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This article examines the impact of mandated nursing ratios in California on key measures of nursing quality among adults in acute care hospitals. This study is a follow-up and extension of our first analysis exploring nurse staffing and nursing-sensitive outcomes comparing 2002 preratios regulation data to 2004 postratios regulation data. For the current study we used postregulation ratios data from 2004 and 2006 to assess trends in staffing and outcomes. Findings for nurse staffing affirmed the trends noted in 2005 and indicated that changes in nurse staffing were consistent with expected increases in the proportion of licensed staff per patient. This report includes an exploratory examination of the relationship between staffing and nursing-sensitive patient outcomes. However anticipated improvements in nursing-sensitive patient outcomes were not observed. This report contributes to the growing understanding of the impacts of regulatory staffing mandates on hospital operations and patient outcomes.

Keywords: *nurse-to-patient ratios; nursing sensitive indicators; patient safety and quality; falls; pressure ulcers; outcomes*

BACKGROUND

In October 1999, California became the first state in the United States to adopt legislation mandating unit-based minimum licensed nurse-to-patient ratios in acute care hospitals. That landmark legislation, introduced as Assembly Bill (AB) 394 (1999), required California's State Department of Health Services (now California Department of Public Health [CDPH]) to develop the specific regulatory language to implement this new mandate for staffing ratios. The new law and regulations expanded existing state licensing regulations adopted more than two decades earlier establishing nurse-to-patient ratios in acute care specialty

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units, and built on more recent state regulations requiring hospitals to use a patient classification system to ensure that staffing allocation and patient needs were aligned (Donaldson, Burnes Bolton, et al., 2005).

As the initial 3-year regulatory rulemaking process began, CDPH acknowledged that "essentially there was not hard, scientific evidence in the literature indicating the number of patients nurses can safely and effectively handle while providing quality patient care" (California State Department of Health Services, 2003, pp. 1, 13). Lang, Hodge, Olson, Romano, and Kravitz's 2004 integrative review of the effects of nurse staffing on outcomes also found that the literature offered no support for specific, minimum nurse-patient ratios, although total nursing hours and skill mix impacts, while inconsistent, were found to affect some important patient outcomes.

Since the initial ratios, particularly those impacting medical-surgical patient care units, came into effect in 2004, many states, considering enacting similar legislation, have been observing the California experience. In August 2005, the California Nursing Outcomes Coalition (CalNOC) published the first report tracing the unit-level impacts on licensed nurse staffing and patient care quality in medical, surgical, and definitive-observation units (including step-down and telemetry) from the preratio period (2002) through the implementation of ratios (2004) (Donaldson, Burnes Bolton, et al., 2005). Findings revealed significant changes in mean staffing levels after implementation of ratios. Despite the changes noted in nurse staffing and licensed nurse-patient ratios, however, CalNOC's preliminary findings, based on the first 6 months of postratio evidence, did not reveal statistically significant changes in the patient safety and quality outcomes studied, the incidence of patient falls and the prevalence of pressure ulcers. The present analysis is a follow-up and extension of that study.

Since CalNOC's preliminary analysis, further implementation of the ratios has taken effect for medical-surgical units. In the initial phase in 2004, mandated ratios required were 1:6 (1 nurse for 6 patients) for medical and surgical units. The requirements in the final phase of implementation moved to a 1:5 ratio in 2005, thus a larger change in staffing for medical and surgical units would be expected in the current analysis. Ratios for the two definitive observation unit categories were 1:4 for step-down and 1:5 for telemetry.[1] CalNOC's step-down designation includes both of these unit types. There was no change in the 2005 final ratio requirements for definitive observation units.

SIGNIFICANCE OF EXAMINING NURSE STAFFING ADEQUACY

Nurses play a vital and pivotal role in ensuring safe patient care in their roles at the sharp end of the point of service (Page, 2004; Savitz, Jones, & Shulamit, 2005). The study of nurse staffing and patient outcomes in hospitals became a national strategic and scientific imperative with the seminal Institute of Medicine (IOM) report on the adequacy of nurse staffing (Wunderlich, Sloan, & Davis, 1996) recommending new "scientifically sound research on the relationships between quality of care and nurse staffing levels and mix, taking into account organizational variables" (p. 17). During the next decade, a plethora of studies responded to the IOM call to action, although their methods, metrics, data sources, unit of analysis, and statistical conclusion validity varied widely. Although it may be argued that these studies, synthesized well by others (e.g., Hickam et al., 2003; Lang et al., 2004; Seago, 2001; Tourangeau, Cranley, & Jeffs, 2006), comprise different fields of inquiry despite their apparent common foci, the fact remains that a preponderance of evidence, albeit inconsistent, links the "dose" of nurse staffing (hours of care and skill mix of direct care nurses) and key patient outcomes (Brooten & Youngblut, 2006). As the national health care quality agenda has narrowed its focus to patient safety and adverse events, following the publication of the IOM's landmark book *To Err Is Human* (Kohn, Corrigan, & Donaldson, 1999), new studies have explored the impact of nurse staffing on catastrophic outcomes of acute care. Among other outcomes, these studies explored death and a range of adverse events, including some with limited plausible links to medical surgical ward nursing patient care practices, such as operative nerve injury, operative organ injury, and operative vessel injury (Weissman et al., 2007). It is noteworthy that inconsistent findings arising from among a new cluster of studies continue to be noted by investigators who have sought to replicate earlier results and/or add new evidence (Estabrooks, Midodzi, Cummings, Ricker, & Giovannetti, 2005; Halm et al., 2005; Mark, Harless, McCue, & Xu, 2004; Stone et al., 2007; Weissman et al., 2007).

