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14. ABSTRACT
Purpose: To explore the influence of workload intensity (acuity and admissions, discharges, and transfers; ADT) and the nursing practice environment on the relationship between nurse staffing and patient and nurse outcomes. **Design:** Secondary analysis of the Military Nursing Outcomes Database. **Methods:** Data included staffing, workload, and outcomes at the shift level, annual nurse-reported practice environment and job satisfaction data, and annual unit-level pressure ulcer prevalence data. **Sample:** The dataset contained 111,500 shifts, 1,586 nurses and 1,643 patients from 57 units of 13 hospitals. **Analysis:** Data mining, generalized estimating equations, Cox proportional hazards modeling, and Bayesian hierarchical (nested) linear models were used. **Findings:** Workload intensity had an effect on the relationships between staffing and adverse events; the magnitude and direction differed by event type and staffing measure. Hospital acquired pressure ulcers (HAPUs) were significantly associated with licensed practical nurse (LPN) care hours three days prior to HAPU discovery; this relationship was partially mediated by ADT. Only in the top tercile practice environments was the staffing and HAPU relationship demonstrated. When controlling for acuity and ADT, total nursing care hours per patient per shift remained associated with shift level adverse events in medical-surgical and critical care (CC) units. ADT, but not acuity, was significantly associated with all adverse events, and neither mediated staffing. Needlesticks were not associated with staffing, ADT nor acuity. Nurse job satisfaction was strongly, but inversely, associated with total nursing care hours per patient shift (TNCHPPS) and had a strong, positive relationship with the practice environment. There was no relationship between job satisfaction and ADT or acuity in multivariate analysis. **Implications for Military Nursing:** Tracking workload is essential to understanding how staffing affects outcomes. ADT (but not acuity) was associated with outcomes. The practice environment may not be related directly to patient outcomes, but it is strongly associated with nurse satisfaction.

15. SUBJECT TERMS

workload intensity, nurse staffing and patient and nurse outcomes, nurse satisfaction

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Abstract

Purpose: To explore the influence of workload intensity (acuity and admissions, discharges, and transfers; ADT) and the nursing practice environment on the relationship between nurse staffing and patient and nurse outcomes.

Design: Secondary analysis of the Military Nursing Outcomes Database.

Methods: Data included staffing, workload, and outcomes at the shift level, annual nurse-reported practice environment and job satisfaction data, and annual unit-level pressure ulcer prevalence data.

Sample: The dataset contained 111,500 shifts, 1,586 nurses and 1,643 patients from 57 units of 13 hospitals.

Analysis: Data mining, generalized estimating equations, Cox proportional hazards modeling, and Bayesian hierarchical (nested) linear models were used.

Findings: Workload intensity had an effect on the relationships between staffing and adverse events; the magnitude and direction differed by event type and staffing measure. Hospital acquired pressure ulcers (HAPUs) were significantly associated with licensed practical nurse (LPN) care hours three days prior to HAPU discovery; this relationship was partially mediated by ADT. Only in the top tercile practice environments was the staffing and HAPU relationship demonstrated. When controlling for acuity and ADT, total nursing care hours per patient per shift remained associated with shift level adverse events in medical-surgical and critical care (CC) units. ADT, but not acuity, was significantly associated with all adverse events, and neither mediated staffing. Needlesticks were not associated with staffing, ADT nor acuity. Nurse job satisfaction was strongly, but inversely, associated with total nursing care hours per patient shift (TNCHPPS) and had a strong, positive relationship with the practice environment. There was no relationship between job satisfaction and ADT or acuity in multivariate analysis.

Implications for Military Nursing: Tracking workload is essential to understanding how staffing affects outcomes. ADT (but not acuity) was associated with outcomes. The practice environment may not be related directly to patient outcomes, but it is strongly associated with nurse satisfaction.

TSNRP Research Priorities that Study or Project Addresses

Primary Priority

Force Health Protection:	☐ Fit and ready force ☐ Deploy with and care for the warrior ☐ Care for all entrusted to our care
Nursing Competencies and Practice:	☐ Patient outcomes ☒ Quality and safety ☐ Translate research into practice/evidence-based practice ☐ Clinical excellence ☐ Knowledge management ☐ Education and training
Leadership, Ethics, and Mentoring:	☐ Health policy ☐ Recruitment and retention ☐ Preparing tomorrow's leaders ☐ Care of the caregiver
Other:	☐

Secondary Priority

Force Health Protection:	☐ Fit and ready force ☐ Deploy with and care for the warrior ☐ Care for all entrusted to our care
Nursing Competencies and Practice:	☐ Patient outcomes ☐ Quality and safety ☐ Translate research into practice/evidence-based practice ☐ Clinical excellence ☐ Knowledge management ☐ Education and training
Leadership, Ethics, and Mentoring:	☐ Health policy ☒ Recruitment and retention ☐ Preparing tomorrow's leaders ☐ Care of the caregiver
Other:	☐

Progress Towards Achievement of Specific Aims of the Study or Project

Findings related to each specific aim, research or study questions, and/or hypothesis:

The Military Nursing Outcomes Database (MilNOD) Project, a national study of staffing and outcomes in military hospitals, was a comprehensive effort to examine how nurse staffing hours, skill levels (i.e., proportion of registered nurse [RN], licensed practical nurse [LPN], and unlicensed personnel), and staff composition (i.e., proportion of active military, civilian, military reserve, and contract nurses) affect patient and nurse outcomes at the shift level. We used the MilNOD dataset to examine the following aims:

Aim #1. Assess the relationships between staffing (skill mix, hours of care per patient shift, and staff category) and patient outcomes (patient falls, medication administration errors and hospital acquired pressure ulcers [HAPU]), together with the moderating (interacting) and mediating (confounding) effect of nurse workload intensity and practice environment on these relationships. The specific research hypotheses were:

H1.1: Staffing is negatively associated with HAPU prevalence, even after adjusting for nurse workload intensity and practice environment
H1.2: The association between staffing and HAPU prevalence remains negative across different levels of workload intensity, practice environment, and their combined levels.
H1.3: Staffing is negatively associated with the occurrence of patient falls and medication administration errors, even after adjusting for workload intensity and practice environment.
H1.4: The association between staffing and the occurrence of patient falls and medication administration errors remains negative across different levels of workload intensity, practice environment, and their combined levels.

Aim 2. Determine the relationships between staffing and nurse outcomes (needlestick injuries and nurse job satisfaction) and assess the moderating (interacting) and mediating (confounding) effect of nurse workload intensity and practice environment on these relationships. Hypotheses were:

H2.1: Staffing is negatively associated with the occurrence of needlestick injury, even after adjusting for nurse workload intensity and practice environment.
H2.2: The association between staffing and prevalence of needlestick injury remains negative across different levels of workload intensity, practice environment, and their combined levels.
H2.3: Staffing is negatively associated with nurse job satisfaction, even after adjusting for nurse workload intensity and practice environment.
H2.4: The association between staffing and nurse job satisfaction remains negative across different levels of workload intensity, practice environment, and their combined levels.

Aim #1. Hospital Acquired Pressure Ulcers (HAPUs)

For the purpose of this analysis and of MilNOD in general, HAPU was defined as a pressure ulcer of Stage II or greater, which was not present on admission. The analysis began with description of patients. Of the 1643 patients on whom data were collected, the majority (N=1104) were in medical-surgical (MS) units, 227 in step-down (SD), and 221 were in critical care (CC) units. Of the 1643 patients, 92 had HAPUs (5.6%). The prevalence was significantly different by unit ($p < .05$), with CC unit patients having the highest prevalence (N=29/192; 13.12%), followed by MS units (N=47/1057; 4.26%), and finally SD

units (N=7/20; 3.08%). Men had proportionally more HAPUs, however, gender was not significantly related to HAPUs (males 63/904; 6.51% and females 29/637; 4.35%; p =NS).

Age was statistically different between those who did (mean 59.3, SD 22.4) and those who did not (mean 53.8, SD 21.5) have HAPUs (p = .006). Braden total scores and subscale scores were all statistically lower in those who had HAPUs (Table 1). Lower Braden scores are associated with higher risk of HAPUs, with generally a score of 18 and lower indicating high risk of developing a HAPU.

Table 1. Braden scale scores

Variable	Total Mean (SD) N=1334-1343	HAPU Mean (SD) N=86	No HAPU MEAN (SD) N=1248-1256	P value (based on GEE with unit as cluster)
Braden total	18.30 (3.86)	15.42 (4.03)	18.49 (3.77)	< .001
Sensory	3.50 (0.78)	3.05 (0.97)	3.53 (0.76)	< .001
Activity	2.66 (1.22)	1.93 (1.07)	2.71 (1.22)	< .001
Nutrition	2.93 (0.82)	2.45 (0.90)	2.60 (0.80)	< .001
Moisture	3.52 (0.77)	3.21 (0.92)	3.54 (0.76)	= .01
Mobility	3.09 (0.90)	2.47 (0.89)	3.13 (0.88)	< .001
Friction	2.62 (0.59)	2.31 (0.67)	2.64 (0.58)	< .001

Albumin was significantly lower (2.71 v. 2.64, p < .001) in those who developed a HAPU, but neither BUN nor creatinine was significantly lower. Risk for HAPUs (Braden score of 18 or below) was analyzed in terms of Braden sensitivity and specificity (Table 2). The Braden scores had a sensitivity of 37.04% (95% CI: 24.3% to 51.26%) and a positive predictive value of only 8.93, indicating that the Braden score alone it did not predict risk for a HAPU effectively in this sample. The Braden score had a much better negative predictive value (95.72%) and specificity of 78.84 (95% CI: 76.12-81.38), indicating that it was better at predicting those *not* at risk for the development of a HAPU.

Table 2. HAPU presence and risk based upon Braden score

HAPU	Determined to be at risk (by Braden score)		
	Yes	No	Totals
Yes	20	34	54
No	204	760	964
Totals	224	794	1018

Patients with HAPUs had Braden scores (all patients, all unit types) as categorized in Table 3. Total Braden scores ranged from 6-23; modes were 16 and 20; mean was 15.42 (4.03SD); median was 15.5.

Table 3. Braden scores and HAPUs

Braden score	N (Patients with HAPUs)	Cumulative %
6-10	10	11%
11-15	35	51%
16-18	18	72%
>=18	25	100%
Total	88	
Missing or no Braden	4	

Patient factors that were associated with HAPU in bivariate Cox proportional hazards analyses are shown in Table 4. Increasing age is associated with HAPUs. Decreasing Braden scores and subscale scores were also associated with HAPUs. Of the six Braden subscales, four were associated with HAPUs (lower scores were associated with higher hazard of HAPU development). In the analysis of patient factors associated with HAPUs, we found a significant amount of missing data on albumin, BUN, and creatinine. We created a dummy variable for missing data on albumin (1=albumin data missing), as well

as a dummy variable for all three lab results missing (all three missing =1). The missing labs indicated that the labs were not ordered (and thus were not needed, as with a less acutely ill patient). Lower albumin scores are associated with HAPUs. Patients who were not missing the three lab values had a higher hazard of HAPUs, that is, those patients who had one or more of the lab results in their chart were also more likely to have HAPUs. Finally, missing albumin values (not having the albumin ordered or no results in the chart) was associated with HAPUs, which is counterintuitive since we would expect that patients at risk for HAPUs would be the same ones that did indeed have albumin levels monitored.

Table 4. Patient factors for developing HAPU (bivariate Cox proportional hazards coefficients and robust standard errors).

Variable	Coefficient (Standard error)
Age	.02 (.01)***
Braden total	-0.09 (0.03)**
Subscale: Activity	-0.28 (0.10)*
Subscale: Nutrition	-0.42 (.14)**
Subscale: Mobility	-0.37 (0.12)**
Subscale: Friction	-0.49(0.19)*
Albumin	-0.26 (0.12)*
Missing albumin labs	1.04 (0.23)***
Missing all labs (albumin, BUN, creatinine)	-2.38 (0.76)***

*p<.05; **p<.01; ***p<.001. Negative coefficients indicate lower levels of the independent variable are associated with HAPUs

HAPUs and the Practice Environment

In order to analyze the relationship between HAPUs and the nurses' practice environment, the Practice Environment Scale (PES) and its subscales were merged with the patient-level HAPU dataset. The PES is a nurse level variable obtained by surveying nursing staff and associating their responses with a particular unit in a particular hospital. Therefore, we aggregated the nurses' PES data to their respective units and merged that data by year, unit, and hospital into the HAPU patient level dataset. Patients who had HAPUs were in units that scored higher (better) on the PES and its subscales and these differences were statistically significant in the overall PES (see Table 5), Nursing Foundations for Quality Care (NFQC) ($p = .05$), and Staffing and Resource Adequacy (SRA) ($p < .001$). These results are likely due to a "Critical Care (CC) unit effect" in that CC units had higher HAPUs and also had higher PES scores, which we show below in Table 6.

Table 5. GEE analysis of PES and subscales by HAPU presence

Variable	HAPU Mean (SD) N=86	No HAPU Mean (SD) N=1248-1256	P value (based on GEE with unit as cluster)*
PES total	2.88	2.73	.03
NPHA	2.75	2.63	NS
NFQC	3.02	2.90	.05
NMALS	2.77	2.69	NS
SRA	2.80	2.51	.001
Ns-MD	3.10	2.93	NS

Notes. GEE = Generalized estimating equations; PES = Practice Environment Scale; NPHA = Nursing Participation in Hospital Affairs; NFQC = Nursing Foundations for Quality Care; NMALS = Nurse Manager Ability, Leadership and Support; SRA = Staffing and Resource Adequacy; Ns-MD = Nurse-Physician Collaboration.

