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Structural Equation Modeling to Explore Patient to Staff Ratios as an Explanatory Factor For Variation in Dialysis Facility Outcomes

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Abstract

Objective—Patient to staff ratios vary based on facility characteristics, and therefore have been proposed as an explanatory factor for the variation in dialysis facility outcomes. This analysis tested that hypothesis.

Design—Observational study using Dialysis Facility Report data

Settings—Dialysis centers in the US with at least 30 adult patients and no pediatric patients.

Subjects—4035 facilities had complete data for the proposed variables.

Main outcomes—Reported staff numbers from the Annual Facility Survey were converted to full time equivalents (FTE). Subsequently, ratios were created for patients per FTE registered dietitian (RD), social worker, nurse, and patient care technician. Bivariate associations and structural equation modeling (SEM) were used to explore relationships between these ratios and patient outcomes: standardized mortality ratio (SMR) and standardized hospitalization rate (SHR), when also considering the impact of non-modifiable facility characteristics (region, chain, profit status). Our focus was on RD staffing; therefore we also included serum phosphorus and normalized protein catabolic ratio in the model, and also conducted a sub-analysis of the 198 facilities that exceeded the KDOQI maximum of 150 patients: FTE RD.

Results—The mean and standard deviation for patients per FTE staff were 90.0 ± 34.0 , 88.7 ± 32.8 , 17.1 ± 20.5 and 11.9 ± 7.0 for RDs, social workers, nurses, and technicians, respectively. Facility characteristics impacted staffing in bivariate analyses and SEM. The only significant paths from staffing ratio to outcomes were for patient: FTE social worker to SMR (standardized beta = -0.09 , 95% CI -0.13 , -0.04) and Patients: FTE RD to SHR Days (standardized beta = 0.04 , 95% CI 0.001 , 0.09). In the sub-analysis, there were no significant paths from staffing to outcomes.

Conclusions—This study did not provide evidence that patient per staff ratios explain variation in dialysis facility outcomes. While there are some important bivariate relationships, these disappear in more complex models. Future research should investigate the impacts of staffing ratios on individual patients, to overcome the possible ecological fallacy.

Introduction

Despite improvements, much progress remains to be made in dialysis patient outcomes. There is variation among facilities that is not explained by patient risk characteristics. Receiving care at a for-profit facility has been associated with a higher risk of death and 15% increased risk of hospitalization (when adjusting for comorbidities) among hemodialysis patients¹. Patients receiving care at non-profit facilities are more likely to have received pre-dialysis nephrology care, which is associated with a 12% lower risk of all-cause hospitalization¹. Patients at non-profit facilities are less likely to have a catheter after 90 days of dialysis, an important predictor of hospitalization and death¹.

Yoder et al² used the Annual Facility Survey data and demonstrated that non-profit facilities have a mean of 2.32 RDs per 100 patients compared to a mean of 1.67 in for-profit facilities, suggesting that facility characteristics predict staffing ratios. In multivariable modeling, Midwest census region and non-chain hospital based facility status remained significant predictors of RD staffing levels². Therefore, staffing levels have been a proposed reason for variations in outcomes based on facility profit status¹ but have not been specifically investigated as an explanatory variable.

While the Centers for Medicare and Medicaid Services (CMS) mandates the composition of the interdisciplinary team, and education/training requirements for allied health professionals, there is no federal mandate for what patient to staff ratios are appropriate³. The KDOQI Nutrition Guidelines suggest, based on expert opinion, that a ratio of not more than 100 patients per full time equivalent (FTE) RD is appropriate, and that 150 patients: FTE RD is the absolute maximum ratio⁴. However, these ratios are frequently exceeded^{2,5-7}. Staffing ratios have received recent interest as California seeks to mandate dialysis patient: staff ratios for nurses (8:1), patient technicians (3:1), social workers and RDs (both 75:1)⁸.

The purpose of this study was to establish the relationship between patient: RD ratio and standardized hospitalization rate (SHR) or standardized mortality ratio (SMR), normalized protein catabolic rate (nPCR), and serum phosphorus at individual dialysis facilities, with the hypothesis that lower patient: RD ratios would be related to better patient outcomes when adjusting for other staff ratios and facility characteristics.

