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Abstract

Background

Promoting continuity of nurse assignment during discharge care has the potential to increase patient readiness for discharge—which has been associated with fewer readmissions and emergency department visits. The few studies that examined nurse continuity during acute care hospitalizations did not focus on discharge or postdischarge outcomes.

Objectives

The aim of this research was to examine the association of continuity in nurse assignment to patients prior to hospital discharge with return to hospital (readmission and emergency department or observation visits), including exploration of the mediating pathway through patient readiness for discharge and moderating effects of unit environment and unit nurse characteristics.

Methods

In a sample of 18,203 adult, medical–surgical patients from 31 Magnet hospitals, a correlational path analysis design was used in a secondary analysis to evaluate the effect of nurse continuity on readmissions and emergency department or observation visits within 30 days after hospital discharge. The mediating pathway through discharge readiness measured by patient self-report and nurse assessments was also assessed. Moderating effects of unit environment and nursing characteristics were examined across quartiles of unit environment (nurse staffing hours per patient day) and unit nurse characteristics (education and experience). Analyses were adjusted for patient characteristics, unit fixed effects, and clustering at the unit level.

Results

Continuous nurse assignment on the last 2 days of hospitalization was observed in 6,441 (35.4%) patient discharges and was associated with a 0.85 absolute percentage point reduction (7.8% relative reduction) in readmissions. There was no significant association with emergency department or observation visits. Sensitivity analysis revealed a stronger effect in patients with higher Elixhauser Comorbidity Indexes. Readiness for discharge was not a mediator of the effect of continuity on return to hospital. Unit characteristics were not associated with nurse continuity. No moderation effect was evident for unit environment and nurse characteristics.

Discussion

Continuity of nurse assignment on the last 2 days of hospitalization can reduce readmissions. Staffing for continuity may benefit patients and healthcare systems, with greater benefits for high-comorbidity patients. Nurse continuity prior to hospital discharge should be a priority consideration in assigning acute care nurses to augment readmission reduction efforts.

Relational continuity of care—a consistent relationship between a provider and a patient that occurs over time and/or across care settings (Bahr & Weiss, 2019)—is an important aspect of patient-centered care (Haggerty et al., 2003). Continuity of care has mainly been studied in the context of the physician–patient relationship, care coordination efforts (management continuity: a consistent approach that responds to changing needs [Haggerty, Roberge, Freeman, & Beaulieu, 2013]), and information transfer (informational continuity: the use of past events to make decisions [Haggerty et al., 2013] between providers and venues of care [Bahr & Weiss, 2019]). In these contexts, greater continuity of care was associated with increased patient satisfaction (Hesselink et al., 2012; van Walraven, Oake, Jennings, & Forster, 2010), increased follow-up with primary care providers (Balaban, Weissman, Samuel, & Woolhandler, 2008), and fewer readmissions (Coleman, Parry, Chalmers, & Min, 2006; Naylor, Aiken, Kurtzman, Olds, & Hirschman, 2011; van Walraven, Taljaard, et al., 2010). There has been limited study of relational nurse continuity during acute care hospitalization and none regarding the influence of continuity in nurse staffing assignments on postdischarge outcomes.

The body of evidence linking nurse continuity in patient care assignments in the acute care setting to patient care outcomes is limited to a few studies—each using different measurement approaches that produced mixed results. Using a patient-level measure of continuity aggregated over the course of hospitalization (number of different nurses assigned to the patient/total number of shifts hospitalized), Siow, Wypij, Berry, Hickey, and Curley (2013) found that sicker patients were more likely to receive continuity of nursing care, but continuity was found to have no influence on patient outcomes (length of stay, adverse events, infection). Stifter, Yao, Lodhi, et al. (2015) examined the effect of nurse continuity—using a different aggregate measure of relational continuity (consecutive care days with the same nurse from the previous day/total care days during the hospitalization)—on hospital-acquired pressure ulcers and found nurse continuity to be low on all units and with no influence on hospital-acquired pressure ulcers. When measured at each patient care encounter (from the electronic health record [EHR]), discontinuity (assignment of a nurse not previously assigned to the patient) negatively affected patient clinical condition, with greater effect in high-mortality-risk patients and older adults (Yakusheva, Costa, & Weiss, 2017).

Continuity of assignment of nurses to patients (nurse continuity) in acute care settings is a management strategy to organize care that enables the nurse to accumulate information about the patient with each interaction (Stifter, Yao, Lopez, et al., 2015). Inconsistent assignment of nurses can limit the nurse's opportunity for repeat assessment and potentially affect the ability of the nurse to identify changes in patient status. Repeated assignment of a nurse to a patient provides increased opportunities to engage the patient, develop a relationship, and individualize the plan of care.

