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Patient Care Staffing Levels and Facility Characteristics in U.S. Hemodialysis Facilities

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Abstract

Background—Higher numbers of registered nurses per patient have been associated with improved patient outcomes in acute care facilities. Variation and associations of patient-care staffing levels and hemodialysis facility characteristics have not been previously examined.

Study Design—Cross-sectional study using Poisson regression to examine associations between patient-care staffing levels and hemodialysis facility characteristics.

Setting & Participants—4,800 U.S. hemodialysis facilities in the 2009 CMS ESRD Annual Facility Survey (CMS-2744), USRDS.

Predictors—Facility characteristics, including profit status, freestanding status, chain affiliation and geographic region, adjusted for facility size, capacity, functional type, and urbanicity.

Outcomes—Patient care staffing levels, including ratios of Registered Nurses (RN), Licensed Practical Nurses (LPN), Patient Care Technicians (PCT), composite staff (RN+LPN+PCT), Social Workers, and Dietitians to in-center hemodialysis patients.

Results—After adjusting for background facility characteristics, the ratios of RNs and LPNs to patients were 35% ($p < 0.001$) and 42% ($p < 0.001$) lower, but the PCT-to-patient ratio was 16% ($p < 0.001$) higher in for-profit facilities than those in nonprofit facilities (Rate ratio, 0.65, 95%CI, 0.63–0.68; 0.58, 0.51–0.65; 1.16, 1.12–1.19; respectively). Regionally, compared to the Northeast, the adjusted RN-to-patient ratio was 14% ($p < 0.001$) lower in the Midwest, 25% ($p < 0.001$) lower in the South, and 18% ($p < 0.001$) lower in the West. Even after additional adjustments, the large for-profit chains had significantly lower RN and LPN ratios than the largest nonprofit chain, but a significantly higher PCT-to-patient ratio. The overall composite staffing levels were also lower in for-profit and chain-affiliated facilities. The patterns hold when the hospital-based units were excluded.

Limitations—Nursing hours were not available.

Conclusions—The significant variation in patient-care staffing levels and its associations with facility characteristics warrants inclusion in future large-scale hemodialysis outcomes studies. ESRD networks and hemodialysis facilities should attend to quality assurance and performance improvement initiatives that maximize licensed nurse-staffing levels in hemodialysis facilities.

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Keywords

USRDS; in-center hemodialysis; CMS ESRD Facility survey; staffing ratios; profit; region

Introduction

Across the United States, approximately 400,000 patients with end-stage renal disease (ESRD) undergo maintenance hemodialysis each year.¹ Medicare provides payment for services, while a health-care team organizes and delivers the hemodialysis treatment. The universal payment from Medicare does not vary by dialysis facility size, capacity, region, chain-affiliation, or profit-status.² Within each facility, Registered Nurses (RN), Licensed Practical Nurses (LPN), and unlicensed patient care technicians (PCT) provide the direct care during hemodialysis. The nurses' and technicians' responsibilities include monitoring of the arteriovenous fistula or access device, physical assessment, safe medication administration, psychosocial and physical problem management, patient education, and care planning and coordination.

Despite equal payment, equal outcomes have not yet been realized. Prior studies have reported differences in quality of care and outcomes such as mortality,³ infection rate,⁴ epoetin dosing,⁵ adequacy of dialysis dose,⁶ and hospitalization.⁷ Studies examining variation in outcomes have included patient-level risk factors and facility characteristics including chain-affiliation and profit-status.^{3,7,8} Very few have considered nurse-staffing mix indicators, social worker, or dietitian measures, despite the fact that these are key professionals providing direct care.

In 2011, a special article by Wolfe⁹ gave a detailed review of issues in dialysis facility staffing and quality of care. He pointed to the need for further investigation of dialysis facility staffing practices. Since the direct care provided to patients in any setting is linked to the degree of expertise and scope of practice of those providing care, and hospitals with higher proportions of RNs experience better patient outcomes,¹⁰ the regional and organizational variation of nurse-staffing-mix in hemodialysis facilities warrants further investigation. If there is significant variation in nurse-staffing mix in relation to facility characteristics, this heterogeneity must be considered in the identification of relevant solutions for outcome disparities. Therefore, the first objective of this study was to examine the variation in nurse staffing levels across U.S. hemodialysis facilities and its associations with facility characteristics and geographic region. Our secondary objective was to examine whether similar variation and associations exist in dietitian and social worker staffing levels.

Methods

Data sources and study sample

We used data from the 2009 CMS ESRD Facility Survey (CMS-2744) in the United States Renal Data System (USRDS),¹¹ which is required annually for all Medicare-certified dialysis facilities. The survey collects facility-level data, including profit status and chain affiliation, services provided, number of patients receiving care, and patient-care staffing. We identified all outpatient dialysis facilities and centers that completed the 2009 Survey form, were located in any of 50 states or the District of Columbia, that provided in-center hemodialysis, and that did not offer transplant services (n = 5068). Units were excluded if they provided only a home-dialysis program or reported zero patients at year-end (n = 78). Additionally, units were excluded if they reported zero on both RNs and LPNs (n = 27), if profit status was not concordant with chain profit status (n = 55), or if no profit status was

indicated (n = 108). The final study sample consisted of the remaining 4,800 hemodialysis (HD) facilities. The Institutional Review Board at University of Virginia approved the study.