It is also interesting to note that two stalwart measures of nurse staffing effectiveness and patient safety continue to be studied—the incidence of patient falls and the prevalence or incidence of hospital-acquired pressure ulcers. First advanced as evidence-based indicators for nursing quality by the American Nurses Association a decade ago (American Nurses Association, 1997), these two indicators have been subjected to repeated scrutiny, and ultimately adopted by the National Quality Forum (NQF, 2004) as among the first 15 consensus standards for measuring hospital quality. With the ongoing accrual of evidence revealing the sensitivity of falls and pressure ulcers to nurse staffing (Stone et al., 2007; Weissman et al., 2007), the use of these measures in the present CalNOC analysis is timely, noting that CalNOC has been collecting these data from its member hospitals since 1996.

CALNOC

CalNOC was established in 1996 as a joint project of the American Nurses Association/ California (ANA/C) and the Association of California Nurse Leaders (ACNL). CalNOC, as the largest regional nursing quality database in the nation, has as its core mission to

- build and sustain the CalNOC statewide nursing staffing and quality database repository,
- conduct research to advance evidence-based administrative and clinical decision making, and
- provide data to resolve public policy and clinical dilemmas in the cost and efficacy of patient care delivery influenced by nurse staffing and quality.

CalNOC's history, data collection methodology, and preliminary benchmark nursing quality data have been described in detail elsewhere (Aydin et al., 2004; Donaldson, Brown, Aydin, & Burnes Bolton, 2001; Donaldson, Brown, Aydin, Burnes Bolton, & Rutledge, 2005).

METHOD

Sampling Methods

Skill mix, staffing, and falls variables. CalNOC member hospitals (185+) submit monthly unit-level nurse staffing, patient days, and falls data as part of CalNOC's ongoing nursing quality measurement and reporting database. Using the methods described below, the sample for the staffing and falls data was drawn from 252 units (187 medical-surgical units and 65 step-down units) in 108 hospitals with complete data available. The sample for this analysis represents more than 500,000 patient days for the 3 years analyzed.

As with CalNOC's 2005 report, the present analyses use preregulation data from the first 6 months of 2002 as a baseline for comparison. For the current analyses, two periods were used as postregulation data to assess trends in staffing and outcomes: 2004 (immediately after initial phase of regulation) and 2006 (following implementation of final phase). Monthly staffing and falls data were drawn from all units in CalNOC hospitals for which staffing, patient days, and falls data were available for a preratio 6-month period in 2002 (months 1 to 6 of 2002) and both postratio periods (months 1 to 6 of 2004 and months 1 to 6 of 2006). Patient care units with fewer than 2 months of data in each period were excluded to ensure representative data for each unit. Data for each variable for each unit were averaged across months into Quarter 1 (Q1) and Quarter 2 (Q2) of 2002, Q1 and Q2 of 2004, and Q1 and Q2 of 2006. Means from Q1 and Q2 of 2002 were averaged to produce preratio period means; similar means for Q1 and Q2 of 2004, and Q1 and Q2 of 2006 were calculated to produce data for the two postratio periods (2004 and 2006, respectively).

Pressure ulcer and restraint use prevalence variables. CalNOC hospitals conduct pressure ulcer prevalence studies at least annually and may submit data as often as quarterly. Each prevalence study is a visual inspection survey of every patient on step-down units and medical and surgical units in the participating hospital on the day of the study. (The CalNOC prevalence study methodology is described in detail in Aydin et al., 2004.) The sample for the pressure ulcer and restraint data, as described below, was drawn from 168 units with data from each of the three periods (128 medical-surgical units and 40 step-down units) in 67 hospitals representing 11,740 patients.

For preratio data, the earliest prevalence study conducted in Q1 or Q2 of 2002 was included. If no studies were conducted during this target period, the prevalence study for the latest data from Q3

or Q4 of 2001 was accepted. For the first postratio data period (2004), the latest study either from Q3/Q4 of 2003 or from Q1/Q2 2004 was used. Similarly, for the second postratio period (2006) the latest study from Q3/Q4 2005 or Q1/Q2 2006 was used. Because many hospitals do not submit studies every quarter, data from only one study was used for each hospital for each period.