Table 6. PES by unit type (ANOVA with post-hoc analysis)

Variable	Unit type	N	Mean (SD)	p
PES	MS*	711	2.77 (.55)	.005
	SD	179	2.80 (.51)	
	CC*	470	2.86 (.52)	
NPHA	MS	707	2.65 (.63)	NS
	SD	178	2.67 (.61)	
	CC	470	2.63 (.66)	
NFQC	MS	713	2.94 (.55)	NS
	SD	177	2.91 (.54)	
	CC	472	2.97 (.53)	
NMALS	MS*	707	2.75 (.81)	.01
	SD*	174	2.92 (.75)	
	CC	463	2.79 (.82)	
SRA	MS*	724	2.59 (.74)	MS v. CC p<.001
	SD*	179	2.63 (.71)	SD v. CC p = .001
	CC*	481	2.83 (.67)	
Ns-MD	MS*	712	2.92 (.66)	MS v. CC p<.001
	SD*	179	2.87 (.65)	SD v. CC p<.001
	CC*	470	3.09 (.60)	

*Unit types that differ; MS = Medical-surgical Units; SD = Step-down Units; CC = Critical Care Units; PES = Practice Environment Scale; NPHA = Nursing Participation in Hospital Affairs; NFQC = Nursing Foundations for Quality Care; NMALS = Nurse Manager Ability, Leadership and Support; SRA = Staffing and Resource Adequacy; Ns-MD = Nurse-Physician Collaboration.

In bivariate analysis (to predict HAPU) with Cox proportional hazard (PH) modeling, clustering at the unit level, the following variables were statistically significantly associated with HAPUs:

- PATIENT FACTORS – age, serum albumin (its availability in the record and its numeric value), total Braden score, and subscale scores: activity, nutrition, mobility, friction.
- UNIT FACTORS - Unit type, overall PES (beta = 1.46, robust standard error (SE)0.68, p = .03), and Staffing and Resource Adequacy (beta 1.41, robust SE 0.39, p = .004).

HAPUs and Staffing

In our previous grant (TSNRP #N03-P07), we found no associations between HAPUs and nurse staffing *on the day of* the pressure ulcer prevalence study (Patrician, Loan, McCarthy, Brosch, Davey, 2010). We confirmed with nurse managers (and our data suggests) that staffing was higher than usual on the day of the pressure ulcer prevalence surveys in order to conduct the surveys, and therefore, this was not an accurate reflection of a unit's typical staffing pattern. Therefore, we searched for a more representative measure of staffing and one that would be more meaningful in terms of the time it takes to develop a Stage II or greater pressure ulcer. We calculated staffing variables at Day 1, 2 and 3 preceding the HAPU discovery or preceding the PU prevalence study, whichever came first. In order to conduct this analysis, we aggregated the shift level data on staffing, census, acuity, and admissions, discharges and transfers (ADT) before adding these new variables to the patient HAPU data set. We created aggregated measures of all shift-level variables, including a variety of staffing measures, to the day (24-hours; Day 1) prior to the day of pressure ulcer discovery, which for some was actually the day of the pressure ulcer prevalence study. We additionally aggregated the shift level variables over the three shifts to the specific 24-hour periods representing 2 days and 3 days prior to the day of pressure ulcer discovery. In order to determine whether the daily variables, when aggregated to higher temporal levels (week), continued to have an association with HAPUs, we also looked at one full week before the day of pressure ulcer discovery. Our hypothesis was that aggregating to higher levels temporally would diminish variability in the data, and ultimately "wash out" any associations that were found in the daily variables.

Table 7 depicts the shift-level patient and staffing factors in terms of their bivariate associations with HAPUs (Cox proportional hazards betas and robust standard errors are reported). This analysis includes all unit types.

Table 7. Bivariate associations with HAPUs - beta coefficients (and robust standard errors) of staffing measures, census, ADT, and acuity and timing prior to HAPU discovery (all unit types combined)

Days prior to HAPU discovery Variable:	Day 1	Day 2	Day 3	1 week
Census	-0.13 (0.06)	-0.16 (0.05)*	-0.06 (0.09)	-0.11 (0.06)
ADT	-1.04 (1.91)	-3.08 (1.65)*	4.69 (1.68)*	0.46 (1.78)
Acuity	0.44 (0.22)	0.45 (0.22)	0.39 (0.22)	0.27 (0.21)
Total NCH	-0.05 (0.02)*	-0.02 (0.02)	-0.02 (0.17)	-0.03 (0.02)
Total NCHPPS	0.07 (0.05)	0.80 (0.60)	-0.10 (0.15)	-0.01 (0.18)
RN NCH	-0.07 (0.03)*	-0.03 (0.03)	-0.009 (0.04)	-0.06 (0.03)
RN NCHPPS	0.21 (0.14)	0.44 (0.22)	-0.14 (0.25)	0.04 (0.31)
Pt:RN Ratio	0.04 (0.40)	-0.22 (0.34)	0.12 (0.23)	-0.02 (0.29)
LPN NCH	-0.06 (0.02)*	-0.05 (0.03)	-0.06 (0.03)*	-0.06 (0.03)*
LPN NCHPPS	-0.47 (0.30)	-0.05 (0.32)	-0.87 (0.20)**	-0.76 (0.26)*
Licensed NCHPPS	0.14 (0.25)	0.15 (0.27)	-0.39 (0.15)*	-0.48 (0.27)
Pt:Licensed Ratio	0.16 (0.42)	-0.42 (0.48)	0.40 (0.30)	0.23 (0.35)
NA NCH	-0.01 (0.05)	0.004 (0.04)	0.004 (0.03)	0.01 (0.04)
Military hours	0.002 (0.18)	-0.001 (0.02)	-0.01 (0.02)	-0.01 (0.02)
Civilian hours	-0.01 (0.02)	0.001 (0.02)	-0.002 (0.02)	0.001 (0.02)
Contract hours	-0.04 (0.02)	-0.03 (0.02)	-0.01 (0.02)	-0.02 (0.03)
Reservist hours	-0.21 (0.12)**	-0.06 (0.07)	-0.11 (0.08)	-0.14 (0.11)
%RN	1.70 (2.28)	-0.43 (3.28)	2.59 (2.44)	2.66 (3.78)
%LPN	-2.37 (2.66)	-1.83 (1.70)	-3.55 (1.46)	-3.07 (1.60)
%NA	1.41 (1.42)	1.56 (1.30)	1.80 (1.37)	1.79 (1.46)
%military	0.77 (0.94)	0.50 (1.07)	0.05 (1.19)	0.16 (1.17)
%civilian	0.10 (1.00)	0.22 (0.94)	0.18 (1.00)	0.32 (1.07)
%contract	-1.24 (1.71)	-1.46 (1.50)	0.25 (1.71)	-0.24 (1.81)
%reservist	-9.89 (6.23)*	-3.14 (3.46)	-4.08 (3.83)	-6.26 (4.96)

*p <.05; **p<.01; Positive coefficients = increase in the IV increases hazard of HAPU. Negative coefficients = lower levels of the IV is associated with higher HAPU hazard; ADT = Admissions, discharges, and transfers; NCH = Nursing care hours; RN = Registered nurse; LPN = Licensed practice nurse; NCHPPS = Nursing care hours per patient per shift; Pt = patient ; %RN = RN skill mix; % LPN = LPN skill mix; NA= unlicensed skill mix

The findings in Table 7 suggest that staffing in the 24-hour period before the HAPU discovery may be associated with HAPUs in that lower levels of total nursing care hours, RN care hours, LPN care hours, and reservist hours are associated with HAPUs. In the period of time 2 days before pressure ulcer discovery, none of the staffing variables are associated, but in the 3 days before the discovery of the HAPU, the LPN total care hours and LPN care hours per patient per shift, as well as the total licensed care hours, were significantly associated with HAPUs. These findings are consistent with the physiology of development of a Stage II pressure ulcer, in that it takes 48-72 hours for a Stage II pressure ulcer to develop. That the LPN hours total, and LPN hours per patient per shift remain statistically significant when aggregated to the week suggests that chronically low LPN hours on a unit may be associated with the development of HAPUs. In the military, LPNs are used in all unit types, but more so in medical-surgical units. We therefore separated the data by unit type and repeated the analyses.

When analyzing the data by unit types the following variables were significant in bivariate analysis of critical care units: patient age (Beta .02, SE .01, p = .01) and reservist nursing care hours only at day 3 (Beta -.60, SE .23, p = .05). Because this analysis of critical care units was not informative, critical care units were dropped from further analyses.

In step-down units, the percent of staff who were contractors or agency nurses only at day 1 was significant (beta -5.75, SE 2.72, p = .03). Therefore, no further analysis was conducted with step-down units.

Table 8 lists only the statistically significant variables in bivariate analysis for medical-surgical units of all hospitals.

Table 8. Statistically significant bivariate Cox proportional hazards betas and robust standard errors (Medical-surgical units only).

Variable	Patient level	Day 1	Day 3	Other
Braden total	-0.12 (0.03)*			
Moisture	-0.34 (0.12)*			
Mobility	-0.63 (0.13)**			
Friction	-0.69(0.23)*			
Albumin	-0.39 (0.18)**			
Missing albumin labs	1.32 (0.24)***			
Missing all labs (alb, bun, creat)	-3.17 (0.94)**			
LPN NCH		-0.08 (0.03)**	-0.10 (0.03)**	1 week: -0.09 (0.03)*
LPN NCHPPS		-1.14 (0.35)**	-1.25 (0.27)**	1 week: -1.08 (0.35)*
Licensed NCHPPS			-0.58 (0.25)*	
Reservist hours		-0.35 (0.16)*		
%Reservist		-14.26 (7.30)*		
Census				

*p <.05; **p<.01; ***p<.001; LPN = Licensed practice nurse; NCHPPS = Nursing care hours per patient per shift.

The patient level variables for MS patients are similar to those obtained in the analysis of all patients (Table 4). There were no statistically significant differences in hospital size for MS units. Compared to monthly aggregated staffing, daily aggregated staffing is more predictive of HAPUs, and only on Days 1 and 3 prior to discovery of the HAPU.

HAPUs: Workload Intensity Mediation

Using MS units in all hospitals, we proceeded with a mediation analysis, to determine whether the relationship between significant staffing variables and HAPUs is mediated by workload intensity. For the mediation analysis, multiple Cox PH models were used with imputed data from MS units in all hospitals. Data were imputed using Random Forest imputation because it handles categorical and continuous data elements equally well.

The four-step approach by Baron and Kenny (1986) and Judd and Kenny (1981) was used, along with backward and forward variable selection techniques. When added into a multivariate model, LPN nursing care hours per patient per shift (NCHPPS) was the only staffing variable significantly associated with HAPU, controlling for patient level factors (Step1; Table 9). Admissions, discharges and transfers (ADT) at day 3 prior to the HAPU discovery and acuity at day 1 were associated with HAPU, controlling for patient level factors (Step 2; Table 10). Staffing variables were not associated with acuity (Step 3a; Table 11), therefore, acuity cannot be considered a mediator. ADT was associated with staffing, but only with

LPN NCHPPS at day 3 (Table 12). In the final model (Table 13), the association between staffing (notably LPN NCHPPS at day 3 prior top HAPU discovery) became less significant, indicating a mediation effect of ADT at day 3. Thus, workload intensity as measured by ADT partially mediates the relationship between LPN care hours per patient per shift and HAPU.

Table 9. Step 1: Multivariate Cox Proportional Hazards Model. Outcome vs. Staffing (N=1104 patients, 47 with HAPUs). DV = HAPU

Variable	Coefficient (robust SE)	HR	p
Age	0.02 (0.01)	1.02	< .001
Mobility	-0.64 (0.13)	0.53	< .001
Presence of Albumin level in record	1.05 (0.23)	2.85	< .001
LPN NCHPPS_day3	-1.31 (0.41)	0.27	< .001
Patient:Licensed nurse_day3	-1.06 (0.66)	0.35	0.11
Licensed NCHPPS_1week	-0.59 (0.40)	0.56	0.15

Notes: LPN = Licensed practice nurse; NCHPPS = Nursing care hours per patient per shift.

Table 10. Step 2: Multivariate Cox Proportional Hazards Model. Outcome vs. workload intensity (N=1101 patients, 47 with HAPUs). DV = HAPU

Variable	Coefficient (robust SE)	HR	p
Age	0.02 (0.01)	1.02	.01
Mobility	-0.54 (0.12)	0.58	< .001
Presence of Albumin level in record	1.32 (0.12)	3.74	< .001
ADT_Day3	9.66 (1.57)	15630.00	< .001
Acuity_Day1	2.17 (0.55)	8.77	< .001

Note: ADT = Admissions, discharges, and transfers.

Table 11. Step 3a: Generalized Estimating Equations. Workload (acuity) vs. Staffing. DV = Acuity

Variable	Coefficient (robust SE)	p
LPN NCHPPS_day3	0.02 (0.07)	NS
Patient:Licensed nurse_day3	-0.15 (0.08)	NS
Licensed NCHPPS_1week	-0.06 (0.06)	NS

Notes: LPN = Licensed practice nurse; NCHPPS = Nursing care hours per patient per shift.