Staffing level measures

We examined six different staff-to-patient ratios. The first three were the ratios of full-time RNs, full-time LPNs, and full-time PCTs to total in-center hemodialysis patients (i.e., excluding home dialysis patients). The next two were the ratios of full-time Social Workers and full-time Dietitians to in-center hemodialysis patients. For any part time staff, we converted two part-time staff to one full-time-equivalent (FTE). Finally, we calculated a composite staffing ratio (FTE RNs + LPNs + PCTs to patients) to assess overall staff-to-patient ratios. To depict variation in staffing mix, we calculated three proportions of total full-time nursing staff (defined as all RNs, LPNs, and PCTs) that were RNs, LPNs, and PCTs. All patient and staffing numbers were based on end-of-year data.

Facility organizational measures and geographic region

We examined the following facility organizational characteristics: profit status (for-profit/nonprofit); hospital-based or freestanding; chain ownership; facility capacity, defined as number of in-center hemodialysis patients per station (≤ 4 or >4); facility size determined by number of hemodialysis stations: small (1–10 stations), medium (11–25 stations), and large (26 or more stations); and functional type, defined by whether or not the facility offered home dialysis services in addition to in-center hemodialysis. For chain ownership, according to the 2009 survey, the majority of chain-affiliated facilities were associated with Dialysis Clinic, Inc. (DCI), DaVita, Fresenius, and Renal Advantage Inc. (RAI). We combined the remaining eight chains into an 'other chains' group. DCI was the only nonprofit chain and chosen as the referent category in all regression analyses. The facilities not affiliated with a chain were further categorized into freestanding and hospital-based because all hospital-based facilities reported no chain affiliation.

Facility urban/rural location was defined according to facility location zipcode using Rural-Urban Commuting Area (RUCA) Codes developed by the USDA Economic Research Service and University of Washington.^{12,13} Finally, we used facility location zipcode to assign each facility to one of the four standard U.S. census regions (Northeast, Midwest, South, and West).

Statistical analyses

Poisson regression was used to examine the relationship between facility characteristics and geographic region with each of the staff-to-patient ratio measures. Facility and geographic characteristics of interest include profit status, freestanding/hospital-based status, chain ownership, and geographic region. For each staff-to-patient ratio, three sets of multivariate models were constructed. The first set of multivariate models (Model 1) examined the effect of each predictor (profit status, freestanding status, geographic region, chain ownership) adjusted for the background variables (facility size, urban/rural location, functional type, and capacity). Since profit and freestanding variables were highly correlated with chain ownership, the second model (Model 2) included all the predictors except chain ownership, together with background variables. Thus, this additionally-adjusted model examined the effect of each predictor (profit, freestanding, region) while adjusting for all others in the model, but not chain ownership. In Model 3, profit and freestanding variables were replaced with chain ownership. That is, the effect of chain ownership was adjusted for all others but not profit and freestanding variables. We used overdispersed Poisson regression models with confidence intervals and p-values adjusted for overdispersion. All Poisson models used the number of facility staff members under investigation as the response and the natural logarithm of number of facility in-center hemodialysis patients as an offset.¹⁴ The results are

presented as rate ratios (RRs) in comparison with the reference group. All models were performed using SAS GENMOD procedures (SAS Institute Inc., Cary, NC).

We conducted several sensitivity analyses to examine the robustness of our main results. The first was to limit the study sample to facilities that provided only in-center hemodialysis (62%) (i.e., excluded facilities with a home program), followed by separate analyses for facilities with small, medium and large sizes (13%, 74%, and 13%, respectively). Then, we conducted the analysis using the study sample that included facilities with profit status corrected according to its chain affiliation ($n = 4,855$), and using the study sample that included those facilities that had not reported profit status ($n = 4,908$). Finally, we analyzed only freestanding facilities ($n = 4,402$) because hospital-based facilities were heavily skewed to nonprofit.

Results

Facility characteristics

Of the 4,800 facilities, the majority were mid-sized (74%), offered only in-center hemodialysis (62.3%), urban (73.7%), for-profit (84.2%), and freestanding (91.7%) (Table 1). Large facilities were more likely to have a home dialysis program, have 4 or more patients per station, and be in an urban setting. Most mid-sized and large facilities were located in the South, whereas most small facilities were in the Midwest. Characteristics of the facilities stratified by median RN-to-patient ratio (≤ 6 or >6 RNs per 100 patients) are also depicted in Table 1. The majority of facilities were chain-affiliated (76.9%) (Table 2). Fresenius was the largest for-profit chain (33.2%), followed by DaVita (29.0%). Compared to other regions, the largest percentage of for-profit facilities was located in the South (48.7%), and the largest percentage of non-profit facilities was in the Midwest (33.1%). All hospital-based facilities reported no chain affiliation and were skewed to nonprofit status. The distributions of nonchain hospital-based and freestanding facilities also differed somewhat in size, urbanicity, and region (Table 2).

