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Organization of Hospital Nursing and 30-day Readmissions in Medicare Patients Undergoing Surgery

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Abstract

Background—Growing scrutiny of readmissions has placed hospitals at the center of readmission prevention. Little is known, however, about hospital nursing - a critical organizational component of hospital service system - in relation to readmissions.

Objectives—To determine the relationships between hospital nursing factors - nurse work environment, nurse staffing, and nurse education - and 30-day readmissions among Medicare patients undergoing general, orthopedic, and vascular surgery.

Method and Design—We linked Medicare patient discharge data, multi-state nurse survey data, and American Hospital Association Annual Survey data. Our sample included 220,914 Medicare surgical patients and 25,082 nurses from 528 hospitals in four states (CA, FL, NJ, & PA). Risk-adjusted robust logistic regressions were used for analyses.

Results—The average 30-day readmission rate was 10% in our sample (general surgery: 11%; orthopedic surgery: 8%; vascular surgery: 12%). Readmission rates varied widely across surgical procedures and could be as high as 26% (upper limb and toe amputation for circulatory system disorders). Each additional patient per nurse increased the odds of readmission by 3% (OR=1.03, 95% CI: 1.00-1.05). Patients cared in hospitals with better nurse work environments had lower odds of readmission (OR=0.97, 95% CI: 0.95-0.99). Administrative support to nursing practice (OR=0.96, 95% CI: 0.94-0.99) and nurse-physician relations (OR=0.97, 95% CI: 0.95-0.99) were two main attributes of the work environment that were associated with readmissions.

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Conclusions—Better nurse staffing and work environment were significantly associated with 30-day readmission, and can be considered as system-level interventions to reduce readmissions and associated financial penalties.

Keywords

nursing; readmission; work environment; nurse staffing; quality of care

Introduction

Medicare's Hospital Readmission Reduction Program (HRRP) penalizes hospitals a proportion (FY 2013, 1%; FY 2014, 2%; FY 2015, 3%) of base operating DRG payments for excess readmission rates.[1] This program began with acute myocardial infarction (AMI), heart failure (HF), and pneumonia (PN), and has included some surgery procedures (e.g., total hip and knee arthroplasty) for FY 2015.[2] **Nurses - the largest health care workforce** - provide round-the-clock bedside care throughout patient hospitalization, of which some has been identified critical to prevent readmissions (e.g., complication surveillance, patient education, and discharge planning).[3] Theory and empirical evidence suggest that the effect of nursing care on patient outcomes is mediated by organizational nursing factors;[4-6] and there are evidence linking hospital nursing to patient outcomes (e.g., surgical mortality, failure to rescue, and infections).[7-11]

To date, however, little research has examined the impact of hospital nursing on readmissions; of those few studies, most focused on medical rather than surgical readmissions.[12] A recent study of Medicare patients with HF, AMI, and PN found that patients have significantly lower risk for 30-day readmissions when cared for in hospitals with better nurse work environments, nurse staffing, and/or more nurses with a bachelor's degree.[13] Hospitals with better nurse staffing were 25% less likely to be penalized under the HRRP.[14] One study on surgical readmissions of Medicare patients included a measure of nurse staffing (which was significantly associated), but this finding was not discussed.[15] Other hospital nursing factors shown to be predictive of patient outcomes, such as work environment, were rarely considered.[12,15]

We aimed to advance the understanding of the impact of hospital nursing on readmissions by identifying the role of nurse work environment, nurse staffing, and nurse education in readmissions among Medicare patients undergoing general, orthopedic, and vascular surgery.