Table 12. Step 3b: Generalized Estimating Equations. Workload (ADT) vs. Staffing. DV = ADT

Variable	Coefficient (robust SE)	p
LPN NCHPPS_day3	-0.06 (0.02)	.05
Patient:Licensed nurse_day3	-0.02 (0.02)	NS
Licensed NCHPPS_1week	0.00 (0.01)	NS

Notes: LPN = Licensed practice nurse; NCHPPS = Nursing care hours per patient per shift.

Table 13. Step 4: Multivariate Cox Proportional Hazards Model. Outcome vs. Staffing + Workload (N=1104, 47 HAPUs). DV = HAPU

Variable	Coefficient (robust SE)	HR	p
Age	0.02 (0.01)	1.02	< .001
Mobility	-0.52 (0.13)	0.59	< .001
Presence of Albumin level in record	1.25 (0.24)	3.48	< .001
LPN NCHPPS_day3	-0.96 (0.37)	0.38	.01
Patient:Licensed nurse_day3	-1.11 (0.61)	0.33	0.07
Licensed NCHPPS_1week	-1.05 (0.28)	0.35	< .001
Acuity_day1	2.12 (0.43)	8.31	< .001
ADT_day3	9.74 (1.45)	16930	< .001

Notes: LPN = Licensed practice nurse; NCHPPS = Nursing care hours per patient per shift; ADT = Admissions, discharges, and transfers.

HAPUs: Practice Environment Moderation

Cox proportional hazards models with interactions were used to test for a moderating effect of PES on the relationship between staffing and HAPUs. Here we were testing whether the practice environment moderates the relationship between staffing and HAPUs, or in other words, whether the relationship between staffing and HAPUs differs based upon the quality of the practice environment. The model was based upon data from MS units in all hospitals (N = 1104 patients, 47 with HAPUs). Random Forest imputation was used.

Table 14 shows a positive coefficient for PES, suggesting that patients in units with a better practice environment have a higher hazard for HAPUs. This is counterintuitive because better practice environments should be associated with fewer HAPUs. The SRA subscale that was significant in bivariate analysis was no longer statistically significant when analyzed with staffing variables. Other researchers have shown that SRA is HIGHLY correlated with staffing measures (especially total NCH, RN skill mix, and PT:RN ratios), and therefore, may be collinear with these variables, accounting for insignificant findings. In our data set these correlations between staffing variables and the SRA subscale were statistically significant but with a very low magnitude (r = .10 - .13).

Table 14. Multivariate Cox Proportional Hazards Model. Outcome vs. Staffing + Workload (N=1104, 47 HAPUs) + PES. DV = HAPU

Variable	Coefficient (robust SE)	HR	p
Age	0.02 (0.01)	1.03	< .001
Mobility	-0.51 (0.13)	0.60	< .001
Presence of Albumin level in record	1.26 (0.24)	3.52	< .001
LPN NCHPPS_day3	-0.91 (0.37)	0.40	.01
Patient:Licensed nurse_day3	-0.88 (0.61)	0.41	.15
Licensed NCHPPS_1week	-1.13 (0.30)	0.32	< .001
Acuity_day1	2.20 (0.44)	8.98	< .001
ADT_day3	9.44 (1.41)	12580	< .001
PES	1.21 (0.29)	3.35	< .001

Notes: LPN = Licensed practice nurse; NCHPPS = Nursing care hours per patient per shift; ADT = Admissions, discharges, and transfers; PES = Practice environment scale.

Table 15 demonstrates the lack of moderation effect of the PES. Neither LPN hours nor licensed care hours were moderated by the practice environment.

Table 15. Multivariate Cox Proportional Hazards Model Testing Moderation by the Practice Environment

Variable	Coefficient (robust SE)	HR	p
Age	0.03 (0.01)	1.03	< .001
Mobility	-0.50 (0.13)	0.14	< .001
Presence of Albumin level in record	1.29 (0.27)	3.63	< .001
LPN NCHPPS_day3	11.35 (7.65)	8508	NS
Patient:Licensed nurse_day3	-4.87 (7.81)	.007	NS
Licensed NCHPPS_1week	2.64 (3.20)	13.94	NS
PES	8.27 (8.11)	3914	NS
Acuity_day1	2.05 (0.43)	0.49	< .001
ADT_day3	9.23 (1.59)	10210	< .001
LPN NCHPPS_day3 * PES	-4.61 (2.79)	0.009	NS
Patient:Licensed nurse_day3 * PES	1.72 (2.92)	5.57	NS
Licensed NCHPPS_1week * PES	-1.42 (1.12)	0.24	NS

Model concordance 0.896 (SE 0.052); R-square 0.10; Wald test = 925.5, df = 12, p = 0; Robust = 14.6, p = 0.2643
Notes: LPN = Licensed practice nurse; NCHPPS = Nursing care hours per patient per shift; ADT = Admissions, discharges, and transfers; PES = Practice environment scale.

In order to investigate further the relationship between PES scores and HAPUs, we divided the PES scores into terciles, with PES Group A scoring highest (best practice environments), B in the middle and C scoring lowest (worst practice environments). The breakout of patients was as follows:

Table 16. Terciles of the PES (MS units only) and Patients with and without HAPUs

PES Group	HAPU	No HAPU	Total	HAPU prevalence
A (best practice environment)	23	327	350	6.6%
B	10	376	386	3%
C	14	339	353	4%
Totals	47	1032	1079	

More HAPUs were observed in the patients who received care from the higher scoring MS units (those with better practice environments). We found a statistically significant relationship between staffing and HAPUs in Group A (best practice environments) only. None of the staffing variables were significantly related to HAPUs in the other 2 groups (B and C).

Table 17. Group A: Highest PES scoring (MS units only). Cox PH Model

Variable	Coefficient (robust SE)	HR	p
Age	0.03 (0.01)	1.03	.01
Mobility	-0.46 (0.28)	0.63	NS
Presence of Albumin level in record	1.47 (0.39)	4.34	< .001
LPN NCHPPS_day3	-4.14 (0.68)	0.02	< .001
Patient:Licensed nurse_day3	0.68 (0.97)	1.98	NS
Licensed NCHPPS_1week	-1.68 (0.30)	0.19	< .001

Model Concordance 0.947 (se = 0.074), R-square 0.214. Wald test =180.1, df=6, p=0. Robust = 9.2, p=0.128
LPN = Licensed practice nurse; NCHPPS = Nursing care hours per patient per shift

To summarize, the staffing variable that was most consistently associated with HAPUs was the LPN nursing care hours per patient per shift three days prior to the HAPU discovery. We conclude from this HAPU analysis:

- High workload intensity (ADT, not acuity) partially mediates the relationship between LPN nursing care hours and HAPUs. It partially explains this relationship.
- Of the three unit types, critical care units score highest on the PES; however critical care and step-down units had no associations between HAPUs and staffing.
- The practice environment does not mediate the staffing and HAPU association. Indeed, this staffing and HAPU relationship only exists in the best tercile of practice environments within medical-surgical units.
- Higher LPN staffing on medical-surgical units was strongly associated with fewer HAPUs in military facilities.
- Staffing and ADT at three days prior to HAPU discovery was most predictive of HAPU development.

Shift Level Adverse Patient Events (Falls, Falls with Injury, Medication Administration Errors)

In the original grant application, the research team stated we would use generalized linear mixed models for all of the shift-level analyses. This was attempted and the models would not converge. The team believes this is the result of the complex dependent data structure, the number of zeros (as with ADT values), and the unbalanced design. Therefore, a decision was made by the analysts to proceed with generalized estimating equation (GEE) for the mediation analysis. The data for the following analyses are at the shift-level.

GEE Analysis: Falls. We began with the base model (Model 1 in Table 18) of factors associated with falls on a shift from our previous study (Patrician et al , 2010). A higher total nursing care hours per patient per shift was significantly associated with fewer falls. The four step approach by Baron and Kenny (1986) and Judd and Kenny (1981) was used, along with backward and forward variable selection techniques. Results are in Table 18 below. In Model 2, falls were not associated with the acuity measure of workload intensity, therefore, acuity could not serve as a mediator. Likewise, ADT (Model 3) was not associated with falls and it could not serve as a mediator. Model 4 included all variables found to be statistically significant in previous analyses and shows that controlling for all shift level variables, including staffing, neither acuity nor ADT were associated with falls. In fact, the parameter estimates of the shift level variables did not change significantly. Model 5 demonstrated that better practice environments, as measured by the PES, were associated with fewer falls. The statistically significant interaction demonstrates that total nursing care hours per patients per day operates differently at different levels of the practice environment to contribute to or to prevent falls.

Table 18. Falls in Medical-Surgical Units. GEE parameter estimates and standard errors are reported.

Variable	Model 1 (DV=Fall)	Model 2 (DV=Acuity)	Model 3 (DV=ADT)	Model 4 (DV=Fall)	Model 5, Interaction (PES)
Fall	---	.000 (.005)	.006 (.007)	---	
Shift 3	.455 (.106)***	.0003 (.000)***	-.253 (.003)***	.483 (.130)***	.481 (.106)***
Shift 2	.231 (.104)*	.0002 (.000)***	-.103 (.003)***	.255 (.119)*	.244 (.104)**
%RN	.378 (.373)	.002 (.000)***	.102 (.012)***	.340 (.418)	.559 (.367)
%LPN	.630 (.381)	.002 (.000)***	.130 (.011)***	.826 (.437)	.728 (.372) *
%military	.023 (.003)***	.000 (.000)***	.000 (.000)	.026 (.004)***	.027 (.003)***
%civilian	.011 (.004)**	.000 (.000)***	-.001 (.000)***	.011 (.005)**	.015 (.004)***
%contract	-.001 (.004)	.000 (.000)***	-.001 (.000)***	-.006 (.004)	.006 (.004)
TNCHPPS	-.073 (.034)*	-.0001 (.000)***	.016 (.001)***	-.087 (.040)*	-.575 (.256)*
Weekend	.067 (.090)	.002 (.005)***	-.067 (.002)***	.098 (.103)	.092 (.091)
Census	.017 (.005)**	-.000 (.000)**	-.002 (.000)***	.018 (.006)**	.015 (.005)**
Large hospital	.708 (.207)***	.234 (.006)***	-.081 (.005)***	.577 (.230)**	.471 (.232)*
Acuity				.300 (.157)	
ADT				.121 (.292)	
PES					-1.617 (.405)***
TNCHPPS*PES					.178 (.088)*

*p <.05; **p<.01; ***p<.001;

Notes: RN = Registered nurse; LPN = Licensed practice nurse; TNCHPPS = Total nursing care hours per patient per shift; %RN = RN skill mix; % LPN = LPN skill mix; ADT = Admissions, discharges, and transfers; PES = Practice environment scale.

We repeated this analysis on the step-down units as well as the critical care units and findings are summarized below.

Step-down units findings:
Model 1. Acuity was associated with falls (p.03), but not TNCHPPS
Model 2. ADT was not associated with falls.
Model 3. Factors associated with falls when adjusting for ADT and acuity: Census only
Model 4. Factors associated with falls: Census only.
Model 5. No interaction of PES and staffing in SD units.

Critical care findings:
Model 1. Acuity was not associated with falls or TNCHPPS.
Model 2. ADT was not associated with falls, but was with TNCHPPS (p=.04).
Model 3. Factors associated with falls when adjusting for ADT and acuity: None.
Model 4. Factors associated with falls: Large hospital only.
Model 5. No interaction of PES and staffing in CC units.

GEE Analysis: Falls with Injury. The above analysis was repeated for the falls with injury adverse event variable. Table 19, Model 1 shows the multivariate results for predicting falls in medical-surgical units. The only staffing variable that was significant was the % military. For that variable, the parameter estimate corresponds to an odds ratio of 1.002 for each 10% decrease in military mix on a shift. This means that for every 10% decrease in military mix, the odds of falls with injury on a shift increases by .2%.

Table 19. **Falls with Injury in Medical-Surgical Units**. GEE parameter estimates and standard errors are reported.

Variable	Model 1 (DV=Fall with injury)
Fall	---
Shift 3	.574 (.233)**
Shift 2	.283 (.230)
%RN	.229 (.809)
%LPN	1.115 (.828)
%military	.024 (.007)***
%civilian	.006 (.008)
%contract	-.007 (.008)
TNCHPPS	-.014 (.057)
weekend	.006 (.199)
Census	.019 (.004)***
Large hospital	1.014 (.417)*

*p <.05; **p<.01; ***p<.001
Notes: TNCHPPS = Total nursing care hours per patient per shift; %RN = RN skill mix; % LPN = LPN skill mix.

Step-down unit findings: There were no associations between any staffing variables and falls with injury.

Critical care unit findings: Only the % contract was associated with falls with injury in critical care units (estimate -.245, SE.087, p .005). When converted to an odds ratio of .80, this indicates that for each drop of 10% in the use of contractors, the odds of a fall with injury drops 20%.

GEE Analysis: Medication Administration Errors (MAEs). Table 20 shows the results of GEE analysis of medication administration (MAE) errors with staffing in medical-surgical units. There are statistically significant associations between MAEs and LPN skill mix, % military, % civilian, and TNCHPPS. The associations for LPN skill mix and military and civilian % are such that higher proportions of these nurse categories on a shift are associated with higher probability of MAEs. The association with total NCHPPS indicates that with higher total NCHPPS, there is a lower probability of the occurrence of a MAE.

Also of note in Table 20 is that we show a practice environment association with MAEs such that higher scores on the PES are associated with fewer medication errors on a shift.