Staffing level characteristics

Across the 4,800 facilities, there were a total of 20,709 FTE RNs at the end of survey year 2009, with an average of 4.31 per facility (range: 0–40.5); 4,220 FTE LPNs, average 0.88 per facility (range: 0–31.0); 30,290 FTE PCTs, average 6.31 per facility (range: 0–44.5); 3,893 FTE dietitians, average 0.81 (range: 0–10.5); and 4,026 FTE social workers, average 0.84 (range: 0–11.0). Figure 1 represents the mean proportions of different types of nursing staff across facilities according to profit and freestanding status and chain ownership.

Figure 2 presents the distributions of RN-, LPN-, PCT-, and the composite staff-to-patient ratios across 4800 facilities, revealing that facilities differed greatly in various staffing ratios. Means and medians for these staffing ratios as well as those of dietitians and social workers are presented in Table 3. Staff-to-patient ratios were generally higher in small facilities than those in large facilities. Nonprofit and hospital-based facilities had higher licensed staff-to-patient ratios, and lower PCT-to-patient ratios than for-profit and freestanding facilities. DCI facilities had higher numbers of RNs and LPNs, but lower PCTs compared to other chain-affiliated facilities.

Across the four geographic regions, the average RN-to-patient ratio was highest in the Northeast and Midwest, intermediate in the West, and lowest in South (10.35, 10.11, 8.06, and 7.29 average RNs per 100 patients, respectively). By contrast, the average PCT-to-patient ratio was lowest in the Northeast (8.76 PCTs per 100 patients) and highest in the West (10.37). The average LPN-to-patient ratio in the South (1.9 LPNs per 100 patients) was notably more than 3 times higher than that in the West (0.62). Interestingly, the

composite staff-to-patient ratio showed less variation by region. Facilities in the Midwest had the highest ratio for both dietitians and social workers compared to other regions.

The adjusted associations between facility characteristics and staffing levels

Table 4 presents the adjusted associations for RN, LPN, PCT, and composite staff, and Table 5 for dietitians and social workers. After controlling for facility size, urban/rural location, functional-type (in-center only or in-center plus home dialysis), and capacity, both the number of RNs and LPNs (per 100 patients) were substantially lower in for-profit facilities compared to nonprofit facilities (RR, 0.65, 95% CI, 0.63–0.68, $p<0.001$; RR, 0.58, 95% CI, 0.51–0.65, $p<0.001$). In contrast, the number of PCTs was significantly higher in for-profit facilities than in non-profit facilities (RR, 1.16, 95% CI, 1.12–1.19, $p<0.001$). The numbers of dietitians and social workers in for-profit facilities was 8% and 7% lower, respectively, than nonprofit facilities ($p=0.001$) (Table 5). After additional adjustments for the facilities' freestanding status and region (Model 2), the profit-status associations were attenuated but remained significant for each of the individual staffing indicators (Table 4), except the dietitians and social workers (Table 5). Although variation in the composite staffing ratio was less dramatic, profit status remained a significant predictor of overall lower nurse-staffing ratios ($p<0.001$). When hospital-based facilities were removed from the analysis (Supplemental Table S1), the effects of profit-status were virtually identical to the original Model 2 results (Table 4 and Table 5).

After controlling for background facility characteristics, the number of RNs and LPNs in freestanding facilities was 45% ($p<0.001$) and 53% ($p<0.001$) lower, and the number of PCTs was 26% ($p<0.001$) higher than those in hospital-based facilities (Table 4). Dietitian numbers were 10% ($p=0.001$) lower, and social worker numbers were 12% ($p<0.001$) lower. All the patterns except for dietitians remained statistically significant after additional adjustment for profit-status and geographic region. The composite staff-to-patient ratio was 16% ($p<0.001$) lower in freestanding facilities after controlling for background variables as well as profit-status and region.

Compared to the Northeast, after adjusting for background characteristics, the number of RNs was 14% lower in the Midwest, 25% lower in the South, and 18% lower in the West (all $p<0.001$) (Table 4). The number of LPNs was 23% ($p=0.002$) lower in the Midwest and 47% ($p=0.001$) lower in the West, but 17% higher ($p=0.02$) in the South. By contrast, PCT-to-patient ratios in these three regions were all significantly higher than in the Northeast ($p<0.001$). The composite staffing ratio differed significantly only in the South (5% lower, $p<0.001$), and was no longer significant after additional adjustment for profit and freestanding status. Compared to the Northeast, after adjusting for background characteristics, only those in the Midwest had higher ratios of dietitians (6%, $p=0.06$) and social workers (8%, $p=0.007$) (Table 5). In the sensitivity analysis where all facilities offering home programs were excluded (Supplemental Table S2), the Northeast had even higher RN ratios.

