Medicare provider identifier. Our sampling approach also accounted for new facilities, closures, and changes of ownership, resulting in a final sample of 6433 unique providers and 43,608 facility-year observations (Supplemental Figure 1).

The principal data source was the US Renal Data System (USRDS), the national repository of data on ESKD providers and patients (16). Facility characteristics and operating statistics came from the Annual Facility Survey (Centers for Medicare & Medicaid Services [CMS] Form 2744), which is required for every Medicare-approved facility providing services to patients with ESKD. We merged these survey data with the Medicare Provider of Service dataset, which has additional information on annual geographic location, certification, and termination dates. Tracking ownership changes in facilities that were sold or purchased by other entities resulted in the exclusion of 240 invalid or duplicate facility-year observations to improve the accuracy of the USRDS-based facility characteristics.

Annual market-based measures of the composition of patients with ESKD were derived from the Medical Evidence Report (CMS Form 2728), which providers are required to complete when a patient begins or re-enters service in ESKD facilities. County-level demographic statistics from the Area Health Resource File were converted to the zip code level on the basis of land area weighting. Hospital census data were obtained from the American Hospital Association's Annual Hospital Survey. All zip code–level patient with ESKD and demographic data were aggregated to generate market-level statistics for each year of the study period. We defined markets as hospital referral regions (HRRs), which approximate the geographic extent of health care markets for tertiary care (38). HRRs better reflect PD service areas than zip code or county designations, because patients on PD are likely to travel outside county boundaries for monthly PD maintenance visits.

Measurement

We examined two outcomes of interest that reflect the ways in which PPS could induce dialysis expansion of PD services: changes in offerings of PD services and expansion of existing PD programs. A dichotomous variable indicated whether a dialysis facility offered continuous ambulatory PD or continuous cycler–assisted PD in a given year (PD provision). PD program size is a continuous variable of a facility's PD program defined as the number of unique patients on PD reported in the year (PD census). Staff-assisted and in-unit self-care PD were excluded from analysis, because these services are rare and unit based.

The main explanatory variable of interest is the pre/post indicator of the change from the prior payment system, under which many medications and ancillary services were billed separately from the dialysis treatment (for years 2006–2010), to the new inclusive PPS (years 2011–2013). We included interactions between the pre/post policy indicator and selected time-varying organizational and regional characteristics of dialysis facilities. For the outcome of PD provision, these included facility chain affiliation, facility urban location (versus nonurban), facility size (number of unique patients on dialysis of all modalities), and dialysis market competition. Dialysis market competition was calculated using the Herfindahl–Hirschman Index, which is equal to the sum of the square of each dialysis facility's market share, on the basis of the number of patients on dialysis unique to each facility. Facilities within a market under the same chain affiliation were treated as a single firm (39,40). Competition values ranged from zero (an unconcentrated, competitive market) to 100 (a concentrated, monopolistic market). In regression models for the PD census outcome, we replaced facility size due to collinearity with the outcome and instead, used HD occupancy rate. HD occupancy represents the annual occupancy rate of a facility's HD stations defined as the total number of in-unit HD treatments provided divided by the total possible HD treatment sessions available (on the basis of the facilities' number of HD stations and assuming an average of three shifts of potential use per station per day operating 6 days weekly and 51 weeks yearly).

Analysis also controlled for time-varying market and organizational characteristics to adjust for factors that may influence facilities' service strategies, including facility characteristics (for-profit ownership, freestanding versus hospital-based status, United States region, and change in facility ownership during the previous year), regional characteristics (the percentage of facilities with PD services; ESKD incidence; patients with ESKD demographic characteristics, such as white, age $<$65 years old, and employed; and general population statistics, such as per capita income, proportion of urban residents, and hospital density

Table 1. Characteristics of dialysis facilities in 2006 (pre-policy) versus 2013 (post-policy)