Methods

Sample and Data

This is a retrospective, cross-sectional study using three data sources. We used the Penn Multi-State Nursing Care and Patient Safety Survey (2006-2007) of **a substantial random sample of registered nurses** (RNs) in California, Florida, New Jersey, and Pennsylvania for hospital measures of nurse work environment, nurse staffing, and nurse education. Details about the nurse survey have been presented elsewhere.[7, 16] Measures of hospital structural

characteristics (e.g., ownership and hospital size) were obtained from the American Hospital Association (AHA) Annual Survey. We included adult nonfederal acute care hospitals with 50 or more annual surgical discharges of study interest and at least 10 RNs providing direct **inpatient** care.[17] Our sample included 528 hospitals in four states with an average of 48 nurse respondents per hospital.

We obtained patient information from the Medicare Provider and Analysis Review File (MedPAR), and included patients hospitalized for a diagnostic related group (DRG) classification of general, orthopedic, or vascular surgery from July 2006 to June 2007. Patients were excluded if they were age 90 or older, died during hospitalization, were transferred from or out to other hospitals, or were discharged on the same day or against medical advice. To avoid double counting an admission as index admission and readmission, only admissions beyond 30 days from the previous discharge were considered eligible index admission. Admissions followed by hospitalization for rehabilitation (DRG 462) within 30 days of discharge were excluded. For patients that had more than one qualified surgery during our observation period, a single index admission was randomly selected in order to ensure statistical independence of observations. Our final sample included 220,914 patients.

Variables

30-day readmission—We included all-cause readmissions within 30 days of discharge from hospitalizations for DRG classifications of general, orthopedic, and vascular surgery. This definition has been used in previous studies of surgical readmissions and corresponds with the HRRP window of observation.[18, 19]

Hospital nursing factors—The nurse work environment was measured using the Practice Environment Scale of the Nursing Work Index (PES-NWI), a nursing-sensitive measure endorsed by the National Quality Forum.[20, 21] The PES-NWI consists of five subscales: nurse participation in hospital affairs; nursing foundations for quality of care; nurse manager ability, leadership, and support; staffing and resource adequacy; and collegial nurse-physician relations. We excluded the staffing and resource adequacy subscale due to its high correlation with our direct measure of nurse staffing.[7] Subscale scores were calculated for each hospital as the mean of the items comprising each subscale. The overall PES-NWI score was then calculated as the mean of the subscales for each hospital. Hospitals' PES-NWI and subscale scores were standardized in regression models.

Nurse staffing was measured at hospital level as the average patient-to-nurse ratios based on nurses' reports of the number of patients and nurses on their last shift. This measure has better predictive reliability compared to administrative sources of staffing data. **[7, 13, 17, 22]**

Hospital nurse education was measured as the proportion of nurses with baccalaureate degrees or above.[13, 23]

Covariates and risk adjustment

We included 27 comorbidities identified by Elixhauser and colleagues (excluding fluid and electrolyte disorder and coagulopathy),[24 - 27] patient demographics (age, gender, and race/

ethnicity), health services utilization (number of hospitalizations in the past 6 months), and DRGs for risk adjustment. We also included hospital characteristics (hospital size, teaching status, technology level, ownership, and geographic location) as covariates.

Analysis

We first described the characteristics of our sample and examined the incidence, variation, and reasons for 30-day readmissions. We used multivariate logistic regression models to estimate the associations between 30-day readmission and hospital nursing - work environment (both overall and subscale specific), nurse staffing, and nurse education. In the first set of models (adjusted separate), each association was estimated separately when controlling for patient and hospital characteristics. In the second set of models (adjusted joint), both staffing and work environment (overall or each subscale) were included in the same model. All analyses were conducted in STATA version 12.

Results

On average, hospitals had an overall PES-NWI score of 2.72 (SD=0.23), and the mean subscale scores ranged from 2.52 to 2.91. Of the 528 hospitals (Table 1), 31% had poor environments (**0.5 SD or more below the mean**), whereas 29% had good environments (**0.5 SD or more above the mean).** Hospitals averaged 5.13 (SD=1.31) patients per nurse and 60% had ratios between 4 and 6. The average percentage of nurses that were BSN-prepared was 38%. Sixteen percent of hospitals had more than half of their nurses that were BSN-prepared. The majority of hospitals were non-profit (81%), with more than 100 beds (90%), and in urban areas (90%). Approximately half of the hospitals were teaching and high technology hospitals. There were more patients and nurses in larger, high technology, and urban hospitals.

