

STTI FINAL GRANT (Application ID# 10361) REPORT

STTI Final Grant Report

For

Project “Unit Climate of Teamwork and Nursing Leadership, and the Effects on Patient Outcomes”

Project Application ID Number 10361

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Summary of Project Aims

In October, 2010, the Institute of Medicine (IOM) through its committee on the Robert Wood Johnson Foundation Initiative on the Future of Nursing released a report titled *The Future of Nursing: Leading Change, Advancing Health*. This landmark report highlighted opportunities as well as challenges in nurses' partnership with other health care professionals and nursing leadership in redesigning health care in the United States.[1] Teamwork among health care professionals and nursing leadership are two essential attributes of the nurse work environments in which delicately designed patient care is accomplished.[2, 3] There is a merging research base documenting the link between favorable nurse work environments and better nurse and patient outcomes.[4-8] While conceptualizing them as essential components of the overall work environment, these studies rarely examined the individual effect of teamwork or nursing leadership on patient outcomes. Therefore, there is a critical need to empirically examine the impact of teamwork and nursing leadership as important organizational factors on patient outcomes. In particular, those outcomes that are considered serious patient safety issues and adverse events, such as pressure ulcer, patient falls, and hospital-acquired infections, are worth special attention. These patient outcomes result in physical, mental, social, and financial harms. [9, 10] They have drawn national attention and are under growing regulatory scrutiny.

The **purpose of this study** is to examine teamwork and nursing leadership in U.S. acute care hospital units and to identify their effects on patient safety indicators. To the best of our knowledge, this study is the first that uses large data from hospitals nationwide to provide empirical evidence of the impacts of teamwork and nursing leadership on patient outcomes at the nursing unit level. Findings from this study will contribute to our understanding of the structure-outcomes relationship and inform hospital administrators and policy makers on how to redesign nurse work environments for patient safety and high quality of patient care.

Specific Aim 1: To describe levels of unit teamwork (nurse-physician teamwork and nurse-nurse teamwork) and nursing leadership, and their variations by hospital- and unit-level organizational characteristics (e.g., hospital size, teaching status, Magnet status, hospital location, unit type, nurse staffing, and nurse education and specialty).

Specific Aim 2: To determine the extent to which unit teamwork and nursing leadership are associated with patient outcomes (i.e., patient falls, hospital-acquired pressure ulcer, and other hospital-acquired infections) controlling for hospital- and unit-level characteristics.