Nurse Staffing and Falls Incidence Variables

Study variable definitions are consistent with the definitions used in CalNOC's first report (Donaldson, Burnes Bolton, et al., 2005) and CalNOC data collection and processing methods have also been described in detail elsewhere (Aydin et al., 2004). Monthly unit-based staffing variables collected included patient days, and hours of care separately for registered nurses (RNs), licensed vocational nurses (LVNs, known as licensed practical nurses [LPNs] in most other states), and other staff such as unlicensed staff and contracted staff. Patient falls variables included both total falls and falls with injury. From submitted data, CalNOC computed the number of patients per RN, number of patients per licensed staff, falls, and falls with injury per 1,000 patient days. Unit-level data were obtained for each variable by averaging across months into quarters and then by averaging across quarters to produce pre and post periods means.

Indicators used for pressure ulcer and restraint data were based on single-day prevalence studies conducted at least annually during specified time periods. Variables included percentage of patients on that day with pressure ulcers, hospital-acquired pressure ulcers, pressure ulcers stage II and above (stage II+), stage II+ hospital-acquired pressure ulcers; and percentage of patients in restraints.

Analytical Procedures

The analysis was conducted in two steps to first understand the impact of the ratio mandate, and second to explore relationships between nurse staffing and patient outcomes. All analyses were performed for medical-surgical and step-down units separately. These categories of units have inherent differences in their patient populations with resulting differences in nurse staffing ratios. California regulations had previously set minimum staffing standards for intensive care units at one RN per two patients and one RN per four patients for step-down units. Telemetry and general acute care units did not have set ratios. Therefore the expected change would primarily occur in these units.

First, to explore the impact of ratios, we compared the absolute change in each variable between 2002 and 2004, 2004 and 2006, and 2002 and 2006 to establish any trends observed over time. Comparison p values were obtained from repeated-measurements ANOVA with three observations per unit and with units nested within hospitals. The time period effects were compared adjusted for hospital size (categorized as an average daily census of < 100, 100 to 199, and > 200). The within-unit covariance matrix was assumed autoregressive of first order to allow for observations more adjacent in time to be more correlated than those further apart. As in our first study, we adjusted for multiplicity of testing in interpreting the skill mix/staffing/falls data set results. The customary 0.05 probability level was divided by 12 (the number of variables in the data set) and 0.0042 was used as the cut point for a significant p value. For the prevalence study data, 0.05 was divided by 5 (the number of variables in the pressure ulcer database) and 0.01 was used as the cut point for a significant p value.

Our second analysis was designed to explore if there was a relationship between staffing variables and nursing-sensitive patient outcomes over time. We fitted a repeated-measurements ANOVA with similar specification to that described above, but tested each staffing, ratio, and skill mix variable as a predictor of nursing-sensitive patient outcomes one at a time. This part of the analysis should be considered exploratory rather than confirmatory. Although we report the model coefficients with significance levels of 0.05 or below, we only considered the results with p values below the above cut-off points set for multiplicity of testing as significant.

FINDINGS

Trends in Staffing and Skill Mix

Table 1 summarizes the trends in staffing and skill mix variables for medical-surgical and step-down units. The means, standard deviations, and p values reported were obtained from repeated-measurement ANOVA models adjusting for hospital size.