Step-down unit findings: The only staffing association with MAEs was with LPN skill mix (estimate 1.84, SE 01). This indicates that higher LPN skill mix is associated with a higher probability of a MAE on a shift. Neither ADT nor acuity were associated with MAEs in step-down units. The practice environment was strongly associated with MAEs but in an opposite direction, such that an increase in PES score corresponded to an increase in MAEs.

Critical care unit findings: There was an association between total NCHPPS and MAEs (estimate -.062, SE.031, p .04) in critical care units. This corresponds to an odds ratio of .93, indicating that each 1 hour increase in care hours on a shift is associated with a 7% drop in the probability of a MAE. Neither ADT not acuity, nor the practice environment were associated with MAEs in critical care.

Table 20. **Medication Administration Errors (MAE) in Medical-Surgical Units**. GEE parameter estimates and standard errors are reported.

Variable	Model 1	Model 4
Fall	---	
Shift 3	.450 (.106)**	
Shift 2	.228 (.104)*	
%RN	.339 (.373)	.550 (.364)
%LPN	.583 (.384)	1.124 (.363)**
%military	.023 (.003)***	.017 (.004)***
%civilian	.011 (.004)**	.015 (.004)***
%contract	-.001 (.008)	-.002 (.005)
TNCHPPS	-.074 (.034)*	-.142 (.031)***
weekend	.065 (.091)	-.015 (.099)
Census	.018 (.006)***	.019 (.006)***
Large hospital	.683 (.208)**	-.535 (.193)***
Acuity		.184 (.136)
ADT		.633 (.185)***
PES		-.910 (.247)***

*p <.05; **p<.01; ***p<.001

Notes: TNCHPPS = Total nursing care hours per patient per shift; %RN = RN skill mix; % LPN = LPN skill mix; . ADT = Admissions, discharges, and transfers; PES = Practice environment scale.

GEE Analysis: Needlestick Injuries. The **needlestick analysis** (not shown) was conducted in all three unit types and the only staffing association was in step–down units, where higher total NCHPPS were associated with higher probability of needlestick injuries. There were no staffing associations in either

medical-surgical or critical care units. There were no associations between needlestick injuries and ADT, acuity, or practice environment.

As the research team progressed toward analysis of mediation and moderation effects, we noticed that some of the results obtained from this analysis differed substantially from the results of the previous MilNOD study (Patrician, et al., 2010). The team then compared results of the Bayesian analysis (from the previous MilNOD study) with the current one for the base models for falls, falls with injury med errors, and needlesticks. Table 21 displays the comparison.

Table 21. Comparison of Bayesian results (in Patrician et al. 2010) and current GEE analysis (*=statistically significant variables in Bayesian analysis; #= statistically significant variables in GEE analysis)

	Falls			Falls w/injury			Med errors			Needle-sticks		
Variable	MS	SD	CC	MS	SD	CC	MS	SD	CC	MS	SD	CC
Shift3	#						#	#	#			*
Shift2	*#						*#	*#	*#			
%RN	*		*	*		*	*		*	*	*	*
%LPN	*						*#	#			*	
%Military	*#	*	*	*#			#				*	
%Civilian	*#	*	*	*	*		#	*	*	*	*	
%Contract	*			*		#					*	*
TNCHPPS	*#	*	*	*	*	*	*#		*#	*	#	
Monday				#*								
Census	*#	*#		#	*#	#	*#	*#	*		*#	
Acuity	*#						*					
Large Hospital	*#		*	*#		*	*#		*			

Notes: %RN = RN skill mix; % LPN = LPN skill mix; TNCHPPS = Total nursing care hours per patient per shift.

Based upon the comparisons above, the group decided to have the Bayesian analysis repeated, and then to have the moderation and mediation done using Bayesian techniques. Because there were fewer findings in step-down units, the analysis below is limited to medical-surgical and critical care units. Also, because of the very few findings related to needlestick injuries, we decided to forgo the needlestick analysis.

Bayesian Analysis Results (Falls, Falls with Injury, Medication Administration Errors)

Table 22 shows the mediation testing of staffing variables in the prediction of falls. Model 1 is the base model that shows the associations between day and evening shifts with fewer falls as compared to night shift. It also shows a decrease in falls with a decrease in the percentages of all staff category variables (as compared to the reservist category), which is counterintuitive, and no associations of skill mix with falls. There is a 7% increase in the odds of falls with each increase in total nursing care hours, which is also counterintuitive. An increased census and large hospitals have higher probabilities of falls.

In order to determine whether a variable has a mediation effect, it is first important to establish a relationship between the dependent variable (falls) and the mediators, in this case, ADT and acuity. Both are associated with falls. Higher ADT is associated with fewer falls and higher acuity is associated with increased odds of a fall. The second step in mediation testing is to determine if the mediators are associated with the independent variables they are supposed to mediate (staffing in this case). In Models 3a and 3b in Table 22, we see that both ADT and acuity are associated with LPN skill mix and TNCHPPS. Additional relationships exist between % military and ADT as well as %RN and %contract and acuity. The %RN and acuity relationship makes sense especially since staffing is supposed to be based on acuity in the military healthcare system.

The final model, Model 4 in Table 22 shows a lack of mediation in that none of the staffing variables are affected by the addition of ADT and acuity into the model. If either ADT or acuity mediated the relationship between staffing and falls, we would see a change in the odds ratios and the significance levels of the staffing variables that were mediated. No change in any of the staffing odds ratios are evident in Table 22. Thus, workload intensity does not mediate the relationship between staffing and falls in medical-surgical units. In addition, the Akaike information criterion (AIC) is an indicator of model fit; Model 1 is the best fitting model as evidenced by the smaller AIC value.

Table 22. Testing mediation effects of ADT and acuity on **falls in medical-surgical units**. Odds Ratios and 95% CS (Models 1, 2a, 2b, and 4) and parameter estimates with standard errors (Models 3a and 3b) (N = 40,830 shifts).

Variable	Model 1 (DV=Fall)	Model 2a (IV=ADT)	Model 2b (IV=Acuity)	Model 3a (DV=ADT)	Model 3b (DV=Acuity)	Model 4 (DV=Falls)
Fall		.79 (.76-.81)***	1.19 (1.04-1.37)**	Parameter estimates (and robust standard errors) reported		
Day shift	.56 (.53-.60)***					.50 (.55-.63)***
Evening shift	.74 (.70-.78)***					.77 (.73-.82)***
Skill mix (10% decrease)						
%RN	1.00 (.96-1.03)			.01 (.01)	.09 (.02)***	1.00 (.97-1.04)
%LPN	.99 (.95-1.03)			-.14 (.01)***	.06 (.02)**	.99 (.95-1.03)
Staff Category (10% decrease)						
%military	.78 (.75-.81)***			.12 (.02)***	-.01 (.03)	.78 (.74-.81)***
%civilian	.83 (.79-.87)***			-.02 (.02)	-.03 (.03)	.83 (.80-.86)***
%contract	.94 (.90-.99)**			.03 (.02)	-.06 (.03)*	.94 (.90-.98)**
TNCHPPS (1 hour increase)	1.07 (1.04-1.10)***			.02 (.001)***	.01 (.01)**	1.07 (1.04-1.10)***
Census (increase of 3 patients)	1.07 (1.03-1.11)***					1.07 (1.03-1.11)***
Large hospital	5.57 (2.47-12.58)***					4.86 (2.16-10.94)***
Acuity (1 SD increase)						1.17 (1.02-1.34)**
ADT (1 SD increase)						.94 (.90-.98)*
Model fit (AIC)	307083	304739	304139			307405

*p <.05; **p<.01; ***p<.001

Notes: %RN = RN skill mix; % LPN = LPN skill mix; TNCHPPS = Total nursing care hours per patient per shift ADT = Admissions, discharges, and transfers.

Table 23 below shows the results of testing the relationship between staffing and falls and the mediation effects of workload intensity. Unlike medical-surgical units, in critical care units, day shift and evening shift are associated with a greater probability of falls as compared to night shift. In critical care, a decrease in RN and LPN skill mix is associated with fewer falls, which is another counterintuitive finding. Lower percentages of military and civilian staff as compared to reservist staff, are also associated with fewer falls, another counterintuitive finding. Shifts with lower percentages of contract

nurses are associated with fewer falls. Higher total nursing care hours are associated with more falls, and higher census is associated with fewer falls. Higher ADT is associated with fewer falls, a similar finding in medical-surgical units. Acuity is not associated with falls in critical care units, possibly because acuity is less variable in critical care units as compared to medical-surgical units. Therefore, no further analysis of acuity was attempted.

When testing the relationship between ADT and staffing variables, the following are significantly associated with ADT: RN and LPN skill mix and total nursing care hours per patient per shift. Adding ADT to the base model yields Model 4, which shows no mediation of the staffing variables by ADT. However, adding ADT causes the census variable to become non-significant, indicating a mediating effect on the relationship between higher census and fewer falls.

Table 23. Testing mediation effects of ADT and acuity on **falls in critical care units**. Odds Ratios and 95% CS (Models 1, 2a, 2b, and 4) and parameter estimates with standard errors (Models 3a and 3b) (N = 23,770 shifts).

Variable	Model 1 (DV=Fall)	Model 2a (IV=ADT)	Model 2b (IV=Acuity)	Model 3a (DV=ADT)	Model 3b (DV=Acuity)	Model 4 (DV=Falls)
Fall		.87 (.83-.91)***	1.11 (.91-1.34)	Parameter estimates (and robust standard errors) reported		
Day shift	1.51 (1.39-1.63)***					1.71 (1.58-1.86)***
Evening shift	1.64 (1.52-1.76)***					1.87 (1.74-2.02)***
Skill mix (10% decrease)						
%RN	.37 (.33-.42)***			-.12 (.03)***	.06 (.06)	.25 (.22-.29)***
%LPN	.36 (.31-.41)***			-.14 (.03)***	.13 (.06)*	.25 (.21-.29)***
Staff Category (10% decrease)						
%military	.65 (.62-.68)***			.02 (.02)	-.01 (.04)	.62 (.60-.65)***
%civilian	.79 (.75-.82)***			-.02 (.02)	-.02 (.04)	.78 (.75-.82)***
%contract	1.46 (1.37-1.55)***			-.02 (.02)	.08 (.06)	1.46 (1.38-1.56)***
TNCHPPS (1 hour increase)	1.06 (1.04-1.09)***			.01 (.01)***	-.01 (.01)***	1.12 (1.10-1.15)***
Census (increase of 3 patients)	.83 (.71-.96)**					.97 (.83-1.13)
Large hospital	1.57 (.23-11)					1.06 (.11-10.83)
Acuity (1 SD increase)						
ADT (1 SD increase)						.66 (.62-.69)***
Model fit (AIC)	227950	210582	210830			239318

*p <.05; **p<.01; ***p<.001

Notes: %RN = RN skill mix; % LPN = LPN skill mix; TNCHPPS = Total nursing care hours per patient per shift ADT = Admissions, discharges, and transfers.

Table 24 displays the results of the analysis of falls with injury on medical-surgical units. Here again ADT is associated with fewer injurious falls and does not mediate the relationship between staffing and falls. Acuity is not associated with injurious falls. One interesting difference between this analysis and

that of all falls (Table 20) is that a decrease in LPN skill mix is associated with more injurious falls, even when controlling for workload intensity as measured by ADT. There is no such association with RN skill mix.

Table 24. Testing mediation effects of ADT and acuity on **falls with injury in medical-surgical units**. Odds Ratios and 95% CS (Models 1, 2a, 2b, and 4) and parameter estimates with standard errors (Models 3a and 3b) (N = 40,793 shifts).

Variable	Model 1 (DV=Fall with injury)	Model 2a (IV=ADT)	Model 2b (IV=Acuity)	Model 3a (DV=ADT)	Model 3b (DV=Acuity)	Model 4 (DV=Fall with injury)
Fall with injury		.72 (.69-.74)***	1.18 (.93-1.51)	Parameter estimates (and robust standard errors) reported		
Day shift	.54 (.51-.57)***					.63 (.59-.67)***
Evening shift	.54 (.51-.57)***					.61 (.58-.65)***
Skill mix (10% decrease)						
%RN	1.00 (.97-1.04)			.01 (.01)	.09 (.02)***	1.01 (.97-1.04)
%LPN	1.16 (1.12-1.20)***			-.14 (.01)***	.06 (.02)**	1.17 (1.13-1.22)***
Staff Category (10% decrease)						
%military	.73 (.71-.76)***			.12 (.02)***	-.01 (.03)	.73 (.70-.76)***
%civilian	.82 (.79-.85)***			-.02 (.02)	-.03 (.03)	.81 (.79-.84)***
%contract	.66 (.63-.68)**			.03 (.02)	-.06 (.03)*	.66 (.63-.68)***
TNCHPPS (1 hour increase)	1.22 (1.18-1.26)***			.02 (.001)***	.01 (.01)**	1.22 (1.18-1.26)***
Census (increase of 3 patients)	.88 (.84-.92)***					.87 (.83-.92)***
Large hospital	21.95 (5.52-87.38)***					20 (5.16-77.49)***
Acuity (1 SD increase)						
ADT (1 SD increase)						.83 (.80-.86)***
Model fit (AIC)	382748	365402	364211			307405

*p <.05; **p<.01; ***p<.001

Notes: %RN = RN skill mix; % LPN = LPN skill mix; TNCHPPS = Total nursing care hours per patient per shift; ADT = Admissions, discharges, and transfers.