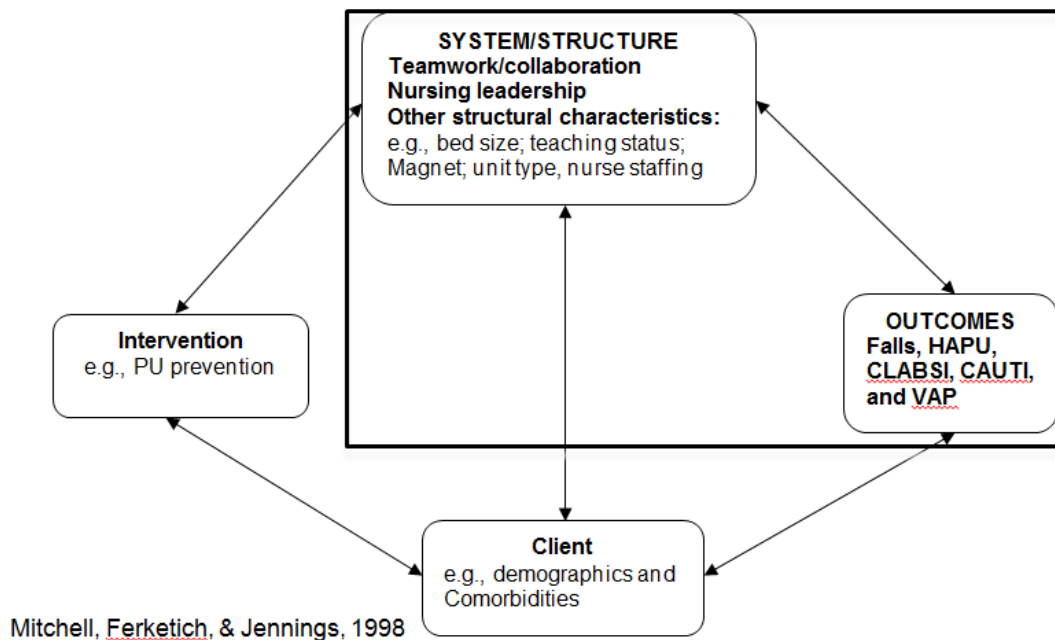
Theoretical Framework

While Specific Aim 1 is descriptive, Specific Aim 2 will be guided theoretically by the Quality Health Outcomes Model (QHOM) by Mitchell and colleagues (Figure 1), a model designed with the purpose of guiding quality of care evaluation and research.[11] The QHOM is an elaboration and extension of the classic Donabedian's structure-process-outcome model.[12] Incorporating new findings in health outcomes research, Mitchell and colleagues extended Donabedian's linear model into a dynamic model that captures the multiple feedback loops between the components of the model. The QHOM includes four components: system/structure, intervention, client, and outcomes. According to Mitchell and colleagues, the relationships

between the four components are bidirectional; and the effect of intervention on outcomes is mediated by system characteristics and client characteristics.

This study will focus only on the link between system/structure and outcomes (highlighted in the box Figure 1). Over the past two decades, increasing evidence has linked organizational factors to patient and nurse outcomes. [4-6, 13, 14, 15, 16] In these studies, nurse work environment has been considered an important structural factor that influences health outcomes. It is commonly accepted that teamwork and nursing leadership are two critical attributes of the nurse work environment, although their effects on patient outcomes rarely have been studied individually. Therefore, this proposed study considers teamwork and nursing leadership as two important structural factors, characterizing the environments in which nurses interact with their nurse peers, other health care professionals, and patients when influenced by nurse leaders. This proposed project hypothesizes that better teamwork and nursing leadership are associated with better patient outcomes.

Figure 1. Theoretical Framework Adapted from the Quality Health Outcomes Model



Methods, Procedures and Sampling

Research Design and Data Sources

This is an observational cross-sectional study using secondary data to examine the role of two essential elements of the nurse work environments – teamwork and nursing leadership – in relation to patient outcomes. All data were collected in 2013 and from NDNQI, including patient outcomes dataset, the Registered Nurse (RN) survey, and hospital and unit administrative dataset.

Sample and Setting

NDNQI RN survey was used for information measuring unit teamwork, nursing leadership, unit nursing characteristics. To be eligible for the RN survey, nurses had to meet the following criteria: 1) spent at least 50% of their time providing direct patient care; 2) had a minimum of 3-month employment in the current unit; and 3) were not agency or contract nurses. Nurses' response will be aggregated to unit level for the analyses.

NDNQI collects unit-level patient outcomes data on a monthly and/or quarterly basis. For all the included patient outcomes in this study, we calculated the annual rate on a unit. Only units with data for at least 9 months or 3 quarters in 2013 were included.

The analysis unit of this study is the nursing units. We will include adult critical care, step-down, medical, surgical, and medical-surgical units that participated in the RN survey in 2013 and had data on at least one of the study outcomes. To ensure the reliability of unit measures of teamwork and nursing leadership aggregated from individual nurse' reports, we excluded units with less than 5 nurse respondents and a response rate smaller than 50%.

Measures/Instruments

Teamwork. Teamwork was measured by two 6-item scales: nurse-nurse (NN) interaction scale and nurse-physician (NP) interaction scale. These two scales were adapted from the Index of Work Satisfaction, [37] a widely used scale for measuring nurses' attitudes toward specific aspects of their jobs, and have been tested in pilot studies for feasibility and reliability. [38]

Nursing leadership. Nursing leadership was measured by the supportive nursing management (NM) scale (5 items), a scale adapted from the Practice Environment Scales of Nursing Work Index (PES-NWI).