All of the three large for-profit chains (DaVita, Fresenius, RAI), as well as the small chains had a significantly lower number of RNs and LPNs than DCI, the largest nonprofit, national chain, but significantly higher number of PCTs after adjustment for background variables (Table 4). Numbers of dietitians and social workers in all other chain categories, compared to DCI, were not significantly different. Finally, we found that even after additional adjustment for region (Model 3), the composite staff-to-patient ratio was between 7–11% lower ($p<0.02$) in the chain-affiliated facilities, and 17% higher ($p<0.001$) in the nonchain hospital-based facilities, compared to DCI.

The results of the sensitivity analyses were similar to these main results. The analyses excluding hospital-based facilities (Table S1) and facilities with home dialysis programs (Table S2) are reported in the Supplemental Materials. Notably, even after removing hospital-based facilities entirely from the regression analyses, the results remained virtually identical to the main results in the additionally-adjusted models (Models 2 and 3) (compare Tables 4 and 5 with Supplemental Table S1).

Discussion

Our findings demonstrate that dialysis facilities for in-center hemodialysis differed substantially in RN, LPN, and PCT staffing levels. The differences were strongly associated with facility characteristics (profit-status, freestanding status, chain affiliation) and geographic region, after controlling for background variables such as facility size, functional type, number of patients per station, and urbanicity. There was less variation in dietitians and social workers across the U.S. facilities. More specifically, there were higher levels of RNs and LPNs in nonprofit and DCI facilities, while PCTs were lower in these facilities. Total nurses were also higher in nonprofit and DCI facilities. The lower number of RNs and LPNs and higher number of PCTs in for-profit facilities is not a completely unexpected finding since the cost of employing a licensed nurse is higher than employing an unlicensed patient care technician. However, the large magnitude of the differences was quite surprising. It should be noted that the higher number of PCTs in for-profit facilities did not offset the lower number of RNs and LPNs as indicated by the overall lower composite nurse-to-patient ratios in these facilities.

With fixed reimbursement, all dialysis facilities face the challenge of balancing outcomes and costs. The practice of replacing licensed nurses with unlicensed assistive personnel doesn't necessarily improve cost efficiency in the organization.¹⁵ Furthermore, replacing licensed nurses with patient care technicians may jeopardize long-term patient outcomes.⁹ Even when the unlicensed technicians are functioning under the direct supervision of a licensed nurse, having fewer licensed nurses per patient increases the demands on the licensed nurse.¹⁶

After controlling for all background facility characteristics plus geographic region, some of the chains differed by up to 26% on the number of RNs with higher levels in DCI facilities (Table 4). Differences between the chains' staffing levels could be attributable to pressure to sign non-compete clauses and difficulty in recruiting licensed nurses.¹⁷ Moreover, it is likely that professional nurses will not want to work in settings with limited support for continuing education, professional advancement, or the time to practice the full scope of their skills.¹⁸ As expected, higher numbers of RNs and LPNs were observed in hospital-based facilities. This could be attributed to the portion of these facilities that might regularly enhance their licensed staff levels to provide care for acutely ill (i.e. hospitalized) patients under a dialysis center certification.

Regionally, the number of RNs was substantially lower in the three regions other than the Northeast, while the South had substantially higher numbers of LPNs (Table 4). There were fewer regional differences in overall composite-staffing levels. Regional differences in staffing mix could be due to the hiring availability of licensed personnel with adequate previous experience,¹⁹ or the availability of training programs to become a licensed nurse within a given region. Although area population contributes to the number of available nurse-training programs, it's notable that a Southern state like Mississippi has approximately 21 available RN training programs, whereas Ohio has approximately 90 programs.²⁰ In essence, the regional differences could be driven by the supply of Registered Nurses or variations in state nurse practice regulations; however, most states do not specify any

regulations for nurse-staffing mix in hemodialysis facilities, and of the five that do (MA, CT, NJ, TX, GA), none of the designated ratios differentiate between RNs and LPNs.⁹

Some policy implications may be drawn from these findings. The 2008 CMS hemodialysis facility regulations list requirements for nurse staffing and qualifications of the nurses and patient care technicians.²¹ They do not discuss nurse to patient ratios and overall staffing mix. Zhang et al.³ recently reported significantly higher mortality rates in for-profit facilities after controlling for numerous patient and facility characteristics. Our study identified strong associations between for-profit status and lower RNs and LPNs per patient. Although we cannot conclude that increased mortality is a direct effect of RN and LPN staffing mix, it is possible that patient-care staffing mix in for-profit facilities influences mortality rates. Lee et al.⁷ found significant differences in the number of days patients were hospitalized depending on facility profit status, but did not include staffing measures. Mandated nurse-to-patient ratios is a controversial issue across the nation.²² Hospitals, however, are beginning to act on the findings of the 2007 AHRQ report which describes the positive effects on patient outcomes related to increased numbers of RNs at the bedside. Regional ESRD networks might assess the barriers to employing more RNs. Supporting specific recommendations for facilities' quality assurance and performance improvement initiatives concerning nurse-friendly work environments could be another approach to attracting licensed nurses to hemodialysis nursing. Finally, for-profit chains and freestanding facilities should examine the ways in which employing more RNs could actually improve their facilities' attractiveness to patients and nurses, the efficiency with which care is planned and delivered, and their patients' outcomes.