Discharge preparation is one area that could be affected by nurse continuity. Discharge preparation requires information exchange, planning, and coordination between the patient, family members, and providers (Hessalink et al., 2012; Weiss et al., 2015). Knowledge accumulated during repeated assignment promotes quality teaching in the form of consistent education to patients and family members and assists in planning timing of individualized educational content (Uijen, Schers, & van Weel, 2010; Zolnierek, 2014). High quality of discharge teaching is a predictor of patient readiness for hospital discharge (Weiss, Yakusheva, & Bobay, 2011), which in turn leads to fewer readmissions and emergency department (ED) visits (Weiss, Costa, Yakusheva, & Bobay, 2014; Weiss, Yakusheva, & Bobay, 2010; Weiss et al., 2011). Evidence is lacking to support the direct relationship between nurse continuity prior to discharge and readiness for discharge; but theoretically, continuity may provide greater opportunity for dialogue and assessment of patient needs and preferences for the discharge transition, promoting patient readiness for discharge and reducing the likelihood of postdischarge return to hospital.

This study focused on the relationship between continuity of nurse assignment for discharge preparation, patient readiness for discharge, and postdischarge return to hospital in order to provide evidence for decisions

about deployment of nursing staff. With current U.S. payment models that include penalties for unplanned readmissions (Centers for Medicare & Medicaid Services, 2019), mechanisms for delivery of nursing care that contribute to readmission reduction need to be identified.

The primary aims of this study were to examine (Aim 1) the association of relational continuity of assignment of the discharging nurse and postdischarge return to hospital for readmission or ED/observation (Obs) visits within 30 days after discharge and (Aim 2) the role of the patient's readiness for hospital discharge as a mediator of the association of nurse continuity prior to discharge and postdischarge return to hospital. Supplemental aims were to examine the effect of the context of care delivery at the unit level to determine if (Aim 3) characteristics of the nursing care unit (nurse staffing levels in hours per patient day [HPPD]) contribute to nurse continuity and (Aim 4) characteristics of the nursing care unit and characteristics of the nursing staff (registered nurse [RN] education and RN experience) moderate the relationship between nurse continuity and postdischarge return to hospital.

METHODS

The design for this study draws from variables included in the Stifter Conceptual Model of Relational Nurse Continuity (Stifter, Yao, Lopez, et al., 2015). The Stifter model includes the concepts nursing continuity, nursing characteristics, unit environment characteristics, patient characteristics, and patient outcomes. The model theorizes that providing patients with consistent nurse caregivers will lead to improved assessments, monitoring, and decision-making, which results in more timely interventions and ultimately improves patient outcomes. In the Stifter model, continuity moderates the relationship of direct nursing care hours received by a patient and the education of the nurses who provided direct patient care with patient outcomes, all measured at the individual nurse–patient level. We adapted the model to examine the direct relationship of nurse continuity prior to discharge on postdischarge return to hospital, the potential mediating effect of an intermediate outcome (readiness for hospital discharge), and the moderating effects of the context of care delivery—specifically unit environment and unit nursing characteristics (Figure 1).

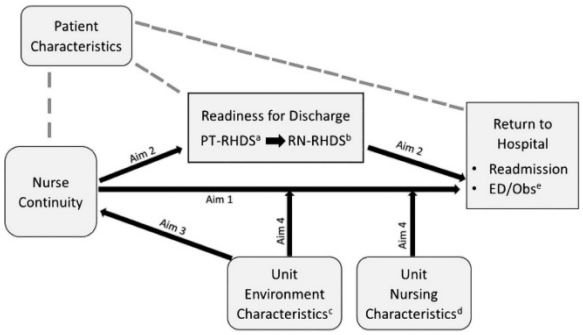

FIGURE 1: Study framework and aims. aPatient-Readiness for Hospital Discharge Scale. bRN-Readiness for Hospital Discharge Scale. cRegistered nurse (RN) overtime hours per patient day, RN nonovertime hours per patient day, and non-RN hours per patient day. dRN education and RN experience. eEmergency (ED) visits and observation (Obs) visits within 30 days.

Nurse continuity, a form of relational continuity, is conceptualized as a structure variable representing the assignment of nurse staffing; for this study, we measured nurse continuity as the discharging nurse being assigned to care for the patient on the day of and the day before discharge. Unit nursing characteristics are characteristics of the collective of nurses providing care to patients within a patient care unit and represent the nursing education and experience available for patient care on the nursing unit. Unit environment characteristics are characteristics of unit-level staffing and represent the amount of nursing care HPPD on the care unit. Patient characteristics are control variables in the study, selected because of their association with

postdischarge utilization (Table 1) (Kansagara et al., 2011). Patient outcomes are represented by the proximal outcome at discharge (patient readiness for discharge) and the distal outcome (return to hospital within 30 days after discharge for a repeat inpatient admission or ED/Obs visit). Figure 1 shows the relationships among the constructs expressed as study aims.