We operationalized teamwork and nursing leadership as unit-level organizational factors by aggregating individual nurse responses to unit level. For each items in the three scales (NN scale, NP scale, and NM scale), response options were provided on a six-point Likert-type scale from strongly disagree (1) to strongly agree (6). We first calculated each scale score for each nurse respondent as the mean of the items comprising the respective scale; we then calculated the unit-level scale scores as the mean of scale scores across all the nurses in a unit. Higher scores represent better collaboration or more supportive nursing leadership in a unit.

Hospital-acquired pressure ulcers (HAPUs). We calculated the total HAPU rate as the proportion of patients who developed HAPUs of any stage per every 1,000 patients assessed in each study unit.

Patient falls. The unit fall rate was operationalized as the number of falls per 1,000 patient days over the year of 2013.

Hospital-Acquired Infections. Three hospital-acquired infections were included, central line-associated blood stream infections (CLABSIs), Catheter-associated urinary tract infections (CAUTIs), and Ventilator-associated pneumonia (VAP). The unit rate for each condition was calculated as the number of events per 1,000 catheter days over the year of 2013.

Covariates. A group of hospital and unit characteristics were included as covariates, including nurse staffing (measured as patient-to-nurse ratio), unit type, unit proportion of female nurses, white nurses, nurses holding bachelor degrees or above, with specialty certification, and working fulltime, hospital ownership, teaching status, bed size, and Magnet status.

Plan for Data Management and Analyses

All data were obtained from NDNQI. Missing data were checked and managed by NDNQI analysts before transferred to the PI. We further cleaned and managed the data by applying inclusion and exclusion criteria in this study.

For Aim 1, our analytical dataset was created by linking RN survey to the hospital and unit administrative dataset. It included 958 nursing units (24,034 nurse respondents to the NDNQI RN survey) from 168 acute care hospitals. Descriptive statistics such as frequencies and measures of central tendency were used to describe patient outcomes and levels of unit teamwork and nursing leadership across units and hospitals respectively. Analysis of Variance were conducted to identify hospital and unit characteristics that were associated with unit teamwork and nursing leadership.

For Aim 2, by linking RN survey and hospital and unit administrative dataset to each patient outcomes dataset, we created 5 analytical datasets with different sample sizes (900 units from 160 hospitals for HAPU, 860 units from 152 hospitals for patient falls, 592 units from 129 hospitals for CAUTI, 586 units from 126 hospitals for CLABSI, and 95 units from 64 hospitals for VAP). A series of two-level hierarchical regression models were used to estimate the effects of unit teamwork or nursing leadership on each patient outcomes when controlling for hospital- and unit-level covariates and nurse staffing. A random effect for hospitals was included in all regression models to account for clustering of units within hospitals. Specifically, hierarchical logistic regression model was used for HAPUs because measure for HAPUs is the number of patients with HAPUs among all patients surveyed; and hierarchical Poisson regression models were used for the other patient outcomes because these outcomes are the counts of events within total patient days or patient catheter days over the study period.

All data management and analyses were completed using STATA 14.0. Statistical significant level (alpha) was set at .05.

Summary of Findings

Findings from Approaching Aim 1

This is a unit level analyses that included 958 nursing units from 168 acute care hospitals in US. To construct the unit-level measures of teamwork, nursing leadership, and other unit nursing characteristics, we used responses of 24,034 nurses to the NDNQI RN survey).

Table 1 summarizes the characteristics of nurses whose information were aggregated for measures at the unit level. On average, nurses were 38 years ($SD=11$) old with an average of 10 years ($SD=10$) working experience as RN and 6 years ($SD=6$) working on current unit. Majority

of them were female (89%), white (67%), and working fulltime (84%). Sixty-eight percent of them held a bachelor degrees (BSN) or above and 64% had at least one specialty certificate.

