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The quality of hospital work environments and missed nursing care is linked to heart failure readmissions: a cross-sectional study of US hospitals

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Abstract

Introduction—Threats to quality and patient safety may exist when necessary nursing care is omitted. Empirical research is needed to determine how missed nursing care is associated with patient outcomes.

Aim—The aim of this study was to examine the relationship between missed nursing care and hospital readmissions.

Methods—Cross-sectional examination, using three linked data sources—(1) nurse survey, (2) patient discharge data from three states (California, New Jersey and Pennsylvania) and (3) administrative hospital data— from 2005 to 2006. We explored the incidence of 30-day readmission for 160 930 patients with heart failure in 419 acute care hospitals in the USA. Logistic regression was used to assess the effect of missed care on the odds of readmission, adjusting for patient and hospital characteristics.

Results—The most frequently missed nursing care activities across all hospitals in our sample included talking to and comforting patients (42.0%), developing and updating care plans (35.8%) and educating patients and families (31.5%). For 4 of the 10 studied care activities, each 10 percentage-point increase in the number of nurses reporting having missed the activity was associated with an increase in the odds of readmission by 2–8% after adjusting for patient and hospital characteristics. However, missed nursing care was no longer a significant predictor of readmission once adjusting for the nurse work environment, except in the case of the delivery of treatments and procedures (OR 1.08, 95% CI 1.02 to 1.14).

Conclusions—Missed care is an independent predictor of heart failure readmissions. However, once adjusting for the quality of the nurse work environment, this relationship is attenuated.

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Improvements in nurses' working conditions may be one strategy to reduce care omissions and improve patient outcomes.

INTRODUCTION

Approximately one in five older patients with heart failure in the USA are rehospitalised within 30 days of discharge.[1] Escalating costs and increased risk of poor long-term outcomes in this population have led to policy initiatives aimed to reduce avoidable heart failure readmissions.[2] Efforts to reduce avoidable readmissions have included a wide range of interventions including investments in additional healthcare personnel such as chronic disease case managers, health coaches and community health workers.[3–7] Though some of these interventions have met with success, they have also faced challenges in scaling up, time intensity requirements and the necessity of training new para healthcare workers.[8 9] Moreover, few of these interventions target the care delivered *during* the acute hospitalisation, and most fail to account for the care provided by hospital staff nurses.

Studies are just now beginning to investigate how the care provided by staff nurses working at the bedside influences hospital readmissions. Organisational features of nursing such as better staffing ratios and the nurse work environment have recently been linked to hospital readmissions.[1011] McHugh and colleagues found, for instance, that care in hospitals characterised by good work environments was associated with an odds of readmission that were 7% lower for patients with heart failure.[10] Similarly, Weiss *et al*[11] found that odds of readmissions and emergency department visits decreased significantly in the presence of higher nurse staffing. The findings of an association between organisational features of nursing and patient outcomes are consistent with longstanding research conducted in the USA and Europe using survey responses of nurses.[1213]

While the link between workloads, environments and readmissions has been described in the literature, less is known about the extent to which various nursing care activities (including patient education, care coordination and nurse communication) independently influence readmissions. Recent studies suggest that nurses are unable to complete even basic nursing care due to a lack of time and that such care omissions result in poor patient outcomes.[14–17] One explanation for the occurrence of missed care may be that nurses are working in settings that are inadequately resourced.[1819] In a study by Ball *et al*,[20] fewer elements of care were missed and the odds of missing any care were significantly lower when nurses cared for less patients. Our study builds conceptually on research about missed nursing care and extensive literature linking nursing organisational features to patient outcomes.[21–26] We extend the literature through our investigation of the association between these features of nursing and heart failure readmissions. Our study explores these relationships and asks:

1. What is the prevalence of missed care (ie, care that nurses regard as necessary but was left undone on their last shift due to a lack of time, and which places patients in harm's way)? And does missed care vary across hospitals characterised by different work environments?
2. What is the association between missed nursing care and heart failure readmissions?

3. Is the relationship between missed nursing care and readmission attenuated once adjusting for the nurse work environment?

