Geographical Variation in Peritoneal Dialysis Catheter Insertion and Initiation within the United States

Peritoneal dialysis (PD) is an effective but underutilized renal replacement therapy modality. There are limited data regarding geographical variation in PD catheter insertion and utilization of PD as a first renal replacement therapy in the United States. We explored the variation in catheter insertion and initiation of PD utilizing 2 large, nationally representative databases. The incidence of catheter insertion differed significantly by geographical region, being highest in the South (7.30/100 end-stage renal disease [ESRD] patients; 95% confidence [CI] interval 6.78 – 7.81) and lowest in the West (5.91/100 ESRD patients; 95% CI 5.43 – 6.38). Peritoneal dialysis initiation also differed by region, being highest in the West (7.10/100 ESRD patients; 95% CI 6.83 – 7.30) and lowest in the Northeast (5.12/100 ESRD patients; 95% CI 4.87 – 5.30). Interestingly, the Northeast region, with the lowest rate of PD utilization, had the highest number of nephrologists per population (3.95/100,000 persons), and the West, with the highest PD utilization, had the lowest number of nephrologists (2.54/100,000 persons). Reasons for this variation should be explored further and efforts should be made to standardize PD implementation throughout the United States.

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Peritoneal dialysis (PD) remains underutilized in the United States compared with other countries (1). Several patient, provider, and geographical factors independently affect PD utilization (2,3), but there are limited data regarding geographical variability in PD catheter insertion and PD utilization as a first modality. To address this, we used the nationwide inpatient sample (NIS), and the United States Renal Data System (USRDS) to determine regional estimates in PD catheter insertion/utilization. We explored potential correlates with regional variation in PD catheter insertion and initial PD utilization with nephrology workforce.

METHODS

The NIS database is the largest publicly available all-payer inpatient care database in the United States (4). We queried the NIS database between 2002 and 2011 using ICD-9-CM procedure code of 54.93 for the creation of cutaneoperitoneal fistula and insertion of PD catheter. We produced national estimates using sampling weights provided by the Healthcare Cost and Utilization Project (5). The USRDS is a national registry that collects demographic, clinical, and treatment-related information on patients receiving ESRD treatment derived from Medical Evidence Reports. We derived incident counts of

ESRD patients and initial treatment modality by using USRDS RenDER System (6). We used data from the American Boards of Internal Medicine and Pediatrics to determine the number of board-certified nephrologists by region as of 2011.

We compared patient- and hospital-level characteristics among 4 geographic regions from the US census (Northeast, Midwest, South, and West) with analysis of variance (ANOVA), chi-squared test and Wilcoxon rank sum tests for continuous, categorical, and non-parametric variables, respectively. We calculated overall and region-specific proportions for PD catheter insertion by dividing the number of catheter insertions by reported incident ESRD counts during the study period. We calculated the proportion of reported ESRD patients with PD as initiation therapy with USRDS data using a similar methodology. We compared incidence rates among the 4 census regions using a Poisson regression for incidence counts, offset by natural log of total population at risk and 95% CIs of incidence rates using a standardized methodology (7). We used a 2-tailed *p* value of 0.05 for statistical significance. We utilized SAS version 9.4 (SAS Institute Inc., Cary, NC, USA) for analyses.

RESULTS

A total of 72,528 discharges with PD catheter insertion were extracted from 2002 to 2011. Baseline characteristics of hospitalizations by geographic region and overall are shown in Table 1. Median age was 52 years, 51.6% were male, and 42.5% were White. With respect to comorbidities, 36.7% had diabetes mellitus and 73.6% had hypertension. Also, 63.2% of hospitalizations had Medicare/Medicaid insurance. With respect to hospital characteristics, 72.5% of hospitals had a large bed size and 62.1% were urban teaching hospitals. There were significant differences in baseline characteristics of hospitalizations by geographic region (Table 1). Hospitalizations in the Northeast region had the highest median age, at 57.5 years, while those in the South had the lowest proportion of White race. Hospitalizations in the Midwest had a higher proportion of diabetes mellitus and hypertension. The Northeast region had the highest proportion of hospitalizations on Medicare/Medicaid and the highest proportion of large and urban teaching hospitals.

The national weighted rates of PD catheter insertion/100 ESRD patients by year are shown in Supplementary Table 1. The number of hospitalizations with PD catheter insertion was 6.78/100 ESRD patients (95% CI 6.50 – 7.06) for the United States overall. However, there existed substantial geographical variation for PD catheter insertion. The rate was the highest in the South, at 7.30 (95% CI 6.78 – 7.81), and lowest in the West, at 5.91 (95% CI 5.43 – 6.38). The Northeast and Midwest had rates of 6.59 (95% CI 5.92 – 7.26) and 6.75 (95% CI 6.26 – 7.25), respectively. These differences were highly significant (*p* < 0.001 in multivariate analyses after adjusting for patient and hospital level variables) (Figure 1).

The rates of PD utilization as first renal replacement therapy (RRT) per 100 ESRD patients by year are shown in Supplementary Table 1. Overall utilization of PD as first RRT modality was 6.54/100 ESRD patients (95% CI 6.30 – 6.78) in the US overall.