TABLE 1: Study Variables

Constructs	**Nursing characteristics**	**Unit environment characteristics**	**Patient characteristics**	**Relational nursing continuity**	**Patient outcomes**	
Study concepts	**Unit nursing characteristics**	**Unit environment characteristics**	**Control variables**	**Nurse continuity**	**Readiness for hospital discharge**	**Return to hospital**
Empirics	• RN education • RN experience	• RN OT HPPD • RN non-OT HPPD • Non-RN HPPD	• Lives alone • Age • Gender • Race • Ethnicity • Payer type • MDC • Elixhauser Comorbidity Index • Length of stay • Prior hospitalization within 90 days • Patient type	Discharging nurse also assigned to the patient on the day before discharge	PT-RHDS RN-RHDS	Readmission within 30 days; emergency department visits and observation visits within 30 days

Note. PT-RHDS = Patient Readiness for Hospital Discharge Scale; R Scale; RN = registered nurse; OT = overtime; HPPD = hours per patient day; MDC = major diagnostic category.

Study Design and Data Source

This study used a correlational path analysis design in a secondary analysis of a data set from the Readiness Evaluation and Discharge Interventions (READI) study, a randomized clinical trial evaluating the effectiveness of structured discharge readiness assessment protocols on return to hospital for readmissions and ED/Obs visits (ClinicalTrials.gov NCT#01873118; Weiss et al., 2019). The READI data set includes over 144,000 patients discharged following an inpatient hospitalization from two adult, medical–surgical units (randomly assigned to intervention and control conditions) in each of 33 Magnet-designated hospitals in the United States (31) and Saudi Arabia (2). The READI study data were obtained from hospital EHRs, from administrative databases, and directly from patients and discharging nurses on the day of discharge. Each hospital in the READI study submitted de-identified patient-level data and unit-level nurse staffing and nurse characteristics. The READI study was approved by the university institutional review board (IRB) of the principal investigator (M. W.) and participating hospitals' IRBs. This secondary analysis received an exempt determination from the university IRB.

Sample

The sample was a multilevel nested (patients within unit/hospital [1 unit per hospital]) sample of patients linked to their discharging nurses. Patients were only included from the intervention units in Phases 2 and 3 of the four-phase READI study where patient and nurse assessment of discharge readiness were included in the protocol (baseline and Phase 1[nurse assessment only] were not included). The protocol was completed for 70% of eligible patients from the intervention units.

Patient inclusion criteria were adult (age 18 years or older) medical–surgical patients admitted on inpatient status and discharged home with or without home care following a length of stay of more than 1 day (to examine repeated care by the same nurse on the last 2 days of hospitalization). Exclusion criteria were patients who were discharged to hospice or left the hospital against medical advice. Only U.S. hospitals (31 of the 33 study hospitals) were included in this analysis; there were 6 academic medical centers, 9 teaching hospitals, and 16 nonteaching hospitals, and bed sizes ranged from 180 to 1,500. Data for this analysis were collected from October 2015 to December 2016.

The sample for the analyses included 18,203 patients. When we examined the moderating effects of unit nurse characteristics in Aim 4, the sample was reduced to 17,358 because one hospital did not report unit-level RN experience (excluded 679 observations) and one hospital provided incomplete RN experience data (excluded 166 observations).

Measures

Nurse continuity was operationalized as a dichotomous variable representing the structure of the nursing care assignment: 1 = the nurse was assigned to the patient the day prior to discharge and the day of discharge or 0 = discharging nurse not assigned on the prior day. Data for the continuity variable were recorded by the discharging nurse on a nurse assessment of discharge readiness form used in the READI study on the day of discharge in response to the question, "Were you assigned to care for this patient yesterday?"

Patient outcomes were measured using the Patient Readiness for Hospital Discharge short form (PT-RHDS) and the Nurse Readiness for Hospital Discharge short form (RN-RHDS). These parallel eight-item scales assess four attributes of readiness for discharge: personal status, knowledge, coping ability, and expected support. The tools are designed to be used on the day of discharge and take patients 5–10 minutes and nurses 2–5 minutes to complete. Both forms use a 0–10 scale, with higher scores indicating greater readiness. Scores are reported as the mean of items (Weiss & Piacentine, 2006). The PT-RHDS is completed by the patient or read to the patient with the response recorded by the nurse. The nurse completes the RN-RHDS after having reviewed the patient self-report and considers the patient perspective and other information available in completing the assessment.