Table 1. Characteristics of Nurse Respondents to the RN survey (n=24,034)

	Mean (SD)	No. (%)
Age	37.6 (11.3)	
RN tenure (years as an RN)	10.0 (9.7)	
Unit tenure (years on current unit)	5.7 (6.3)	
Gender		
Female		20,896 (89.1)
Race/Ethnicity		
White		19,994 (68.5)
Black		1,772 (7.6)
Asian/Pacific		3,078 (13.2)
Hispanic/Latina(o)		991 (4.25)
Other		1,503 (6.4)
BSN degree or higher		16,218 (68.0)
Specialty certificate		15,240 (64.3)
Fulltime		19,909 (83.9)
Unit types		
Critical care unit		6,512 (27.1)
Step-down unit		3,775 (15.7)
Medical unit		4,712 (19.6)
Surgical unit		3,404 (14.2)
Med-Surgical combined unit		5,631 (23.4)

Table 2 shows the characteristics of study hospitals and units of different types. Of the 168 hospitals study, 85% were non-for-profit hospitals, 48% were teaching hospitals, 48% were medium size hospitals with 100-299 stuffed beds, and approximately 66% were Magnet hospitals. Of the 5 unit types, step down units had the least number of units (15%) and medical-surgical combined units had the largest number of units (27%).

Table 3 shows unit teamwork, nursing leadership, and other unit characteristics of the 958 study units, overall and by unit types. Overall, units had a mean score of 4.59 (SD=.33) on the nurse-nurse interaction scale (NN scale), 4.14 (SD=.35) on the nurse-physician interaction scale (NP scale), and 4.33 (SD=.65) on the nursing leadership scale (NM scale). Overall, units had a mean patient-to-nurse ratio of 5.01 (SD=1.70), working experience as RNs of 10.37 years (SD=4.23) and working experience on current unit of 5.67 years (SD=2.77). On averages, units had 90% of their nurses being female, 68% being white, 65% with BSNs or above, 9% with

basic nursing education completed abroad, 62% with specialty certificate, and 84% working fulltime. One-Way Analysis of Variance (ANOVA) also indicated that statistical significant unit type differences existed in unit NP scale scores, NM scale scores, patient-to-nurse ratios, work experience as RNs, working experience on current unit, unit proportion of female nurses, nurses with BSN, nurses with specialty certificate, foreign educated nurses, and nurse working fulltime.

Table 2. Hospital Characteristics and Units Types (n=958 units from 168 hospitals)

	No.	%
Hospital characteristics		
Ownership		
Non-profit	143	85
Profit	14	8.33
Government-owned	11	6.55
Bed size		
Small, <100 beds	38	22.62
Medium, 100-299 beds	80	47.62
Large, >=300 beds	50	29.76
Teaching status		
Academic medical center	20	11.9
Teaching hospitals	60	35.71
Non-teaching hospitals	88	52.38
Magnet status		
Non-Magnet	111	66.07
Magnet	57	33.93
Unit characteristics		
Unit types		
Critical care	212	22.3
Step-down	148	15.45
Medical	186	19.42
Surgical	155	16.18
Medical-surgical combined	257	26.83

We conducted ANOVA to identify hospital characteristic that were associated with different levels of teamwork and nursing leadership on units (**Table 4**). Results from analyses shows that hospital ownership and hospital bed size were associated with nurse-nurse interactions, and hospital Magnet status was associated with nurse leadership.

Table 3. Unit Teamwork, Nursing Leadership, and Other Unit Characteristics by Unit Type