TABLE 1
Baseline Characteristics of Hospitalizations with PD Catheter Insertion from 2002 to 2011

Hospital region	Northeast	Midwest	South	West	Overall US	P
Total no. of hospitalizations	12,584 (17.4%)	15,755 (21.7%)	31,683 (43.7%)	12,507 (17.2%)	72,528	
Age (median, IQR)	57.49 (43.09–69.39)	56.89 (40.01–69.31)	49.47 (26.88–62.45)	48.04 (22.46–62.72)	52.33 (31.83–65.87)	<0.001
Sex (%)						<0.001
Male	52.1	50.9	52.1	51.0	51.6	
Female	47.9	49.1	47.9	48.7	48.3	
Race (%)						<0.001
Whites	59.3	38.5	41.4	33.4	42.5	
Blacks	21.6	12.1	24.2	9.1	18.5	
Hispanics	10.1	2.0	12.8	30.0	12.9	
Others	6.8	3.5	4.6	15.2	16.6	
Missing	2.2	44.0	17.0	12.3	19.5	
Diabetes mellitus	36.0	40.4	35.1	37.2	36.7	<0.001
Hypertension	70.0	75.2	74.1	74.1	73.6	<0.001
Median household income category for patient's zip code (%)						<0.001
0–25 th percentile	23.2	26.0	43.1	20.9	32.1	
26–50 th percentile	22.5	31.3	25.8	25.0	26.3	
51–75 th percentile	22.6	25.7	19.2	25.3	22.3	
76–100 th percentile	31.7	17.0	11.8	28.7	19.3	
Primary payer (%)						
Medicare & Medicaid	64.3	64.1	62.4	63.0	63.2	<0.001
Private including HMOs & PPOs	31.8	32.5	30.0	31.3	31.1	
Other/self-pay/no charge	12.1	13.0	57.8	17.5	5.7	
Hospital characteristics						
Bed size of hospital (%)						
Small	8.0	10.4	5.0	5.3	6.8	<0.001
Medium	18.7	17.8	22.1	23.4	20.8	
Large	73.3	71.8	72.9	71.3	72.5	
Hospital location & teaching status (%)						<0.001
Rural	5.0	4.3	6.3	1.9	4.9	
Urban non-teaching	21.3	27.5	33.3	47.7	32.4	
Urban teaching	73.7	66.5	60.0	50.1	62.1	

PD = peritoneal dialysis; IQR = interquartile range; HMO = health maintenance organization; PPO = preferred provider organization.

Utilization was highest in the West, at 7.10 (95% CI 6.83 – 7.30), and lowest in Northeast, at 5.12 (95% CI 4.87 – 5.30). The South and Midwest had rates of 6.71 (95% CI 6.50 – 6.91) and 6.89 (95% CI 6.69 – 7.09), respectively. These differences were highly significant ($p < 0.001$) (Figure 1).

The density of board-certified nephrologists varied geographically. Notably, the Northeast region, with the lowest rate of PD utilization, had the highest number of nephrologists per population (3.95 per 100,000 persons). The West, with the highest PD utilization, had the lowest number of nephrologists (2.54 per 100,000 persons). The density of nephrologists for the South and Midwest was 2.78 and 2.72 per 100,000 persons, respectively.

DISCUSSION

This study demonstrates a significant difference by US geographic region in both PD catheter insertion and PD

utilization as a first RRT modality. The exact causes of these differences cannot be established with the current data. In addition, we show that in the US, PD utilization as a first RRT modality increased significantly from 7.08/100 ESRD patients in 2002 to 7.35/100 ESRD patients in 2011, although this was not a linear increase. This increase in utilization was not matched by increasing PD insertion. This discrepancy might be due to coding issues inherent to the databases and that all catheters inserted might not be captured by our analysis, especially those inserted on an outpatient basis by interventional nephrologists.

The increased PD catheter insertion in the South could be reflective of greater surgeon availability. A recent report suggests that the South has had the greatest gain in general surgeons (8). However, the South had only the third highest rate of PD utilization as initial therapy while the West had the highest rate. This could suggest that a large proportion of catheters are not used for PD initiation in the South, with

Figure 1 — Incidence rates of PD catheter insertion and PD initiation by geographic region in the United States. The navy circles indicate the incidence rates (with 95% CIs) of PD catheter insertion by geographic region. Similarly, the red triangles indicate the incidence rates (with 95% CIs) of PD initiation by geographic region. The dotted vertical lines indicate the overall US incidence for PD catheter insertion and PD initiation respectively. PD = peritoneal dialysis; CI = confidence interval; ESRD = end-stage renal disease.

patients switching to another modality. Patient migration after catheter insertion could also account for this, although we were not able to capture this.

Interestingly, the Northeast region, with the highest density of nephrologists, had the lowest rate of initial PD utilization and second lowest rate of PD catheter insertion, while the West, with the lowest nephrologist density, had the highest rates of initial PD utilization. This suggests that factors other than provider and facility availability contribute to PD utilization. These factors could include patient characteristics and patient choice as well as demographics and socioeconomic factors of a region.

Although national databases allowed excellent power and generalizability, we recognize limitations. Foremost among those is lack of patient-level information including attitudes and beliefs to explain this disparity. We also could not identify patients who had a PD catheter but did not initiate PD due to lack of linkage between the NIS and USRDS. In addition, we did not have any information on the practice patterns within each geographic region that likely play a vital role in PD initiation and utilization.

In conclusion, there exist significant regional differences in PD catheter insertion and PD initiation as first RRT therapy in the US. Because PD is an acceptable but underutilized dialysis modality, attempts to understand the reasons behind this should be made and coordinated plans to standardize PD implementation should be considered.

DISCLOSURES

The authors have no financial conflicts of interest to declare.

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