Hospital Nursing and 30-Day Readmissions Among Medicare Patients With Heart Failure, Acute Myocardial Infarction, and Pneumonia

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Background: Provisions of the Affordable Care Act that increase hospitals' financial accountability for preventable readmissions have heightened interest in identifying system-level interventions to reduce readmissions.

Objectives: To determine the relationship between hospital nursing; that is, nurse work environment, nurse staffing levels, and nurse education, and 30-day readmissions among Medicare patients with heart failure, acute myocardial infarction, and pneumonia.

Method and Design: Analysis of linked data from California, New Jersey, and Pennsylvania that included information on the organization of hospital nursing (ie, work environment, patient-to-nurse ratios, and proportion of nurses holding a BSN degree) from a survey of nurses, as well as patient discharge data, and American Hospital Association Annual Survey data. Robust logistic regression was used to estimate the relationship between nursing factors and 30-day readmission.

Results: Nearly 1 quarter of heart failure index admissions [23.3% (n = 39,954)], 19.1% (n = 12,131) of myocardial infarction admissions, and 17.8% (n = 25,169) of pneumonia admissions were readmitted within 30 days. Each additional patient per nurse in the average nurse's workload was associated with a 7% higher odds of readmission for heart failure [odds ratio (OR) = 1.07; confidence interval CI, 1.05–1.09], 6% for pneumonia patients (OR = 1.06; CI, 1.03–1.09), and 9% for myocardial infarction patients (OR = 1.09; CI, 1.05–1.13). Care in a hospital with a good versus poor work environment was associated with odds of readmission that were 7% lower for heart failure (OR = 0.93; CI, 0.89–0.97), 6% lower for myocardial infarction (OR = 0.94; CI, 0.88–0.98), and 10% lower for pneumonia (OR = 0.90; CI, 0.85–0.96) patients.

Conclusions: Improving nurses' work environments and staffing may be effective interventions for preventing readmissions.

Key Words: nursing, readmissions, quality of health care, work environment, organizational culture

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Preventable hospital readmissions are a source of unnecessary costs to Medicare—over $15 billion annually.[1,2] Readmissions jeopardize the health of the frail elderly who are particularly vulnerable to loss of function, hospital-acquired infections, and other poor outcomes when hospitalized.[3] Many interventions aimed at reducing hospital readmissions target transitional care, care-coordination, or postdischarge care services for select populations.[4–6] Evidence on the effectiveness of these interventions, which can be costly and require scarce human resources, is promising but mixed.[7,8] Little work has focused on how the organization of inpatient nursing services—which all patients are exposed to—is associated with readmissions.

Our work is grounded in Donabedian's structure–process–outcomes framework, which suggests that structural factors affect outcomes through their impact on care processes. We are informed by organizational sociology that differentiates stable structural factors (eg, hospital size, ownership) from dynamic organizational elements (eg, work environment, workforce composition, leadership, communication) that can be changed by administrators and policymakers. This framework suggests that hospitals organized as better places for nurses to work—those that value nurses' autonomy, excel in frontline manager supervisory ability, invest in staff development, support good nurse-physician relations, have high proportions of educated staff, and staff for manageable workloads—empower nurses to provide high-quality care resulting in better patient outcomes.[9] The majority of evidence shows that hospitals with these features have better patient outcomes.[10–16]

There has been less research on the relationship between hospital nursing and readmissions.[17,18] We expect that hospitals with better nurse work environments, better staffing levels, and a more educated nursing workforce create the

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context for nurses to provide optimal care that would translate into, not only reduced risk for mortality and other adverse events, but reduced readmission risk.

Readmission prevention begins the moment the patient enters the hospital. Nurses' round-the-clock presence at decisive moments allows them to prepare patients and families for discharge throughout the hospitalization. This preparation and teaching supports seamless transitions to other settings. Bedside nurses also act as sentinels—identifying early warning signs and addressing complications and adverse events in the acute care setting that increase patients' risk of readmission.[19,20] Nurses are the frontline for providing many of the core processes of care aimed at preventing readmissions—knowledge assessment, patient education, discharge preparation, and care-coordination. These processes, however, can be disrupted when nurses have little autonomy, poor interdisciplinary relationships, minimal managerial support, overwhelming workload, inadequate resources, and poor integration throughout the institution's decision-making structure.