	Overall, Mean (SD)	Critical care units, Mean (SD)	Step-down units, Mean (SD)	Medical units, Mean (SD)	Surgical units, Mean (SD)	Medical- surgical units, Mean (SD)
RN-RN interactions	4.59 (0.33)	4.62 (0.31)	4.63 (0.32)	4.59 (0.2)	4.58 (0.33)	4.54 (0.37)
RN-MD interactions*	4.14 (0.35)	4.17 (0.39)	4.12 (0.31)	4.17 (0.34)	4.16 (0.36)	4.11 (0.35)
Nursing leadership*	4.33 (0.65)	4.23 (0.74)	4.30 (0.61)	4.42 (0.60)	4.37 (0.65)	4.34 (0.61)
Patient-to-nurse ratio**	5.01 (1.70)	2.57 (0.43)	4.68 (0.92)	5.73 (1.05)	5.93 (1.11)	6.15 (1.19)
Unit mean of Nurses' Years as RN**	10.37 (4.23)	12.26 (4.43)	9.14 (3.83)	9.64 (3.71)	10.57 (4.62)	9.92 (3.90)
Unit mean of Nurses' Years on unit**	5.67 (2.77)	6.59 (2.95)	4.91 (2.32)	5.28 (2.39)	6.11 (2.98)	5.38 (2.76)
Unit proportion of female nurses**	0.90 (0.09)	0.84 (0.10)	0.88 (0.09)	0.91 (0.08)	0.92 (0.07)	0.92 (0.07)
Unit proportion of white nurses	0.68 (0.27)	0.75 (0.25)	0.66 (0.26)	0.63 (0.30)	0.72 (0.25)	0.67 (0.29)
Unit proportion of nurses with BSN	0.65 (0.20)	0.72 (0.17)	0.68 (0.19)	0.64 (0.19)	0.62 (0.21)	0.60 (0.20)
Unit proportion of foreign-educated nurses**	0.09 (0.14)	0.07 (0.12)	0.09 (0.14)	0.11 (0.14)	0.07 (0.12)	0.10 (0.15)
Unit proportion of nurses with certificate**	0.62 (0.36)	0.97 (0.07)	0.86 (0.21)	0.44 (0.32)	0.32 (0.28)	0.49 (0.33)
Unit proportion of fulltime nurses**	0.84 (0.14)	0.85 (0.11)	0.87 (0.12)	0.83 (0.15)	0.82 (0.16)	0.82 (0.15)

RN, registered nurses; BSN, bachelor's degree in nursing

*P<0.05; **p<0.01

Table 4. Unit Teamwork and Nursing Leadership by Hospital Characteristics

	RN-RN interactions		RN-MD interactions		Nursing Leadership	
	Mean	SD	Mean	SD	Mean	SD
Ownership						
Non-profit	4.61 (.32)	0.32	4.15 (.35)	0.35	4.34 (.64)	0.64
Profit	4.47 (.30)	0.30	4.06 (.34)	0.34	4.33 (.63)	0.63
Government-owned	4.45 (.47)	0.47	4.09 (.40)	0.40	4.19 (.69)	0.69
Bed size						
Small, <100 beds	4.55 (.41)	0.41	4.24 (.41)	0.41	4.34 (.69)	0.69
Medium, 100-299 beds	4.57 (.32)	0.32	4.14 (.33)	0.33	4.32 (.63)	0.63
Large, >=300 beds	4.60 (.33)	0.33	4.13 (.36)	0.36	4.34 (.66)	0.66
Teaching status						
Academic medical center	4.62 (.33)	0.33	4.17 (.37)	0.37	4.32 (.64)	0.64
Teaching hospitals	4.58 (.34)	0.34	4.13 (.35)	0.35	4.34 (.62)	0.62
Non-teaching hospitals	4.57 (.34)	0.34	4.14 (.34)	0.34	4.33 (.67)	0.67
Magnet status						
Non-Magnet	4.56 (.35)	0.35	4.06 (.35)	0.35	4.36 (.59)	.059
Magnet	4.61 (.32)	0.32	4.21 (.34)	0.34	4.30 (.69)	0.69

To identify unit characteristics that were associated with teamwork and nursing leadership, we estimated the correlation coefficients (r) between variables. Results for the two analyses were presented in **Table 5**. We found that nurse-nurse interaction was associated with patient-to-nurse ratio ($r=-0.20$, $p=.000$), unit mean on nurses' average working experience as RNs ($r=-.10$, $p=.002$), unit proportion of foreign educated nurses ($r=-.09$, $p=.004$), female nurses ($r=.07$, $p=.026$), and white nurses ($r=.23$, $p=.000$). Nurse-physician interaction was associated with patient-to-nurse ratio ($r=-.08$, $p=.009$), unit mean on nurses' average working experience as RNs ($r=.08$, $p=.015$), and unit proportion of female nurses ($r=.08$, $p=.020$) and white nurses ($r=.13$, $p=.000$). Nursing leadership was associated with unit mean on nurses' average working experience as RNs ($r=.08$, $p=.015$), unit mean on nurses' average working experiences on current unit ($r=-.11$, $p=.000$), and unit proportion of female nurses ($r=.10$, $p=.002$), nurses with BSNs ($r=-.09$, $p=.008$), and nurse with special certificates ($r=-.09$, $p=.003$).