Several limitations of our study need to be considered. First, we were unable to account for actual nursing hours per patient, a common measure used to evaluate nursing effects. This information cannot be ascertained from the facility survey. Second, our study cohort did not exclude hospital-based units because our purpose was to provide a more complete assessment of US dialysis facilities. Although the adjusted findings in Models 2 and 3 should remove the confounding from inclusion of hospital-based units, there may still be some residual confounding not accounted for by the models. To further assess this, we performed sensitivity analysis that excluded hospital-based units. We found that the results were indeed similar to the main results. Third, the data are subject to reporting error because of the survey techniques. To overcome this limitation, we did sensitivity analyses and determined that any identifiable reporting error had no significant effects on the results. Finally, we are aware that our use of two part-time staff as equivalent to one full-time person has limitations. This was, however, the most accurate way we could identify the number of nurses per patient using the available data.

Hemodialysis outcomes of interest include mortality,^{23–26} transplant,²⁷ quality of life,²⁸ hospitalization rates,^{29,30} and adequate dialysis.³¹ Arteriovenous fistula use,³² pre-ESRD nephrologist care,³³ regional intensity of care,⁸ ESRD network,³⁴ chain status³ and for-profit status⁷ of dialysis facilities have explained some of the variation in these outcomes, even after accounting for patient case mix. Fortunately, physician prescribing practices, quality improvement efforts, advances in technology, and updated quality measures³⁵ are helping to enhance hemodialysis services. Unfortunately, the contribution of licensed and unlicensed nursing staff in these processes remains under-investigated. To our knowledge, the present study is the first to systematically examine the variation in patient-care staffing levels across U.S. hemodialysis facilities by facility characteristics and geographic region. We found RN, LPN, and PCT staffing levels differed substantially across U.S. dialysis facilities. There are intangible elements of care that occur in the nurse-patient relationship that have been shown to improve outcomes.¹⁰ Future studies that examine dialysis patient outcomes should include processes of dialysis care, quality of life, medical conditions and

socioeconomic influences, and also facility staffing ratios to better understand the unique interactions of these elements. This will provide the requisite foundation for better understanding optimal staffing ratios and the impact of different health care providers in various dialysis facility settings. CMS, ESRD networks, and hemodialysis facilities should attend to the policies, regulations, and performance improvement initiatives that support advancing the role of and exploring the relationship between dietitians, social workers and licensed nurses in structurally different hemodialysis facilities.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Figure 1. Mean proportions of total full-time nursing staff that are registered nurses (RN), licensed practical nurses (LPN), and unlicensed patient care technicians (PCT) across facilities according to profit status, freestanding status, and chain ownership

DCI, Dialysis Clinic, Inc.; RAI, Renal Advantage Inc.; F, Freestanding; H, Hospital-based.

Figure 2. Histograms of nurse-staffing ratios across hemodialysis facilities

Facilities with staffing ratios above the largest depicted category were included in the largest category. RN, registered nurse; LPN, licensed practical nurse; PCT, patient care technician.

Table 1

Distribution of dialysis facilities, overall and by size and median RN-to-patient ratio

Characteristics	Overall	Size (number of hemodialysis stations)			RN-to-patient ratio (n per 100 patients)	
		10	11 to 25	26	6	>6
Number of facilities, n	4800	623 (13%)	3552 (74%)	625 (13%)	2336 (49%)	2464 (51%)
Functional type (%)						
In-center HD only	62.3	82.3	62.5	41.1	67.5	57.4
In-center HD and home dialysis	37.7	17.7	37.5	58.9	32.5	42.6
Capacity (patients/station) (%)						
4	63.5	72.1	63.4	55.5	55.4	71.1
>4	36.5	27.9	36.6	44.5	44.6	28.9
Geographic location (%)						
Urban	73.7	44.0	76.0	90.1	81.0	66.8
Rural	26.3	56.0	24.0	9.9	19.0	33.2
Profit status (%)						
For-profit	84.2	64.8	87.9	82.7	93.7	75.3
Nonprofit	15.8	35.2	12.1	17.3	6.3	24.7
Freestanding/hospital-based status (%)						
Freestanding	91.7	73.7	94.5	93.9	98.1	85.6
Hospital-based	8.3	26.3	5.5	6.1	1.9	14.4
Census region (%)						
Northeast	14.2	14.0	14.2	14.4	9.5	18.7
Midwest	23.6	41.4	21.7	17.0	19.1	27.9
South	44.7	29.2	46.3	51.0	51.6	38.2
West	17.5	15.4	17.8	17.6	19.8	15.2

Abbreviation: RN, registered nurse.