Materials and Methods

Data from the Dialysis Facility Annual Reports for 2009–2012 were purchased from ProPublica, Inc; which obtained them from the Centers for Medicare and Medicaid Services through a Freedom of Information Act Request. Dialysis Facility Annual Reports aggregate data from a variety of sources, including the Annual Facility Survey (AFS) (CMS form 2744), the CMS Fistula First Initiative, monthly clinical values reporting by facilities, and the CMS Medical Evidence form 2728 (completed on all new dialysis patients)⁹. AFS data,

from which we drew the staffing data and the number of patients per facility, are self-reported by the dialysis facilities as point estimates on December 31 each year⁹. Serum albumin and phosphorus are annual averages, drawn from the data that dialysis facilities report monthly to CMS via CROWNweb (Consolidated Renal Operations in a Web-enabled Network)⁹. SMR and SHR are calculated by the Kidney Disease Epidemiology and Cost Center, with patients assigned to a facility based on form 2728 and claims payment data, and hospitalizations and death determined via payment data and death notifications, respectively⁹. Patient characteristics of age, race, ethnicity, sex, co-morbidities on dialysis initiation, BMI, and nursing home status are included as confounders in the calculation of SMR and SHR⁹⁻¹¹. Facility characteristics including location and affiliation are self-reported to CROWNweb⁹.

5891 facilities were in the dataset as received. The most recent staffing and patient data were from December 31, 2012. Therefore, for all point estimates we used December 31, 2012 data. For averages (serum albumin, phosphorus, and SMR/SHR), we used data from 2013, under the assumption that staffing at year end was reflective of what would be carried forward into the next year, rather than what had occurred in the previous year, and in order to make use of the most recent data. We included the 4576 facilities that reported at least 30 adult patients and no pediatric patients during the selected time period.

Employees are reported on the AFS as either part time (less than 32 hours per week) or full time (greater than or equal to 32 hours per week). Using the assumption that 2 part-time employees reported on the AFS was equivalent to 1 full time employee reported², we calculated the number of full time equivalent (FTE) RDs, social workers, nurses, and patient care technicians. Then, we calculated the ratio of patients per calculated FTE staff member for each professional type. We created variables for chain affiliation (DaVita, Fresenius, and other/non-affiliated--reference) and converted renal network into census region (Northeast—reference, Midwest, South, or West). Facilities were further categorized as to whether or not they were for profit.

We determined the mean, standard deviation, skewness, kurtosis and median of continuous variables. We determined the percentage of facilities within each group for categorical variables. We conducted bivariate statistics (correlations, chi-square test, t-tests, or ANOVA) as appropriate for all of the candidate variables. We considered a Pearson's correlation >0.1 to be clinically important. For t-tests and ANOVA, we used Levene's test for homogeneity of variance. If this was significant, we used robust tests (Welsh's F). We used Bonferoni-corrected post hoc tests for the chi-square and ANOVA tests, unless variances were unequal in which case we used Tamhane's T2. Data manipulations and descriptive statistics were conducted in SPSS version 20.0 (IBM Inc, Armonok NY).

We developed an initial model for SMR that included variables based on logic, theory and prior empirical evidence and modified from there, documenting model fit indices for each step. We assessed the normality of each variable and tested for influential cases using Mahalanobis Distance. Model development and testing was conducted using AMOS version 24.0 (IBM Inc, Armonok NY).

We tested the initial model on the 4035 facilities that had complete data for all variables in the specified year so that we could calculate modification indices. We first added paths or covariances based on modification index >10 ; and then removed covariances, followed by paths, that were non-significant, unless their retention was indicated by logic, theory or prior evidence. Our goals for model fit were: non-significant chi-square, CFI and TLI >0.95 , RMSEA <0.05 . After establishing a model for SMR, we used this the base model for SHR admissions and days, because of the strong correlation among the outcomes in bivariate tests.

Because the KDOQI Nutrition Guideline states that no RD should be responsible for more than 150 patients⁴, we conducted the same analyses described above in the subset of facilities in which the patient: FTE RD ratio was more than 150. There were 198 facilities that met this criterion and had complete data for the variables of interest.