TABLE 1: Pre–Post Change Analysis Results: Staffing Variables

Variable	*Pre Mean 2002*	*Post Mean 2004*	*Post Mean 2006*	*Absolute Change 02–04*	*Absolute Change 04–06*	*Absolute Change 02–06*	*% Change 02–06*	*Pre* SD *2002*	*Post* SD *2004*	*Post* SD *2006*	*Hospital Size* p *Value*
Medical-surgical (64 hospitals; 187 units)											
Staffing											
Hours of care/patient day	8.08	8.71	9.07	0.63**	0.36*	0.99**	12.25	1.50	1.77	1.58	
Hours RN care/patient day	4.76	5.77	6.31	1.01**	0.54**	1.55**	32.56	1.34	1.40	1.16	
Hours licensed/patient day	5.41	6.41	6.86	1.00**	0.45**	1.45**	26.80	1.33	1.45	1.08	
Ratios											
Number of patients/RN	5.41	4.44	3.96	–0.97**	–0.48**	–1.45**	–26.80	1.29	1.07	0.78	
Number of patients/licensed	4.70	3.95	3.60	–0.75**	–0.35**	–1.10**	–23.40	0.99	0.80	0.55	
Skill mix											
% RN hours	59.18	66.78	70.34	7.60**	3.56**	11.16**	18.86	11.94	11.01	11.11	.05
% licensed hrs	67.20	74.07	76.43	6.87**	2.36*	9.23**	13.74	10.75	9.42	9.42	.03
% LVN hours	8.01	7.29	6.09	–0.72	–1.20*	–1.92	–23.97	7.70	6.94	6.14	
% other	32.80	25.93	23.57	–6.87**	–2.36**	–9.23*	–28.14	10.75	9.42	9.42	.03
% contracted	8.33	8.40	7.59	0.07	–0.81	–0.74	–8.88	8.43	8.32	6.98	.02
Step-down (44 hospitals; 65 units)											
Staffing											
Hours of care/patient day	9.60	10.15	10.47	0.55*	0.32	0.87*	9.06	1.86	1.86	2.10	
Hours RN care/patient day	6.66	7.32	7.73	0.66**	0.41*	1.07**	16.07	2.00	1.81	1.87	.05
Hrs. licensed/patient day	7.03	7.59	7.95	0.56**	0.36	0.92**	13.09	1.88	1.68	1.79	
Ratios											
Number of patients/RN	4.00	3.53	3.33	–0.47**	–0.20	–0.67**	–16.75	1.41	1.04	0.89	
Number of patients/licensed	3.68	3.35	3.22	–0.33**	–0.13	–0.46**	–12.50	0.96	0.80	0.81	
Skill mix											
% RN hours	69.51	72.45	74.26	2.94*	1.81	4.75*	6.83	15.84	13.75	12.45	.01
% licensed hours	73.50	75.39	76.45	1.89*	1.06	2.95*	4.01	14.12	12.75	11.98	.01
% LVN hours	3.99	2.94	2.19	–1.05	–0.75	–1.80	–45.11	6.26	4.78	3.56	.01
% other	26.50	24.61	23.55	–1.89	–1.06	–2.95	–11.13	14.12	12.75	11.98	
% contracted	8.88	10.52	8.95	1.64	–1.57	0.07	0.79	8.53	8.83	8.59	

NOTE: All *p* values for hospital size under 0.05 shown, but are not significant after adjustment for multiple comparisons. *SD* = standard deviation; RN = registered nurse; LVN = licensed vocational nurse.

*$p < .0042$. **$p < .0001$ (ANOVA p-values with hospital size in analysis for prechange to postchange).

Registered nurses. Hours of RN care per patient day increased significantly from 2002 to 2004 by an average of about 1 hr in medical-surgical units and 0.7 hrs in step-down units. A significant increase of about 0.5 additional hours was observed from 2004 to 2006 in medical-surgical units and about 0.4 additional hours in step-down units. Overall, significant average increases in RN care hours from 2002 to 2006 were about 1.5 hrs in medical-surgical units and about 1 hr in step-down units. Accordingly, the number of patients per RN decreased significantly from 2002 to 2006 by an average of 1.5 patients in medical-surgical units, and by an average of 0.7 patients in step-down units. The percentage of care provided by RN staff increased significantly from 2002 to 2006 in medical-surgical units by 11.2%. The corresponding increase in step-down units was 4.8%. The initial changes from 2002 to 2004 in staffing and patient-to-nurse ratios were approximately double the size of those from 2004 to 2006.

Other nursing staff. Trends in all licensed nursing staff reflected the significant increases in RN hours and decreases in patient-to-nurse ratios. Accordingly, the skill mix data reflected overall reductions in the use of LVNs in both medical-surgical (decreased from 8% to 6%) and step-down units (from 4% to 2%) over the 4-year observation period. The decline in percentage of LVN hours was statistically significant in medical-surgical units during the 2004-2006 period. Between 2002 and 2006 there were also reductions in the use of unlicensed nursing care staff. In medical-surgical units the percentage of care delivered by unlicensed personnel significantly decreased from 33% to 24%; in step-down units the reduction was not statistically significant (from 27% to 24%).

Trends in Nursing-Sensitive Patient Outcomes

Table 2 summarizes the trends in nursing-sensitive outcomes for medical-surgical and step-down units. These results are also reported adjusting for hospital size.

Falls. There were no statistically significant trends found in falls or falls with injuries from 2002 to 2006 in medical-surgical units and step-down units. There were, however, several trends of interest. A nonsignificant decreasing trend in falls per 1,000 patient days was observed in step-down units which we will continue to follow over time (2.95 to 2.43 falls per 1,000 patient days). A significant increase by 0.06 injury falls per 1,000 patient days ($p = .004$) was observed in medical-surgical units from 2002 to 2004, which reversed in 2004 to 2006 resulting in a nonsignificant change overall. Of note is that the entire CalNOC falls data set, including the pre–post ratios matched units in this analysis as well as all other units participating in the CalNOC database project, show a similar nonsignificant increase in falls per 1,000 patient days in 2004 and subsequent return to 2002 levels in 2006. Medical-surgical units also showed a statistically significant association between falls and hospital size. Units in hospitals with an average daily census of more than 200 patients had increased fall rates over the time periods, from 2.60 in 2002 to 3.20 in 2006, converging toward the originally higher rates in smaller hospitals that had been decreasing. Table 3 illustrates this association between falls and hospital size.