This study evaluates how variation in the organization of hospital nursing services, that is, nurse work environment, nurse staffing levels, and nurse education, is associated with 30-day all-cause readmissions among Medicare patients over age 65 with heart failure, acute myocardial infarction, and pneumonia. Readmissions for these conditions are common, costly, and often preventable.[1,2,4,5] Under the Affordable Care Act, the Centers for Medicare and Medicaid Services (CMS) will reduce payments to hospitals with higher than expected readmissions rates for these conditions. Understanding how the nursing care environment affects readmissions can inform the development of system and policy level interventions, which have the potential for considerable effects while increasing the effectiveness of established clinical interventions targeting readmissions.

METHODS

Sample and Data

Hospitals

Measures of hospital work environment, nurse staffing levels, and nurse educational attainment, were taken from a cross-sectional (2005–2006) survey of registered nurses in California, Pennsylvania, and New Jersey. The sampling approach has been detailed previously.[16,21] The sampling frame was state licensure lists from the 3 states. Random samples of all licensed nurses (California 40%, Pennsylvania 40%, and New Jersey 50%) were surveyed by mail at their homes regardless of work setting. Direct care hospital nurses gave the name of their employer, allowing us to aggregate responses by hospital. This approach allowed us to avoid hospital-level response bias but amounted to surveying >200,000 nurses, making repeated follow-ups and monetary incentives impossible. The initial response rate of nurses was 39%. Using extensive follow-ups and incentives[22,23] in a second survey of 1300 nonresponder nurses, we obtained a very high response rate (91%), and the information indicated that on all of the variables related to nursing organization and the quality of nursing care, nonresponders did not differ from responders.[24]

Data describing structural characteristics of hospitals were obtained from the American Hospital Association Annual Survey. Analyses were limited to adult, nonfederal acute care hospitals with at least 50 annual discharges for each condition and at least 10 direct care nurse respondents.[12] The analytic sample of hospitals for this secondary analysis was 412 hospitals: California 210, Pennsylvania 134, and New Jersey 68.

Patients

Data on the index admissions and readmissions were obtained from state discharge abstract databases from the 3 states for 2005–2006. We identified index admissions based on CMS's validated Risk-Standardized Readmission Measures[25–27] modified for use with the state databases. All patients with Medicare as the primary payer; between the ages of 65 and 89; and who were discharged from an adult, nonfederal acute care hospital with heart failure, acute myocardial infarction, or pneumonia as primary diagnosis [see Table 1, Supplemental Digital Content 1 http://links.lww.com/MLR/A386, for *International Classification of Diseases, 9th Revision, Clinical Modification* (ICD-9-CM) codes] were considered potential index admissions to assess 30-day all-cause readmission (separately by condition). Admissions for the same condition >30 days from the last discharge could be considered another index admission but readmissions within 30 days were excluded to avoid double counting an admission as both an index admission and readmission. Patients aged 90 and older, who died during hospitalization, transferred out to acute care facilities, were discharged the same or next day, or discharged against medical advice were excluded.

Variables

Nurse Staffing

Nurses provided the number of patients and nurses on their last shift that allowed us to calculate an average hospital patient-to-nurse ratio.[16] Evidence suggests that direct survey measures of staffing are better than other sources (eg, administrative data) for predicting patient outcomes.[10–12,28]

Nurse Education

Nurses provided detailed educational background information that we used to create a hospital-level measure of the percentage of nurses with a bachelor of science in nursing (BSN) degree.[11]

Nurse Work Environment

We measured the nurse work environment with the National Quality Forum-endorsed Practice Environment Scale of the Revised Nursing Work Index.[29] Nurses indicated the degree to which various organizational features were present in their practice setting. Hospital-level measures were created by aggregating nurses' responses to items comprising the 5 subscales including nursing foundations for quality care; staffing and resource adequacy; nurse

participation in hospital affairs; nurse manager ability, leadership, and support; and nurse-physician relations.[29] We used a categorical measure with good predictive validity where hospitals above the median on 4 or 5 subscales were classified as having "good" work environments; hospitals above the median on 2 or 3 subscales were classified as having "mixed" work environments; and hospitals above the median on only 1 or no subscales were classified as having "poor" work environments.[10]