Our study estimates a structural model as described by Donabedian's quality model.[27] For the purpose of this study, we examine the relationship between the nurse work environment (structure), missed nursing care (process) and patient readmissions (outcome).

METHODS

Design

We performed a cross-sectional analysis using secondary data of 419 general acute care hospitals in the USA. The study included 20 605 professional bedside nurses and >160 930 patients from participating hospitals. Our study used three linked data sources from 2005 to 2006: the University of Pennsylvania Multi-State Nursing Care and Patient Safety Survey of registered nurses (RNs), administrative patient discharge records and the American Hospital Association (AHA) Annual Survey. This study included adult non-federal acute care hospitals in three states (California, New Jersey and Pennsylvania) that (1) had a minimum of 50 heart failure index admissions during the study period, (2) had a minimum of 10 respondents to the nurse survey and (3) participated in the 2006 AHA Annual Survey.

Setting and sample

Nurses—Our study employed the use of survey data from three states that were collected through the Multi-State Nursing Care and Patient Safety Survey, a large mail-based study conducted by the University of Pennsylvania. Large random samples of RNs were surveyed between 2005 and 2006. Our sampling fraction for the survey included 40% of all RNs in California and Pennsylvania, respectively, and 50% of nurses in New Jersey. Details about the survey methodology are available elsewhere.[12] The response rate was 39%. Extensive follow-up of 1300 non-responders, using a $10 monetary incentive, obtained a higher response rate of 91%. Further evaluation revealed no non-response bias associated with the measurement of the key variables in this report.[28] The survey included items related to nurse demographics, workload, the work environment and the care provided to patients on the respondent's last shift. Nurses were also asked to provide the name of their employer.

Hospitals—We used the nurse survey data described above and the AHA Annual Survey data to characterise the 419 hospitals in our study. Study hospitals included an average of 49 nurse survey respondents, ranging from 10 to 282 nurses. Hospital characteristics derived from the AHA Annual Survey provided information on hospital's organisational structure (eg, teaching status, high-tech capacity) and total beds.

Patients—The sample included individuals aged 65–90 years with a principal diagnosis of heart failure. Patient discharge data were obtained from California's Office of Statewide Health Planning and Development, the New Jersey Department of Health and Senior Services and the Pennsylvania Health Care Cost Containment Council. These data included patient demographics, discharge disposition, length of stay (LOS), and primary and secondary diagnosis and procedure codes based on the *International Classification of Diseases 9th revision Clinical Modification*. We merged patient zip codes derived from the

administrative patient data with publically available US. Census-based data to derive a neighbourhood socioeconomic index measure, as outlined in previous work,[29] and will adjust for the influence of socioeconomic status (SES) in our models.

Variables and measures

Outcome variable (analysed at the patient level)—Our primary outcome variable was all-cause readmission within 30 days of discharge from an index admission for heart failure.[2] Index heart failure admissions were defined based on the Centers for Medicare and Medicaid Services (CMS) Risk-Standardized Readmission Measures.[30–32] The patient's first admission during the study period (for which there was no prior admission within 30 days for the same condition) was selected as the index admission. Because each patient in the state databases is assigned a unique pseudo-identifier, we are able to identify readmissions even when the patients were readmitted to a different hospital than they were discharged from on the prior admission. Consistent with the CMS readmission measure, we excluded patients who left the hospital against medical advice, died during the hospitalisation, were discharged to another acute care facility or who were discharged the same or next day.[32]

Explanatory variables (analysed at the hospital level)—We used the nurse survey to calculate hospital-level measures of missed nursing care. Respondents were asked to report whether they left incomplete any of the 10 common nursing activities on their last shift due to lack of time. For each intervention, the percentage of nurses in each hospital who reported that they left the care incomplete was calculated and aggregated as a mean to the hospital level. The nursing care activities included pain management, providing treatments and procedures, coordinating patient care, administering medication on time, preparing patients/families for discharge, adequate patient surveillance, documenting nursing care, teaching/counselling patients/families, developing or updating care plans, and comforting/ talking to patients.