Table 25 shows falls with injury analysis in critical care units. ADT is associated with falls with injury in critical care units, but once again it does not mediate the staffing (TNCHPPS) association with injurious falls. In critical care units, a decreased LPN skill mix is associated with fewer injurious falls, even after controlling for workload intensity. This finding is in the opposite direction of that of medical-surgical units (where a drop in LPN skill mix is associated with a higher probability of falls), and may be related to the level of intensity of patient care in critical care units, where the patient types require a higher RN skill mix. However the odds ratio is extremely small (.002)

ADT but not acuity is related to injurious falls in critical care, and the addition of ADT to the model does change the odds ratio for TNCHPPS but does not change the statistical significance. Therefore, there is no mediation effect of ADT in critical care.

Table 25. Testing mediation effects of ADT and acuity on **falls with injury in critical care units**. Odds Ratios and 95% CS (Models 1, 2a, 2b, and 4) and parameter estimates with standard errors (Models 3a and 3b) (N = 23,768 shifts).

Variable	Model 1 (DV=Fall with injury)	Model 2a (IV=ADT)	Model 2b (IV=Acuity)	Model 3a (DV=ADT)	Model 3b (DV=Acuity)	Model 4 (DV=Fall with injury)
Fall with injury		.14 (.02-.96)*	1.19 (.80-1.76)	Parameter estimates (and robust standard errors) reported		
Day shift	.89 (.78-1.01)					1.31 (1.14-1.51)***
Evening shift	5.11 (4.54-5.75)***					4.95 (4.41-5.55)***
Skill mix (10% decrease)						
%RN	.007 (.005-.009)***			-.12 (.03)***	.06 (.06)	.008 (.006-.01)***
%LPN	.002 (.002-.003)***			-.14 (.03)***	.13 (.06)*	.002 (.002-.003)***
Staff Category (10% decrease)						
%military	.24 (.22-.26)***			.02 (.02)	-.01 (.04)	.24 (.22-.26)***
%civilian	1.13 (1.05-1.23)**			-.02 (.02)	-.02 (.04)	1.06 (.98-1.15)
%contract	202 (155-265)***			-.02 (.02)	.08 (.06)	.65 (48-88)***
TNCHPPS (1 hour increase)	.62 (.57-.67)***			.01 (.001)***	-.003 (.01)***	.43 (.39-.47)***
Census (increase of 3 patients)	2.15 (1.66-2.78)***					.68 (.49-.93)*
Large hospital	.01 (0-3630)					.02 (0-6524)
Acuity (1 SD increase)						
ADT (1 SD increase)						.31 (.26-.38)***
Model fit (AIC)	631194	259714	247410			634639

*p <.05; **p<.01; ***p<.001
Notes: %RN = RN skill mix; % LPN = LPN skill mix; TNCHPPS = Total nursing care hours per patient per shift; ADT = Admissions, discharges, and transfers.

Tables 26 and 27 show the Bayesian results for medication errors in medical-surgical and critical care units, respectively. Medication administration errors (MAEs) are strongly associated with TNCHPPS in both unit types. Each increase in nursing care hours is associated with a 17% drop in the probability of a MAE occurring on a shift – the result is the same in both unit types. In medical-surgical units, the percentage of staff who are civilians is strongly associated with MAEs such that each 10% drop in civilian staff percent is associated with a 5% increased probability of MAEs. Although ADT is strongly

related to MAEs (but acuity is not), it does not mediate the staffing –MAE relationship for either TNCHPPS or percentage of civilian staff.

In critical care units, both RN and LPN skill mix decreases are associated with a drop in the probability of a MAE, which is another counterintuitive finding. Decreased percentages of civilian and military nurses on a shift are both associated with an increased probability in MAEs, but this relationship is not mediated by ADT.

Table 26. Testing mediation effects of ADT and acuity on **medication administration errors (MAEs) in medical-surgical units**. Odds Ratios and 95% CS (Models 1, 2a, 2b, and 4) and parameter estimates with standard errors (Models 3a and 3b) (N = 40,220 shifts).

Variable	Model 1 (DV=MAE)	Model 2a (IV=ADT)	Model 2b (IV=Acuity)	Model 3a (DV=ADT)	Model 3b (DV=Acuity)	Model 4 (DV=MAE)
MAE		1.51 (1.46-1.55)***	1.08 (.95-1.23)	Parameter estimates (and robust standard errors) reported		
Day shift	3.29 (3.09-3.51)***					2.90 (2.7-3.12)***
Evening shift	3.05 (2.87-3.24)***					2.77 (2.60-2.96)***
Skill mix (10% decrease)						
%RN	1.03 (.99-1.07)			.01 (.01)	.08 (.02)***	1.04 (.99-1.07)
%LPN	.98 (.94-1.02)			-.14 (.01)***	.06 (.02)*	.98 (.95-1.02)
Staff Category (10% decrease)						
%military	1.01 (.97-1.06)			.12 (.02)***	-.01 (.03)	1.01 (.96-1.05)
%civilian	1.05 (1.01-1.10)*			-.02 (.02)	-.03 (.03)	1.05 (1.00-1.09)*
%contract	.99 (.94-1.03)			.04 (.02)	-.08 (.03)**	.98 (.93-1.02)
TNCHPPS (1 hour increase)	.83 (.81-.86)***			.02 (.001)***	.002 (.001)**	.82 (.79--.84)***
Census (increase of 3 patients)	.91 (.86-.95)***					.92 (.88-.96)***
Large hospital	1.60 (.59-4.34)					1.67 (.63-4.45)
Acuity (1 SD increase)						
ADT (1 SD increase)						1.16 (1.11-1.20)***
Model fit (AIC)	295728	304739	304139			296062

*p <.05; **p<.01; ***p<.001

Notes: %RN = RN skill mix; % LPN = LPN skill mix; TNCHPPS = Total nursing care hours per patient per shift; ADT = Admissions, discharges, and transfers.

Table 27. Testing mediation effects of ADT and acuity on **medication administration errors (MAEs) in critical care units**. Odds Ratios and 95% CS (Models 1, 2a, 2b, and 4) and parameter estimates with standard errors (Models 3a and 3b) (N = 23,367 shifts).

Variable	Model 1 (DV=MAE)	Model 2a (IV=ADT)	Model 2b (IV=Acuity)	Model 3a (DV=ADT)	Model 3b (DV=Acuity)	Model 4 (DV=MAE)
MAE		1.12 (1.08-1.16)*	1.02 (.90-1.17)	Parameter estimates (and robust standard errors) reported		
Day shift	4.43 (4.09-4.79)***					4.67 (4.30-5.07)***
Evening shift	3.95 (3.66-4.28)***					4.13 (3.82-4.48)***
Skill mix (10% decrease)						
%RN	.83 (.73-.93)**			-.12 (.03)***	.06 (.06)	.85 (.75-.96)**
%LPN	.71 (.62-.80)***			-.14 (.03)***	.13 (.06)*	.72 (.64-.82)***
Staff Category (10% decrease)						
%military	1.23 (1.17-1.29)***			.02 (.02)	.005 (.04)	1.22 (1.16-1.28)***
%civilian	1.40 (1.34-1.46)***			-.02 (.02)	-.02 (.04)	140 (1.34-1.46)***
%contract	1.04 (.97-1.11)			-.02 (.02)	.08 (.06)	1.03 (.97-1.10)
TNCHPPS (1 hour increase)	.83 (.81-.85)***			.01 (.0004)***	-.003 (.001)**	.83 (.81--.85)***
Census (increase of 3 patients)	.68 (.58-.79)***					.66 (.57-.77)***
Large hospital	.62 (.18-2.12)					.64 (.19-2.10)
Acuity (1 SD increase)						
ADT (1 SD increase)						.88 (.84-.93)***
Model fit (AIC)	201853	304739	304139			202107

*p <.05; **p<.01; ***p<.001

Notes: %RN = RN skill mix; % LPN = LPN skill mix; TNCHPPS = Total nursing care hours per patient per shift ADT = Admissions, discharges, and transfers.

Bayesian Analysis Results (Practice Environment Moderation)

Part of Aim #1 was to test the possible moderation effect of the practice environment on the relationship between staffing variables and the adverse events of falls, falls with injury, and medication administration errors. For these analyses, we began with the base model, or Model 1 in the tables above and added the composite practice environment scale (PES). If the PES was statistically significant in that model, we tested for interaction effects with the most significant staffing variable.

Falls. In the base models (including all Model 1 variables as above) for falls in medical-surgical (MS) and critical care (CC) units the odds ratios (OR) for PES were not significant in either unit type (MS: OR 1.21, p .31; CC: OR 2.93, p .07).

Falls with Injury. The PES ORs were not significant in MS or CC units for falls with injury, when added to the base models (Model 1 variables as above) (MS: OR .82, p .51; CC: OR .97, p .36).

Medication Administration Errors (MAEs). The PES was not significantly associated with MAEs in either MS units (OR 1.23, p .07) or CC units (OR 1.15, p .73).

Because there is no association of the adverse events with the PES, there is no moderation effect of the practice environment.

Table 28. Comparison of Bayesian results (in Patrician et al. 2010) and current GEE analysis (*=statistically significant variables in Bayesian analysis; # = statistically significant variables in GEE analysis; $ = statistically significant in Second Bayesian analysis)

	Falls		Falls with Injury		MAEs	
Variable	MS	CC	MS	CC	MS	CC
Shift3	# $	$	$		# $	#
Shift2	* # $	$	$	$	* # $	* # $
%RN	*	* $	*	* $	*	* $
%LPN	*	$	$	$	* #	$
%Military	* # $	* $	* # $	$	#	$
%Civilian	* # $	* $	* $	$	# $	* $
%Contract	* $	$	* $	# $		
TNCHPPS	* # $	* $	* $	* $	* # $	* # $
Census	* # $	$	# $	# $	* # $	* $
Acuity	* # $				*	
ADT (not used in *)	$	$	$	$	$	$
Large Hospital	* # $	*	* # $	*	*#	*

Notes: %RN = RN skill mix; % LPN = LPN skill mix; TNCHPPS = Total nursing care hours per patient per shift ADT = Admissions, discharges, and transfers.

Based on the comparisons of results obtained with different modeling techniques, it is clear that more associations between adverse events and staffing are evident using Bayesian techniques as opposed to classical statistical techniques. Bayesian analysis has as its advantages the use of prior information to calculate starting values for model building, and for this reason may be considered a more evidenced based modeling strategy. Bayesian analysis may also produce more stable estimates because it is not affected by the many issues associated with unbalanced data, including many cells with zeros (or shifts with no events) in this particular data set. Another important distinction is that GEE analysis allows for nesting at only one level, whereas, with the hierarchical modeling techniques in Bayesian analysis we can nest at several levels. This is important in our particular data set, where the data are dependent, i.e., shifts are nested within days, days within units, and units within hospitals.

Therefore, relying on our Bayesian results, we can conclude that:

1. Staffing has a significant effect on adverse events, particularly total nursing care hours.
2. ADT is significantly associated with all types of adverse events in both unit types.
3. Acuity is largely not associated with adverse events, and this may be due to the use of acuity to plan staffing in military settings.
4. There were no associations between the practice environment and adverse events when staffing variables were added to the base models. In the initial GEE analysis (with falls) there was a significant interaction effect for PES and Total NCHPPS; however, in a sub analysis, we found

that only in better work environments was there a staffing and averse event association. No such association was observed in poorer practice environments.

Aim #1 Hypotheses Summary

H1.1: Staffing is negatively associated with HAPU prevalence, even after adjusting for nurse workload intensity and practice environment.

This hypothesis is supported as LPN hours are strongly associated with HAPU prevalence on medical-surgical units, even after adjusting for acuity, ADT, and the practice environment. Higher LPN hours was associated with fewer HAPUs.

H1.2: The association between staffing and HAPU prevalence remains negative across different levels of workload intensity, practice environment, and their combined levels.

This hypothesis was partially supported. In medical-surgical units, LPN hours remained negatively associated with HAPUs, but only in the highest terciles of PES scores (best practice environments). There were no staffing and HAPU associations in moderate or poor practice environments.

H1.3: Staffing is negatively associated with the occurrence of patient falls and medication administration errors, even after adjusting for workload intensity and practice environment.

This hypothesis was partially supported. Staffing component (military and civilian percentages) was negatively associated with falls and injurious falls in medical-surgical and critical care units. The percentage of contract staff had mixed results. Total NCHPPS was strongly and positively associated with falls in both unit types and falls with injury in medical-surgical units, but was negatively associated with falls with injury in critical care and MAEs in both unit types. Adjusting for workload intensity did not change these staffing results. There were no practice environment effects on these relationships.

H1.4: The association between staffing and the occurrence of patient falls and medication administration errors remains negative across different levels of workload intensity, practice environment, and their combined levels.

No practice environment effects were observed in the Bayesian analyses. ADT but not acuity was associated with these adverse events, but did not mediate any of the staffing effects.

AIM #2: Staffing and Nurse Outcomes

The second aim of this study was to determine the relationships between staffing and nurse outcomes (needlestick injuries and nurse job satisfaction) and assess the moderating (interacting) and mediating (confounding) effect of nurse workload intensity and practice environment on these relationships.
H2.1: Staffing is negatively associated with the occurrence of needlestick injury, even after adjusting for nurse workload intensity and practice environment.
H2.2: The association between staffing and prevalence of needlestick injury remains negative across different levels of workload intensity, practice environment, and their combined levels.
H2.3: Staffing is negatively associated with nurse job satisfaction, even after adjusting for nurse workload intensity and practice environment.
H2.4: The association between staffing and nurse job satisfaction remains negative across different levels of workload intensity, practice environment, and their combined levels.