Table 2

Distribution of dialysis facilities by profit status and chain ownership

Characteristics	Profit status		Chain ownership						
	Nonprofit N=756 (15.8%)	For-profit N=4044 (84.2%)	DCI N=179 (3.7%)	DaVita N=1392 (29.0%)	Fresenius N=1595 (33.2%)	RAI N=118(2.5%)	Other chains N=406 (8.5%)	Nonchain freestanding N=712 (14.8%)	Nonchain hospital-based N=398 (8.3%)
			Nonprofit		For-profit		NP: FP, 7.4%: 92.6%		NP: FP, 23.0%:77.0%
Size (number of hemodialysis stations) (%)									
10	29.0	10.0	12.8	10.7	7.6	1.7	9.9	17.3	41.2
11 to 25	56.7	77.2	69.8	77.7	77.6	79.7	79.3	69.6	49.2
26	14.3	12.8	17.3	11.6	14.8	18.6	10.8	13.1	9.6
Functional type (%)									
In-center HD	65.5	61.7	65.4	59.0	65.8	50.8	59.4	61.2	66.6
In-center HD and home dialysis	34.5	38.3	34.6	41.0	34.2	49.2	40.6	38.8	33.4
Capacity (patients/station) (%)									
4	62.4	63.7	82.7	58.4	69.6	61.9	59.1	61.7	56.3
>4	37.6	36.3	17.3	41.6	30.4	38.1	40.9	38.3	43.7
Urban (%)	62.3	75.8	67.6	78.6	70.8	83.9	81.8	76.7	54.3
Freestanding/hospital-based status (%)									
Freestanding	49.3	99.6	100.0	100.0	100.0	100.0	100.0	100.0	
Hospital-based	50.7	0.4							100.0
Census region (%)									
Northeast	24.3	12.3	24.0	9.9	11.1	---	19.7	16.9	31.2
Midwest	33.1	21.9	16.2	22.3	22.8	18.6	17.0	23.9	42.7
South	23.1	48.7	45.3	47.2	53.3	49.2	38.2	40.4	14.3
West	19.4	17.1	14.5	20.6	12.8	32.2	25.1	18.8	11.8

Abbreviation: DCI, Dialysis Clinic, Inc.; RAI, Renal Advantage Inc.; NP, nonprofit; FP, for-profit

Table 3

Staffing levels by facility characteristics

Characteristics	n per 100 patients											
	RN-to-patient		LPN-to-patient		PCT-to-patient		Composite staff-to-patient		Dietitian-to-patient		Social worker-to-patient	
	Mean	Median	Mean	Median	Mean	Median	Mean	Median	Mean	Median	Mean	Median
Overall	8.52	6.12	1.45	0.00	9.66	9.38	19.63	16.67	1.78	1.20	1.81	1.22
Size (number of hemodialysis stations)												
10	20.57	9.09	2.11	0.00	10.51	8.70	33.20	20.00	4.26	2.27	4.25	2.27
11 to 25	6.89	5.95	1.35	0.00	9.54	9.38	17.79	16.67	1.47	1.18	1.51	1.20
26	5.80	5.38	1.37	0.84	9.44	9.62	16.61	16.23	1.01	0.97	1.08	1.01
Functional type												
In-center HD	8.02	5.88	1.31	0.00	9.60	9.38	18.93	16.38	1.80	1.24	1.85	1.27
In-center HD and home dialysis	9.36	6.56	1.68	0.55	9.75	9.40	20.79	17.34	1.73	1.15	1.75	1.18
Capacity (patients/station)												
4	9.89	6.59	1.61	0.00	9.95	9.43	21.45	17.39	2.18	1.41	2.23	1.47
>4	6.15	5.48	1.17	0.56	9.15	9.23	16.47	15.91	1.07	0.98	1.10	1.01
Geographic location												
Urban	8.55	5.80	1.32	0.00	9.91	9.48	19.78	16.46	1.69	1.12	1.73	1.16
Rural	8.45	7.14	1.83	0.00	8.94	8.90	19.23	17.86	2.02	1.56	2.05	1.56
Profit status												
Nonprofit	15.67	9.09	2.28	0.68	8.43	8.15	26.39	19.76	2.32	1.33	2.44	1.42
For-profit	7.19	5.79	1.30	0.00	9.89	9.52	18.37	16.38	1.67	1.19	1.70	1.20
Freestanding/hospital-based status												
Freestanding	7.42	5.88	1.32	0.00	9.81	9.47	18.54	16.50	1.68	1.19	1.70	1.22
Hospital-based	20.77	11.11	2.91	0.94	8.00	7.00	31.68	21.74	2.87	1.56	3.05	1.61
Chain ownership												
DCI	10.11	7.55	2.17	1.60	8.23	8.53	20.51	18.50	1.58	1.22	1.70	1.33
DaVita	6.56	5.41	1.47	0.75	9.40	9.02	17.44	15.86	1.77	1.22	1.78	1.22
Fresenius	6.80	5.77	0.66	0.00	10.09	10.00	17.56	16.36	1.49	1.14	1.56	1.18
RAI	5.61	5.20	1.53	1.11	9.40	9.23	16.55	16.27	1.38	1.16	1.39	1.12