Facility and Market Characteristics	By Policy Period	
	Pre-PPS: 2006, *n*=4775	Post-PPS: 2013, *n*=6089
Any PD service, %	36	42
No. of patients on PD in facility, mean (SD)	5.7 (12.4)	6.9 (14.5)
No. of patients on PD in PD facilities, mean (SD)	15.6 (16.4)	16.5 (18.6)
Patients on PD in facility, %, mean (SD)	7 (17)	10 (20)
Patients on PD in facility in PD facilities, %, mean (SD)	20 (24)	23 (24)
Any home dialysis, %	38	44
Home dialysis only, %	3	4
Enter the dialysis market, %	4	4
Exit the dialysis market, %	0.8	0.8
Freestanding unit, %	88	92
For-profit ownership, %	80	85
Chain affiliation, %	82	88
Ownership change, %	1	0.6
Facility size	70.8 (49.1)	71.1 (49.0)
Hemodialysis station occupancy	54.5 (25.1)	52.1 (26.3)
Urban location, %	74	76
United States region, %		
Northeast	15	14
South	44	44
Midwest	24	24
West	17	18
Market-level characteristics (HRR)		
PD facilities, %	36.4 (15.5)	41.7 (14.4)
Competition, general	8.8 (10.4)	7.0 (8.0)
Competition, chain based	33.3 (19.4)	39.7 (17.6)
PD prevalence	76.3 (29.2)	84.3 (29.3)
ESKD incidence	3.9 (1.5)	3.7 (1.5)
White ESKD, %	51.5 (22.2)	49.9 (21.8)
Nonelderly ESKD, %	59.1 (5.2)	58.0 (4.5)
Employed ESKD, %	16.2 (3.7)	18.3 (4.0)
Hospital density	313.8 (120.3)	292.4 (108.4)
Urban residents, %	78.9 (16.1)	79.2 (15.9)
Per capita income	$35,771 (583.3)	$43,779 (408.1)

Definitions are as follows. (*1*) Facility size: number of unique patients on dialysis (all treatment modalities) per facility-year. (*2*) Hemodialysis station occupancy: total number of in-unit hemodialysis treatments provided divided by the total possible hemodialysis treatment sessions available (on the basis of the facilities' numbers of hemodialysis stations and assuming an average of three shifts of potential use per station per day operating 6 days weekly and 51 weeks yearly) and truncated at 100%. (*3*) PD prevalence: number of patients on prevalent PD per 1000 ESKD prevalent population in each HRR-year. (*4*) ESKD incidence: number of patients with ESKD per 10,000 general population in each HRR-year. (*5*) Hospital density: number of hospital beds per 100,000 in the HRR general population. PPS, prospective payment system; PD, peritoneal dialysis; HRR, hospital referral region.

defined as the number of hospital beds per 100,000 in the HRR general population), and year fixed effects. All explanatory variables were lagged by 1 year, because associations were unlikely to be instantaneous.

Analyses

Generalized estimating equation models (41) were used to account for the repeated facility-level observations across years. We used a binomial distribution with a logit link for the binary PD provision outcome and a negative binomial with a log link for the continuous PD census outcome, with an unstructured pairwise log odds ratio (OR) pattern for PD provision and an autoregressive (1) covariance structure for PD census that best accounted for facility-level repeated measures (42,43). For both outcomes, we modeled time in years (2006–2013) with PPS beginning in 2011 using the best fit model (43,44). To model the policy effect, the best fit discontinuity regression model had an intercept shift at 2011 for payment reform (which determines whether there is a detectable shift after policy period) with a linear slope for all time points (*i.e.*, no separate pre- and post-policy trends) (Supplemental Material). Continuous time-varying covariates contribute both cross-sectional and longitudinal sources of variation in our facility-level PD outcomes (43) and were decomposed into between-facility and within-facility components, respectively, for inclusion in models. The final PD provision model included between-facility linear, quadratic, and cubic fixed effects for facility size; between-facility linear and quadratic effects for market competition; within-facility hospital density and facility size; and linear effects for the remaining continuous covariates. The final PD census model included between-facility linear and quadratic effects for HD occupancy and linear effects for the remaining continuous covariates. To assess policy effects by organizational characteristics, interaction terms were included (*i.e.*, between the post-period intercept shift and lagged urban and chain categorical fixed effects for both outcomes and linear fixed effects for between-facility