Results

Variables were normally distributed, with the exception of patient:FTE nurse and patient: FTE technician ratios, which had a skewness of 21.1 and 10.2, respectively and kurtosis of 565.5 and 190.6 (Table 1). Although we identified some potential outliers of >100 patients per FTE nurse or FTE technician, Mahalanobis Distance was acceptable so it was determined that those were not influential cases. There was much more variance in patient: FTE staff ratios than in the outcomes, which is logical given that the outcomes have been standardized. Descriptive statistics for continuous variables are in Table 1. 89.4 % of facilities were for profit, with an almost even distribution of DaVita, Fresenius, and other/unaffiliated facilities. The plurality of facilities (44.8%) were located in the South census region, with the next most frequent region being Midwest (21.7%).

Although we used the same formulas as Yoder et al², we calculated higher mean patient:FTE ratios for RDs and social workers (Table 2). Our calculated patient: FTE technician and nurse ratios were similar. Almost half of facilities (46.7%) had at least one part time RD (Table 2). A large majority of facilities had only one RD (83.3%) or only one social worker (83.5%), whether full or part time (Online Supplemental Material 1).

Correlation coefficients greater than 0.1 were observed between average nPCR and average serum phosphorus, and SMR and patient: FTE social worker ratio. There were strong correlations between patient: FTE RD Ratio and patient: FTE social worker ratio ($r=0.75$, $p<0.001$) and between SMR and the SHR measures (Table 3).

Means for all continuous variables were significantly different between profit and non-profit facilities based on independent t-tests, with the exception of patient: social worker ratio (Table 4). Patient:FTE RD ratio was higher in non-profit facilities (94.5 ± 37.7 vs. 89.4 ± 33.5 , $p<0.004$), while patient: FTE nurse ratio was lower in non-profit facilities (13.8 ± 9.8 vs. 17.5 ± 21.3 $p<0.001$). Outcomes were all better (values less than 1) in non-profit facilities (Table 4).

We achieved a stable model for SMR in 17 steps; beginning with the base model that included chain, and census region influencing staffing ratios, profit status influencing

staffing ratios and SMR, a covariance between nursing and technician ratios, all staffing ratios influencing SMR, and patient: FTE RD ratio also influencing SMR indirectly via average serum phosphorus and nPCR. The final model fit statistics were chi-square=26.1 ($p=0.01$), CFI=0.99, TLI=0.99, RMSEA=0.02. Some non-significant regression weights were maintained in the final model (Online Supplemental Material 2) based on logic, theory, and prior empirical evidence. The largest standardized regression weight was DaVita (chain) → average nPCR (standardized beta=0.48, 95% CI 0.44, 0.52). The largest covariance weight was between the error terms for patient:FTE RD ratio and patient:FTE social worker ratio (standardized beta=0.74, 95% CI 0.71, 0.76). The only significant path from staffing ratio to SMR was for patient:FTE social worker (standardized beta=-0.09, 95% CI -0.13, -0.04).

The final model for SMR was also the most stable model for SHR admissions and days. The model fit statistics were the same as those achieved for SMR. For both measures of SHR, the path from patients: FTE social worker to the outcome was no longer significant, in contrast to SMR. The path from Patients: FTE RD was small but significant in the model for SHR Days (standardized beta=0.04, 95% CI 0.001, 0.09).

Subset analysis of facilities with >150 patients:FTE RD

Ratios of patients: FTE RD and social worker varied significantly between facilities with >150 patients:RD compared to those with 150 patients:FTE RD (Table 4). The mean number of patients per FTE RD in the subset was 176.5 ± 24.7 compared to 85.5 ± 27.9 in the facilities with fewer than 150 patients:FTE RD ($p<0.001$). This was similar to patients: FTE social workers, although the ratio was slightly lower in the subset than that found for patients: FTE RDs (139.2 ± 43.8). There was a statistically but not clinically significant difference in BMI between facilities with and without >150 patients:FTE RD (Table 5). Other characteristics of facilities were not different, except for SMR which was lower in facilities with >150 patients:FTE RD (0.95 ± 0.30 vs 1.01 ± 0.35 , $p=0.01$) and average serum phosphorus which was higher in the subset (5.2 ± 0.3 vs 5.1 ± 0.3 , $p<0.001$). More facilities in the >150 patients:FTE RD group were FMC facilities (40.9%) and fewer were DaVita (22.2%) compared to the distribution in the general sample which was approximately 33% for each chain affiliation. Profit status also varied based on the subset.