Confirmatory factor analysis, contrasted group comparisons, and predictive validity testing support the construct validity of the RHDS scales (Bobay, Jerofke, Weiss, & Yakusheva, 2010; Bobay, Weiss, Oswald, & Yakusheva, 2018; Weiss & Piacentine, 2006; Weiss et al., 2011, 2014). Predictive validity testing indicates that lower RN-RHDS scores (<7) were correlated with higher risk of readmission (Bobay et al., 2018; Weiss et al., 2014) and combined postdischarge return to hospital (readmission/ED) (Weiss et al., 2010). Higher PT-RHDS scores were correlated with less patient-reported postdischarge coping difficulty, readmissions (Weiss et al., 2007), and ED visits within 30 days (Weiss et al., 2011). Reliability estimates were .82 for the RN-RHDS and .83 for the PT-RHDS (Weiss et al., 2014).

Return to the same hospital within the first 30 days postdischarge is a multinomial variable collected from EHR data and coded as 0 = no return to hospital for ED/Obs visits or readmission, 1 = one or more ED/Obs visits without an inpatient admission within 30 days, 2 = one or more inpatient admission within 30 days. Obs stays (short stay < 23 hours) without inpatient admission were combined with ED visits as noninpatient returns to the hospital.

Unit environment characteristics describe the context of nursing care as operationalized by unit-level staffing variables: RN overtime HPPD, RN nonovertime HPPD, and non-RN HPPD. These data were available monthly from nursing administrative databases, used National Quality Forum definitions (National Quality Forum, 2004), and were linked to the patient-level data based on the month of discharge.

Unit nursing characteristics describe the characteristics of the nurses assigned to the nursing unit: RN education (percent bachelor's in nursing [BSN]—number of RNs with a BSN or higher degree divided by the total number of RNs on the unit) and RN experience (sum of years since obtaining RN license for all RNs divided by total number of RNs on the unit). These data were captured annually by study hospitals and linked to individual patients based on the year of discharge.

Patient characteristics were included as control variables: patient lives alone (yes/no [reference]), age (in years), gender (female or male [reference]), race (American Indian or Alaska Native, Asian, Black or African American, Native Hawaiian or Other Pacific Islander, White, and unknown [reference]), ethnicity (Hispanic/Latino or not Hispanic/Latino [reference]), payer type (private [reference], Medicare, Medicaid, uninsured, other), major diagnostic categories (MDC; derived from allocating diagnosis-related groups into 25 mutually exclusive groups; Centers for Medicare & Medicaid Services, n.d.), Elixhauser Comorbidity Index for readmission (Elixhauser, Steiner, Harris, & Coffey, 1998), length of stay (number of midnights between admission and discharge), prior hospitalization within 90 days (yes/no [reference]), and patient type (medical or surgical [reference]). All study variables and measures are listed in Table 1.

Analyses

In preparation for data analysis, data were examined for missing values. Patients were included in the analysis if PT-RHDS and RN-RHDS data were missing on no more than 50% of items (up to four items); otherwise, the patient was eliminated from the analysis (Mazza, Enders, & Ruehlman, 2015). If nursing or unit environment characteristics were missing, patients were dropped casewise from the relevant analyses.

For Aim 1, we examined the direct effect of continuity on return to hospital (readmissions, ED/Obs visits) using patient-level logistic regression. For Aim 2, we used patient-level, multiple linear, and logistic regression for a series of equations in a simultaneous equation regression model to estimate in sequence the effects of continuity on readiness for discharge (PT-RHDS, RN-RHDS) and return to hospital (readmissions and ED/Obs visits). Simultaneous equation modeling using the seemingly unrelated regression equations estimation function in Stata Version 14 (StataCorp, 2015) allows for the examination of multiple equations while reducing error associated with multiple analyses of the same data (Clayton & Pett, 2011). This approach also allowed us to test

for the key criteria of a mediating effect: (a) variation in nurse continuity significantly account for variation in readiness for hospital discharge; (b) variation in readiness for hospital discharge significantly account for variation in postdischarge return to hospital; and (c) when controlling for Criteria 1 and 2, a previously significant relationship between nurse continuity and the postdischarge return to hospital no longer achieves significance. Then, we calculated direct and indirect path effects (Baron & Kenny, 1986). The equations for the path of influence through readiness for discharge were estimated as a sequential path from continuity to patient-reported readiness to nurse assessment of readiness (Figure 1) to outcomes. This approach was consistent with the READI study intervention, where patients completed their self-report, which their nurses reviewed before completing their own independent assessment based on patient input and their awareness of other factors influencing their patients' readiness for discharge.

To examine the effect of unit environment characteristics on continuity (Aim 3), we used logistic regression, regressing continuity on unit environment characteristics. For Aim 4—examining the moderating effect of unit environment and unit nursing characteristics—we performed logistic regression of readmission and ED/Obs on continuity across the four quartiles of the distribution of each unit environment and unit nurse characteristic variable. This method was chosen to determine the marginal effects at each quartile of the unit environment and nurse characteristics and compare contrasts between quartiles. Significant differences at $p < .05$ indicate an increase (or decrease) in the effect of continuity on readmission or ED/Obs.