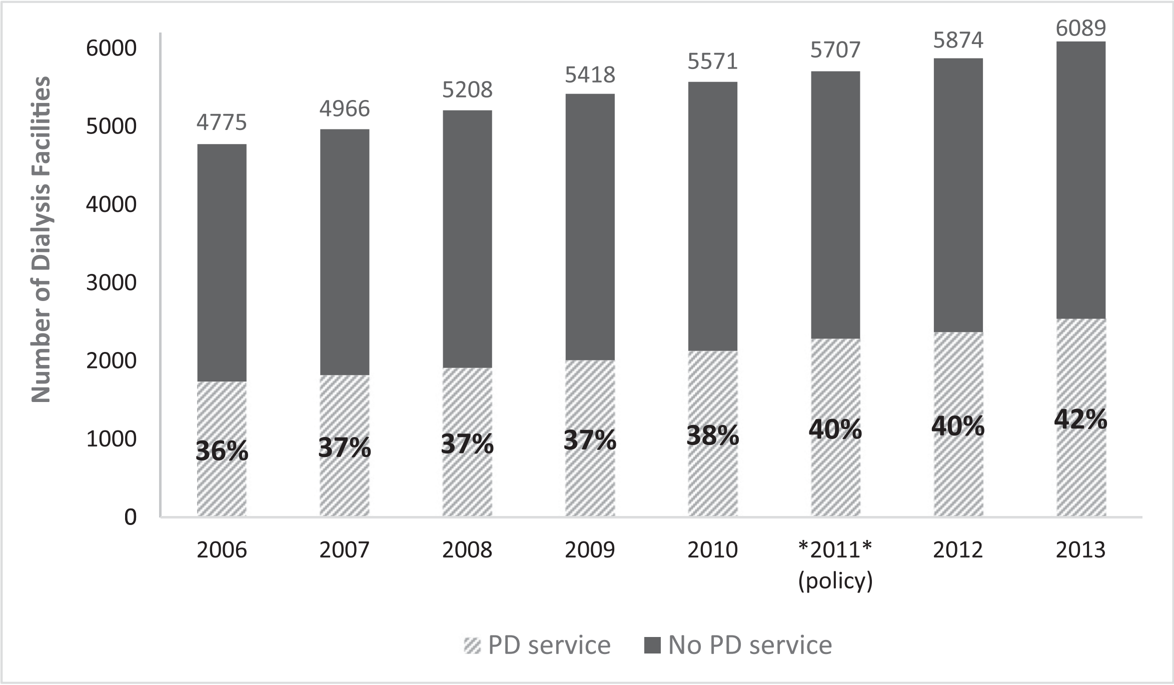

Figure 1. | **Growth in dialysis facilities and facility peritoneal dialysis (PD) provision in the United States by year.** The facility sample is not fixed across time periods, reflecting facility closure, new entry, and changes in ownership over time.

market competition, facility size [for PD provision], and HD occupancy [for PD census]). To interpret our regression results, model-based SEM estimates were used for inference due to the large number of continuous covariates (43).

To provide an estimate of the overall PPS effect (OR for PD provision and incidence rate ratio [IRR] for PD census) in models with interactions, we estimated the difference in PD provision and PD census between the pre-PPS payment period (2006–2010) and post-period (2011–2013) across selected interaction variables (*i.e.*, urban) at mean levels of the remaining covariates in the model. Predicted probabilities and counts were estimated for interactions of the policy period and the explanatory variables of interest for fixed values of covariates; thus, caution should be used inferring these to population parameters. This study was approved by the Institutional Review Board of Duke University.