Potential confounding variables (analysed at the hospital level)—The nurse work environment was measured using the Practice Environment Scale of the Nursing Work Index (PES-NWI) that was included in the nurse survey.[33] PES-NWI has well-established psychometric properties and is a National Quality Forum-endorsed measure.[3435] Each nurse completed the 31-item instrument, which is divided into five subscales related to staffing and resource adequacy, participation in hospital affairs, nurse manager leadership, foundations for quality of care and relations between nurses and physicians. Nurses' individual subscale scores were aggregated to the hospital level. Intraclass correlation coefficients (1,k) ranged from 0.74 for the nurse–physician relations subscale to 0.91 for the participation in hospital affairs subscale. As all five PES subscale scores exceeded 0.6, aggregation to the hospital level was justified.[36] Median scores of each PES-NWI subscale were then calculated for each hospital. The quality of each hospital's nurse work environment was then classified into three distinct categories based on the number of subscales that exceeded the median. Hospitals were classified as poor (0–1 subscales), mixed (2–3 subscales) or good (4–5 subscales).[101237]

A measure of nurse staffing was estimated from the nurse survey by dividing the average number of patients on the unit by the average number of RNs on the unit during their last shift. These individual values were aggregated to create a hospital-level nurse staffing variable. Prior studies have demonstrated the predictive validity of this measure of nurse staffing.[2938] Structural characteristics of our hospital sample were derived from the AHA Annual Survey and included teaching status, size, technology capability, ownership and core-based statistical area (a Census-based measure of population density). We linked Medicare cost-to-charge report data to calculate a measure of hospital operating margin directed towards patient care (ie, the ratio of total hospital revenue to operating expenses).[10] Finally, we used the patient discharge data to create a volume measure for each hospital that accounted for the number of heart failure cases treated during the study period.[39]

Analysis

We first descriptively examined the characteristics of the patients and hospitals in our sample using frequencies. We calculated the mean percentage and SD of each of the 10 specified care activities that nurses reported missing (despite being considered necessary) in each hospital. Analysis of variance procedures were used to estimate and test the significance of the differences in percentages of missed nursing care between hospitals with different work environments. To examine the association between missed nursing care and heart failure readmissions, we employed a set of mixed-level, robust fixed effects logistic regression models that accounted for the clustering of patients in hospitals. We scaled the nursing care activities by a factor of 10 so that coefficients could be interpreted as the change in readmission odds associated with a 10 percentage-point increase in the number of nurses reporting that the care intervention was not done. The adjusted models estimate the effects of missed care on readmissions while adjusting for, sequentially, (1) patient characteristics (age, sex, race, ethnicity, SES, LOS, discharge disposition and the presence of 27 individual comorbidities as defined by Elixhauser[40]); (2) structural hospital characteristics (nurse staffing, teaching status, size, technology capability, ownership, population density, volume of patients with heart failure, Medicare cost-to-charge ratio and state); (3) both patient and hospital characteristics; and (4) patient characteristics, hospital characteristics and the nurse work environment.

RESULTS

Characteristics of patients with heart failure in the study sample are described in table 1.

Among the 160 930 unique patients with heart failure index admissions, 38 382 (23.9%) patients were readmitted within 30 days of discharge. This finding is consistent with national readmission rates as reported in the Dartmouth Atlas database between 2004 and 2010.[41] The median LOS in our sample was 5.9 days. More than half (55%) of the sample was women, with a median age of 79.1 years. The most frequent reason for readmission was heart failure (33.8%), followed by acute renal failure (4.5%) and pneumonia (3.8%). More than half (n=82 420; 51.2%) of the patients were discharged from the hospital to home. Nearly one-quarter (n=37 990; 23.6%) of patients were discharged home with home healthcare.

Table 2 describes the distribution of the study sample by patients, hospital and nursing characteristics. The majority of the hospitals (50.4%) and patients (41.7%) in the sample were located in California. Over a third of the hospitals in our sample (n=163, 39.1%) were characterised by good work environments, while 157 hospitals (37.7%) had poor work environments. The remaining 23.3% (n=97) of work environments were of mixed quality. The distribution of patients across work environment types revealed a similar pattern of poor (n=67 827, 39%) and good environments (n=61 616, 38.3%). Within the study hospitals, the mean patient-to-nurse ratio was 5:1 (SD 1.06).