Needlestick Injuries

There were no associations between staffing and needlestick injuries in any of the unit types, therefore, needlestick injuries were dropped from further analyses. This could be due to the very small number of needlestick injuries in the data set (N=80).

Job Satisfaction

The data for the job satisfaction analyses were obtained from nurse survey data via the MilNOD database. To prepare the analytic database, staffing and shift level variables were aggregated to the unit level 6 months before and 6 months after nurse survey administration. We chose to use only the 2005/6 data because surveys were not matched over the years to the same individual. The sample size for this analysis was 892 staff nurses.

Table 29. Sample Characteristics (using 2005/6 data).

	N	Mean (SD)	Min	Max
Job satisfaction	857	3.58 (1.26)	1	5
PES	864	2.86 (.54)	1.11	4
NPHA	859	2.71 (.64)	1	4
NFQC	861	2.99 (.55)	1	4
NMALS	852	2.85 (.79)	1	4
SRA	874	2.73 (.72)	1	4
Ns-MD	865	2.99 (.65)	1	4
Age	794	36.78 (11.07)	19	69
%RN	827	.60 (.15)	.42	1.00
%LPN	827	.16 (.13)	0	.43
%Military	827	.48 (.25)	.08	1.00
%Civilian	827	.34 (.23)	0	.86
%Contract	827	.16 (.14)	0	.57
TNCHPPS	827	6.18 (3.38)	2.70	23.30
Census	827	13.06 (7.85)	1.84	34.73
Acuity	827	3.95 (.82)	2.89	5.55
ADT	791	.20 (.10)	0	.48

Notes: %RN = RN skill mix; % LPN = LPN skill mix; TNCHPPS = Total nursing care hours per patient per shift
ADT = Admissions, discharges, and transfers.

A correlation matrix in Table 30 shows high correlations of job satisfaction with both the PES and its subscales, but its correlations with staffing and workload intensity (acuity and ADT) were low. GEE Analysis was conducted to determine what factors were associated with job satisfaction (N=892 observations), results are in Table 31 below.

Table 30. Correlation Matrix.

	PES	NPHA	NFQC	NMALS	SRA	Ns-MD	age	TNCHPPS	Census	Acuity	ADT
Jobsat2	.54***	.48***	.46***	.47***	.41***	.36***	.10**	-.05	.04	.07*	-.08*
PES		.87***	.86***	.85***	.76***	.71***	-.11*	.07*	.002	.12***	-.07*
NPHA			.76***	.76***	.53***	.51***	-.16***	.01	.03	.04	-.07*
NFQC				.66***	.56***	.58***	-.10**	-.02	.06	.06	-.08*
NMALS					.54***	.40***	-.13***	.01	.06	.07*	-.08*
SRA						.42***	-.06	.12***	-.07	.14***	-.04
Ns-MD							-.003	.12***	-.06*	.16***	-.03
Age								.02	-.14***	.17***	.003
TNCHPPS									-.68***	.60***	.26***
Census										-.52***	-.28***
Acuity											-.11*

*p=.05, **p=.01, ***p <=.001Notes: TNCHPPS = Total nursing care hours per patient per shift; PES = Practice Environment Scale; NPHA = Nursing Participation in Hospital Affairs; NFQC = Nursing Foundations for Quality Care; NMALS = Nurse Manager Ability, Leadership and Support; SRA = Staffing and Resource Adequacy; Ns-MD = Nurse-Physician Collaboration.

Table 31. Predictors of Nurse Job satisfaction (GEE Parameter Estimates and Robust SEs)

Variable	Model 1	Model 2 (SRA removed)	Model 3 (Acuity added)	Model 4 (ADT added)
PES	.396 (.034)***	.368 (.028)***	.367 (.028)***	.367 (.029)***
SRA subscale	-.029 (.023)	-------	-----	---
age	.003 (.001)*	.003 (.001)*	.003 (.001)*	.003 (.001)*
RN	NS	NS	NS	NS
MS unit	NS	NS	NS	NS
SD Unit	NS	NS	NS	NS
%RN	NS	NS	NS	NS
%LPN	NS	NS	NS	NS
%Military	NS	NS	NS	NS
%civilian	NS	NS	NS	NS
%Contract	NS	NS	NS	NS
TNCHPPS	-.018 (.005)*	-.011 (.005)*	-.010 (.005)*	-.012 (.006)*
Census	NS	NS	NS	NS
Non-military nurse	.067 (.024)**	NS	.065 (.025)**	.057 (.026)*
Acuity			NS	NS
ADT				NS
Teamwork RN & NA				
Teamwork RN & LPNs				
Model fit (QIC)	671.22	678.71	679.51	653.58

*p <.05, **p<.01, ***p>.001; %RN = RN skill mix; % LPN = LPN skill mix; TNCHPPS = Total nursing care hours per patient per shift; ADT = Admissions, discharges, and transfers.; NA = Nursing assistant

This analysis clearly demonstrates a significant association between fewer TNCHPPS and higher job satisfaction, even when the practice environment is controlled. This is important as typically higher PES

ratings are associated with higher staffing as well, and this shows that even with the practice environment controlled, staffing persists as an important consideration in nurse job satisfaction. Our results above also show that nonmilitary nurses have higher levels of job satisfaction. Because teamwork has been associated with better working environments, we also included two items from the nurse survey that asked about teamwork between RNs and LPNs and also RNs and NAs. Neither teamwork variable was associated with job satisfaction in multivariate analysis.

We then investigated job satisfaction vs. teamwork variables by crosstabs and Chi square. For teamwork between RNs and LPNs: Chi square 94.77, 12 df, $p < .001$. For teamwork between RNs and NAs, Chi square 97.75, 12 df, $p < .001$. So there were differences in job satisfaction based upon teamwork on the unit. There was no effect for hospital size (Chi square 2.61, 4 df, p .625) and no effect of being in the military (Chi-square 7.75, 4 df, p.101), although it is significant in multivariate analysis with GEE. There was no difference in job satisfaction by nursing type (RN, LPN, NA) (Chi square 6.50, 8 df, $p = .592$).

Therefore, we can conclude the following about job satisfaction and staffing:

- Job satisfaction is associated with higher PES scores, higher age, lower TNCHPPS, and with being a civilian nursing staff member.
- Acuity and ADT had no relationship with job satisfaction, thus, there was no mediation observed.
- Removing the SRA (staffing and resource adequacy) had no effect on the staffing variables. In other studies, SRA and staffing measures are highly correlated and multicolinearity could be a problem. This was not observed in our study.
- Teamwork, as measured by the nurse survey, seemed to have no effect on job satisfaction.

Nursing Practice Environment

The data set contained a total of 1,586 PES surveys. The table below shows response rates by year, facility and nursing provider type.

Table 32. PES survey return rates by year, facility, and nursing type.

Facility	Year	RN Surveys			LPN/NA Surveys		
		Sent	Return	Response Rate	Sent	Return	Response Rate
101	2003	212	79	37.3%	200	50	25.0%
	2004	219	77	35.2%	186	42	22.6%
	2005/6	219	68	31.1%	166	30	18.1%
102	2003	158	66	41.8%	150	39	26.0%
	2004	165	61	37.0%	127	39	30.7%
	2005/6	139	66	47.5%	92	44	47.8%
103	2004	218	98	45.0%	117	73	62.4%
	2005/6	270	105	38.8%	163	46	28.2%
104	2005/6	244	100	40.9%	98	20	20.4%
105	2005/6	124	32	25.8%	73	8	10.9%

106	2005/6	144	66	45.8%	126	42	33.3%
501	2003	150	38	25.3%	100	15	15.0%
	2004	55	28	50.9%	16	7	43.8%
	2005/6	59	26	44.1%	38	18	47.4%
502	2003	60	37	61.7%	75	12	16.0%
	2004	44	21	47.7%	48	9	18.8%
	2005/6	27	11	40.7%	27	5	18.5%
503	2005/6	23	20	87.0%	33	21	63.6%
901	2003	30	8	26.7%	35	7	20.0%
	2004	17	8	47.1%	18	6	33.3%
	2005/6	17	4	23.5%	14	5	35.7%
902	2005/6	16	10	62.5%	15	3	20.0%
903	2004	16	10	62.5%	4	1	25.0%
	2005/6	10	3	30.0%	8	2	25.0%
	TOTALS	2,636	1042	39.5%	1,929	544	28.2%

Table 33. Useable returned PES surveys by nursing provider type and year.

Year	RN	LPN	NA	Totals
2003	118	41	26	185
2004	301	1245	40	465
2005/6	610	152	157	919
Totals	1029	317	223	1569

Using all survey years combined, the average age of respondents was 37.36 (SD 10.80), range 19-69. The entire sample and ages are shown below in Table 34. There is a about a 14-year difference between military and civilian nurses, with military being younger.

Table 34. PES respondents by category and age (all years combined).

Employment category	N (%)	Age mean (SD)	RNs only (N)	Age mean (SD) RNs
Active military	739 (49%)	31.09 (8.04)	470	33.06 (7.96)
Civilian	560 (37.2%)	44.67 (9.55)	328	45.53 (8.95)
Contract	151 10%)	40 (9.40)	78	39.83 (9.70)
Reservist	57 (4%)	41.3 (8.82)	48	42 (8.21)

Table 35 shows that PES scores improved over the years of the study; this improvement was statistically significant.

Table 35. PES scores by year.

Year	N	PES Mean (SD)	ANOVA
2003	139	2.69 (.52)	F = 5.55, df 3, p = .001
2004	396	2.76 (.52)	
2005/6	763	2.86 (.54)	

The Cronbach's alpha over the three nurse types is in Table 36 below. The instrument performed well with different nurse types.

Table 36. Internal consistency reliability of the PES.

Nurse type	N	alpha
RN	878	.94
LPN	279	.94
Unlicensed (NAs)	150	.93
All types	1307	.94

Notes: RN = Registered nurse; LPN = Licensed practical nurse; NA = Nursing assistant.

Because of the dependency of the data (i.e., the same nurses could have responded all three years and we did not match surveys to individuals from year to year), we chose to use the final year's data to complete the PES analyses. The 2005/6 survey data had 919 respondents. The demographics of this sample are as follows in Table 37. The average age in the 2005/6 data was 36.92 (11.16).

Table 37. Sample demographics (2005/6 surveys).

2005/6 data	N (%)
Nurse type	
RN	610 (68%)
LPN	152 (17%)
Unlicensed (NAs)	130 (15%)
Category	
Active military	441 (50.8%)
Civilian	310 (35.7%)
Contract	93 (10.7%)
Reservist	4 (2.8%)

Notes: RN = Registered nurse; LPN = Licensed practical nurse; NA = Nursing assistant.

We began the PES analysis by conducting a Confirmatory Factor Analysis (CFA). There is strong internal consistency reliability (Cronbach's alphas are very high for PES overall and for the subscales). CFA shows strong lack of fit of the 5-subscale PES, which was more pronounced among nursing assistants (NAs). Combining the subscales Nursing Foundations for Quality Care (NFQC) and Nursing Participation in Hospital Affairs (NPHA) could improve fit.

Comparisons show statistically significant differences in responses between NAs and licensed providers (LPNs and RNs), both with and without adjusting for other covariates. NAs tend to rate the PES higher, even when clustering by unit for this analysis.

In the model with all staff, the CFA results were: Model Chi square 3883.5, df 377, $p < .001$, GOF index, adjusted 0.674, RMSEA = 0.110. The CFA results for RNs & LPNs together were: Model chi square 3350.9, df 377, $p < .001$, adjusted GOF index 0.713, RMSEA = 0.111. In the NA only model, the results were: Model chi square 1032.9, df 377, $p < .001$, adjusted GOF index 0.537, RMSEA = 0.128. The decreased GOF index is suggestive of the difference in the NAs responses.

We next conducted a GEE analysis to determine what factors accounted for how nurses responded to the PES. As shown in Table 38, licensed providers tended to rate the PES lower than unlicensed did. Those rating the PES more positively tended to be more satisfied with their jobs, and more satisfied with working in the military environment, were more likely to be military nursing staff, and were more likely to be working in critical care.

Table 38. Factors that Account for PES Responses

Variable	Estimate	SE	Wald	p
Licensed	-0.178	0.061	8.64	.003
Age	-0.003	0.002	2.52	NS
Job sat (AMEDD)	0.107	0.025	17.60	< .001
Job sat (current job)	0.159	0.024	45.86	< .001
Military	0.175	0.045	14.76	< .001
Facility size	-0.088	0.057	2.39	NS
Step-down unit	0.017	0.052	0.11	NS
Critical care unit	0.117	0.040	8.78	.003

Tables 39 and 40 below show in great detail (by individual items in the PES and its subscales) the differences in mean scores for RNs, LPNs, and NAs in a GEE analysis that accounted for clustering within units (using only 2005/6 data). This clearly shows differences in mean responses by nursing provider type. Table 40 shows the percent agreement (combining "strongly agree" and "agree" responses) of each nursing provider type with each of the PES items, and the chi square p values.