Results

Descriptive Characteristics of Dialysis Facilities

The final sample consisted of 6433 unique Medicare-participating outpatient dialysis facilities operating in 2006–2013. There was an average of 6.8 years of repeated observations per facility in the 8-year study period, resulting in 43,608 facility-year observations for analysis with 69% (*n*=4465) having observations in all 8 years. Between 2006 and 2013, an increasing proportion of the dialysis industry was composed of freestanding, for profit–owned, and chain-affiliated facilities located in urban areas (Table 1).

The growth in the number of facilities offering PD (44%) outpaced growth in the number of dialysis facilities in the United States (28%), and therefore, there was a modest increase in the unadjusted proportion of facilities offering PD between 2006 and 2013. Only 36% of all dialysis facilities offered PD in 2006, 38% offered PD in 2010 (1 year before PPS), and 42% offered PD in 2013 (Figure 1). There was marked stability in PD service availability, where 65% of facilities did not change their PD services over time (Supplemental Figure 2). However, regional-temporal variation in PD services was evident, where the regional PD provision increased most in rural southern, midwestern, and western regions (Figure 2).

Similarly, there was an increase in unadjusted PD program size (Figure 3). The average number of patients on PD per facility across all dialysis facilities was 5.7 (median =0) in 2006 and 6.9 (median =0) in 2013. Among facilities actually providing PD services, the average PD program increased from 15.6 patients in 2006 (median =10) to 16.5 in 2013 (median =11).

Associations of Prospective Payment with PD Provision in Dialysis Facilities

In the adjusted model, there was a positive association of PPS and facility-level PD provision (OR, 1.20; 95% confidence interval [95% CI], 1.13 to 1.28) (Supplemental Table 1, Table 2). The estimated rate of PD provision in the pre-period was 37% (95% CI, 35% to 39%), and it was 41% (95% CI, 39% to 43%) after PPS. Figure 4 displays both observed and model-estimated PD provision by year.

The association of PPS and PD provision varied by several hypothesized facility characteristics. Compared with the pre-PPS period, the odds of PD provision after PPS were 1.26 (95% CI, 1.16 to 1.36) times higher for nonurban facilities versus urban facilities and 1.14 (95% CI, 1.05 to 1.23) times