All models included patient characteristics as control variables as well as fixed effects for unit and clustering at the unit level. Level of significance was set at $p = .05$ for a two-tailed test. All statistical analyses were completed using Stata Version 14 (StataCorp, 2015).

RESULTS

The characteristics for the sample are presented in Table 2. In this sample of 18,203 patients, continuous nursing assignment was observed in 6,441 (35.4%) discharges. The sample consisted of primarily White patients (70%) and African American (15%) patients. The average age was 59 years with length of stay averaging 4.80 days. Payer type consisted primarily of Medicare patients (41%) and private insurance (32%). The percentage of patients who had a prior hospitalization within 90 days was 23%. Table e1 in the Supplemental Digital Content includes expanded descriptive information for all MDCs and units.

TABLE 2: Sample Characteristics

	(1)		(2)		(3)
	All patients		Non-continuity		Nurse continuity
	N = 18,203		*n* = 11,762		*n* = 6,441
ED/Obs [count (%)]	2,174 (11.94)		1,431 (12.17)		743 (11.54)
Readmission [count (%)]	1,971 (10.83)		1,250 (10.63)		721 (11.19)
Nurse continuity [count (%)]	6,441 (35.38)				6,441 (100)
Age [mean (SD)]	59.06 (17.22)		59.13 (17.20)		58.93 (17.26)
Length of stay [mean (SD)]	4.798 (4.12)		4.782 (4.19)		4.827 (4.00)
Male [count (%)]	8,896 (48.87)		5,702 (48.48)		3,194 (49.59)
Race [count (%)]					
Unknown race	2,035 (11.18)		1,311 (11.15)		724 (11.24)
Native American/Alaskan	235 (1.29)		142 (1.21)		93 (1.44)
Asian	452 (2.48)		313 (2.66)		139 (2.16)
African American	2,630 (14.45)		1,668 (14.18)		962 (14.94)
Pacific Islander/Hawaiian	43 (0.24)		27 (0.23)		16 (0.25)
White	12,808 (70.36)		8,301 (70.57)		4,507 (69.97)
Ethnicity [count (%)]					
Non-Hispanic	15,328 (84.21)		9,862 (83.85)		5,466 (84.86)
Hispanic	2,518 (13.83)		1,670 (14.20)		848 (13.17)
Unknown ethnicity	357 (1.96)		230 (1.955)		127 (1.97)
Marital status [count (%)]					
Not married	8,186 (44.97)		5,284 (44.92)		2,902 (45.06)
Married	8,394(46.11)		5,388 (45.81)		3,006 (46.67)
Unknown marital status	1,623 (8.92)		1,090 (9.27)		533 (8.28)
Payer [count (%)]					
Private payer	5,843 (32.1)		3,790 (32.22)		2,053 (31.87)
Medicare	7,478 (41.08)		4,770 (40.55)		2,708 (42.04)
Medicaid	2,519 (13.84)		1,589 (13.51)		930 (14.44)
Uninsured	375 (2.06)		231 (1.96)		144 (2.24)
Other payer	1,988 (10.92)		1,382 (11.75)		606 (9.41)
Admission type [count (%)]					

Medical	13,461(73.95)		8,774(74.60)		4,687 (72.77)
Surgical	4,713 (25.89)		2,969(25.24)		1,744 (27.08)
Unknown medical or surgical	29 (0.16)		19(0.16)		10 (0.16)
Comorbidities [count (%)]					
Elixhauser Comorbidity Index < 0	2,367 (13)		1,498(12.74)		869 (13.49)
0 ≤ Elixhauser Comorbidity Index <5	5,117 (28.11)		3,291(27.98)		1,826 (28.35)
5 ≤ Elixhauser Comorbidity Index <10	5,093 (27.98)		3,328(28.29)		1,765 (27.40)
10 ≤ Elixhauser Comorbidity Index <15	1,839(10.10)		1,199(10.19)		640 (9.94)
15 ≤ Elixhauser Comorbidity Index <20	1,868 (10.26)		1,217(10.35)		651 (10.11)
Elixhauser Comorbidity Index ≥20	1,919 (10.54)		1,229(10.45)		690 (10.45)
Prior hospitalization past 90 days [count (%)]	4,134 (22.71)		2,671(22.71)		1,463 (22.71)

Note. Nurse continuity is operationalized to represent the structure of the nursing care assignment as a dichotomous variable: 1 = the nurse was assigned to the patient the day prior to discharge and the day of discharge and 0 = discharging nurse not assigned on the prior day. Expanded demographic information es for all major diagnostic categories and units are in Supplemental Digital Content Table e1.