Table 39. Nurse Perceptions of Practice Environment: Differences between RNs, LPNs, and NAs

	% Agree			
	RN	LPN	NA	*p*
1. Nurse Participation in Hospital Affairs [a]				
Staff nurses are involved in the internal governance	54.92%	44.74%	70.77%	<.001*
Opportunity for staff nurses to participate in decisions	46.56%	44.08%	60.77%	<.001*
Opportunities for advancement	63.77%	66.45%	80.00%	<.001*
Administration that listens and responds to concerns	72.79%	71.71%	70.00%	0.81
A chief nursing officer who is highly visible and accessible	57.38%	44.74%	68.46%	<.001*
Career development/clinical ladder opportunity	55.41%	56.58%	70.00%	<.001*
Nursing administrators consult with staff on problems	51.48%	51.32%	68.46%	<.001*
Staff nurses have the opportunity to serve	76.89%	63.82%	80.77%	<.001*
A chief nurse officer equal in power and authority	69.67%	70.39%	79.23%	<.001*
2. Nursing Foundations for Quality of Care [a]				
An active quality assurance program	67.38%	64.47%	82.31%	<.001*
A preceptor program for newly hired RNs	90.00%	91.45%	88.46%	0.88
Nursing care is based on a nursing, rather than medical, model	70.00%	73.68%	80.00%	0.005*
Patient care assignments that foster continuity of care	78.36%	78.29%	82.31%	0.37
A clear philosophy of nursing that pervades patient care	67.38%	65.13%	78.46%	0.02*
Written, up-to-date nursing care plans for all patients	74.59%	76.97%	83.85%	<.001*
High standards of nursing care are expected	67.87%	66.45%	87.69%	<.001*
Active staff development or continuing education program	64.75%	72.37%	84.62%	<.001*
Working with nurses who are clinically competent	82.46%	67.76%	83.08%	<.001*
3. Manager Ability, Leadership, and Support [a]				
A nurse manager who is a good manager and leader	68.85%	67.76%	81.54%	0.01*
A nurse manager who backs up the nursing staff in decision	72.62%	70.39%	82.31%	0.03*
A supervisory staff that is supportive of the nurses	53.44%	49.34%	67.69%	0.004*
Praise and recognition for a job well done	72.46%	67.11%	80.00%	0.03*
4. Staffing and Resource Adequacy [a]				
Enough staff to get the work done	65.90%	67.76%	77.69%	0.02*
Enough registered nurses to provide quality patient care	70.33%	76.97%	80.00%	0.01*
Adequate support services allow me to spend time	58.36%	67.76%	65.38%	0.03*
Enough time and opportunity to discuss patient care	58.52%	59.21%	56.15%	0.88
5. Collegial Nurse–Physician Relations [a]				
A lot of teamwork between nurses and physicians	87.05%	86.18%	80.00%	0.10
Physicians and nurses have good working relationships	75.25%	74.34%	76.15%	0.75
Collaboration between nurses and physicians	73.11%	70.39%	73.85%	0.71

[a] Percent of "Agree" or "Strongly Agree" responses

* Indicates significance difference at $\alpha = .05$

*p <.05; **p<.01; ***p<.001

Notes: RN = Registered nurse; LPN = Licensed practical nurse; NA = Nursing assistant.

Table 40. Practice Environment Scale Scores by Nurse Type

	Mean (SD)		
	RN [a]	LPN [b]	NA [c]
(*N* = 869 – 1024)	**2.75(.22)**	**2.78(.26)**	**3.02(.19)**
1. Participation in Hospital Affairs (α = 0.85)*	**2.67(.22)**	**2.59(.27)**	**2.92(.16)**
Staff nurses are involved in the internal governance	2.49(.91)	2.45 (.91)	2.80(.77)
Opportunity for staff nurses to participate in policy decision	2.38(.88)	2.29(.89)	2.73(.89)
Opportunities for advancement	2.57(.95)	2.23(.99)	2.87(.95)
Administration that listens and responds to emp. concerns	2.52(.95)	2.59(.91)	2.86(.91)
A chief nursing officer who is highly visible and accessible	2.81(1.01)	2.81(.97)	3.18(.85)
Career development/clinical ladder opportunity	2.52(.96)	2.30(.95)	2.83(.87)
Nursing administrators consult with staff on daily problems	2.92(.96)	2.87(.93)	3.18(.86)
Staff nurses have the opportunity to serve on hospital	2.98(.82)	2.73(.78)	2.98(.66)
A chief nurse officer equal in power and authority	3.01).88)	2.94(.81)	2.84(.79)
2. Foundations for Quality of Care (α = 0.85)*	**2.92(.22)**	**2.96(.21)**	**3.17(.11)**
An active quality assurance program	2.84(.87)	2.81(.78)	3.01(.78)
A preceptor program for newly hired RNs	2.98(.95)	3.07(.80)	3.29(.73)
Nursing care is based on a nursing, rather than medical, model	2.80(.81)	2.77(.84)	3.16(.57)
Patient care assignments that foster continuity of care	3.15(.83)	2.82(.98)	3.14(.80)
A clear philosophy of nursing that pervades the patient care	2.83(.80)	2.87(.74)	3.08(.71)
Written, up-to-date nursing care plans for all patients	2.72(.94)	2.97(.88)	3.17(.71)
High standards of nursing care are expected by admin	2.38(.74)	3.47(.71)	3.40(.76)
Active staff development or continuing education program	2.78(.89)	2.78(.88)	3.08(.80)
Working with nurses who are clinically competent	3.03(.77)	3.06(.77)	3.23(.76)
3. Manager Ability (α = 0.79)*	**2.77(.24)**	**2.78(.22)**	**3.09(.17)**
A nurse manager who is a good manager and leader	2.97(1.00)	2.90(1.04)	3.25(.91)
A nurse manager who backs up the nursing staff in decision	2.97(.99)	2.89(.99)	3.12(.79)
A supervisory staff that is supportive of the nurses	2.86(.94)	2.90(.98)	3.16(.80)
Praise and recognition for a job well done	2.46(.95)	2.44(.93)	2.83(.99)
4. Staffing and Resource Adequacy (α = 0.75)	**2.70(.10)**	**2.76(.11)**	**2.87(.22)**
Enough staff to get the work done	2.60(.94)	2.58(.92)	2.57(.90)
Enough registered nurses to provide quality patient care	2.60(.99)	2.75(.86)	2.85(.92)
Adequate support services allow me to spend time	2.75(.87)	2.82(.93)	2.98(.73)
Enough time and opportunity to discuss patient problems	2.83(.82)	2.87(.82)	3.10(.80)
5. Physician Relations (α = 0.78)	**2.98(.16)**	**2.92(.08)**	**3.03(.12)**
A lot of teamwork between nurses and physicians	2.91(.79)	2.92(.81)	2.99(.71)
Physicians and nurses have good working relationships	3.25(.75)	3.00(.85)	3.17(.83)
Collaboration between nurses and physicians	2.87(.79)	2.83(.74)	2.92(.68)

[a] *N* = 600 - 654; [b] *N* = 145 - 196; [c] *N* = 124 - 174

* Indicates GEE model results that LPN is significantly different at α = .05 from NA and LPN is not different from RN.

Notes: RN = Registered nurse; LPN = Licensed practical nurse; NA = Nursing assistant.

Table 41. GEE estimates for comparing LPN with RN and NA

	Estimate	SE	*p*
Overall PES	-		
LPN (reference)*		-	-
NA	0.16	0.07	0.02**
RN	-0.01	0.04	0.72
1. Participation			
LPN (reference)*	-	-	-
NA	0.28	0.07	<.001**
RN	0.08	0.05	0.12
2. Foundation			
	-		
LPN (reference)*		-	-
NA	0.18	0.07	.01**
RN	-0.04	0.05	0.39
3. Manager			
LPN (reference)*	-	-	-
NA	0.24	0.08	<.001**
RN	-0.002	0.05	0.39
4. Staffing			
LPN (reference)*	-	-	-
NA	0.18	0.10	0.08
RN	-0.07	0.06	0.22
5. Physician			
LPN (reference)*	-	-	-
NA	-0.02	0.09	0.82
RN	-0.03	0.06	0.59

* LPN category is compared with NA and RN
Notes: RN = Registered nurse; LPN = Licensed practical nurse; NA = Nursing assistant

We conducted an ANOVA with Post-hoc analysis to look at unit type differences in PES and subscales using the "PES_New" variable that is just LPNs and RNs scores. Table 42 demonstrated statistically significant differences between units on the PES and subscales, with critical care units usually scoring higher indicating better practice environments in critical care.

Table 42. Differences in unit types by PES (with NAs removed)

Variable	Unit type	N	Mean (SD)	p
PES	1 MS*	711	2.77 (.55)	.005
	2 SD	179	2.80 (.51)	
	3 CC*	470	2.86 (.52)	*Unit types that differ
NPHA	1 MS	707	2.65 (.63)	NS
	2 SD	178	2.67 (.61)	
	3 CC	470	2.63 (.66)	
NFQC	1 MS	713	2.94 (.55)	NS
	2 SD	177	2.91 (.54)	
	3 CC	472	2.97 (.53)	
NMALS	1 MS*	707	2.75 (.81)	.01
	2 SD*	174	2.92 (.75)	
	3 CC	463	2.79 (.82)	
SRA	1 MS*	724	2.59 (.74)	MS v. CC p<.001
	2 SD*	179	2.63 (.71)	SD v. CC p = .001
	3 CC*	481	2.83 (.67)	
Ns-MD	1 MS*	712	2.92 (.66)	MS v. CC p<.001
	2 SD*	179	2.87 (.65)	SD v. CC p<.001
	3 CC*	470	3.09 (.60)	

Notes: PES = Practice Environment Scale; NPHA = Nursing Participation in Hospital Affairs; NFQC = Nursing Foundations for Quality Care; NMALS = Nurse Manager Ability, Leadership and Support; SRA = Staffing and Resource Adequacy; Ns-MD = Nurse-Physician Collaboration.; MS = Medical-surgical unit; CC = Critical care unit; SD = step-down unit.

In summary, workload intensity had an effect on the relationships between staffing and adverse events, but the effects differed by event type and staffing measure. Hospital acquired pressure ulcers (HAPUs) were significantly associated with nursing care hours worked by licensed practical nurses (LPNs); this relationship was partially mediated by ADT. These associations were observed three days prior to the HAPU discovery.

Total nursing care hours per patient per shift was consistently associated with the shift level adverse events in both medical-surgical and critical care (CC) units even when acuity and ADT were controlled. ADT was significantly associated with all adverse events, but acuity was not. The addition of ADT did not change the staffing estimates, indicating no mediation. Both RN and LPN skill mix were significantly associated with adverse events in CC units, but not in the expected direction such that a decrease in skill mix was associated with lower odds of an adverse event. The practice environment was significantly associated with HAPUs but not in the expected direction. In fact, only in the best practice environments was the association observed between staffing and HAPUs. There was a significant interaction of PES with total NCHPPS and falls in medical-surgical units.

Effect of problems or obstacles influencing the results:

The major issue with this analysis is the strikingly different results that were obtained with GEE in the shift level analysis. In addition, the surprise that the originally proposed models, generalized linear mixed models would not converge. For these reasons, we determined the need to contract for a Bayesian analysis in order to obtain meaningful and consistent results. Bayesian results are different than those obtained with GEE, making interpretation more challenging.

A secondary issue was the discovery of additional ADT data. When preparing the data sets for analysis, we found that one particular institution was missing large amounts of ADT data. We contacted the facility and were able to obtain these data from their archived sources. This could explain some of the difference in our results from what we reported in the previous study. With the addition of the missing ADT data, we had a more complete dataset for analysis.

Conclusions

ADT is an important workload intensity variable that is strongly associated with adverse events. ADT should be included in staffing studies as a measure of workload; however, ADT alone does not completely capture workload. There remain unmeasured factors that we could not address in this secondary analysis, such as experience levels of the staff on a shift, as well as the interactions and teamwork among the staff.

Acuity, our other workload intensity variable, was not associated with adverse events. Possible explanation s could be that acuity does not vary and that could be why we did not find the results we expected. A more precise measure of workload intensity used in a recent shift-level study (Needleman et al., 2011) may be the acuity-based required nursing care hours versus the actual care hours.

The practice environment, as measured by the PES, does not seem to be sensitive to the shift level adverse events, however, the PES is an annual level variable and unit level characteristic, and attempting to use this variable to explain shift level events may be problematic from a temporal standpoint; perhaps it is best used with annual aggregate variables. One interesting observation is that at the highest PES levels, staffing affects both HAPUs and falls, but this is not observed at lower or moderate PES levels. It may be that the composite measure may not be as sensitive as perhaps the subscales would be; however, it was beyond the purpose of this study to investigate the individual subscale performance, although this would be a useful analysis to conduct at some future point.

There is a strong association between the PES and nurse job satisfaction. We found differences between the PES responses of RNs, LPNs and NAs, with NAs tending to score much higher than the others do. For this reason, we recalculated an RN + LPN-only measure of PES aggregated to the unit level and used this for all analyses. Job satisfaction is strongly associated with total NCHPPS, even when adjusting for the PES.

It is important to evaluate the effects of staffing and adverse events at the closest time point to the event, as with discrete adverse events tied to a shift (i.e., falls and medication errors). We were able to show a staffing association with HAPUs at a point in time when one would expect the HAPU to be developing. These associations would not be observable in aggregate data at the annual level, except in the context of chronically low staffing levels.

Limitations.