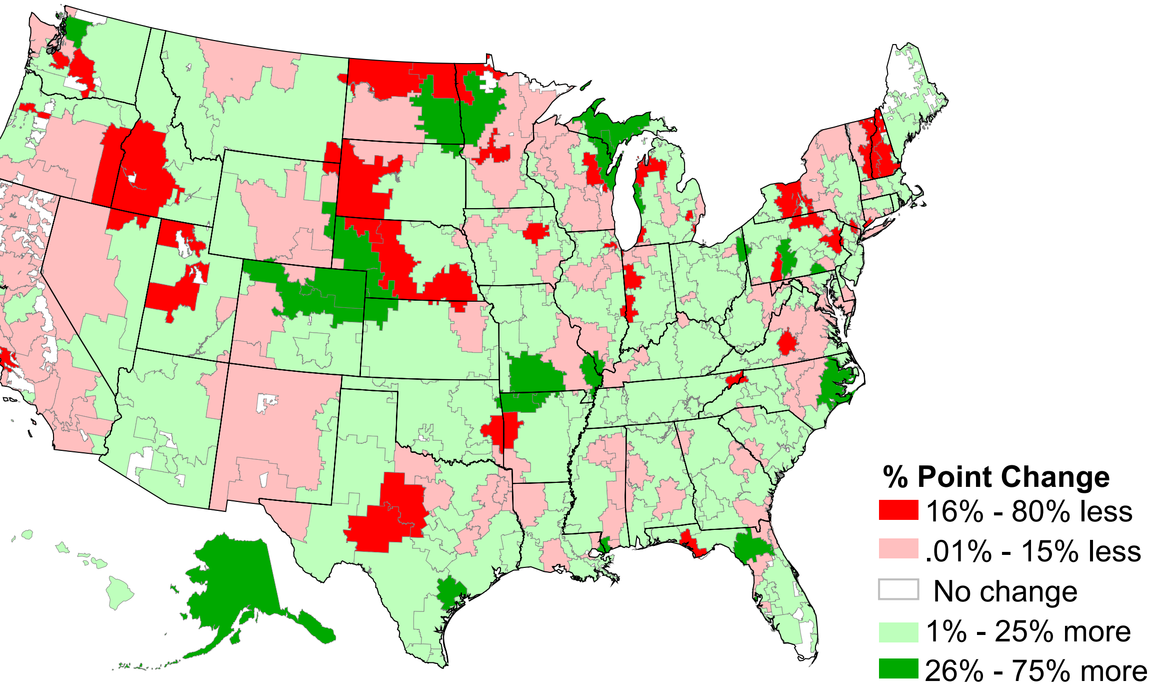

Figure 2. | **Geographic variation in changes in regional supply of dialysis facilities' provision of peritoneal dialysis: 2006 versus 2013.**

higher for chain-affiliated facilities versus nonchains (Table 2). Increasing facility size was associated with higher rates of PD provision, with a slower rate of increase after PPS implementation than before PPS (OR, 0.99; 95% CI, 0.98 to 0.99 per ten additional patients in facilities per year). Pre- and post-policy PD provision did not vary by dialysis market competition (*P*=0.08). Facilities offered PD at higher rates in regions with greater regional PD supply ($P<0.001$) in all years, and facilities in the South offered PD at higher rates than facilities in the West (*P*=0.01) (Supplemental Table 1).

Associations of Prospective Payment with PD Program Size in Dialysis Facilities

Introduction of PPS was associated with a 27% predicted increase (IRR, 1.27; 95% CI, 1.22 to 1.33) in PD program size, with adjusted estimates of 3.5 patients (95% CI, 3.2 to 3.7) before PPS and 4.4 patients (95% CI, 4.1 to 4.8) post-PPS (Table 2). There was an increase in expected numbers of PD program size after PPS for both urban and nonurban facilities, but the rate of growth is higher for nonurban facilities: compared with the pre-PPS period, the expected PD census in the post-PPS period increased by a factor of 8% for facilities in nonurban versus urban facilities (IRR, 1.08; 95% CI, 1.03 to 1.13) (Table 2). This rate of increase was larger among nonurban facilities than their urban counterparts, but the actual change in PD census numbers was larger in urban facilities due to their larger pre-PPS program size. Post-policy change in the rate of PD program size growth did not vary by chain affiliation (*P*=0.15), HD occupancy (*P*=0.36), or chain market-level competition (*P*=0.11). In all years of observation, facility PD program size was larger in facilities with higher HD occupancy ($P<0.001$), regions with greater regional PD supply ($P<0.001$), and facilities located in the West compared with all other regions (all $P<0.05$).

Discussion

Recent work has shown upward trends in patient PD utilization after implementation of Medicare PPS for dialysis (31–34). Results of our study indicate a concurrent increase in PD provision in dialysis facilities after the payment reform. Understanding both provider- and patient-level responses to Medicare's ESKD PPS provides a more nuanced understanding of how payment reform is inducing change as designed.

To our knowledge, this is the first study to examine the effects of Medicare's dialysis PPS, which provided incentives for greater provision of PD, on provision of PD in dialysis facilities. Historically, one third of facilities offered PD: primarily those located in urban areas (36,37,45) and facilities that are not chain affiliated (35,36). In the first 3 years after payment reform, we found a modest increase in facility provision of PD services and the rate of PD program size growth primarily among nonurban facilities, where there was a relative dearth of PD, likely because nonurban facilities had more potential for change in PD provision and program size. Payment reform was also associated with increased PD provision in chain-affiliated facilities, possibly because chain organizations have the resources to respond to PPS incentives of increased margins under the PD service line across their affiliated clinics, as reflected in service availability and the growth of their PD programs.