Table 2 summarizes the patient characteristics. Medicare patients undergoing general, orthopedic, or vascular surgery had a 30-day readmission rate of 9.5%. Of these patients, the average age was 76 years (SD=6.0), 58% were females, and 90% were white. Roughly half of the patients were hospitalized for orthopedic surgery. The majority (89%) had at least one comorbidity and 62% had multiple comorbidities. Approximately 21% of the patients experienced hospitalization(s) in the past 6 months. Older **African** American males were more likely to have 30-day readmissions. For those patients who had more comorbidities and prior hospitalization(s), they were more likely to be readmitted within 30 days. Patients who were discharged to healthcare facilities (e.g., nursing homes) had the highest 30-day readmission rate (12%), compared to patients discharged to home with care services (9%) or without services (8%).

Table 3 shows the 30-day readmission rates of the 10 largest index admission DRGs and the top two reasons for readmissions. Patients of these DRGs accounted for 75% of the sample, and 71% of all readmissions. In eight groups, infection was one of the two most common causes for 30-day readmissions.

Table 4 shows the 10 patient DRGs with the highest 30-day readmission rates and the top two reasons for readmissions. The 30-day readmission rates ranged from17% (pancreas,

liver, and shunt procedures) to 26% (upper limb and toe amputation for circulatory system disorders). Patients were more likely to be readmitted for medical (vs. surgical) conditions.

Estimates from logistic regression models (Table 5) showed that, controlling for patient and hospital characteristics, each standard deviation increment in the PES-NWI score was associated with a 3% decrease in odds of 30-day readmission (OR=0.97, 95% CI: 0.95-0.99). Each standard deviation increase in the subscale scores of nursing foundations for care quality, administrative support to nursing practice, and collegial nurse-physician relationship was associated with lower odds (2% - 4% lower) of 30-day readmission. Adding an additional patient per nurse on average was associated with a 3% increase in the odds for 30-day readmission (OR=1.03, 95% CI: 1.00-1.04). The association between better work environment (overall and two subscales) and lower risk for readmission persisted despite controlling for nurse staffing levels, as shown in the adjusted joint models.

Discussion

This study provides evidence that nursing resources – namely the quality of nurse work environments and adequacy of nurse staffing – are significantly associated with surgical readmissions.

Better hospital nurse work environments had a protective effect on risk for readmissions among older surgical patients. This association was independent of nurse staffing levels, which suggests patients cared for in hospitals with better nurse work environments will have lower odds for readmission, even accounting for staffing levels. This finding suggests an opportunity for achieving greater value for investment in hospital nursing. Changing the work environment requires institutional commitment to professional nursing but can be accomplished at little cost.[28] Our findings underscore the benefit to both patients and hospitals by investing in the work environment, which is consistent with IOM's report "Keeping Patients Safe: Transforming the Work Environment of Nurses."[29] Administrative support to professional nursing practice and interprofessional partnerships are two attributes of the work environment that can affect the risk for surgical readmissions, and their influences were independent of nurse staffing. As highlighted in IOM's report "Future of Nursing: Leading Change, Advancing Health," administrative support is crucial in enabling nurses to practice to the full extent of their education and training.[30] Poor collaboration among co-workers jeopardizes quality of care and therefore patient outcomes.[31] A robust body of literature has shown that ANCC's Magnet Recognition program has had success in improving hospital work environment,[32 - 34] and is an important evidence-based resource to guide interventions. TheTeamSTEPPS program, an evidence-based teamwork system, is another resource that hospital administrators can refer to.[35]