The average number of items missed during a shift was 1.92 out of 10. In table 3, we present the distribution and frequency of care that nurses were unable to complete in a shift due to a lack of time across our entire hospital sample (n=419) and between good (n=163), mixed (n=97) and poor work environments (n=157).

When comparing working conditions, we found that a greater percentage of nurses reported being unable to talk to (47.5% vs 37.1%, $p<0.001$), complete care plans for their patients (40.5% vs 31.9%, $p<0.001$) or teach (38.1% vs 25.2%, $p<0.001$) in poor as compared to good working environments. Nurses were less apt to report missing medical treatments (3.5% vs 4.4%, $p=0.03$) or pain management (3.2% vs 5.1%, $p<0.001$) in good as opposed to poor work environments.

Table 4 displays ORs of 30-day readmission for each missed nursing care intervention. The unadjusted ORs indicate that, before adjusting for patient and hospital characteristics, patients were more likely to experience a readmission when nursing care activities were more frequently missed with the exception of pain management and timely medication administration. For every 10-point increase in the percentage of nurses who reported missing nursing care, the odds of a patient being readmitted increased by 3% for care planning, discharge preparation and surveillance; by 4% for documentation, talking/comforting and teaching/counselling; by 6% for care coordination and by 12% for treatments and procedures. After adjusting for patient and hospital characteristics, the odds of readmission remained significantly increased when care planning (OR 1.02, 95% CI 1.00 to 1.03), teaching (OR 1.02, 95% CI 1.00 to 1.04), care coordination (OR 1.03, 95% CI 1.00 to 1.06) and treatments (OR 1.08, 95% CI 1.02 to 1.14) were missed.

While our ORs convey the risk of readmission for each 10% increase in missed nursing care, the effect sizes are particularly meaningful given that reports of missed care ranged widely across hospitals in our sample (table 3). Care coordination, for example, where OR 1.03 (before taking account of the work environment) and the range in the per cent reporting missed care coordination is 0–38%, the difference in readmissions between a hospital in which 5% report missed care coordination and 35% report missed care coordination would be $1.03\times1.03\times1.03=1.09$, or about 9% greater. For care planning, where OR 1.02 (before taking account of the work environment) and the range in the per cent reporting missed care planning is 0–81%, the difference in readmissions between a hospital in which 15% report missed care planning and 75% report missed care planning would be $1.02\times1.02\times1.02\times1.02\times1.02\times1.02\times1.02=1.13$, or about 13% greater.

In our final model, we examined whether the relationships between missed nursing care and readmissions were attenuated by the nurse work environment. Once adjusting for the work environment, the effect of missing essential nursing was no longer a significant predictor of readmission. The exception to this trend was in the case of treatments and procedures, where the odds of readmission remained elevated even after adjusting for the quality of the work environment (OR 1.07, 95% CI 1.01 to 1.13).

DISCUSSION

Our results reveal an association between missed nursing care and heart failure readmissions. The relationship between missed nursing care and heart failure readmissions is largely contingent, however, on the quality of the nurse work environment such that nurses working in favourable conditions are less apt to report missing care. Optimal or good working conditions are often characterised by ‘magnet-like’ properties, such as collegial interprofessional relationships, investments in staff development and adequate managerial resources.[42] In these settings, adequate institutional support is devoted to nursing, which in turn fosters an environment where nurses are able to more efficiently deliver patient care.[33]

Our findings add to the growing body of literature that demonstrates a relationship between readmissions and the working conditions of nurses.[43] Recent studies have suggested that hospitals may experience fewer CMS readmission penalties by increasing financial resources devoted to nursing care.[43] Others have found that the cost of such investments is offset by the return in savings due to reduced 30-day readmissions and postdischarge emergency department visits.[11]

From a clinical perspective, investments in nursing resources may provide nurses with the time and support necessary to attend to the multifaceted needs of patients with heart failure. Research suggests that a range of factors influence heart failure readmissions, including decompensation in renal function, high rates of medical comorbidities, challenges with adherence, psychosocial stressors and functional limitations.[44–46] Our findings suggest that missing essential nursing care may hinder a nurse’s ability to discern and attend to the complex care needs of this population, which subsequently increases the likelihood of repeat hospitalisations. We also note that patients with heart failure are commonly rehospitalised for a variety of reasons, including acute renal failure and pneumonia. A relevant area for future research should consider the relationship between the reasons for repeat hospitalisations and missed nursing care.