We found continued and marked stability in PD services at facilities where facility patterns of PD service strategies were quite similar to patterns spanning almost two decades

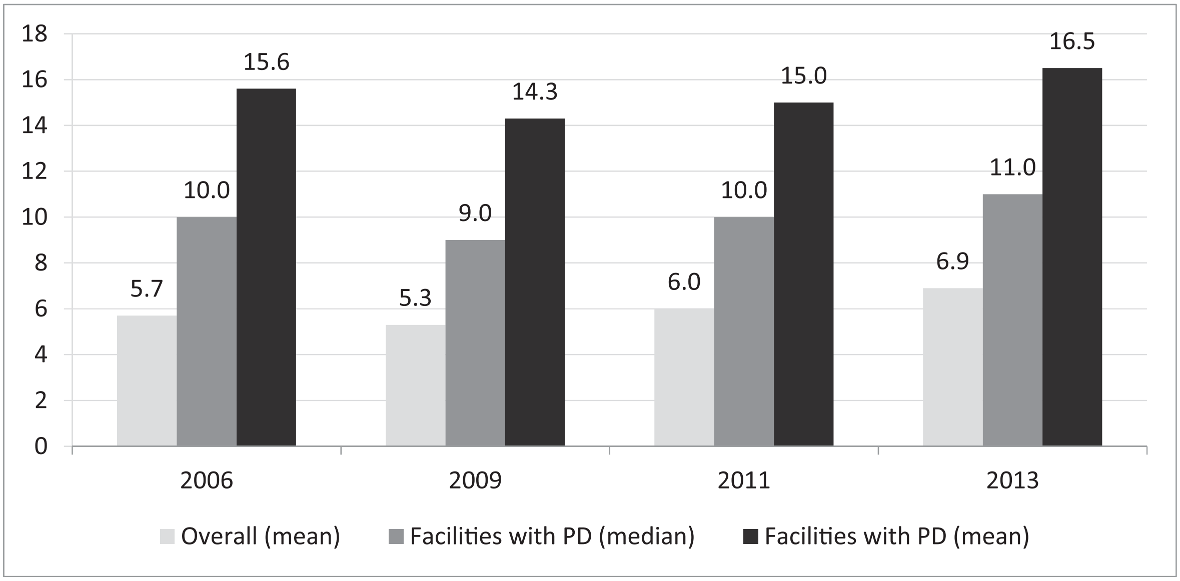

Figure 3. | **Dialysis facility peritoneal dialysis (PD) program size by selected year.** Facility PD program size (PD census) was reported for facilities reporting any patients on PD in a year.

before PPS (35–37). One half (n=3103) of facilities operating between 2006 and 2013 never offered PD services compared with 41% of facilities in 1995–2003, suggesting limited policy effects of PPS on PD provision. The anticipated margins from the PPS (30) may not be large enough to initiate capital investment for PD services, for which there are several possible explanations. Bundling formerly separately billable injectable medications into dialysis payment led to significant reductions in medication use, which may have diminished the anticipated margins between PD and HD services and thus, economic incentives for more PD. Coupled with the nonsignificant effects of PPS on PD service offerings by regional dialysis market competition, it is also possible that financial incentives may not be strong enough for providers to compete on PD services (36). Providers may have little incentive to bear the opportunity costs of PD (*i.e.*, risk losing economies of scale by shrinking HD programs) and justify sunk labor and equipment costs related to HD services, leading to organizational inertia (46). Importantly, there may be a learning curve for facilities to adopt and implement PD services (46), which means that policy effects were greater among incumbent PD programs that have established expertise or experience in delivering PD. Facilities with no prior PD history may need additional lead time to initiate a PD service, and thus, a longer post-policy observation period may be needed to realize payment policy effects in a more substantial way. Future research will be needed to assess the contributions of these critical factors to trends in dialysis facility provision and subsequent patient utilization.