Characteristics	n per 100 patients											
	RN-to-patient		LPN-to-patient		PCT-to-patient		Composite staff-to-patient		Dietitian-to-patient		Social worker-to-patient	
	Mean	Median	Mean	Median	Mean	Median	Mean	Median	Mean	Median	Mean	Median
Other chains	8.03	6.19	1.29	0.61	9.46	9.38	18.78	16.67	1.60	1.15	1.59	1.18
Nonchain freestanding	9.75	6.63	2.26	0.58	10.61	9.52	22.62	17.95	2.03	1.26	1.98	1.30
Nonchain hospital-based	20.77	11.11	2.91	0.94	8.00	7.00	31.68	21.74	2.87	1.56	3.05	1.61
Census regions												
Northeast	10.35	6.98	1.39	0.00	8.76	8.57	20.51	16.93	1.52	1.09	1.62	1.13
Midwest	10.11	6.94	1.26	0.00	9.90	9.09	21.27	17.17	2.23	1.37	2.24	1.41
South	7.29	5.71	1.90	1.11	9.53	9.38	18.72	16.67	1.72	1.22	1.77	1.27
West	8.06	5.66	0.62	0.00	10.37	10.00	19.05	16.67	1.50	1.09	1.50	1.09

Abbreviation: DCI, Dialysis Clinic, Inc.; RAI, Renal Advantage Inc.; RN, registered nurse; LPN, licensed practical nurse; PCT, patient care technician

Table 4

The adjusted associations between facility characteristics and geographic region with nurse staffing levels

Characteristics	RN-to-patient ratio		LPN-to-patient ratio	
	Rate ratio (95% CI)		Rate ratio (95% CI)	
	Adjusted for background variables (Model 1) ^a	Adjusted for background variables and others (Model 2 or 3) ^b	Adjusted for background variables (Model 1) ^a	Adjusted for background variables and others (Model 2 or 3) ^b
For-profit vs. Nonprofit	0.65 (0.63–0.68)	0.82 (0.78–0.87)	0.58 (0.51–0.65)	0.68 (0.58–0.79)
Freestanding vs. Hospital-based	0.55 (0.52–0.58)	0.68 (0.64–0.73)	0.47 (0.41–0.54)	0.61 (0.50–0.74)
Census region (Northeast is the reference)				
Midwest	0.86 (0.81–0.91)	0.91 (0.86–0.96)	0.77 (0.65–0.91)	0.84 (0.71–0.99)
South	0.75 (0.71–0.79)	0.84 (0.80–0.88)	1.17 (1.02–1.34)	1.43 (1.24–1.65)
West	0.82 (0.78–0.87)	0.90 (0.85–0.95)	0.53 (0.44–0.63)	0.62 (0.52–0.74)
Chain ownership (DCI is the reference)				
DaVita	0.72 (0.67–0.79)	0.74 (0.68–0.81)	0.67 (0.55–0.83)	0.66 (0.54–0.81)
Fresenius	0.78 (0.71–0.85)	0.79 (0.73–0.86)	0.30 (0.24–0.37)	0.28 (0.23–0.35)
RAI	0.71 (0.62–0.80)	0.72 (0.63–0.83)	0.69 (0.49–0.96)	0.73 (0.54–1.00)
Other chains	0.79 (0.72–0.87)	0.80 (0.72–0.88)	0.64 (0.50–0.82)	0.65 (0.51–0.82)
Nonchain freestanding	0.90 (0.82–0.98)	0.90 (0.82–0.98)	0.81 (0.65–1.01)	0.82 (0.67–1.02)
Nonchain hospital-based	1.43 (1.31–1.57)	1.40 (1.27–1.53)	1.23 (0.97–1.55)	1.31 (1.05–1.63)