Findings from Approaching Aim 2

We first described the distribution of patient safety indicators by hospital characteristics and unit types. We then used a series of two-level regression models to estimate the impact of teamwork and nursing leadership on patient safety indicators. Due to the variance in the number of units submitting data of each patient safety indicators to NDNQI, each regression model varied in sample sizes.

Overall, units had mean HAPU rate of 26.13 (SD=38.19) per 1,000 patients, mean patient fall rate of 2.51 (SD=1.50) per 1,000 patient days, mean CAUTI rate of 1.55 (SD=1.76) per catheter days, mean CLABSI rate of .81 per 1,000 central line days, and .35 per 1,000 ventilating days.

Table 6 summarizes unit patient outcomes (safety indicators) by hospital characteristics. Results from ANOVA (not presented in table) indicate that unit HAPU rates varied significantly by hospital teaching status ($p=.000$), bed size ($p=.000$), and Magnet status ($p=.000$); unit patient fall rates varied significantly by hospital ownership ($p=.000$), teaching status ($p=.002$), bed size ($p=.000$), and Magnet status ($p=.000$); unit CUATI rates varied by hospital ownership ($p=.000$), teaching status ($p=.000$), and bed size ($p=.000$); unit CLABSI rates varied by hospital teaching status ($p=.000$), bed size ($p=.000$), and Magnet status ($p=.043$); unit VAP rates varied by hospital ownership ($p=.001$) and Magnet status ($p=.005$).

Table 7 shows distribution of patient outcomes (safety indicators) by unit types. Results from ANOVA (not presented in table) show that HAPU rates were highest on critical care units ($M=49.58$) and lowest on surgical units ($M=13.85$); patient fall rates were highest on medical unit ($M=3.21$) and lowest on critical care units ($M=1.09$); CAUTI rates were highest on critical care units ($M=2.09$) and lowest on surgical units ($M=.95$); CLABSI rates were highest on step-down unit and medical units ($M=1.00$) and lowest on surgical units ($M=.43$). Data on VAP rates were only available on critical care units ($M=.35$) and step-down units ($M=.40$). Significant unit type differences were observed in all outcomes except VAP.

Estimates from two-level regression models adjusting for hospital and unit characteristics are presented in **Table 8**. With one-unit increase of the nurse-nurse interactions scale score, the

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nurse-physician interactions scale score, or the nursing leadership scale score, units had 32% (95% CI, .56-.81), 21% (.66-.94), or 16% (.77-.92) lower odds of having a HAPU respectively. With one-unit increase of the nurse-nurse interactions scale score, the nurse-physician interactions scale score, or the nursing leadership scale score, unit had 8% (95% CI, .87-.98), 13% (95% CI, .81-.92), or 4% (95% CI, .93-.99) less likely to have a patient fall. Significant associations were not identified between teamwork, nursing leadership, and hospital-acquired infections (CAUTI, BLABSI, and VAP).

Table 5. Correlation Matrix of Unit Teamwork, Nursing Leadership, and Other Unit Characteristics