Improving nurse staffing is another potential strategy to prevent readmissions. While administrators may balk at the cost of adding additional nurses, growing evidence suggests that the direct cost of improving staffing may be offset by savings accrued from preventing costly adverse patient outcomes.[36, 37] Better nurse staffing, particularly RN staffing, enables nurses to detect adverse events earlier and provide interventions timely. Research shows that replacing licensed nurse hours with RN hours saves money and lives.[38] This study and

others point to the potential for hospitals to reduce readmissions and associated financial penalties by improving nurse staffing.[13, 14]

Our study did not show an association between hospital proportion of BSN nurses and surgical readmissions. We know only one other study of readmissions and BSN nurses where the results were mixed: a significant association was found between proportion of BSN nurses and readmission for PN, but not for HF and AMI.[13] Additional research is warranted to explore whether nurses' education impacts readmissions, as has been found for the effect of BSN qualifications on hospital mortality.[23]

Our study has some limitations. The nature of cross-sectional design limits our ability to determine causal relationships between hospital nursing and readmissions. Despite controlling for various patient and hospital characteristics, there may be covariates that have been omitted. We studied patients and hospitals in four states. Caution should be exercised when generalizing the findings; however, these four states account for a significant percentage of Medicare beneficiaries (25%) and hospitalizations.[39]

In conclusion, our findings show that better nurse work environments and nurse staffing, two manageable organizational factors that hospital administrators can influence, may result in fewer readmissions. Hospital managers and policy makers may be underestimating the value of investments in inpatient nursing resources as an effective strategy to reduce readmissions and avoid financial penalties.

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Table 1

Characteristics of Study Hospitals with Number and Percentage of Patients and Nurses

	Patient (n=220,914)	Nurse (n=25,082)	Hospital (n=518)
	N (%)	N (%)	N (%)
Ownership			
Non-profit	184,684 (83.6)	22,457 (89.5)	425 (80.5)
For profit	36,230 (16.4)	2,625 (10.5)	103 (19.5)
Bed size			
Small (<=100)	7,892 (3.6)	931 (3.7)	55 (10.4)
Medium (101-250)	61,896 (28.0)	7,057 (28.1)	231 (43.8)
Large (>=251)	151,126 (68.4)	17,094 (68.2)	242 (45.8)
Teaching status			
Non-teaching	105,564 (47.8)	10,550 (42.1)	271 (51.3)
Minor	92,003 (41.7)	10,540 (42.0)	214 (40.5)
Major	23,347 (10.6)	3,992 (15.9)	43 (8.1)
Technology level			
Not high tech	66,895 (30.3)	8,968 (35.8)	277 (52.7)
High tech	154,019 (69.7)	16,114 (64.3)	251 (47.5)
Location			
Rural	11,026 (5.0)	1,194 (4.8)	52 (9.9)
Urban	209,888 (95.0)	23,888 (95.2)	476 (90.2)
Nurse work environment			
Poor (<=2.60)	49,800 (22.5)	5,537 (22.1)	162 (30.7)
Mixed (2.60-2.83)	96,134 (43.5)	11,478 (45.8)	215 (40.7)
Good (>=2.83)	74,980 (33.9)	8,067 (32.2)	151 (28.6)
Nurse staffing (patient/nurse)			
<=4	41,496 (18.9)	4,816 (19.2)	96 (18.2)
>4 & <=5	84,710 (38.4)	10,222 (40.8)	175 (33.1)
>5 & <=6	61,062 (27.4)	6,332 (25.3)	142 (26.9)
>6 & <=7	24,289 (11.0)	2,625 (10.5)	70 (13.3)
>7	9,357 (4.2)	1,087 (4.3)	45 (8.5)
Nurse education (BSN)			
<=20%	14,895 (6.7)	1,340 (5.3)	51 (9.7)
>20% & <=30%	37,987 (17.2)	3,856 (15.4)	98 (18.6)
>30% & <=40%	66,374 (30.1)	7,033 (28.0)	151 (28.6)
>40% & <=50%	63,599 (28.8)	7,422 (29.6)	142 (26.9)
>50%	38,059 (17.2)	5,431 (21.7)	86 (16.3)

Note: Hospitals with poor work environments: overall environment score was 0.5 SD or more below the mean; hospitals with mixed work environments: overall environment score was mean ± 0.5 SD; hospitals with good work environments: overall environment score was 0.5 SD or more above the mean.