Prevalence study results. We observed a general decrease in the percentage of patients with community- and/or hospital-acquired pressure ulcers from 2002 to 2006, however this was not statistically significant. There were interesting mixed-outcome patterns in these prevalence trends. For any pressure ulcers, there was a 14% reduction on medical surgical units and 9% reduction on step-down units over the 4-year period. For hospital-acquired pressure ulcers, there was approximately a 14% reduction in the total period of study (14.0% on medical-surgical units and 14.5% on step-down units); however, on medical-surgical units the means were essentially the same in 2002 and 2004, with a decrease only occurring in 2006. Medical-surgical units also showed a statistically significant association between pressure ulcers and hospital size. Units in hospitals with a higher average daily census had increased rate of pressure ulcers compared to smaller hospitals. Step-down units demonstrated an increase between 2002 and 2004, with a nonsignificant decrease in 2006 for any ulcers as well as any hospital-acquired ulcers. However, the percentage of patients with both ulcers stage II+ as well as hospital-acquired ulcers stage II+ increased in step-down units over the total time period. The

TABLE 2: Pre–Post Change Analysis Results: Patient Safety and Quality Outcome Variables

Variable	*Pre Mean 2002*	*Post Mean 2004*	*Post Mean 2006*	*Absolute Change 02–04*	*Absolute Change 04–06*	*Absolute Change 02–06*	*% Change 02–06*	*Pre* SD *2002*	*Post* SD *2004*	*Post* SD *2006*	*Hospital Size* p *Value*
Medical-surgical (64 hospitals; 187 units)											
Falls											
Falls/1,000 patient days	3.12	3.22	3.12	0.10	–0.10	0.00	0.00	1.98	1.77	1.89	.004+
Injury falls/1,000 patient days	0.09	0.15	0.10	0.06*	–0.05	0.01	11.11	0.21	0.27	0.17	
Prevalence studies											
% with any ulcers	14.86	14.67	12.72	–0.19	–1.95	–2.14	–14.40	11.76	11.25	11.84	
% with stage II+ ulcers	8.93	8.93	8.47	0.00	–0.46	–0.46	–5.15	8.02	8.06	7.83	
% with any hospital-acquired	7.45	7.98	6.41	0.53	–1.57	–1.04	–13.96	8.04	8.28	10.35	.008+
% with hospital-acquired II+	3.81	3.94	3.06	0.13	–0.88	–0.75	–19.69	5.77	4.54	4.22	
% in restraint	4.60	3.60	3.73	–1.00	0.13	–0.87	–18.91	7.49	6.87	6.07	
Step-down (44 hospitals; 65 units)											
Falls											
Falls/1,000 patient days	2.95	2.63	2.43	–0.32	–0.20	–0.52	–17.63	2.21	1.56	1.53	
Injury falls/1,000 patient days	0.09	0.13	0.09	0.04	–0.04	0.00	0.00	0.18	0.29	0.21	
Prevalence studies											
% with any ulcers	13.97	17.76	12.72	3.79	–5.04	–1.25	–8.95	10.08	12.33	9.47	.02
% with stage II+ ulcers	8.50	11.85	10.19	3.35	–1.66	1.69	19.88	6.59	8.72	8.60	
% with any hospital-acquired	8.06	10.16	6.89	2.10	–3.27	–1.17	–14.52	9.24	11.36	7.04	
% with hospital-acquired II+	3.87	5.70	4.90	1.83	–0.80	1.03	26.61	5.31	6.71	6.09	
% in restraint	8.24	4.95	5.04	–3.29	0.09	–3.20	–38.83	11.37	6.11	7.34	

NOTE: *SD* = standard deviation.

+ Hospital size main effect statistically significant in 2002 to 2006. All hospital size *p* values under $p < .05$ shown, but others not significant after adjustment for multiple comparisons ($p < 0.0042$ for falls and < 0.01 for pressure ulcers).

*$p < .01$.

TABLE 3: Falls Per 1,000 Patient Days by Hospital Size for Medical-Surgical Units

		Falls Per 1,000 Patient Days	
Hospital Size (Average Daily Census Category)	*Time Period*	*Mean*	*Standard Deviation*
Under 100 patients ($N = 27$)	Pre 2002	4.21	2.25
	Post 2004	4.12	2.07
	Post 2006	3.78	2.14
100 to 199 patients ($N = 95$)	Pre 2002	3.17	1.94
	Post 2004	3.07	1.67
	Post 2006	2.88	1.92
200+ patients ($N = 65$)	Pre 2002	2.60	1.73
	Post 2004	3.06	1.69
	Post 2006	3.20	1.67

same trends are also noted in the entire CalNOC data set.