Covariates

Models included covariates characterizing structural and descriptive attributes of hospitals that may be associated with quality of care outcomes.[30–33] Size was defined by the number of staffed hospital beds within the facility. Teaching status was categorized as none (no residents or fellows), minor ($0.01 \leq$ resident/fellow-to-bed ratio ≤ 0.25), and major (resident/fellow-to-bed ratio > 0.25). High-technology hospitals had open-heart surgery capabilities, organ transplant capabilities, or both. Ownership was defined as not-for-profit or for-profit. We used dummy variables to indicate the category based on population size of the hospital's geographic location. The volume of cases was measured by taking the average of the total number of cases for the hospital by condition for years 2005–2006.[34] We created a hospital-level variable categorizing volume into quartiles. We also linked Medicare cost report data to calculate a measure of total operating margin—the ratio of a hospital's total revenues related to direct patient care and total operating expenses.

Outcome

30-Day Readmission

We identified all-cause readmissions to any adult, nonfederal, acute care hospital within 30 days of discharge from an index hospitalization for heart failure, acute myocardial infarction, and pneumonia (separately) based on CMS's validated Risk-Standardized Readmission Measures.[25–27] A binary variable was created to indicate readmission within 30 days of index hospitalization for a given individual. For acute myocardial infarction patients, there are readmissions that might be considered planned and within the course of quality care and thus should not be counted as readmissions. These included follow-up revascularization procedures or coronary artery bypass graft surgery.

Risk Adjustment

Using Elixhauser's approach, we identified 27 comorbidities (excluding fluid and electrolyte disorders and coagulopathy) to account for comorbid illnesses.[35–37] We also included sex, age, and for acute myocardial infarction models, we included dummy variables indicating the anatomic location of the infarction (ICD-9-CM codes: anterior 410.00–410.19, inferolateral 410.20–410.69, subendocardial 410.7x, other 410.80–410.99). We also created a summary measure for socioeconomic position based on zipcode-level data linked to each beneficiary's zipcode.[38–39] We used Census data on 6 factors including median household income, percentage of adults who have completed high school, percentage of persons employed in predominantly working class occupations, percentage of owner-occupied homes worth >400% of the median value of owned homes, and percentage of unemployed persons to create the index. A zipcode-level z-score was estimated for each variable and the scores were then summed to obtain a socioeconomic position measure for each zipcode that were applied to individuals living in those zip codes. Our c-statistics, 0.61 for heart failure and 0.59 for both myocardial infarction and pneumonia, were similar to other reports.[25,27,30]

Analysis

We have provided descriptive statistics to characterize the patients, nurses who provided information on hospitals, and the hospitals in our sample. We estimated robust logistic regression models separately for each condition to determine the relationship between the work environment, patient-to-nurse ratios, proportion of BSN-educated nurses, and the risk-adjusted odds of readmission. The key predictor variables—nurse work environment, nurse staffing, and nurse education—were hospital-level measures. We also included stable hospital structural characteristics. The outcome—30-day readmission—was measured at the patient level along with detailed patient characteristics for risk adjustment. To account for clustering patients within hospitals, we estimated robust standard errors and significance levels that were corrected for heteroscedasticity and accounted for hospital-level clustering.[40] Using our model results, we estimated the probability of readmission given particular work environment and staffing characteristics. All analyses were conducted using Stata v.11.

RESULTS

Table 1 describes patient characteristics. There were 171,883 (46%) heart failure index admissions (134,695 unique patients), 62,394 (16%) acute myocardial infarction index admissions (60,837 unique patients), and 141,404 (38%) pneumonia index admissions (128,510 unique patients). Nearly 1 quarter of the heart failure index admissions [23.3% (n = 39,954)]; 19.1% (n = 12,131) of acute myocardial infarction index admissions; and 17.8% (n = 25,169) of pneumonia index admissions were readmitted within 30 days. These rates are similar to national rates for Medicare beneficiaries reported in the Hospital Compare database between July 1, 2006 and June 30, 2009 (heart failure 24.7%, acute myocardial infarction 19.9%, and pneumonia 18.3%).

The most common reason for readmission among heart failure patients was a subsequent heart failure admission (32%). Heart failure was also the most common cause of readmission (15%) among acute myocardial infarction patients. Patients with pneumonia were most frequently readmitted for subsequent pneumonia (21%).