Examining the bivariate correlations between proposed model variables showed different patterns in the subset of facilities with >150 patients:FTE RD. The correlation between patients: FTE social worker and patients: FTE RD was no longer important or significant (Table 6). However, there were important and significant relationships between Patient:FTE RD ratio and average serum phosphorus ($r=0.20$, $p=0.005$) and average nPCR ($r=-0.22$, $p=0.002$).

We started our SEM process on this subset with the same base model and achieved a stable final model (chi square=32.1, $df=29$, $p=0.32$, CFI=0.99, RMSEA 0.02) in 7 steps (Online Supplemental Material 3). Differences from the model with the entire sample include no correlations between any patient: FTE staff ratios and no direct paths from chain to outcome. Despite the significant bivariate correlations between patient:FTE RD ratio and nPCR and

serum phosphorus in the subset of facilities, these paths were nonsignificant in the model (standardized beta=-0.12, 95% CI=-0.30, 0.04 and standardized beta =0.06, 95% CI=-0.07, 0.20, respectively). The path from patient:RD ratio to SMR had a standardized beta of 0.12 (95% CI= -0.05, 0.32).

Discussion

Although our patient to staff ratios varied (likely due to inclusion/exclusion criteria), these results support previous research indicating that facility characteristics are important predictors of patient: FTE staff ratios. Yoder found that facilities in the Midwest had the fewest patients:FTE RD and social worker (even after adjustment)²; we found similar patterns in the Midwest, but also in the South. Region remained a statistically significant predictor of patient:FTE RD ratio in our structural equation model. Yoder also found that facility profit status did not impact RD and social worker ratios after adjustment for other predictors². In our structural equation model, profit status was almost significant for predicting patient:FTE RD ratio, but was not significant for social workers. However, profit status was a statistically significant predictor for both nurse and technician ratios. In Yoder's multivariable modeling, patient:FTE RD ratio had the fewest significant predictors², which was also true in our SEM, where only region was a statistically significant predictor of patient:FTE RD ratio, while other ratios were predicted by a combination of profit status, region, and chain affiliation.

In the full sample, we did not observe the expected relationship between patient: FTE staff ratios ratio and outcomes. The only relationship between staffing ratios and outcomes at the bivariate level was for social workers, but we continued to multivariate modeling to examine whether staffing explained differences seen in outcomes based on facility type. In the subset of facilities with >150 patients:FTE RD, we did find important bivariate relationships between patient: FTE RD ratios and nutrition outcomes, but these did not remain significant when adjusting for confounders via SEM.

The strong correlation between patient: RD and patient: social worker ratios in the full sample is logical, given that both RDs and social workers are generally scheduled to cover an entire facility. The relationship between RD and social worker ratios disappeared in the sample of facilities with >150 patients per RD. Yoder et al² found that there were fewer patients:FTE staff in smaller facilities, likely reflecting the fact that both a 10 hour per week and a 32 hour per week position would show up identically in the AFS data (as a PT position). We excluded very small facilities (<30 patients) to eliminate some of this bias. However, the non-specific nature of the reporting mechanism (full vs. part time) results in the ratio of patient to any FTE healthcare professional being underestimated by as much as 250% or overestimated by as much as 35%, with underestimation being much more frequent. This would have impacted RD and social worker patient ratio estimates most, given that there is generally only one RD and social worker per facility. In addition, our estimates of patient: staff ratios only account for in-center patients.