Restraint prevalence also demonstrated a nonsignificant downward trend over this time period, which is again corroborated in the total CalNOC data set. During these 4 years, there was an 18.9% reduction in restraint use among medical-surgical units and a 38.8% reduction among step-down units. The trend occurred largely in the 2004 to 2006 period.

Relationship Between Staffing and Outcomes

The following analyses respond to the challenging task of establishing a relationship between staffing variables and nursing-sensitive outcomes over time. The findings were variable and are presented in Table 4 for selected variables grouped by outcome categories.

Falls. In medical-surgical units, one statistically significant finding and several trends were noted. A significant negative or inverse association was found between the percentage of contracted staff and falls with injury (coefficient = –0.003, $p = .008$). We estimated a decrease by 0.03 injury falls per 1,000 patient days associated with a 10% increase in contracted staff hours, which would result in an estimated 30.0% reduction in the 2006 medical-surgical unit average of 0.10. The skill level of the contracted staff is not known. Nonsignificant trends, which associated more staff with fewer injury falls, were noted for total hours of care, hours of RN care, and hours of care by licensed staff. A similar nonsignificant trend was noted that associated more patients per RN with increased injury.

In step-down units, we found a significant negative or inverse association between the percentage of care hours provided by RN staff and any falls (coefficient = –0.02897, $p = .008$). This result would predict that a 10% increase in RN hours in a step-down unit would result in an average drop of 0.3 falls per 1,000 patient days, which would translate to an estimated 12.3% reduction in the 2006 step-down unit average of 2.43. Nonsignificant trends associated more hours of RN care and higher percentages of licensed staff with fewer falls, and units with more patients per RN and higher percentages of LVNs and unlicensed nursing staff with higher fall rates.

Prevalence of pressure ulcers and restraint use. There were no significant findings associating nurse staffing variables with pressure ulcers or restraint use among medical-surgical units. We did note a nonsignificant trend for the prevalence of restraint use in medical-surgical units where units reporting higher numbers of patients per RN also report higher restraint use.

Among step-down units we observed a significant positive association of units reporting higher total hours of care per patient day with higher prevalence of hospital-acquired stage II+ pressure ulcers. This would represent an estimated increase of almost 1% (0.92%) in hospital-acquired stage II ulcers for each hour increase in total hours of care per patient day. This would correspond to an 18.8% increase from the 2006 step-down unit average prevalence of 4.9%. Multiple regression adjustment for additional unit-level risk factors available to us, including

TABLE 4: Relationship Between Selected Staffing and Outcomes: Mixed ANOVA Model Results

	Staffing			*Ratios*	*Skill Mix*				
Outcome Variable	*Total Hours of Care/ Patient Day (Coefficient;* p *Value)*	*Hours RN Care/Patient Day (Coefficient;* p *Value)*	*Hours Licensed Care/Patient Day (Coefficient;* p *Value)*	*Number of Patients/RN (Coefficient;* p *Value)*	*% RN Hours (Coefficient;* p *Value)*	*% LVN Hours (Coefficient;* p *Value)*	*% Licensed Hours (Coefficient;* p *Value)*	*% Other (Unlic) Hours (Coefficient;* p *Value)*	*% Contracted (Coefficient;* p *Value)*
Medical-surgical									
Injury falls/1,000 patient days	−0.013; .030	−0.016; .02	−0.014; .04	0.018; .03					−0.003; .008*
% any hospital-acquired ulcers									0.143; 0.03
% in restraint				0.61; .04					
Step-down									
Falls/1,000 patient days		−0.186; .02		0.253; .04	−0.029; .008*		0.081; .01	−0.02; .05	0.023; .05
% any hospital-acquired ulcers						−0.49; .05			
% hospital-acquired II+ ulcers	0.928; .004*					−0.363; .04			

NOTE: All p-values under .05 shown, but not statistically significant after adjustment for multiple comparisons. RN = registered nurse; LVN = licensed vocational nurse.
*$p < .01$.

average age of patients, percentage of patients assessed at-risk at admission, total Braden score, and percentage of patients in restraints, did not eliminate the significance of the finding. We found no apparent outliers that might explain this significance. We also observed an upward trend in the percentage of patients assessed at-risk for pressure ulcers at admission in step-down units. The means and standard deviations by period were 26.3% and 20.0, 31.9% and 17.3, and 39.6% and 23.5 for the 2002, 2004, and 2006 periods respectively. We found no significant results or trends relating staffing variables to restraint prevalence among step-down units.