Hospitals, and the numbers and percentages of patients and nurses in them, are described in Table 2. Nearly one third of the hospitals had good work environments (n = 120; 29%) and nearly another third had poor work environments (n = 118; 29%). The remainder had mixed work environments (n = 174; 42%). The average hospital patients-to-nurse ratio was 4.95 (SD = 1.1). The average proportion

TABLE 1. Patient Characteristics by Condition

Patient Characteristics	Heart Failure (N = 171,883) No. (%)	Myocardial Infarction (N = 62,394) No. (%)	Pneumonia (N = 141,404) No. (%)
Readmissions within 30 d	39,954 (23.2)	12,131 (19.1)	25,169 (17.8)
Length of stay (d), median (IQR)	4 (3–7)	5 (3–8)	5 (3–7)
Age (y), median (IQR)	80 (74–84)	78 (72–84)	79 (74–84)
Female	92,884 (54)	31,350 (49)	75,440 (53)
Top reasons for readmission			
Most frequent	Heart failure 12,961 (32.4)	Heart failure 1850 (15.3)	Pneumonia 5318 (21.1)
Second most frequent	Renal failure 1718 (4.3)	Coronary atherosclerosis 1696 (14)	COPD 1966 (7.8)
Third most frequent	Cardiac dysrhythmias 1398 (3.5)	Acute myocardial infarction 1000 (8.2)	Heart failure 1764 (7.0)
Fourth most frequent	Pneumonia 1330 (3.3)	Cardiac dysrhythmias 497 (4.1)	Respiratory failure 1009 (4.0)
Fifth most frequent	COPD 1223 (3.1)	Nonspecific chest pain 469 (3.9)	Septicemia 720 (2.9)
Sixth most frequent	Coronary atherosclerosis/heart disease 5139 (3.0)	Complications of device or procedure 421 (3.5)	Urinary tract infection 622 (2.5)
Seventh most frequent	Respiratory failure 5070 (2.9)	Pneumonia 353 (2.9)	Cardiac dysrhythmias 564 (2.2)
Eighth most frequent	Hypertension with complications 4366 (2.5)	Renal failure 308 (2.5)	Renal failure 521 (2.1)
Ninth most frequent	Complications of device or procedure 4314 (2.5)	Respiratory failure 285 (2.4)	Intestinal infection 518 (2.1)
10th most frequent	Urinary tract infection 3111 (1.8)	Gastrointestinal hemorrhage 282 (2.3)	Fluid/electrolyte disorders 445 (1.8)

Top reasons for readmission are based on the Agency for Healthcare Research and Quality's Clinical Classification's software.
COPD indicates chronic obstructive pulmonary disease; IQR, interquartile range.

of BSN-prepared nurses was 39%. On average, hospitals with the best work environments had lower patient-to-nurse ratios and higher proportions of nurses with a BSN compared with other hospitals.

Logistic regression models (Table 3) showed that, accounting for patient and hospital characteristics, care in a hospital with a good versus poor work environment was associated with 7% lower odds of 30-day readmission for heart failure patients [odds ratio (OR) = 0.93; 95% confidence interval (CI), 0.89–0.97], 6% lower odds for acute myocardial infarction patients (OR = 0.94; 95% CI, 0.88–0.98), and 10% lower odds for pneumonia patients [OR = 0.90; 95% CI, 0.85–0.96). The odds of readmission was 4% lower for heart failure (OR = 0.96; 95% CI, 0.94–0.98), 3% lower for acute myocardial infarction (OR = 0.97; 95% CI, 0.94–0.99), and 6% lower for pneumonia (OR = 0.95; 95% CI, 0.92–0.98) patients cared for in a hospital with a mixed versus poor work environment.

Nurse educational attainment was not statistically significantly associated with readmission among patients with heart failure or acute myocardial infarction. Among patients with pneumonia, each additional 10% in the proportion of hospital nurses with a BSN-level education was associated with 3% lower odds of 30-day readmission (OR = 0.97; 95% CI, 0.95–0.99).

An OR of 1.07 (95% CI, 1.05–1.09) suggested that the odds of readmission was 7% higher for heart failure patients for each additional patient per nurse in the average nurse's workload. The findings were similar for patients with acute myocardial infarction and pneumonia—each additional patient per nurse was associated with 9% (OR = 1.09; 95% CI, 1.05–1.13) and 6% (OR = 1.06; 95% CI, 1.03–1.09) higher odds of readmission, respectively.