Table 2

Characteristics of Study Patients and Those with 30-day Readmissions.

	Overall	Readmitted 30-day	Readmission rate
	N (%)	N (%)	%
Age (Mean, SD)	76.2±6.4	76.9±6.7	
Gender			
Male	93,327 (42.3)	9,160 (43.9)	9. 8
Female	127,587 (57.8)	11,727 (56.1)	9.2
Race			
White	198,466 (89.8)	18,354 (87.9)	9. 3
Black	9,536 (4.3)	1,285 (6.2)	13.5
Others	12,912 (5.8)	1,248 (6.0)	9.7
Number of comorbidities			
0	24,336 (11.0)	1,393 (6.7)	5. 7
1	59,952 (27.1)	4,191 (20.1)	7.0
2-4	122,723 (55.6)	12,606 (60.4)	10.3
5 or more	13,903 (6.3)	2,697 (12.9)	19.4
Number of admissions within prior 180 days			
0	175,136 (79.3)	14,117 (67.6)	8. 1
1	32,051 (14.5)	4,098 (19.6)	12.8
2 or more	51,766 (23.4)	2,672 (12.8)	19.5
Length of Stay (days)	4.8±4.9	6.8±6.7	
Discharge Destination			
Home/self-care	106,281 (48.1)	8,718 (41.7)	8. 2
Home with care service	45,929 (20.8)	4,082 (19.5)	8.9
Health care facilities	68,704 (31.1)	8,087 (38.7)	11.8
Surgical procedure			
General	60,687 (27.5)	6,375 (30.5)	10 .5
Orthopedic	108,461 (49.1)	8,215 (39.3)	7.6
Vascular	51,766 (23.4)	6,297 (30.2)	12.2

Note: This list of comorbidities was based on Elixhauser's comorbidity list. The diagnosis of comorbidities was based on the secondary diagnoses of index admission as well as both the primary and secondary diagnosis of any admission in 180 days prior to index admissions. The HCUP comorbidity software version 3.2 was used for analysis.

Table 3

30-day Readmission Rates and Two Most Frequent Reasons for Readmissions in the 10 Largest Diagnosis Related Groups (DRGs) for Index Admissions

DRG at Index Admission	30-day Readmission Rate	Most Frequent Reason (%)	2nd Most Frequent Reason (%)
Major joint replacement	6.2	Revision of joint replacement (5.5)	Aftercare (5.2)
Percutaneous cardiovascular procedures	11.0	Cardiac stent (11.84)	Heart failure (7.2)
Major bowel procedures	12.7	Other digestive diagnoses (9.8)	Postoperative infections (8.2)
Hip and femur procedures except major joint	11.1	Kidney and urinary infections (5.1)	Septicemia (4.9)
Laparoscopic cholecystectomy with common duct exploration	7.9	Esophagitis, gastroenteritis, and miscellaneous disorders (11.5)	Disorder of the biliary tract (4.5)
Back and neck procedures except spinal fusion	6.1	Operating procedure for infections (8.9)	Postoperative infections (6.8)
Major cardiovascular procedures	13.3	Heart failure (7.3)	Postoperative infections (5.0)
Spinal fusion	7.9	Operating procedure for infections (12.1)	Postoperative infections (6.5)
Lower extremity and humerus procedure except hip, foot, femur	8.0	Lower extremity and humerus procedures (9.6)	Postoperative infections (5.8)
Hernia procedures except inguinal & femoral	7.6	Postoperative infections (11.1)	Other digestive diagnoses (8.3)

Table 4

30-day Readmission Rates and Two Most Frequent Reasons for Readmission in the 10 Diagnosis Related Groups (DRGs) with Highest Readmission Rates