DISCUSSION

Since 2000, five systematic reviews have examined the impact of nurse staffing on patient outcomes (Hickam et al., 2003; Kane, Shamliyan, Mueller, Duval, & Wit, 2007; Lake & Cheung, 2006; Lang et al., 2004; Seago, 2001). It is noteworthy that only two of these reports (Lang et al., 2004 and Lake & Cheung, 2006) have included falls and pressure ulcers among the outcomes studied. Affirming Lange et al.'s finding, Lake & Cheung (2006) noted that the 11 studies included in their analysis "collectively have not identified the contributions of nurse staffing to patient falls and pressure ulcers" (p. 666). CalNOC's findings based on primary, prospective unit-level data sources for both staffing and outcome variables as well as a robust sample of hospitals and units are congruent with this conclusion.

The observed changes in nurse staffing and skill mix were consistent with the changes expected as a consequence of the mandated staffing ratios, just as CalNOC reported in 2005 (Donaldson, Burnes Bolton, et al., 2005). In medical-surgical units, the increase in nurse staffing and decrease in the number of patients per RN and licensed staff continued from 2004 to 2006, with approximately one third of the absolute change occurring in the later time period. In step-down units, the trends also continued from 2004 to 2006, but were not statistically significant. The larger change in medical and surgical units from 2004 to 2006 was expected because those units had a final ratio requirement of 1:5 that went into effect in 2005.

The decrease in the percentage of care provided by LVNs and other (i.e., unlicensed) staff also suggests that administrators have chosen to meet regulatory requirements through the use of RNs rather than LVNs and unlicensed staff. Our findings also show greater variability in staffing among step-down units when compared to the medical-surgical units in our sample, reflecting the fact that the CalNOC step-down unit category includes all definitive observation units, including both the step-down and telemetry categories designated by the CDPH.

Results for clinical outcomes for the 4-year time period varied by indicator, type of unit, and hospital size. The only trend (though not statistically significant) toward improved patient outcomes was seen in falls per 1,000 patient days on step-down units. Analyses of the relationship between staffing and outcomes for medical-surgical units showed trends toward a relationship between staffing, ratios, and skill mix and injury fall rates. It is noteworthy that these data are gleaned from a period in which hospitals were addressing falls as a core indicator of The Joint Commission (TJC) as well as a focus of the national Institute for Healthcare Improvement's (IHI) 100,000 Lives campaign (IHI, 2007; TJC, 2007). In addition, 33 CalNOC hospitals were actively engaged in the CalNOC Partners for Quality Project (AHRQ Grant # U18 HS13704) with the aim of reducing patient falls. These convergent historical phenomena suggest that myriad factors were likely impacting observed reductions in patient falls and that the lack of significance is a valid measure of the association between falls and nurse staffing. The one significant finding for medical-surgical units indicated a negative relationship between percentage contracted staff and injury falls (more contract staff associated with fewer injury falls). Because injury falls are very rare events and it is difficult statistically to relate the occurrence of a rare event to changes in staffing which may be ongoing, these results should be interpreted with caution. Medical-surgical units also showed a significant association between falls and hospital size, with the smallest hospitals (average daily census under 100) showing a decrease in falls, whereas larger hospitals (200 and above) showed an increase in falls. For step-down units, there was a nonsignificant decrease in falls per 1,000 patient days over the three time periods and a significant finding relating a larger percentage of RN hours of care to fewer falls. There were also nonsignificant trends relating total RN hours of care and several skill mix variables to fewer falls on step-down units.

Prevalence study findings did not indicate a consistent trend in the association between staffing and hospital-acquired pressure ulcers or restraint use. Furthermore, the percentage of patients with all ulcers (both community- and hospital-acquired) decreased. This overall decrease and the lack of relationship to nurse staffing may also reflect the current historical context in which there are multiple local, state, and national initiatives targeted at patient safety and pressure ulcers in particular, making it difficult to reveal independent staffing associations (e.g., IHI, 2007).

Our analyses also showed an unexpected, statistically significant positive relationship in step-down units between the percentage of patients with hospital acquired pressure ulcers stage II and above (stage II+) and total hours of care per patient day (i.e. more hospital-acquired stage II+ ulcers associated with more hours of care). Our step-down unit data also showed a nonsignificant increase in both the percentage of patients with all stage II+ pressure ulcers and the percentage with hospital-acquired stage II+ pressure ulcers. We further examined these data for potential outliers and fitted multiple regression models controlling for other potential risk factors for hospital-acquired ulcers available to us. These exploratory analyses did not yield alternative explanations, although we did find an increased percentage of patients assessed at-risk at admission over time. Even after controlling for the positive effect of this variable on the outcome, however, total hours of care per patient day remained significant and positively associated with the incidence of hospital-acquired stage II+ ulcers. The combination of more serious pressure ulcers (stage II+) and higher total staffing in this analysis may be explained by a preponderance of patients with higher care needs and greater acuity not measured in the CalNOC data. CalNOC's revised 2007 prevalence study data collection tools include more specific questions on patient risk status and subsequent interventions undertaken to prevent hospital-acquired pressure ulcers and will provide the ability to "drill down" on similar findings in the future.