We also found a modest increase in PD program size in the first 3 years after payment reform, with a greater increase in the rate of growth among nonurban facilities. Changes in the rate of PD program size growth between pre- and post-PPS were not associated with chain affiliation, possibly because a large proportion of dialysis facilities never offered PD services. To better understand provider response to PPS, additional study could examine factors that facilitate the response. For example, larger chains may have the resources and market penetration to generate economies of scale in regionalizing PD programs compared with smaller chains and independently owned facilities. The degree to which patient outcomes may differ by these provider types is not yet known.

This study has several limitations. First, our dichotomous outcome of PD provision may not accurately reflect the degree of PD availability, because it is on the basis of patient census. The USRDS no longer generates the service indicator, and therefore, this census-based measurement may undercount facilities offering PD services that do not

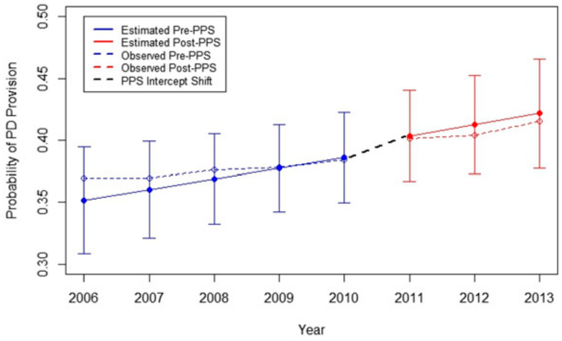

Figure 4. | **Increased rates of dialysis facility provision of peritoneal dialysis (PD) services after implementation of 2011 Medicare Prospective Payment System (PPS) for dialysis, as shown in observed and estimated rates of PD provision and associated 95% confidence intervals by year.** Estimates and 95% confidence intervals from the generalized estimating equation logistic regression model for PD provision, with all other covariates centered at mean values. A full set of regression results is available in Supplemental Table 1.

Table 2. Associations of the Medicare Prospective Payment System and selected dialysis facility characteristics with facility provision of peritoneal dialysis and facility peritoneal dialysis program size

Characteristics	Pre-PPS 2006–2010 Estimate (95% CI)[a]	Post-PPS 2011–2013 Estimate (95% CI)[a]	Odds Ratio or IRR (95% CI) Post versus Pre	Odds Ratio or IRR (95% CI); *P* Value Interaction (Difference Post versus Pre by Characteristic)[b,c]
Outcome: PD provision				
Overall	37% (35% to 39%)	41% (39% to 43%)	1.20 (1.13 to 1.28)	—
Chain affiliation				
Yes	37% (35% to 38%)	41% (39% to 43%)	1.23 (1.15 to 1.30)	1.14 (1.05 to 1.23); *P*=0.002
No	39% (36% to 41%)	40% (38% to 43%)	1.08 (0.98 to 1.17)	—
Urban				
Yes	40% (38% to 42%)	43% (41% to 45%)	1.13 (1.06 to 1.20)	—
No	29% (26% to 32%)	37% (34% to 40%)	1.43 (1.31 to 1.55)	1.26 (1.16 to 1.36); *P*<0.001
Facility size[d]				
70.7 (Mean)	37% (35% to 39%)	41% (39% to 43%)	1.20 (1.13 to 1.27)	—
80.7	40% (38% to 42%)	45% (42% to 47%)	1.19 (1.12 to 1.21)	0.99 (0.98 to 0.99); *P*<0.001
Market competition[e]				
36.4 (Mean)	37% (35% to 38%)	41% (39% to 43%)	1.20 (1.13 to 1.27)	—
41.4	38% (35% to 40%)	42% (40% to 44%)	1.19 (1.12 to 1.26)	0.99 (0.98 to 1.00); *P*=0.08
Outcome: PD program size (PD census)				
Overall	3.5 (3.3 to 3.7)	4.4 (4.1 to 4.8)	1.27 (1.22 to 1.33)	—
Chain affiliation				
Yes	3.5 (3.2 to 3.7)	4.4 (4.1 to 4.7)	1.27 (1.21 to 1.33)	1.04 (0.98 to 1.10); *P*=0.15
No	3.6 (3.5 to 3.9)	4.4 (4.0 to 4.7)	1.22 (1.15 to 1.30)	—
Urban				
Yes	4.7 (4.3 to 5.1)	5.8 (5.4 to 6.3)	1.24 (1.18 to 1.29)	—
No	1.5 (1.3 to 1.6)	2.0 (1.7 to 2.2)	1.34 (1.26 to 1.41)	1.08 (1.03 to 1.13); *P*<0.001
HD occupancy[f]				
53.4 (Mean)	3.5 (3.1 to 3.9)	4.4 (3.9 to 5.0)	1.26 (1.19 to 1.33)	—
63.4	4.0 (3.5 to 4.5)	5.0 (4.4 to 5.6)	1.26 (1.18 to 1.33)	1.00 (0.99 to 1.00); *P*=0.36
Market competition[e]				
36.4 (Mean)	3.5 (3.1 to 3.9)	4.4 (3.9 to 5.0)	1.26 (1.19 to 1.33)	—
41.4	3.6 (3.1 to 4.0)	4.5 (3.9 to 5.0)	1.26 (1.19 to 1.33)	1.00 (0.99 to 1.00); *P*=0.11