The direct (unmediated) effect of continuity on readmission, after controlling for patient characteristics, was a 0.85 absolute percentage point lower readmission rate in the presence of continuity (marginal effect = −.0085, 95% CI [−.0166, −.0004], p = .04). There was no significant effect on ED/Obs (Supplemental Digital Content Table e2, http://links.lww.com/NRES/A346). Table 3 shows the results of analysis for the mediating effect of continuity on return to hospital through readiness for discharge (Aim 2). In the mediated model, the effect of continuity on readmission was a 0.83 absolute percentage point (95% CI [−0.017, −0.000], p < .05) reduction in readmissions; a Wald test of equality of unmediated and mediated continuity coefficients on readmission indicated no difference between the estimates (F = 0.87, p = .36). The indirect association of continuity through PT-RHDS and RN-RHDS on readmissions was 0.02 absolute percentage points (0.0578*0.4843*0.0079 = 0.00022, p = .04); the association with ED/Obs was not significant. From these results, we concluded that, although the sequential path of influence from continuity to readiness for discharge (proximal outcome) to readmissions (distal outcomes) was itself significant, it was not clinically meaningful and did not mediate of the association between continuity and readmissions (Baron & Kenny, 1986). Supplemental Digital Content Table e3 displays the full series of simultaneously estimated regression equations.

TABLE 3: Simultaneous Equation Estimates for the Sequential Path of Influence of Nurse Continuity to PT-RHDS RN-RHDS, and Return to Hospital (Readmissions and ED/Obs)

	PT-RHDS		RN-RHDS		Return to hospital		
	Marginal effects		Marginal effects		ED/Obs marginal effects		Readmission marginal effects
Exposures	**[95% CI]**		**[95% CI]**		**[95% CI]**		**[95% CI]**
RN-RHDS					−0.0034 [−0.0074, 0.0007]		−0.0079**[−0.0126, −0.0033]
PT-RHDS			0.4843*** [0.4300, 0.585]		−0.0021 [−0.0058, 0.0016]		0.0009 [−0.0034, 0.0053]
Nurse continuity	0.0578* [0.0029, 0.1127]		0.0018 [−0.0332, 0.0368]		0.0053 [−0.0050, 0.0150]		−0.0083* [−0.0165, −0.0001]

Note. Equations are estimated simultaneously using seemingly unrelated regression equations estimation technique. Shown are marginal effects and 95% confidence intervals (CIs) of marginal effects, multiple linear regression for RN-RHDS and PT-RHDS scores, and logistic regression for readmission and ED/Obs. The analysis controlled for the fol- lowing variables: lives alone, age, gender, race, ethnicity, payer type, major diagnostic categories (MDCs), Elixhauser Co- morbidity Index, length of stay, prior hospitalization within 90 days, and patient type, and used unit fixed effects. Nurse continuity is operationalized to represent the structure of the nursing care assignment as a dichotomous variable, 1 = the nurse was assigned to the patient the day prior to discharge and the day of discharge and 0 = discharging nurse not assigned on the prior day. All control variables and fixed effects are in Supplemental Digital Content Table e3. PT-RHDS = Patient self-report form: Readiness for Hospital Discharge Scale scores 0–10, higher scores = greater readiness; RN-RHDS = Nurse assessment form: Readiness for Hospital Discharge Scale; ED/Obs = emergency department visit or observation stay <23 hours within 30 days postdischarge.
*p < .05. **p < .01. ***p < .001.

In the analyses for Aim 3, none of the unit environment characteristics were directly associated with nurse continuity (Supplemental Digital Content Table e4). Results for Aim 4 indicate that unit environment and unit nurse characteristics did not moderate the relationship of nurse continuity to readmissions (Supplemental Digital Content Table e5). The quartile effect estimates are within the statistical error margin of each other, and none of the contrast margins follow an increasing or decreasing pattern that we would expect under the

moderation hypotheses. However, as shown in Table 4, unit BSN percent influenced the strength of the association of continuity with readmissions in the lowest (less than 56%) and the highest (more than 80%) BSN quartiles. In the lowest quartile, the marginal effect on readmission of −0.017 (95% CI [−0.031, −0.002], $p < .05$) indicated that readmissions declined further, adding to the direct effect of continuity on readmissions (marginal effect = 0.008 percentage points). At the same time, ED/Obs visits (without a concurrent readmission) increased (marginal effect 0.021, 95% CI [0.004, 0.038], $p < .05$). For the highest BSN quartile, readmissions were also lower (marginal effect, −0.018, 95% CI [−0.033, −0.004], $p < .05$), but without a concurrent increase in return to hospital for an ED/Obs visit. Supplemental Digital Content Table e6 displays the full series of regression models with all variables and fixed effects for Aim 4.