DRG at Index Admission	30-day Readmission rate	Most Frequent Reason (%)	2nd Most Frequent Reason (%)
Upper limb & toe amputation for circulatory system disorders	26.0	Amputation: circulatory system disorders (18.0)	Amputation: musculoskeletal system and connective tissue disorders (6.0)
Other hepatobiliary or pancreas operating procedures	25.7	Peripheral vascular disorders (11.5)	G.I. obstruction (7.7)
Amputation for circulatory system disorders except upper limb & toe	22.4	Amputation: musculoskeletal system & connective tissue disorders (8.8)	Amputation: circulatory system disorders (8.1)
Other circulatory system operating procedures	21.3	Other circulatory system diagnoses (12.1)	Heart failure (11.4)
Other endocrine, nutritional, and metabolic disease operating procedures	20.6	Heart failure (7.1)	Other circulatory system diagnoses (5.5)
Other digestive system operating procedures	19.7	G.I. hemorrhage (6.6)	Heart failure (6.6)
Skin grafts and wound debridement for endocrine, nutritional and metabolic disorders	18.6	Other circulatory system diagnoses (7.4)	Septicemia (7.4)
Hepatobiliary diagnostic procedure for non-malignancy	17.8	Esophagitis, gastroent and miscellaneous disorders (15.4)	Cirrhosis & alcoholic hepatitis (15.4)
Amputation for musculoskeletal system and connective tissue disorders	17.0	Amputation: circulatory system disorders (8.1)	Renal failure (6.5)
Pancreas, liver, & shunt procedures	16.9	Postoperative infections (15.8)	Other digestive system diagnoses (7.9)

Note: G.I., gastrointestinal

Table 5

Effects of Organization of Hospital Nursing on 30-day Readmissions (N=220,914)

	Unadjusted, separate			Adjusted, separate			Adjusted, joint*		
	OR	**95% CI**	**P-value**	**OR**	**95% CI**	**P-value**	**OR**	**95% CI**	**P-value**
Work environment	0.95	0.92-0.97	0.000	0.97	0.95-0.99	0.003	0.97	0.95-1.00	0.030
Nurse staffing†	1.03	1.00-1.05	0.027	1.03	1.00-1.05	0.015	1.01	0.99-1.04	0.225
Nurse education	1.22	1.01-1.48	0.039	1.06	0.90-1.24	0.504	-	-	-
Work environment attributes									
Hospital affairs participation	0.96	0.94-0.99	0.007	0.98	0.96-1.00	0.062	0.99	0.96-1.01	0.233
Foundations for care quality	0.95	0.93-0.98	0.000	0.97	0.95-0.99	0.010	0.98	0.96-1.00	0.110
Administrative support	0.93	0.91-0.96	0.000	0.96	0.94-0.99	0.003	0.98	0.99-0.99	0.009
RN-MD relations	0.95	0.93-0.98	0.000	0.97	0.95-0.99	0.002	0.97	0.95-1.00	0.031

Notes: RN, registered nurse; MD, medical doctor.

Control variables in adjusted models (adjusted separate and adjusted joint) included patient characteristics (age, gender, race/ethnicity, number of hospitalizations within 180 days prior to index admission, 27 comorbid conditions, and surgery DRGs) and hospital characteristics (bed size, teaching status, ownership, technology level, and hospital geographic area population density).

The adjusted separate models examined each hospital nursing variable separately when controlling for patient and hospital covariates. The adjusted joint models included both work environment (overall work environment measure or each attribute of the work environment respectively) and staffing in the same model when controlling for patient and hospital covariates.

**ROC (a measure of model performance) ranged from 0.6576-0.6577, which are similar to other reports.*

†The estimates of the effect of nurse staffing on readmission in adjusted joint models were similar when we included either the overall work environment measure or each subscale measure. Therefore we only reported the results from the adjusted join model with both nurse staffing and overall work environment measure.