Nurses in our sample reported wide variation in their ability to complete all necessary care interventions during their most recent hospital shift. Nurses were less apt to miss aspects of care that were more technologically oriented, such as providing medications in a timely fashion, managing patient pain, and completing procedures and treatments. In contrast, aspects of nursing care that may be viewed as a lower immediate priority such as comforting and talking with patients, completing care plans, patient education and documentation were more likely to be missed. Roughly 40% of nurses reported being unable to talk with their patients during the last shift; within these interactions may be important moments in which additional knowledge about the patient can be gleaned or patients’ questions may be

answered. Likewise, nearly one-third of nurses reported that they were unable to complete patient teaching, which is of utmost importance to patients with heart failure who require a significant amount of education regarding medications, diet, signs and symptoms of fluid retention, and instructions about when to contact their care provider.[47]

The care activities with the greatest effect on readmission risk (ie, talking/comforting, care planning, teaching, care coordination) include activities that are often time intensive for the nurse and require developing an interpersonal relationship with the patient. When completed, these essential care activities can foster engagement between providers and patients around salient factors influencing disease management, including, social, economic and personal challenges that impede patient self-management and adherence.[4849] Helping patients manage chronic conditions requires fostering patient engagement and aligning patient and provider goals of care. When time constraints force nurses to omit necessary care, the relational nature of nursing practice is compromised, resulting in threats to patient outcomes.

Some of the nursing care activities in this study were not found to be significant predictors of readmission, when missed. We were surprised, for instance, that missing discharge preparation did not significantly increase patients' risk for readmission. However, discharge preparation is typically narrowly targeted on the discharge diagnosis and does not consider other health and social factors that may contribute to exacerbations of a chronic condition. Furthermore, this finding is not surprising in light of a systematic meta-review revealing limited evidence linking discharge planning to postdischarge adverse events.[7] Finally, our measure of discharge preparation may theoretically overlap with other essential activities that are part of the discharge process, including care coordination and patient education.

To our knowledge, ours is the first study to empirically examine the relationship between missed nursing care and heart failure readmissions. In so doing, we provide support for the consideration of interventions that reflect the full range of nursing care activities associated with readmissions and recognise the organisational context where nursing care takes place. Future work must also examine whether patients subjectively report noting the absence of necessary nursing care and whether such omissions are reflected in reports of patient satisfaction. Additional research is also needed to determine the impact of missed care in other patient populations that are at increased risk for readmissions.

Limitations

Because of the cross-sectional nature of our study, we are unable to assert causality. In addition, because our measures were drawn from nurse reports, there is a risk that the actual occurrence of missed care may be inaccurately reported, although other research has validated nurse reports of quality.[50] While our survey includes many activities commonly performed by nurses, there are aspects of nursing care that are not captured by our survey, such as maintaining universal infection precautions and reviewing laboratory tests and diagnostics. We also note the age of our data drawn from 2005 to 2006 and that our analysis is restricted to three US states. Despite these limitations, we are confident in the generalisability of our findings. Our sample of hospitals represents roughly 20% of the acute care admissions in the USA and by extension a similar percentage of readmissions. Finally,

we note that the introduction of policies since 2010 to reduce readmissions may have influenced nursing and hospital care, subsequently raising questions about the relevance of our findings to readmission rates today. However, evidence suggests that the financial penalties currently levied against hospital systems compromise only a small portion of the base CMS reimbursements and that the penalties are too small to incentivise immediate practice changes.[5152] Therefore, our findings drawn from 2006 illuminate important nursing practices that remain relevant.

CONCLUSION

Chronically ill patients, including those with heart failure, require comprehensive care management that must begin during a hospitalisation. However, increasing demands on staff nurses paired with increasing patient acuity and complexity may result in patient clinical needs outpacing nurses' ability to meet them. Our finding that nurses are less apt to miss care in hospitals with more supportive environments suggests that affording nurses the time and resources to attend to these various needs may prove beneficial in reducing readmissions.