TABLE 4: Logistic Regression Models for Moderating Effects of Unit BSN Percent on the Relationship of Nurse Continuity to Return to Hospital (Readmissions and ED/Obs)

	ED/Obs visits		**Readmissions**	
	Effect of nurse continuity	**Contrast with Quartile 1**	**Effect of nurse continuity**	**Contrast with Quartile 1**
Unit BSN Percent	**Marginal effects [95% CI]**	**Contrasts of marginal effects with respect to baseline [p values of the contrasts, 95% CI]**	**Marginal effects [95% CI]**	**Contrasts of marginal effects with respect to baseline [p values of the contrasts, 95% CI]**
Quartile 1 [13-58%]	0.021* [0.004, 0.038]		−0.017*[−0.031, −0.002]	
Quartile 2 [59-67%]	−0.003 [−0.011, 0.006]	−0.024* [−0.041, −0.006]	0.014 [−0.000, 0.028]	0.031* [0.004, 0.057]
Quartile 3 [68-78%]	−0.006 [−0.029, 0.017]	−0.027 [−0.0562, 0.002]	−0.008 [−0.032, 0.016]	0.008 [−0.009, 0.025]
Quartile 4 [79-100%]	−0.000 [−0.017, 0.017] 18,203	−0.021* [−0.039, −0.003]	−0.018* [−0.033, −0.004] 18,203	−0.002 [−0.020, 0.017]

Note. Equations are estimated simultaneously using seemingly unrelated regression equations estimation technique. Shown are marginal effects and 95% confi- dence intervals (CIs) of marginal effects. The analysis controlled for the following variables: lives alone, age, gender, race, ethnicity, payer type, major diagnostic categories, Elixhauser Comorbidity Index, length of stay, prior hospitalization within 90 days, and patient type. Nurse continuity is operationalized to represent the structure of the nursing care assignment as a dichotomous variable, 1 = the nurse was assigned to the patient the day prior to discharge and the day of discharge and 0 = discharging nurse not assigned on the prior day. All moderating effects are in Supplemental Digital Content Table e5, and control variables and fixed effects are in Supplemental Digital Content Table e6. BSN = bachelor's degree nurse; ED/Obs = emergency department visit or observation stay <23 hours within 30 days postdischarge.
*p < .05. **p < .01. ***p < .001.

In a sensitivity analysis, we examined whether the effect of continuity on return to hospital was stronger in more complex patients by splitting Elixhauser Comorbidity Index scores into tertiles. As expected, the presence of continuity of nurse assignment for discharge was associated with fewer readmissions (marginal effect −0.031, 95% CI [−0.054, −0.008], $p < .05$) in the highest tertile group (Supplemental Digital Content Figure e1 and Table e7). There was no association in the low-comorbidity group and no effect on ED/Obs. Sensitivity analysis also confirmed that nonreporting of RN experience by two hospitals did not affect the results.

DISCUSSION

The findings of this study demonstrate that patients discharged with continuous nursing care during the last 2 days of hospitalization had a lower likelihood of readmission, independent of other factors associated with return to hospital (Aim 1). Current financial penalties in place for readmissions have driven hospital systems to prioritize readmission reduction initiatives (Joynt, Sarma, Epstein, Jha, & Weissman, 2014). Though the absolute magnitude of the effect of 0.85 percentage points is modest, implementing initiatives to increase continuity can add to other hospital initiatives to reduce readmissions (Bradley et al., 2013) and contribute to cost savings and penalty avoidance. The effect of continuity was greater for higher comorbidity patients, pointing to the importance of staffing assignments that prioritize continuity for complex patients (Yakusheva et al., 2017).

Although we found that continuity on the day prior to and the day of discharge can reduce readmissions, it does not appear to be through readiness for discharge (Aim 2). The indirect pathway from continuity through discharge readiness to readmissions produced a small overall effect compared to the direct path of continuity to readmissions. Patients discharged with continuous nursing care had slightly higher self-reported perception of readiness. In terms of the associations of readiness with readmissions independent of continuity, whereas nurse and patient assessment of discharge readiness were correlated, nurse assessments but not patient self-reported assessments were associated with fewer readmissions, following a pattern established by earlier work (Weiss et al., 2010, 2014). It is possible that continuous nursing care improved the patients' perceptions of their readiness for discharge but did not necessarily improve the clinical reality as assessed and documented by the nurse on the RN-RHDS. Patient-reported outcomes, such as readiness for discharge, are measures of patient experience and patient-centered care, which can be used to improve patient–provider interactions, identify benefits of interventions, and assess the effect of new care practices and guidelines (Snyder, Jensen, Segal, & Wu, 2013).

Because readiness does not appear to be a mediator, it will be important in future research to identify care processes and intermediate outcomes affected by structuring nursing assignments for continuity that affect postdischarge patient outcomes. In a situation where relational continuity is in place, informational (communication) and management (coordination) continuity could potentially be intervening processes that build on the structure of continuous nursing assignment to decrease return to hospital. Relational continuity is foundational to communication, and both are necessary for effective coordination (Bahr & Weiss, 2019). Understanding the relationship developed and specific actions carried out by the nurse during times of continuity would provide insight into the mechanisms by which the structure of nursing care assignments affect intervening process variables related to discharge preparation to affect patient outcomes—including postdischarge return to hospital.