Public Policy Implications

These findings highlight the challenge to better understand how characteristics and credentials of the direct care nursing staff, unit microsystem, and organizational culture of safety interact to impact patient outcomes, as mandated alterations in the volume of direct care staff alone has not resulted in expected reductions in two common adverse events in hospitals, falls and pressure ulcers.

Our findings also demonstrate interesting results for the use of contracted staff. An unintended outcome of mandated nurse–patient ratios in the presence of a shortage of qualified employees may be to recruit temporary workers from agencies, whose presence may add a new threat to patient safety. Thus, although a larger percentage of contracted staff on medical-surgical units is significantly associated with fewer injury falls, we found a nonsignificant trend associating a higher percentage of contracted staff and more hospital-acquired pressure ulcers. Perhaps a greater percentage of contracted staff on a unit implies more staff that are unfamiliar with unit practice and may compromise continuity of care, potentially exerting an impact on patient safety. It is also possible that some patient outcomes (e.g., falls) are more sensitive to raw numbers of staff, whereas others are more sensitive to continuity of care. To date there is little research literature on the impact of supplemental staff on patient outcomes, a topic that needs to be examined carefully in future research.

As the nation confronts the increasing demand for acute care by its exploding aged population, policy makers will turn to the health services research enterprise to assist them in optimizing costs, quality, and outcomes of hospital care. The California experiment in mandated ratios has increased patient access to licensed professional nurses in hospitals but has not yet improved their safety from falls or assurance that they will emerge from acute care with less likelihood of a hospital-acquired pressure ulcer. Further research using standardized metrics, unit-level primary data sources and integrating microsystem and organizational measures, as well as granular variables examining the characteristics of the workforce have been repeatedly called for (Hickam et al., 2003; Kane et al., 2007; Lake & Cheung, 2006; Lang et al., 2004; Seago, 2001) and this study affirms this imperative.

Methodological Limitations

The significant findings and trends noted in these complex analyses must be considered exploratory. The CalNOC database brings to the analysis unit-based data with a high degree of standardization in data capture methodology, potentially adding power to the analysis by reducing variability in data collection (Aydin et al., 2004; Donaldson, Burnes Bolton, et al., 2005). As noted in 2005, however, these analyses are based on data from a convenience sample of California hospitals. Although these analyses generally represent hospitals statewide, it is not known how hospitals that do not participate in CalNOC differ from those that do. Furthermore, although we have controlled for time period and adjusted for differences in hospital size (average daily census) and between unit types, more complex stratification would be useful.

CalNOC data are aggregated as averages for units, clustered within hospitals, clustered within time periods. Beyond our analyses by unit type and adjustments for hospital size, these analyses do not adjust for variability in patient care needs among patients on units of the same type. CalNOC's monthly data cannot affirm compliance with ratios per shift, per unit, at all times. As hospitals prioritize improvement efforts to target opportunities to improve poor outcomes, these data likely reflect a continuum of units moving rapidly on improvements along with other units that are not—thus individual hospital or unit results may be able to demonstrate excellent outcomes, whereas the overall data set may not. These analyses also do not take into account historic trends toward older patients, increasingly severe case mix for inpatients, changes in technology, and increased patient or bed turnover on nursing units—all of which require more RN time.

CONCLUSION

This analysis provided a follow-up and extension of CalNOC's 2005 report on the impact of mandated nursing ratios in California adult acute care hospitals. Findings continued to indicate that changes in nurse staffing were consistent with expected increases in licensed staffing. However, anticipated significant improvements in two key nurse-sensitive indicators of patient care quality and safety, the incidence of falls and the prevalence of hospital-acquired pressure ulcers, were not observed. This report contributes to the growing understanding of the impacts of regulatory staffing mandates on hospital operations and patient outcomes and the nuances that may impact these phenomena.

NOTES

1. The California Department of Public Health (CDPH) regulations define "step-down unit" as a unit that is organized, operated, and maintained to provide for the monitoring and care of patients with moderate or potentially severe physiologic instability requiring technical support but not necessarily artificial life support. Step-down patients are those patients who require less care than intensive care but more than that which is available from medical or surgical care (California Code of Regulations, Title 22, Section 70217, 2005). A "telemetry unit" is defined as a unit organized, operated, and maintained to provide care for and continuous cardiac monitoring of patients in a stable condition, having or suspected of having a cardiac condition or a disease requiring the electronic monitoring, recording, retrieval, and display of cardiac electrical signals (California Code of Regulations, Title 22, Section 70217, 2005). In addition to these types of units, AB 394 and the CDPH implementation regulations required staffing ratios for postpartum units, labor and delivery, emergency departments, pediatrics, specialty care (oncology), telemetry, psychiatric units, and mixed units. Mandated ratios had already been in place for other units, including intensive or critical-care units, operating rooms, well-baby nurseries, intermediate-care nurseries, and neonatal intensive care units.

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