Characteristics	PCT-to-patient ratio		Composite staff-to-patient ratio	
	Rate ratio (95% CI)		Rate ratio (95% CI)	
	Adjusted for background variables (Model 1) ^a	Adjusted for background variables and others (Model 2 or 3) ^b	Adjusted for background variables (Model 1) ^a	Adjusted for background variables and others (Model 2 or 3) ^b
For-profit vs. Nonprofit	1.16 (1.12–1.19)	1.08 (1.03–1.12)	0.86 (0.84–0.88)	0.94 (0.90–0.97)
Freestanding vs. Hospital-based	1.26 (1.20–1.32)	1.15 (1.09–1.22)	0.79 (0.76–0.82)	0.84 (0.80–0.88)
Census region (Northeast is the reference)				
Midwest	1.09 (1.05–1.13)	1.08 (1.04–1.12)	0.97 (0.94–1.00)	0.99 (0.96–1.02)
South	1.10 (1.06–1.13)	1.06 (1.03–1.10)	0.95 (0.92–0.98)	0.99 (0.96–1.02)
West	1.19 (1.15–1.23)	1.16 (1.12–1.20)	0.98 (0.95–1.01)	1.01 (0.98–1.05)
Chain ownership (DCI is the reference)				
DaVita	1.11 (1.04–1.18)	1.09 (1.02–1.16)	0.89 (0.84–0.94)	0.89 (0.84–0.94)
Fresenius	1.22 (1.15–1.31)	1.22 (1.14–1.30)	0.92 (0.87–0.97)	0.92 (0.87–0.97)
RAI	1.12 (1.02–1.23)	1.07 (0.98–1.17)	0.89 (0.82–0.96)	0.88 (0.81–0.96)
Other chains	1.14 (1.06–1.23)	1.13 (1.05–1.21)	0.93 (0.87–0.99)	0.93 (0.87–0.99)
Nonchain freestanding	1.16 (1.08–1.24)	1.15 (1.08–1.24)	1.00 (0.94–1.06)	1.00 (0.94–1.06)
Nonchain hospital-based	0.92 (0.85–0.99)	0.93 (0.86–1.01)	1.17 (1.10–1.25)	1.17 (1.10–1.25)

Abbreviation: DCI, Dialysis Clinic, Inc.; RAI, Renal Advantage Inc.; RN, registered nurse; LPN, licensed practical nurse; PCT, patient care technician

^aEach individual predictor is adjusted for the background variables (facility size, urban/rural location, functional type, and capacity) (Model 1).

^bResults for profit, freestanding, and region are from Model 2 that included these three predictors and the background variables, and results for chain ownership are from Model 3 that included chain ownership, region, and the background variables.

Table 5

The adjusted associations between facility characteristics and geographic region with dietitian and social worker staffing levels

Characteristics	Dietitian-to-patient ratio		Social worker-to-patient ratio	
	Rate ratio (95% CI)		Rate ratio (95% CI)	
	Adjusted for background variables (Model 1) ^a	Adjusted for background variables and others (Model 2 or 3) ^b	Adjusted for background variables (Model 1) ^a	Adjusted for background variables and others (Model 2 or 3) ^b
For-profit vs. Nonprofit	0.92 (0.88–0.97)	0.94 (0.89–1.00)	0.93 (0.89–0.97)	0.97 (0.91–1.03)
Freestanding vs. Hospital-based	0.90 (0.84–0.95)	0.94 (0.87–1.02)	0.88 (0.83–0.93)	0.89 (0.83–0.97)
Census region (Northeast is the reference)				
Midwest	1.06 (1.00–1.12)	1.07 (1.01–1.13)	1.08 (1.02–1.14)	1.09 (1.03–1.15)
South	1.03 (0.97–1.08)	1.05 (0.99–1.10)	1.04 (0.98–1.09)	1.06 (1.01–1.12)
West	0.98 (0.93–1.04)	1.00 (0.94–1.06)	0.98 (0.93–1.04)	1.00 (0.95–1.06)
Chain ownership (DCI is the reference)				
DaVita	1.04 (0.94–1.15)	1.03 (0.94–1.14)	0.99 (0.90–1.08)	0.98 (0.89–1.07)
Fresenius	0.94 (0.85–1.04)	0.93 (0.84–1.02)	0.92 (0.84–1.01)	0.91 (0.83–1.00)
RAI	0.99 (0.86–1.14)	0.99 (0.86–1.14)	0.94 (0.82–1.07)	0.93 (0.81–1.07)
Other chains	1.03 (0.93–1.15)	1.03 (0.93–1.15)	0.95 (0.85–1.05)	0.95 (0.86–1.05)
Nonchain freestanding	1.08 (0.98–1.20)	1.07 (0.97–1.19)	1.03 (0.93–1.13)	1.02 (0.93–1.12)
Nonchain hospital-based	1.13 (1.01–1.26)	1.12 (1.01–1.26)	1.11 (1.00–1.23)	1.10 (0.99–1.22)

Abbreviation: DCI, Dialysis Clinic, Inc.; RAI, Renal Advantage Inc.; RN, registered nurse; LPN, licensed practical nurse; PCT, patient care technician

^aEach individual predictor is adjusted for the background variables (facility size, urban/rural location, functional type, and capacity) (Model 1).

^bResults for profit, freestanding, and region are from Model 2 that included these three predictors and the background variables, and results for chain ownership are from Model 3 that included chain ownership, region, and the background variables.