ORIGINAL RESEARCH

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

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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 and Methods: Observational study using Dialysis Facility Report data. 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 and standardized hospitalization rate, 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.

Subjects: Dialysis centers in the US with at least 30 adult patients and no pediatric patients. 4035 facilities had complete data for the proposed variables.

Main Outcome Measure: Standardized mortality ratio and standardized hospitalization rate were the primary outcomes.

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 patients.[1] Patients receiving care at nonprofit facilities are more likely to have received predialysis nephrology care, which is associated with a 12% lower risk of all-cause hospitalization.[1] Patients at nonprofit facilities are less likely to have a catheter after 90 days of dialysis, an important predictor of hospitalization and death.[1]

Yoder et al[2] used the Annual Facility Survey (AFS) data and demonstrated that nonprofit facilities have a mean of 2.32 registered dietitians (RDs) per 100 patients compared with a mean of 1.67 in for-profit facilities, suggesting that facility characteristics predict staffing ratios. In multivariable modeling, Midwest census region and nonchain hospital-based facility status remained significant predictors of RD staffing levels.[2] Therefore, staffing levels have been a proposed reason for variations in outcomes based on facility profit status[1] but have not been specifically investigated as an explanatory variable.

Although the Centers for Medicare and Medicaid Services (CMS) mandates the composition of the interdisciplinary

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team, and education/training requirements for allied health professionals, there is no federal mandate for what patient to staff ratios are appropriate.[3] 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 ratio.[4] 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 CMS through a Freedom of Information Act Request. Dialysis Facility Annual Reports aggregate data from a variety of sources, including the 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 year.[9] 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, respectively.[9] Patient characteristics of age, race, ethnicity, sex, comorbidities on dialysis initiation, body mass index (BMI), and nursing home status are included as confounders in the calculation of SMR and SHR.[9-11] Facility characteristics including location and affiliation are self-reported to CROWNweb.[9]

Five thousand eight hundred ninety-one facilities were in the data set 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 to make use of the most recent data. We included the 4,576 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/week) or full time (greater than or equal to 32 hours/week). Using the assumption that 2 part-time employees reported on the AFS were equivalent to 1 full-time employee reported,[2] we calculated the number of 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 affiliated/nonaffiliated–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 Analysis of Variance [ANOVA]) as appropriate for all 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, Armonk, 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, Armonk, NY).

We tested the initial model on the 4,035 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 nonsignificant, unless their retention was indicated by logic, theory, or prior evidence. Our goals for model fit were nonsignificant chi-square test, Comparative Fit Index (CFI), and Tucker-Lewis Coefficient (TLI) > 0.95, root mean square error of approximation (RMSEA) < 0.05. After establishing a model for SMR, we used this as 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 patients,[4]