1. The operationalization of workload intensity as acuity and ADT may not capture the essence of nurses' workloads. Although ADT is a much better estimation of workload intensity than census, work must continue to document the workload of nurses, especially as it is associated with staffing and adverse events.
2. The practice environment composite measure may not be as sensitive a measure as perhaps the categorization schema of Lake and Friese (2006), where based upon the subscales, practice environments are conceptualized as a 3-level categorical variable: favorable, mixed, or poor.
3. Missing data, rare events, and possible underreporting of adverse events are other limitations that we have no control of in secondary analysis.

Relationship of current findings to previous findings: The relationship of our findings to our previous findings are explained in detail on page 16 (Table 20). Only one other study has attempted to measure staffing at the shift level, therefore, it is difficult to compare our findings with others who used aggregate data. Needleman et al. (2011) found increased inpatient mortality associated with shifts where the staffing levels were below what was recommended by the staffing planning methodology. They also found increased patient turnover (ADT) associated with increased patient mortality. Others who have used ADT as a workload variable have used aggregated data, with mixed results related to adverse events.

Our findings related to the practice environment and nurse job satisfaction are consistent with a large body of literature on the topic of magnet hospitals, which have high practice environment ratings and high nurse satisfaction. We have demonstrated this effect in non-magnet, military hospitals.

Significance of Study or Project Results to Military Nursing

Significance to nursing in nationally and internationally.

- The MilNOD studies were included in the body of evidence used by the American Nurses' Association (ANA) Task Force on the *Principle of Safe Staffing*, and is cited in the publication, Principle for Nurse Staffing (2012) published by the ANA.
- The Canadian report *Toward a National Report Card in Nursing: A Knowledge Synthesis* (2011) featured MilNOD studies in their evidence review of nursing report cards. A summary is included in the publication of the same title: Doran, D. Mildon, B. & Clarke, S. (2011). *Nursing Leadership, 24*(2), 38-57 and can be accessed at http://www.longwoods.com/content/22464.

Significance to military nursing.

- The MilNOD series of studies, including the current one, informed the "Optimized Metrics" of the Patient CaringTouch System, a new practice model in Army Nursing that includes metrics to examine staffing effectiveness and the nursing practice environment via adverse patient events, patient satisfaction, and nursing outcomes. The measurement strategies developed over the years of the MilNOD was adopted by this new system of care.
- This particular study examines workload measures and has determined that ADT is something that should continue to be tracked in examining staffing effectiveness. We also have shown that

acuity may not be a good measure of workload in statistical modeling of staffing and adverse outcomes, and this may be in part because acuity is used to plan staffing in the military setting. The measurement of workload intensity as it affects the need for additional staffing has been elusive to the field of health services research in nursing; this study shows that ADT is superior to census alone in measuring staffing effectiveness.

- This study also has implications for how the practice environment is measured with the PES. In this population, only RNs or at the most, RNs and LPNs should be the "reporters" of the practice environment in the military setting using the PES since the ratings by nursing assistants are significantly higher.
- The findings related to HAPUs are another reason why staffing must be evaluated and optimized every shift. These findings also verify the importance of non-RN providers in the delivery of patient care. In the military, LPNs have a critical role in assisting the RNs with many patient care tasks including turning and otherwise mobilizing patients, and this study supports that critical role.
- The findings are important to hospital and nursing leadership by further delineating how staffing, workload, and the practice environment together, produce certain outcomes. It should be of utmost importance to leadership to cultivate a practice environment where nurses have the authority, autonomy and resources to do what they know is best for their patients.

Changes in Clinical Practice, Leadership, Management, Education, Policy, and/or Military Doctrine that Resulted from Study or Project

The entire series of MilNOD studies informed the Army, Air Force, and Navy Nurse Corps of the need to monitor staffing, workload intensity, outcomes, and the context of care (the practice environment). It laid the foundation for annual monitoring of the practice environment in the Army Nurse Corps and formed the basis for the optimized metrics of the Patent CaringTouch system of care. Our findings that ADT is associated with adverse events suggests that it is a strong and important factor in determining nurses' workloads. This is important information for nurse leaders to track on a regular basis and should be the impetus for trying various models of care, including an admission and/or discharge nurse to help with the patient turnover on very turbulent units. ADT certainly has important policy implications for determining appropriate staffing, and should always be considered in staffing decisions.

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Summary of Dissemination

Type of Dissemination	Citation	Date and Source of Approval for Public Release
Publications	Breckenridge-Sproat, S. Johantgen, M., & Patrician, P. A. (2012) Influence of unit level staffing on medication errors and falls in military hospitals. *Western Journal of Nursing Research*, 34 (4), 453-472.	PAO: WRAMC, 22 February 2010
	West, G., Patrician, P.A. & Loan, L. (2012). Staffing matters...every shift. *American Journal of Nursing*, 112 (12), 22-27.	PAO: USUHS, 6 January 2012
	Raju, D., Su, X., & Patrician, P. A., Loan, L. A., McCarthy, M. S. (2014). Exploring factors associated with pressure ulcers: A data mining approach. *International Journal of Nursing Studies*. (Epub ahead of print. http://dx.doi.org/10/1016/j.ijnurstu.2014.08.002).	PAO: USUHS, 18 April 2013 6 June 2013 - MAMC
	Raju, D., Su, X., & Patrician, P. A. (2014). Using item response theory models to evaluate the Practice Environment Scale (PES). *Journal of Nursing Measurement, 22*(2), 323-341.	PAO: USUHS, 24 July 2013
Information for publication	MilNOD information provided for book chapter Performance Measurement of Nursing Care (Needleman, J. Kizer, K., & Kurtzman, E.). In Andersen, R. M., Rice, T. H., & Kominski, G. F. Changing the U.S. Health Care System (4th ed). Jossey-Bass	The publication date is unknown and the authors are currently in the process of submitting to publishers (Jossey-Bass). Because this information was very general and included information from many of our previous publications, no separate PAO approval was sought.
Podium Presentations	Patrician, P. A. (2010, January). *Medication errors, patient falls, and pressure ulcers: Improving outcomes over time.* Paper presented at the American Nurses Association, National Database for Nursing Quality Indicators Conference, New Orleans, LA.	22 February 2010 – WRAMC
	Patrician, P. A. (2010, March). *Measuring the effects of nurse staffing on adverse events: The Military Nursing Outcomes Database project.* Paper presented at the American College of Healthcare Executives, 2010 Congress of Healthcare Leadership, Forum on Advances in Healthcare Management Research, Chicago, IL.	1 February 2010 - MAMC

	McCarthy, M., Loan, L., & Patrician, P. A., (2010, June). *Measuring the effects of nurse staffing on patient outcomes: The MilNOD project.* Paper presented at the Academy Health, 2010 Annual Research Meeting, Boston, MA.	1 February 2010 - MAMC
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	Patrician, P. A. (2011, February). *From microsystem to macrosystem: Measuring the effects of nurse staffing on quality indicators.* Paper presented at the 26th Annual Conference of the Southern Nursing Research Society, Jacksonville, FL.	1 February 2010 - MAMC
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	Loan, L., & Patrician, P. A. (2011, April). *Overview: Does nurse staffing matter?* Paper presented as part of a symposium, Does staffing matter? Findings from a national outcomes database study, at the Western Institute of Nursing 44th Annual Communicating Nursing Research Conference, Las Vegas, NV.	14 February 2011 - MAMC
	Loan, L. & Patrician, P. A. (2011, April). *Are nursing outcomes databases sensitive to outcomes changes over time?* Paper presented as part of a symposium, Does staffing matter? Findings from a national outcomes database study, at the Western Institute of Nursing 44th Annual Communicating Nursing Research Conference, Las Vegas, NV.	14 February 2011 - MAMC

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	Breckenridge-Sproat, S. (2012, February). *Influence of unit-level staffing on medication errors and falls in military hospitals*, Paper presented at Southern Nursing Research Society 26th Annual Conference, New Orleans, Louisiana.	22 February 2012 - WRAMC
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	Breckenridge-Sproat, S., Patrician, P. A., Johantgen, M. (2012, June). *Influence of unit-level staffing on medication errors and falls in military hospitals.* Paper presented at the International Nursing Conference, Jerusalem, Israel.	1 May 2012 – MAMC

	McCarthy, M., Loan, L. A., & Patrician, P. A. (2012, June). *Do nursing outcomes databases produce valid and reliable data?* Paper presented at the International Nursing Conference, Jerusalem, Israel.	1 May 2012 – MAMC
	Breckenridge-Sproat, S., Patrician, P. A. (2012, September). *Building an evidence based practice (EBP) mentorship program to sustain bedside evidence based culture*. Paper presented at the 4th International MSD Nursing Conference, Jeddah, Kingdom of Saudi Arabia.	1 May 2012 – MAMC
	Salazar, A., Loan, L.A., West, G., Patrician, P.A., McCarthy, M.A. (2013, January). Nurse Staffing Matters… Every Shift, 2013 Seattle Nursing Research Conference, Shoreline, WA.	12 December 2012 - MAMC
	Patrician, P. A. (2013, March). *Nurse staffing and adverse events: An update.* Paper presented for the Endowed Professor Lecture Series, University of Alabama at Birmingham School of Nursing, Birmingham, AL.	14 February 2011 - MAMC
	Patrician, P.A., Breckenridge-Sproat, S., McCarthy, M.A., & Loan, L.A. (2013, May). *How do workload and the nursing practice environment influence the relationship between nurse staffing and adverse events?* International Council of Nurses 25th Quadrennial Congress, Melbourne, Australia.	13 April 2013 - USUHS
	Breckenridge-Sproat, S. & Loan Lori A. (2013, May). T*he power of data: the Army nursing dashboard.* International Council of Nurses 25th Quadrennial Congress, Melbourne, Australia.	13 May 2013 - TAMC
	Patrician, P. A., Loan, L. & Sproat, S. (2014, September*). The association of staffing with hospital acquired pressure ulcers (HAPUs), and the mediating effects of workload intensity.* Council for the Advancement of Nursing Science State of the Science Conference, Washington, DC.	30 June 2014 - MAMC

Poster Presentations	Patrician, P. A. (2011, June). *Needlestick injuries among nursing staff: association with shift-level staffing.* Poster presented at Academy Health Annual Research Meeting, Seattle, WA.	14 February 2011 – MAMC
	Breckenridge-Sproat, S., Loan, L., McCarthy, M., & Patrician, P. A. (2012, February). *Are nursing outcome databases sensitive to outcome changes overtime?,* Southern Nursing Research Society 26th Annual Conference, New Orleans, LA, 22-25 February 2012.	14 February 2011 – MAMC
	Patrician, P. A., Azuero, A. Bingham, M., Loan, L. A., & McCarthy, M. (2012, February). *Does nurse staffing contribute to job satisfaction in nursing personnel,* Southern Nursing Research Society 26th Annual Conference, New Orleans, LA.	1 May 2012 - MAMC
	Patrician, P. A., Loan, L. A., McCarthy, M., Bingham, M., & Brosch, L. R. (2012, June). *Is nurse staffing associated with adverse events?* Poster presented at the International Nursing Conference, Jerusalem, Israel.	1 May 2012 – MAMC
	Patrician, P. A., Su, X., & Raju, D. (2013, May). *Enhanced prediction of pressure ulcer incidence using data mining techniques.* International Council of Nurses 25th Quadrennial Congress, Melbourne, Australia.	18 April 2013 – USUHS
	Patrician, P. A., Su, X., Raju, D., Breckenridge-Sproat, S., Loan, L., & McCarthy, M. (2103, November). *Hospital acquired pressure ulcers, staffing, and workload intensity.* Poster presented at the International Nursing Administration Research Conference, Baltimore, MD.	8 April 2013 - USUHS
	Patrician, P. A., Loan, L. & Raju, D. (2014, February). *Is the Practice Environment Scale appropriate for non-RNs?* Poster presented at Southern Nursing Research Society Annual Meeting, San Antonio, TX.	13 April 2013 - USUHS
	Patrician, P. A., Su, X., & Raju, D. (2014, February). *Enhanced prediction of pressure ulcers using data mining techniques.* Poster Discussion at Southern Nursing Research Society Annual Meeting, San Antonio, TX.	18 April 2013 – USUHS

	Patrician, P. A., Su, X., Raju, D., Breckenridge-Sproat, S., Loan, L., & McCarthy, M. (2104, June). *Hospital acquired pressure ulcers, staffing, and workload intensity*. Poster presented at the Academy Health Annual Research meeting, San Diego, CA.	8 April 2013 – USUHS 4 February 2014 - MAMC
Media Reports	Army Nurse Corps Association Newsletter, 38(1), March 2013. Research, Literature and Arts Corner. COL (Ret) Bartz wrote a review of the West (2012) paper.	NA
Other: Webinar	Patrician, P. A., & Loan, L. (2011, June). *Creating and using a multi-institutional database for quality improvement and research.* Webinar presented for Institute for Health Metrics.	1 February 2010 - MAMC

Final Budget Report

Date: January 5, 2015	Funds Approved	Expenditures To Date	Projected Expenses
Personnel	$278,330.00	$282,282.75	$0.00
Consultant	$4,800.00	$0.00	$0.00
Equipment	$0.00	$0.00	$0.00
Supplies	$4,533.00	$1,902.33	$0.00
Travel	$8,560.00	$4,774.82	$0.00
Other Expenses	$1,860.00	$10,037.96	$0.00
Patient Expenses	$0.00	$0.00	$0.00
Consortium Costs	$9,084.00	$8,169.47	$0.00
Indirect Costs	$142,833.00	$142,832.67	$0.00
TOTALS	**$450,000.00**	**$450,000**	**$0.00**