While there is interest in California for mandated staffing ratios, and eight other states have some regulations related to dialysis staffing^{12,13}, at the moment these ratios cannot be

considered to be evidence-based. There is a logical theoretical basis for the idea that increased staffing would improve patient care, but this analysis does not provide support for the hypothesis that variations in facility outcomes are explained by patient: staff ratios. States that wish to mandate staffing levels are left at the moment with expert consensus to guide these mandates. Outcomes should be tracked before and after staffing mandates are imposed as there is potential for unintended consequences¹⁴. Any staffing research or mandate should be careful to specify full time equivalents or other standardized measure of staffing.

Limitations

While the strengths of the Dialysis Facility report data are their availability for most dialysis providers in the US and longitudinal nature, their limitations are the focus on facility rather than individual inputs and outcomes, leading to a risk of the ecological fallacy. Data are self-reported by dialysis facilities, and are point estimates at year-end. Additionally, the data on facility staffing is inexact when converted to FTE, as described above, and does not capture other staff characteristics such as length of experience or training. Data reporting lags several years behind, limiting the rapid assessment of changes in ownership, staffing or outcomes. SMR and SHR are patient-oriented outcomes but they have a multitude of inputs, only some of which are related to dialysis treatment and/or the RD. Intermediate outcomes that change more quickly may be more valuable for measuring the impact of staffing ratios, but may not be important to patients. Future research should examine the impact of staffing on outcomes that both patients and providers agree are important including cardiovascular disease, dialysis adequacy, and fatigue, in addition to mortality¹⁵.

We were not able to identify short-staffing situations, either at the time of reporting or earlier in the year. Previous research has demonstrated that these situations have an impact on quality: covering short-staff situations with per diem nurses was identified as a more frequent practice at facilities that are high-performing for anemia management¹⁶. Finally, we were unable to quantify staff experience/turnover, which may be important.

Given these limitations, it will be important to examine the relationship between patient: staff ratios and outcomes using a study design that overcomes the ecological fallacy and focuses on individual rather than group outcomes. Future research should also describe qualitative elements of staffing, including the experience and other characteristics of staff, what responsibilities staff are being asked to take on, and whether these responsibilities are the best use of their time⁶.

Practical Application

There is still undeniable logic to the idea that lower patient: staff ratios would result in better patient outcomes. However, at this point neither facilities nor legislators have evidence to support any specific recommended staffing levels. Those who wish to mandate such levels are left with expert opinion as the best guide. Individual facilities or companies that make staffing changes should carefully track resulting outcomes to provide data on this important question. Individual staff members (RDs, nurses, social workers, or technicians) can also

contribute to this question by tracking their contribution to individual patient outcomes based on time spent and more qualitative inputs such as the characteristics of the interaction.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Descriptive statistics for continuous variables in a proposed model for the impact of patient: full time equivalent (FTE) staff ratios on dialysis facility outcomes.

Table 1

	Patient: FTE Social Worker Ratio	Patient: FTE Nurse Ratio	Patient: FTE RD Ratio	Patient: FTE Tech Ratio	Average normalized protein catabolic rate (nPCR)	Average serum phosphorus	Standardized Mortality Rate	Standardized Hospitalization Ratio: Admissions	Standardized Hospitalization Ratio: Days
Mean	88.7	17.1	90.0	11.9	0.9	5.1	1.01	1.01	0.98
Median	85.3	14.9	86.0	10.5	0.9	5.1	0.98	0.97	0.94
Std. Deviation	32.8	20.5	34.0	7.0	0.1	0.3	0.35	0.28	0.33
Skewness	0.9	21.1	0.9	10.2	-1.6	-0.1	0.85	0.95	0.91
Kurtosis	2.4	565.5	1.6	190.6	5.6	3.0	3.73	2.93	2.30

N for all variables=4035.

Comparison of dialysis patient: full time equivalent (FTE) staff ratios as estimated by Yoder using FY 2009 this study using FY 2012 of Annual Facility Survey Data.