	1	2	3	4	5	6	7	8	9	10	11	12
1. RN-RN interactions	1.00											
2. RN-MD interactions	0.49**	1.00										
3. Nursing leadership	0.45**	0.25**	1.00									
4. Patient-to-nurse ratio	-0.20**	-0.08**	0.02	1.00								
5. Unit proportion of female nurses	0.07*	0.08*	0.10**	0.26**	1.00							
6. Unit proportion of white nurses	0.23**	0.13**	0.05	-0.15**	0.10**	1.00						
7. Unit mean of nurses' years as RN	-0.10**	0.08*	-0.10**	-0.12**	0.06	-0.24**	1.00					
8. Unit mean of nurses' years on current unit	-0.05	0.05	-0.11**	-0.05	0.09**	-0.12**	0.72**	1.00				
9. Unit proportion of nurses with BSN	0.05	0.02	-0.09**	-0.27**	-0.08*	-0.25**	0.00	0.06	1.00			
10. Unit proportion of foreign educated nurses	-0.09**	-0.01	0.03	0.09**	-0.04	-0.73**	0.38**	0.16**	0.27**	1.00		
11. Unit proportion of nurses with certificate	0.05	0.00	-0.09**	-0.49**	-0.24**	0.01	0.06*	-0.03	0.15**	0.01	1.00	
12. Unit proportion of fulltime nurses	0.00	-0.06	0.02	-0.05	-0.16**	-0.19**	-0.19**	-0.20**	0.13**	0.15**	0.11**	1.00

*p<.05; **p<.01

Table 6. Unit Patient Outcomes (Safety Indicators) by Hospital Characteristics

	HAPU rate Mean (SD)	Patient falls rate Mean (SD)	CAUTI rate Mean (SD)	CLABSI rate Mean (SD)	VAP rate Mean (SD)
Ownership					
Non-profit	24.14 (37.55)	2.47 (1.46)	1.45 (1.58)	0.78 (1.13)	0.39 (0.83)
Profit	35.05 (36.32)	3.13 (2.21)	1.31 (1.74)	0.89 (0.92)	0.00 (0.00)
Government-owned	40.54 (42.32)	2.48 (1.29)	2.79 (2.88)	1.06 (1.12)	0.16 (0.23)
Teaching status					
Academic medical center	30.29 (36.59)	2.37 (1.30)	2.14 (1.87)	1.13 (1.30)	0.71 (0.97)
Teaching hospitals	28.85 (44.69)	2.70 (1.56)	1.65 (1.96)	0.71 (1.02)	0.38 (0.85)
Non-teaching hospitals	20.61 (32.04)	2.44 (1.58)	1.04 (1.31)	0.67 (1.01)	0.24 (0.66)
Bed size					
Small, <100 beds	38.13 (53.00)	2.69 (2.14)	0.68 (1.17)	0.36 (0.78)	0.15 (0.57)
Medium, 100-299 beds	20.61 (32.28)	2.48 (1.44)	1.17 (1.32)	0.62 (0.96)	0.33 (0.76)
Large, >=300 beds	30.71 (41.68)	2.51 (1.46)	2.02 (2.02)	1.06 (1.23)	0.48 (0.89)
Magnet status					
Non-Magnet	29.42 (44.82)	2.64 (1.65)	1.45 (1.79)	0.75 (1.05)	0.42 (0.89)
Magnet	23.33 (31.26)	2.40 (1.36)	1.64 (1.74)	0.88 (1.18)	0.26 (0.58)

HAPU, hospital-acquired pressure ulcers; CAUTI, central line-associated bloodstream infections; CLABSI, catheter-associated urinary tract infections; VAP, ventilator-associated pneumonia.

HAPU rate indicates the number of patient with HAPU per every 1,000 patients; patient fall rate indicates the number of patient falls per every 1,000 patient days; CAUTI/CLABSI/VAP rate indicates the number of CAUTI/CLABSI/VAP incident per 1,000 catheter days.

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Table 7 Unit Patient Outcomes (safety Indicators) by Unit Types

	HAPU rate Mean(SD)	Patient falls rate Mean(SD)	CAUTI rate Mean(SD)	CLABSI rate Mean(SD)	VAP rate Mean(SD)
Overall (units of all types)					
Unit types	26.13 (38.19)	2.51 (1.50)	1.55 (1.76)	0.81 (1.12)	0.35 (0.78)
Critical care	49.58 (48.63)	1.09 (0.81)	2.09 (1.70)	0.81 (0.85)	0.35 (0.75)
Step-down	29.50 (34.80)	2.71 (1.27)	1.36 (1.48)	1.00 (1.28)	0.40 (1.09)
Medical	21.45 (42.95)	3.21 (1.34)	1.54 (1.91)	1.00 (1.31)	-
Surgical	13.85 (18.41)	2.53 (1.41)	0.95 (1.15)	0.43 (0.85)	-
Medical-surgical combined	15.34 (24.11)	3.07 (1.46)	1.39 (1.98)	0.79 (1.22)	-

HAPU, hospital-acquired pressure ulcers; CAUTI, central-line-associated bloodstream infections; CLABSI, catheter-associated urinary tract infections; VAP, ventilator-associated pneumonia

“-“ indicates no data submitted to NDNQI from those units.