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Table 1

Characteristics of patients with heart failure

Patient characteristics	No. (%) N=160 930
Readmission within 30 days	38 382 (23.9)
Length of stay (day), median (IQR)	5.9 (3–7)
Age (years), median (IQR)	79.1 (74–85)
Women	88 566 (55)
Discharge disposition	
Home	82 420 (51.2)
Home with home healthcare	37 990 (23.6)
Skilled nursing facility	21 771 (13.5)
Intermediate care	550 (0.3)
Other facility	18 199 (11.3)
Top reasons for readmission	
Congestive heart failure	12 983 (33.8)
Acute renal failure	1711 (4.5)
Pneumonia	1457 (3.8)
Cardiac dysrhythmias	1376 (3.6)
Hypertension w/complications	1280 (3.3)
Septicaemia	1257 (3.3)
Respiratory failure	1167 (3.0)
Coronary atherosclerosis/heart disease	1058 (2.8)
Fluid and electrolyte disorders	953 (2.5)
COPD	921 (2.4)

Author's analysis.

Top reasons for readmission are based on the Agency for Healthcare Research and Quality's Clinical Classification Software.

COPD, chronic obstructive pulmonary disease.

Table 2

The distribution of hospital and nursing characteristics for study hospitals and patients

Characteristics	Hospital (N=419) No. (%)	Patient (N=160 930) No. (%)
Hospital characteristic		
State		
California	210 (50.4)	67 049 (41.7)
New Jersey	70 (16.8)	31 309 (19.5)
Pennsylvania	137 (32.9)	62 572 (38.9)
Region		
Division	192 (46.0)	77 222 (48.0)
Metro	183 (43.9)	73 575 (45.7)
Micro	35 (8.4)	9007 (5.6)
Rural	7 (1.7)	1126 (0.7)
Ownership		
For profit	44 (10.6)	12 567 (7.8)
Not-for-profit	346 (83)	140 974 (87.6)
Government, non-federal	27 (6.5)	7389 (4.6)
High technology	185 (44.4)	88 860 (55.2)
Hospital size		
Small	46 (11.0)	8460 (5.3)
Medium	192 (46.0)	62 909 (39.1)
Large	179 (42.9)	89 561 (55.7)
Teaching status		
Non-teaching	215 (51.6)	75 284 (46.8)
Minor teaching	163 (39.1)	66 953 (41.6)
Major teaching	39 (9.4)	18 693 (11.6)
Nursing characteristic		
Work environment		
Poor	157 (37.7)	62 827 (39)
Mixed	97 (23.3)	36 487 (22.7)
Good	163 (39.1)	61 616 (38.3)
Nurse staffing (patients/nurse)		
<4	84 (20.1)	26 328 (16.4)
4 to <5	154 (36.9)	60 629 (37.7)
5 to <6	105 (25.2)	46 180 (28.7)
6 to <7	51 (12.2)	21 072 (13.1)
≥7	23 (5.5)	6721 (4.2)

Author's analysis.

Percentages may not sum to 100% due to rounding. High-technology hospitals conduct organ transplants, open heart surgery, or both.

Table 3

Percentages of nurses reporting missed care by quality of nurse work environment

Nursing care activity	All hospitals N=419 Mean % (SD) (range)	Poor environment N=157 Mean % (SD)	Mixed environment N=97 Mean % (SD)	Good environment N=163 Mean % (SD)	p Value
Talking/comforting	42.0 (10.8) (16.6–79.0)	47.5 (10.4)	41.1 (9.6)	37.1 (9.4)	<0.001
Care planning	35.8 (13.1) (0–80.8)	40.5 (13.4)	34.6 (13.1)	31.9 (11.1)	<0.001
Teaching/counselling	31.5 (11.2) (0–72.7)	38.1 (10.4)	31.4 (10.6)	25.2 (8.3)	<0.001
Documentation	23.2 (9.0) (0–54.5)	26.5 (10.2)	23.1 (7.8)	20.2 (7.1)	<0.001
Surveillance	17.8 (9.3) (0–63.6)	23.0 (10.1)	16.9 (7.4)	13.3 (6.8)	<0.001
Discharge preparation	13.7 (6.8) (0–42.9)	15.8 (7.2)	12.9 (7.0)	12.1 (5.6)	<0.001
Timely medications	10.6 (6.5) (0–40.0)	11.7 (7.0)	10.1 (6.9)	9.8 (5.6)	0.03
Care coordination	9.5 (5.8) (0–37.9)	11.4 (6.1)	9.3 (6.3)	7.8 (4.5)	<0.001
Treatments/procedures	3.8 (3.5) (0–16.0)	4.4 (4.1)	3.4 (3.2)	3.5 (3.1)	0.03
Pain management	4.0 (3.7) (0–20.0)	5.1 (4.2)	3.4 (3.6)	3.2 (3.0)	<0.001