We found that the interaction between staffing and the work environment was not significant. On the basis of the additive models, Table 4 shows the average estimated probabilities of 30-day readmission in our sample if the patients were treated in hospitals with different staffing and work environment characteristics. The average probability of readmission within 30 days was 0.24 for heart failure patients treated in hospitals with poor work environments, 0.232 in mixed environments, and 0.226 in good work environments. The average probability of readmission for heart failure patients in hospitals with an average workload of 7 patients per nurse was 0.256, considerably higher than if patients were treated in hospitals with 5 patients per nurse (0.232) or 3 patients per nurse (0.209). In all cases, the probability of readmission would be decidedly lower if both the workloads were less and nurses' work environment was better.

On average, only about half (52%) of hospital staff nurses surveyed were confident that their patients were able to manage their own care when they were discharged. This varied, however, by work environment and staffing level. For

TABLE 2. Numbers and Percentages of Study Hospitals With Different Characteristics, and Numbers and Percentages of Patients and Nurses in Them

Hospital Characteristics	Hospitals (n = 412)	Patients (n = 375,681)			Nurses (n = 20,585)
		Heart Failure (n = 171,883)	Acute Myocardial Infarction (n = 62,394)	Pneumonia (n = 141,404)	
	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)
State					
California	210 (51)	71,075 (41)	28,482 (45)	69,339 (49)	8122 (40)
New Jersey	68 (17)	31,933 (19)	8992 (14)	24,463 (17)	5581 (27)
Pennsylvania	134 (33)	68,875 (40)	25,920 (41)	47,602 (34)	6882 (33)
Urban	362 (88)	157,219 (91)	58,464 (92)	128,361 (91)	19,162 (93)
Ownership					
For-profit	37 (9)	10,027 (6)	3512 (6)	9894 (7)	1029 (5)
Not-for-profit	375 (91)	161,856 (94)	59,882 (94)	131,510 (93)	19,556 (95)
High technology	183 (44)	97,771 (57)	46,281 (73)	72,633 (51)	12,539 (61)
Hospital size					
Small	41 (10)	7227 (4)	1407 (2)	7886 (6)	680 (3)
Medium	191 (46)	65,022 (38)	19,113 (30)	56,809 (40)	6363 (31)
Large	180 (44)	99,634 (58)	42,874 (68)	76,709 (54)	13,542 (66)
Teaching status					
Nonteaching	209 (51)	78,033 (45)	26,111 (41)	70,904 (50)	7929 (39)
Minor teaching	161 (39)	72,402 (42)	27,162 (43)	57,397 (41)	8899 (43)
Major teaching	42 (10)	21,448 (12)	10,121 (16)	13,103 (9)	3757 (18)
Work environment					
Poor	118 (29)	52,210 (30)	17,050 (27)	39,690 (28)	5107 (25)
Mixed	174 (42)	72,291 (42)	27,826 (44)	61,358 (43)	8947 (44)
Good	120 (29)	47,382 (28)	18,518 (29)	40,356 (29)	6531 (32)
Nurse staffing (patients/nurse)					
<4	85 (21)	28,542 (17)	11,872 (19)	26,505 (19)	4123 ((20)
4–<5	148 (36)	64,823 (38)	27,009 (43)	53,449 (38)	7969 (39)
5–<6	106 (26)	48,774 (28)	16,749 (26)	37,629 (27)	5540 (27)
6–<7	50 (12)	22,764 (13)	6082 (10)	18,192 (13)	2341 (11)
7 or more	23 (6)	6980 (4)	1682 (3)	5629 (4)	612 (3)
Nurse education (BSN)					
<20%	25 (6)	7423 (4)	1792 (3)	7379 (5)	628 (3)
20%–29%	89 (22)	35,259 (21)	11,342 (18)	29,236 (21)	3519 (17)
30%–39%	103 (25)	45,176 (26)	17,951 (28)	36,481 (26)	5347 (26)
40%–49%	112 (27)	47,594 (28)	18,248 (29)	39,560 (28)	5954 (29)
50% or more	83 (20)	36,431 (21)	14,061 (22)	28,748 (20)	5137 (25)

BSN indicates Bachelor of Science in nursing.

example, 56% of nurses working in better staffed hospitals (<4 patients per nurse on average) and 59% of nurses working in hospitals with good work environments were confident, compared with less than half (48%) in hospitals with ≥6 patients per nurse and in hospitals with poor work environments (45%).