Table 2

	As reported by Yoder 2009 data (FTE staff per 100 patients)		Yoder 2009 data converted to Patients: FTE		2012 data(Patients: FTE)		2012 data
	mean	median	mean	median	mean	median	Facilities with at least one part time staff in category
RN	8.5	6.1	11.7	16.3	17.1	14.9	43.5%
LPN	1.5	0	69.0	0			
PCT	9.6	9.4	10.4	10.7	11.9	10.5	37.7%
RD	1.8	1.2	56.2	83.3	90.0	86.0	46.7%
Social worker	1.8	1.2	55.3	82.0	88.7	85.3	44.2%

Table 3

Correlations among continuous variables in a proposed model for the impact of patient: full time equivalent (FTE) staff ratios on dialysis facility outcomes.

		Patient: FTE Nurse Ratio	Patient: FTE RD Ratio	Patient: FTE Tech Ratio	Average serum phosphorus	Average nPCR	SHR Days	SHR Admissions	SMR
Patient: FTE Social Worker Ratio	Pearson Correlation	.07	.75	-.01	-.02	.03	0	.03	-.11
	Sig. (2-tailed)	<.001	<.001	.69	.16	.11	1.0	.11	<.001
Patient: FTE Nurse Ratio	Pearson Correlation		.06	-.04	-.02	.03	-.02	.01	-.03
	Sig. (2-tailed)		<.001	.005	.21	.04	.26	.49	.1
Patient: FTE RD Ratio	Pearson Correlation			.02	.02	-.01	.02	.024	-.09
	Sig. (2-tailed)			.24	.26	.44	.32	.13	<.001
Patient: FTE Tech Ratio	Pearson Correlation				-.01	0	0	-.05	.01
	Sig. (2-tailed)				.45	.68	.82	.001	.60
Average serum phosphorus levels	Pearson Correlation					-.18	-.05	-.04	.02
	Sig. (2-tailed)					<.001	.003	.006	.27
Average nPCR	Pearson Correlation						-.06	-.04	-.06
	Sig. (2-tailed)						.001	.01	<.001
SHR Days	Pearson Correlation							.76	.34
	Sig. (2-tailed)							<.001	<.001
SHR Admissions	Pearson Correlation								.28
	Sig. (2-tailed)								<.001

N for all variables=4035. Bold indicates $r>0.1$ (clinically important).

** indicates $p<0.01$;

* indicates $p<0.05$.

Table 4

t-tests comparing continuous variables based on facility profit status

	Mean $\pm$ SD Not for profit (n=429)	Mean $\pm$ SD For profit (n=3606)	p-value
Patient: FTE Social Worker Ratio	90.6 $\pm$ 37.3	88.5 $\pm$ 32.2	0.20
Patient: FTE Nurse Ratio	13.8 $\pm$ 9.8	17.5 $\pm$ 21.3	<0.001
Patient: FTE RD Ratio	94.5 $\pm$ 37.7	89.4 $\pm$ 33.5	0.004
Patient: FTE Tech Ratio	14.0 $\pm$ 10.3	11.7 $\pm$ 6.5	<0.001^a
Average serum phosphorus	5.3 $\pm$ 0.33	5.1 $\pm$ 0.29	<0.001^a
Average nPCR	0.88 $\pm$ 0.22	0.91 $\pm$ 0.12	<0.001^a
SHR Days	0.88 $\pm$ 0.34	0.99 $\pm$ 0.33	<0.001
SHR admissions	0.93 $\pm$ 0.28	1.02 $\pm$ 0.28	<0.001
SMR	0.95 $\pm$ 0.32	1.01 $\pm$ 0.35	<0.001^a

^a indicates that Levene's test for equality of variances was significant, therefore the t-test result reported is for equal variances not assumed. If no superscript, Levene's test was non-significant and the p-value is for t-test assuming equal variances. Bold indicates statistical significance.