The amount of nurse staffing available for patient care, measured as unit-level HPPD, did not directly affect the assignment for continuity (Aim 3). Staffing assignments on each unit may be focused on another aspect of care, such as acuity or nurse preference. Unit environment and nurse characteristic variables did not moderate the relationship between continuity (Aim 4). However, the effect of continuity was stronger in reducing readmissions at the highest and lowest quartiles of percent BSN. This reduction in readmissions in

these quartiles may have different mechanisms. In the lowest quartile BSN, readmissions were reduced, but patients were more likely to have an ED visit that did not result in readmission (a net effect of no change in return to hospital). At the highest quartile of BSN staffing, the effect of continuity was augmented and return to hospital was reduced, without the shift to more ED/Obs visits. These findings add to the growing body of evidence supporting national recommendations for hospital staffing with higher proportions of BSN nurses (Institute of Medicine, 2011; Yakusheva, Lindrooth, & Weiss, 2014a). Discharge preparation is an important nursing function, and assigning nurses with higher education could contribute to readmission reduction, especially for more complex patients.

Nursing practice environments are often unable—whether due to available staffing or specific patient needs—to prioritize nurse continuity when structuring nursing assignments (Zolnierek, 2014). On the day of discharge, patients are at lower acuity levels than other patients on the nursing unit and may be deprioritized for assignment based on continuity. The findings of this study point to the importance of continuity of assignment for discharge preparation in optimizing postdischarge outcomes and are consistent with evidence relating nursing structure in the form of discontinuity in nursing care to readmission (Yakusheva et al., 2017).

Limitations

There are several limitations to this study. The focus of the study was the relationship of continuity to postdischarge return to hospital and the possible mediating effect of patient readiness for discharge. Intervening nursing processes such as planning, coordination, and teaching were not measured. These processes could have diminished or augmented the effect of continuity on the selected outcome variables. We only examined continuity on the day before and the day of discharge; examining patterns of continuity throughout the hospitalization or for a longer period of time may uncover more detailed information to inform staffing for continuity. The return to hospital outcome was the product of many factors, known and unknown, including continuity of discharge care by a single nurse. Individual nurse performance varies, and there are many factors associated with higher and lower performing nurses (Yakusheva, Lindrooth, & Weiss, 2014b) that could contribute to discharge readiness and return to hospital.

The study design may have introduced some bias in the results. Protocols in the parent study were implemented as usual care, and the nurses were aware of the patient's rating of discharge readiness—which informed the nurse's own assessment and was used to plan care. There could have been selection bias as to which patients the nurses chose. Seventy percent of eligible patients received the intervention, and factors related to the nurse's workflow, unrelated distractions, and rapid patient exits were explanations offered by nurses at the study site.

A limitation of the data set was the availability of same-hospital readmission and ED/Obs data. Accurately measuring readmission can be challenging because it is difficult to know if a patient has been admitted to another hospital, underestimating the actual occurrence of a readmission (Nasir et al., 2010). All causes of readmissions were included. Readmissions were counted as an occurrence of readmission—not the number of readmissions nor the time since discharge—which is a factor in their preventability (Graham et al., 2018). Improved interoperability between health systems will permit more complete capture of data for future studies.

Although direct links between patients and discharging nurses were available, nurse and unit environment characteristics could only be attributed to patients as unit-level aggregated data. These measures were reported within study hospitals on a monthly (unit characteristics) or annual (RN education and experience) basis and therefore served as proxy measures of actual exposure. Nurse assignment is a unit management function; assignments were not random and were likely affected by several factors including patient acuity, length of stay, nurse competence, nurse preference, and current staffing (Allen, 2015). The number of units available for

analysis of moderating effects was small, limiting statistical power. Study units were all from Magnet hospitals, which limits the generalizability to patients and nurses in non-Magnet hospitals.

Finally, we only studied relational continuity. The three types of continuity described by Haggerty et al. (2013) and Bahr and Weiss (2019) (relational/patient–provider relationship, informational/communication, management/coordination) each build upon the previous dimensions, and each component requires different strategies to provide comprehensive care and may have different effects on return to hospital. Future research should include evaluation of all three dimensions of continuity of care.

CONCLUSION

Nurse continuity of discharge care is associated with readmission reduction. This study adds to the emerging evidence base linking nurse continuity during hospitalization to patient outcomes. Staffing for continuity of discharge care benefits both patients and healthcare systems, increasing quality of care for patients with greater benefits for high-comorbidity patients, and contributing to avoidance of readmission penalties. Implementing a plan to increase the percentage of BSN nurses and maximize continuity has the potential to augment the effects of nurse continuity in minimizing readmissions. Continuity in nurse assignments as the day of discharge approaches should be a priority consideration in deployment of acute care nurse staffing.

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