TABLE 3. Effects of Nurse Work Environment, Nurse Staffing, and Nurse Education on 30-Day Readmissions

	Heart Failure		Myocardial Infarction		Pneumonia	
	OR (95% CI)	*P*	OR (95% CI)	*P*	OR (95% CI)	*P*
Work environment (poor category as reference)						
Good	0.93 (0.89–0.97)	0.001	0.94 (0.88–0.98)	0.01	0.90 (0.85–0.96)	<0.001
Mixed	0.96 (0.94–0.98)	0.001	0.97 (0.94–0.99)	0.01	0.95 (0.92–0.98)	<0.001
Proportion of BSN nurses	1.00 (0.98–1.01)	0.82	1.00 (0.98–1.03)	0.98	0.97 (0.96–0.99)	0.006
Patients per nurse	1.07 (1.05–1.09)	<0.001	1.09 (1.05–1.13)	<0.001	1.06 (1.03–1.09)	<0.001

Adjusted models included controls for hospital characteristics (core-based statistical area size of geographic location, hospital size, technological status, ownership, teaching status, total operating margin, and percentage of Medicaid discharges) and patient characteristics. Estimates for nurse work environment reflect change in estimate for effect of better versus mixed (or of mixed vs. poor) environments. The 2 estimates for the nurse work environment effect for each of the 3 patient groups are derived from a single OR that involves a linear effect; for example, for heart failure, the OR of 0.93 for the contrast of good:poor equals the squared OR for good:mixed or mixed:poor, or 0.96x0.96. Estimates for proportion of BSN nurses reflect the change in estimates for the effect of an increase of 10% BSN nurses. Estimates for nurse staffing reflect the change in estimates for the effect of an increase of 1 patient per nurse.

BSN indicates Bachelor of Science in nursing; CI, confidence interval; OR, odds ratio.

TABLE 4. Estimated Average Probabilities of Readmission by Nurse Staffing Level and Quality of the Work Environment of the Hospital

	Staffing (Patients Per Nurse)					
Environment	**3**	**4**	**5**	**6**	**7**	**Overall**
Heart failure						
Poor	0.216	0.227	0.239	0.251	0.263	0.239
Mixed	0.209	0.221	0.232	0.244	0.256	0.232
Good	0.204	0.214	0.225	0.237	0.249	0.226
Overall	0.209	0.221	0.232	0.244	0.256	0.232
Acute myocardial infarction						
Poor	0.172	0.184	0.197	0.211	0.225	0.195
Mixed	0.168	0.180	0.193	0.207	0.221	0.191
Good	0.165	0.177	0.189	0.203	0.217	0.187
Overall	0.168	0.180	0.193	0.207	0.221	0.191
Pneumonia						
Poor	0.169	0.177	0.186	0.195	0.204	0.185
Mixed	0.162	0.170	0.178	0.187	0.196	0.178
Good	0.155	0.163	0.171	0.179	0.188	0.171
Overall	0.162	0.170	0.178	0.187	0.196	0.178

DISCUSSION

Our results suggest that improving nurses' work environment and reducing nurses' workload are organization-wide reforms that could result in fewer readmissions for Medicare beneficiaries with common medical conditions. This is consistent with the evidence showing significant associations between the nurse work environment, staffing, and other patient outcomes.[10,12–15]

The relationship between the organization of hospital nursing services and readmissions presents an opportunity for hospital administrators interested in system-based interventions to improve care. The need for interventions within the immediate control of the hospital is intensifying as payers increasingly shift accountability for outcomes onto hospitals. Intensive, often nurse-led, coordinated care management and transitional care models are currently in practice and hold promise for reducing readmissions.[4–6] Although these targeted programs for managing patients in the hospital and through their transition from the hospital to home are vital, the financial and human resources for such services is limited compared with their demand. In addition, these interventions alone inconsistently prevent readmissions and decrease costs.[7,8] The nursing care environment is an attractive target for organizational intervention because all hospitalized patients are exposed to bedside nursing throughout their hospital stay. Combining targeted transitional care interventions with high-quality inpatient hospital nursing care may yield optimal outcomes for all patients.