Table 8. The Effects of Unit Teamwork and Nursing Leadership on Patient Outcomes (Safety Indicators)

	N of Units in Model	RN-RN Interactions		RN-MD Interactions		Nursing Leadership	
		OR/IRR	95% CI	OR/IRR	95% CI	OR/IRR	95% CI
HAPU	900	0.68	.56 - .81	0.79	.66 - .94	0.84	.77 - .92
Patient falls	860	0.92	.87 - .98	0.87	.81 - .92	0.96	.93 - .99
CAUTI	592	1.06	.88 - 1.27	1.08	.91 - 1.13	1.06	.98 - 1.16
CLASBI	586	1.18	0.92 - 1.53	0.94	.66 - 1.07	1.05	.93 - 1.17
VAP*	95	-	-	-	-	-	-

*Due to the small number of units with VAP data, we were not able to run the two-level Poisson regression model adjusting for hospital and unit characteristics.

List of hospital characteristics included in regression models as covariates: hospital ownership, teaching status, bed size, and Magnet status.

List of unit characteristics included in regression models as covariates: nursing staffing (patient-to-nurse ratio), proportion of female nurses, white nurses, unit mean of nurses' years as RN, proportion of nurses with BSN, certificate, foreign-educated nurses, and unit type.

Recommendations

Our analyses show some important findings of unit teamwork and nursing leadership and their impact on patient outcomes (safety indicators). Unit teamwork and nursing leadership varied by hospital characteristics (e.g., hospital ownership, bed size, and Magnet status) as well unit characteristics (e.g., unit type, nurse staffing, unit proportion of female nurse, white nurses, foreign-educated nurses, and nurses with BSN). Unit teamwork and nursing leadership are significantly associated with the risk for developing a hospital-acquired pressure ulcer and patient fall.

Our study also has several limitations. This is a cross-sectional study and therefore it limits our ability to present causal results. Although we included a variety of hospital- and unit-level variable as covariates, there may be other covariates omitted. Not all units submit all patient outcome data to NDNQI, therefore in this study we only had 95 units with data on both VAP and unit teamwork and nursing leadership, which limited our ability to test the associations between them.

Based on our findings as well study limitations, there are several meaningful and important suggestions for improving teamwork and nursing leadership and patient outcomes in patient care settings as well recommendations for future research. 1) Given our finding that teamwork and nursing leadership are associated with hospital and unit characteristics, one potential strategy to improve teamwork and/or nursing leadership is to consider re-structuring modifiable organizational characteristics, such as investment in becoming a Magnet hospital and improving nurse staffing. 2) our finding suggests that improving teamwork among nurses and between nurses and other healthcare professionals as well strengthen nursing leadership should be included and highlighted when hospitals consider quality improvement initiatives to prevent and reduce hospital-acquired pressure ulcer and patient falls. 3) We found that teamwork and nursing leadership were associated with units' proportion of nurses with different race/ethnicity background, educational degrees, working experiences, and foreign-educated nurses; however, it was unclear about the mechanism behind these associations. Therefore, researcher should investigate more thoroughly of this phenomenon in the future. 4) We did not found significant associations between CAUTI, CLABSI, and VAP. It is possible that these are all incident with a low prevalence; therefore, despite our relatively large samples (592 units for CAUTI and 586 units for CLABSI), they are still not large enough to test the difference, and larger samples are required. Future studies with large data are needed to future explore the association between teamwork, nursing leadership, and hospital-acquired infections.

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