Author's analysis

Values based on hospital aggregated nurse responses from the multistate nurse survey. Higher percentages reflect more missed care. p Values generated from analysis of variance and reflect differences in missed care between practice environments.

Table 4

Effect of a 10% increase in missed nursing care on odds of 30-day readmission

Nursing care activities	Model 1 Unadjusted OR (95% CI)	Model 2 Patient characteristics OR (95% CI)	Model 3 Hospital characteristics OR (95% CI)	Model 4 Patient and hospital characteristics OR (95% CI)	Model 5 Patient, hospital characteristics and work environment OR (95% CI)
Care coordination	1.06***	1.05**	1.05**	1.03*	1.02
	(1.03 to 1.09)	(1.02 to 1.08)	(1.02 to 1.08)	(1.00 to 1.06)	(0.99 to 1.05)
Documentation	1.04***	1.03**	1.02	1.01	1.00
	(1.02 to 1.06)	(1.01 to 1.05)	(1.00 to 1.04)	(0.99 to 1.03)	(1.00 to 1.02)
Timely medications	1.03	1.02	1.02	1.01	1.01
	(1.00 to 1.06)	(0.98 to 1.05)	(0.99 to 1.05)	(0.98 to 1.04)	(0.97 to 1.04)
Pain management	1.01	0.99	0.99	0.97	0.95
	(0.96 to 1.07)	(0.94 to 1.05)	(0.94 to 1.05)	(0.91 to 1.02)	(0.90 to 1.01)
Care planning	1.03***	1.03***	1.02**	1.02*	1.01
	(1.02 to 1.05)	(1.02 to 1.04)	(1.01 to 1.03)	(1.00 to 1.03)	(1.00 to 1.03)
Discharge preparation	1.03*	1.03	1.02	1.02	1.01
	(1.00 to 1.06)	(0.99 to 1.06)	(0.99 to 1.05)	(0.99 to 1.05)	(0.98 to 1.04)
Surveillance	1.03**	1.03**	1.02	1.01	1.00
	(1.01 to 1.05)	(1.01 to 1.05)	(1.00 to 1.04)	(0.99 to 1.03)	(0.98 to 1.02)
Talking/comforting	1.04***	1.03**	1.03***	1.02	1.01
	(1.02 to 1.05)	(1.01 to 1.05)	(1.01 to 1.05)	(1.00 to 1.04)	(1.00 to 1.03)
Teaching/counselling	1.04***	1.04***	1.03***	1.02*	1.01
	(1.03 to 1.06)	(1.02 to 1.06)	(1.02 to 1.05)	(1.00 to 1.04)	(0.99 to 1.03)
Treatments/procedures	1.12***	1.09**	1.10***	1.08**	1.07*
	(1.06 to 1.18)	(1.04 to 1.15)	(1.04 to 1.16)	(1.02 to 1.14)	(1.01 to 1.13)

Author's analysis

Model 2 adjusts for patient-level characteristics: race, age, sex, comorbidities, length of stay, socioeconomic status and discharge disposition. Model 3 adjusts for hospital-level characteristics: geographical location, profit type, technology status, teaching status, bed size, volume, cost-to-charge ratio and nurse staffing. Model 4 adjusts for patient and hospital characteristics. Model 5 adjusts for patient, hospital characteristics and the nurse work environment. All models used robust procedures to account for clustering of patients in hospitals.

*p<0.05,

** p<0.01,

*** p<0.001.