Hospitals with good work environments and sufficient nurse staffing formalize an organizational culture that expects and establishes the necessary conditions for nurses to effectively influence transitions throughout the hospital stay while continually preparing patients for discharge. Research has shown that nurses working in hospitals with better nurse staffing levels are better able to provide discharge teaching and get their patients prepared for discharge—factors associated with readmissions.[17] Our data are consistent with these reports: a larger percentage of nurses practicing in better staffed hospitals with good work environments were confident in their patients' ability to manage their care upon discharge.

The clinical significance of the effects of staffing and work environment on readmission could be considerable. On the basis of our estimates, the average difference in heart failure readmission rates between hospitals with poor versus good work environments is 1.4%, which, based on Hospital Compare data, nearly equals the SD in the readmission rate for these patients (1.9%). If a hospital with a poor work environment could improve to a good environment, we would expect its readmission rate to decline from roughly the 84th to 50th percentile or the 50th to 16th percentile in this distribution of hospitals. A hospital that could change its work environment from poor to good and reduce nurse workloads from 6 to 4 patients per nurse would, all else being equal, see their readmission rates reduced from 25% to 21%.

An example of an organizational intervention aimed at improving the work environment is the American Nurses Credentialing Center's Magnet Recognition Program. Evidence suggests that hospitals that have achieved Magnet recognition fit the good work environment category as we have measured it[41,42] and achieve better patient outcomes.[43,44] Short of achieving Magnet recognition, changing the work environment in ways that provide more administrative support for nursing, promote better nurse-physician relationships, and empower nurses to have a stronger role in the decision-making process would all contribute to producing better patient outcomes, including fewer readmissions.

Increasing staffing levels inherently raises concerns regarding costs given the labor costs of nursing for hospitals.[45] Hospitals, however, may be able to make up for some of these costs with increased productivity, reduced costs lost to turnover and retraining, improved patient outcomes, and reductions in postdischarge service utilization and readmission costs.[46–49] Weiss et al[17] showed that postdischarge utilization costs could be significantly reduced by investing in better nurse staffing. The costs of improving work environments and staffing will likely be increasingly offset as new models of care and pay for performance financing increase hospitals' incentives to achieve good outcomes. For example, the Hospital Readmissions Reduction program under the Affordable Care Act will result in reduced Medicare payments to hospitals with excessive readmissions.

The proportion of BSN nurses had a significant effect on readmissions for pneumonia but not the other 2 conditions. A broader set of patient types should be considered to address the question of why having more nurses with BSNs affects readmissions for some patients and not others. Conditional effects of organizational factors and targeted programmatic interventions, for example, the differential effect of intensive discharge planning programs in hospitals with different proportion of BSN nurses, may be an important avenue for research.

This investigation is the largest analysis of the relationship between the nurse work environment, staffing, and readmissions. The chief limitation is that the cross-sectional design limits us to identifying associations rather than causal

inferences about the relationship between the organization of nursing and readmissions. Longitudinal designs should be employed to evaluate the associations we found. There are no perfect measures of nurse staffing and other measures of staffing might have yielded different results. When we estimated models substituting our staffing variable with a staffing variable from another data source (registered nurse hours per patient day from the American Hospital Association), our findings do not substantively change. There are also other ways to define readmissions. We used the CMS approach that allowed subsequent index admissions from the same patient so long as that admission was outside of 30 days (thus no admission could also be counted as a readmission). When we limited our definition to only a single first index admission per unique patient, the sample was smaller but the results were virtually identical (Table 2, Supplemental Digital Content 2, http://links.lww.com/MLR/A387). Finally, there are unmeasured factors that likely contribute to readmissions. These factors may also account for the relatively low c-statistics here and reported elsewhere.[25,27,30] Access to and utilization of primary care is an example, although the research is not clear whether increased primary care access would necessarily reduce readmissions.[1,50]

CONCLUSIONS

Preventing readmissions is an ongoing process that includes helping patients fend off functional decline; preventing, identifying, and mobilizing a team response to complications; providing effective discharge teaching and planning; and advocating for discharge at the appropriate time and with the appropriate coordinated postdischarge resources in place. These fundamental nursing processes of care can make the difference between good and bad outcomes. To do this work effectively, nurses must practice in an environment that reinforces their professional role and autonomy, provides adequate resources, demonstrates consistent and high-quality managerial support and leadership, and includes nursing in institutional decision making. The challenge of readmissions will require a range of interventions. One potentially effective means of reducing overall readmissions may come through improving the organization and delivery of hospital nursing services.

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