Table 5

Comparison of dialysis facility characteristics among facilities with more and less than 150 patients: FTE RD

	150 patients:FTE RD		>150 patients:FTE RD		P value
	N	Mean $\pm$ SD	N	Mean $\pm$ SD	
Patients: FTE social worker	3837	86.1 $\pm$ 29.9	198	139.2 $\pm$ 43.8	<0.001^a
Patients:FTE nurse	3837	17.1 $\pm$ 20.9	198	18.7 $\pm$ 9.4	0.273
Patients:FTE RD	3837	85.5 $\pm$ 27.9	198	176.5 $\pm$ 24.7	<0.001^a
Patients:FTE Tech	3837	11.9 $\pm$ 7.1	198	11.6 $\pm$ 4.0	0.535
% incident patients	3837	16.9 $\pm$ 5.9	198	16.6 $\pm$ 6.25	0.473
% Non-Hispanic patients	3824	84.5 $\pm$ 21.0	197	83.7 $\pm$ 19.6	0.581
% white	3824	57.0 $\pm$ 29.4	197	51.5 $\pm$ 27.6	0.011
% female	3824	44.4 $\pm$ 7.8	197	43.9 $\pm$ 6.0	0.345
Average vintage	3824	4.6 $\pm$ 1.0	197	4.6 $\pm$ 0.9	0.788
BMI gender weighted	3775	28.78 $\pm$ 2.8	197	28.4 $\pm$ 2.4	0.019^a
Average age	3824	62.0 $\pm$ 3.7	197	62.0 $\pm$ 3.5	0.930
Average serum albumin on initiation	3643	3.1 $\pm$ 0.3	183	3.1 $\pm$ 0.3	0.973
Average number of comorbidities on initiation	3835	5.1 $\pm$ 0.7	197	5.2 $\pm$ 0.7	0.350
% diabetes	3835	65.0 $\pm$ 10.1	198	65.3 $\pm$ 8.8	0.729
Average kt/V	3830	1.6 $\pm$ 0.1	198	1.6 $\pm$ 0.1	0.984
% catheter	3830	16.2 $\pm$ 7.3	198	15.6 $\pm$ 6.1	0.245
SHR days	3837	0.98 $\pm$ 0.33	198	0.99 $\pm$ 0.31	0.601
SHR admissions	3837	1.01 $\pm$ 0.28	198	1.02 $\pm$ 0.27	0.617
SMR	3837	1.01 $\pm$ 0.35	198	0.95 $\pm$ 0.300	0.010^a
Average nPCR	3837	0.91 $\pm$ 0.14	198	0.89 $\pm$ 0.18	0.116 ^a
Average serum phosphorus	3837	5.1 $\pm$ 0.3	198	5.2 $\pm$ 0.3	<0.001

^a indicates that Levene's test for equality of variances was significant, therefore the t-test result reported is for equal variances not assumed. If no star, Levene's test was non-significant and the p-value is for equal variances assumed t-test. Bold indicates statistical significance.

Table 6

Bivariate correlations between patient: FTE staff ratios and dialysis facility outcomes in the subset of facilities where Patient: FTE RD ratio is >150.

	Patient: FTE nurse ratio	Patient: FTE RD ratio	Patient: FTE Tech ratio	Average serum phosphorus (mg/dl)	Average nPCR	SHR Days	SHR admissions	SMR
Patient:FTE social worker	Pearson Correlation	.08	.07	.03	-.12	-.06	.02	-.07
	Sig. (2-tailed)	.28	.31	.68	.09	.43	.75	.35
Patient:FTE nurse	Pearson Correlation		0	-.06	-.06	.06	.10	-.08
	Sig. (2-tailed)		1.0	.40	.44	.40	.18	.28
Patient: FTE RD	Pearson Correlation			.20**	-.22**	.01	-.02	.09
	Sig. (2-tailed)			.01	.002	.90	.82	.22
Patient: FTE Tech	Pearson Correlation			-.10	-.03	-.01	-.07	-.001
	Sig. (2-tailed)			.18	.73	.93	.32	.99
Average serum phosphorus (mg/dl)	Pearson Correlation				-.10	-.11	-.08	.01
	Sig. (2-tailed)				.15	.12	.24	.88
Average nPCR	Pearson Correlation					-.12	-.1	.04
	Sig. (2-tailed)					.08	.18	.65
SHR Days	Pearson Correlation						.76**	.46**
	Sig. (2-tailed)						<.001	<.001
SHR Admissions	Pearson Correlation							.282**
	Sig. (2-tailed)							<.001

N=198 Bold indicates $r>0.1$ (clinically important).

** indicates $p<0.01$;

* indicates $p<0.05$.