PPS, prospective payment system; 95% CI, 95% confidence interval; IRR, incidence rate ratio; PD, peritoneal dialysis; HD, hemodialysis.
[a]Estimates from generalized estimating equation logistic regression model for PD provision and generalized estimating equation negative binomial regression model for PD census, with all other covariates centered at mean values; 95% CI is from model-based SEM. The full set of regression results is available in Supplemental Tables 1 and 2.
[b]Odds ratio of interaction (ratio of odds ratio post versus pre by characteristic) of the PD provision outcome: for chain affiliation, the odds of PD increases by a factor of 1.14 for chain versus nonchain in post-policy compared with pre-policy era.
[c]IRR of interaction (ratio of IRR post versus pre by characteristic) of the PD program size (PD census outcome): for urban characteristic, PD census increased by a factor of 8.0% for nonurban facilities versus urban in post-policy compared with pre-policy era.
[d]Facility size is a continuous variable in the generalized estimating equation model, with linear, quadratic, and cubic terms with a linear by post-policy interaction. Estimates are provided for the mean level of facility size across all years and an increase in facility size of ten unique patients on dialysis.
[e]Dialysis market competition is a continuous variable in the generalized estimating equation model, with a linear term and linear term by post-policy interaction. Estimates are provided for the mean-level value of chain-based regional competition across all years and an increase of 5% points.
[f]HD occupancy is a continuous variable in the generalized estimating equation model, with linear and quadratic terms with a linear by post-policy interaction. Estimates are provided for the mean level value of HD occupancy across all years and an increase of 10% points in HD occupancy rate.

(yet) have patients on the modality. However, we suspect that this is highly unlikely given the consistency of PD provision in prior research (35–37). Second, we were unable to reliably assign facilities to specific small regional chains over time. Third, we did not have national data that could account for other supply-side factors that affect dialysis facility service offerings, such as clinicians (*e.g.*, nephrologists, nurses, and surgeons), adequacy of provider training and clinical experience, and provider-led patient education, that influence recommendations and patient decisions about dialysis modality (47–49). Fourth, the rise in PD accelerated after the implementation of PPS, and therefore, there was already some growth before 2011. Because PPS was anticipated, some of the increases in the late pre-PPS period may actually reflect a program effect. It has been shown that growth in PD use accelerated during the last quarter of 2010 after the posting of the final payment rule for the bundle (31).

The 2011 dialysis PPS nudged more facilities to offer PD and modestly increase the size of their PD programs. Our findings inform future changes in provider incentives should policy makers want to further encourage the

availability of home kidney replacement therapies, which is a necessary step to increasing patient access and uptake.

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M.L.M. reports ownership of Amgen stock due to his spouse's employment. The other authors (V.W., C.J.C., L.L.S., S.-Y.D.L., and R.A.H.) report no relationship or financial interest with any entity that would pose a conflict of interest to the subject matter of this article.

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