Nursing and Home Care

Implications of the California Nurse Staffing Mandate for Other States

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Objectives. To determine whether nurse staffing in California hospitals, where state-mandated minimum nurse-to-patient ratios are in effect, differs from two states without legislation and whether those differences are associated with nurse and patient outcomes.

Data Sources. Primary survey data from 22,336 hospital staff nurses in California, Pennsylvania, and New Jersey in 2006 and state hospital discharge databases.

Study Design. Nurse workloads are compared across the three states and we examine how nurse and patient outcomes, including patient mortality and failure-to-rescue, are affected by the differences in nurse workloads across the hospitals in these states.

Principal Findings. California hospital nurses cared for one less patient on average than nurses in the other states and two fewer patients on medical and surgical units. Lower ratios are associated with significantly lower mortality. When nurses' workloads were in line with California-mandated ratios in all three states, nurses' burnout and job dissatisfaction were lower, and nurses reported consistently better quality of care.

Conclusions. Hospital nurse staffing ratios mandated in California are associated with lower mortality and nurse outcomes predictive of better nurse retention in California and in other states where they occur.

Key Words. Nurse staffing, California nurse ratios

In 2004, California became the first state to implement minimum nurse-to-patient staffing requirements in acute care hospitals (Coffman, Seago, and Spetz 2002; Spetz 2004).

As of September 2009, 14 states and the District of Columbia had enacted nurse staffing legislation and/or adopted regulations addressing nurse staffing and another 17 states had introduced legislation (American Nurses Association 2009). California remains the only state to have enacted minimum nurse staffing requirements, and as the amount of legislative and regulatory

activity suggests, there is widespread interest in what can be learned from California's example.

For two decades, nurses have reported that there are not enough nurses in hospitals to provide high-quality care (Aiken and Mullinix 1987; Aiken, Sochalski, and Anderson 1996; Aiken et al. 2001). In response to these concerns, Congress, in 1993, requested an Institute of Medicine (IOM) study of the adequacy of nurse staffing in hospitals and nursing homes. The IOM report concluded that there was insufficient evidence to support specific nurse staffing ratios in hospitals and called for additional research (Wunderlich, Sloan, and Davis 1996). Since then, the evidence supporting an association between nurse staffing and better patient outcomes has grown. We reported in 2002 that each patient added to nurses' workloads was associated with a 7 percent increase in mortality following common surgeries, and that nurse burnout and job dissatisfaction, precursors of voluntary turnover, also increased significantly as nurses' workloads increased (Aiken et al. 2002). Replications in Canada, England, and Belgium produced similar findings as did other studies in the United States (Aiken, Clarke, and Sloane 2002; Needleman et al. 2002; Estabrooks et al. 2005; Rafferty et al. 2007; Tourangeau et al. 2007; van den Heede et al. 2009). A meta-analysis of 90 studies commissioned by the Agency for Healthcare Research and Quality (AHRQ) subsequently concluded that there is an evident association between nurse staffing and patient outcomes (Kane et al. 2007).

Registered nurse (RN) staffing in California hospitals increased substantially following the passage of the legislation and implementation of the regulations (Donaldson et al. 2005; Bolton et al. 2007; Spetz et al. 2009). Whether the increase in nurses is associated with improved outcomes has been more difficult to determine. Researchers were unable to detect an impact

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of improved nurse staffing on falls or hospital-acquired pressure ulcers (Donaldson et al. 2005; Bolton et al. 2007), but research findings in general on the association between hospital nurse staffing and falls and pressure ulcers have been inconsistent in the literature (Lake and Cheung 2006). While not related to the impact of the legislation on patient outcomes, Mark, Harless, and Spetz (2009) found that wage growth for RNs in California after implementation of mandated minimum nurse staffing increased more than RN wage growth in other states; the researchers could not rule out alternative explanations for the wage increases including the impact of the nurse shortage.

Research by Sochalski et al. (2008) using data before implementation of mandated minimum ratios offers a glimpse of the possible impact on patient outcomes. During the study period between 1993 and 2001, when RN levels rose by roughly 1.2 percent per year, they found that more RN hours per patient day were associated with lower mortality for patients with acute myocardial infarction. They also found, as would be expected, that mortality reductions associated with increased nurse staffing were greatest for hospitals that began with the worst staffing ratios. If this result can be replicated when hospital outcome data become available for the years following implementation, many would conclude the legislation produced a desirable outcome.

The California Department of Health undertook a multiyear process to determine the minimum ratios to be mandated based upon research and other factors. The California mandates can be viewed as a benchmark against which to compare hospitals within California and between California and other states. We compare patient-to-nurse ratios in California hospitals with similar ratios in New Jersey and Pennsylvania hospitals, states without nurse staffing legislation at the time of the study, and compare associated outcomes. We report findings from California nurses about the impact of the legislation on factors affecting the quality of hospital care. We examine potential unintended consequences of the legislation: whether RNs in California perceive that nursing skill mix in hospitals has been negatively affected by increased employment of licensed vocational nurses (LVNs), and whether non-nurse ancillary support services have been reduced—two issues that were concerns at the outset of the legislation (Coffman, Seago, and Spetz 2002). We compare the outcomes for nurses and indicators of quality of care across hospitals in all three states according to the proportion of nurses with workloads consistent with the benchmarks derived from the California-mandated ratios. Finally, we compare patient outcomes—30-day inpatient mortality and failure-to-rescue (FTR)—across hospitals in which nurses care for fewer and more patients each. This provides an estimate of the possible impact on nurse retention,

quality of care, and patient mortality in other states if nurse staffing ratios were to improve to the levels mandated in California.

DATA AND METHODS

Our primary data are from surveys completed in 2006, 2 years after the start of the mandatory ratios, by nearly 80,000 RNs in California, New Jersey, and Pennsylvania. New Jersey and Pennsylvania were chosen to compare with California not only because of survey funding availability but also because neither state had enacted nurse staffing legislation at the time; they are admittedly a convenience sample of states. The hospitals, nurses, and patients in the three states combined provide broad, diverse, and reasonably representative samples of hospitals, nurses, and patients in the United States as a whole. Large random samples of RNs were obtained from licensure lists in California (40 percent), Pennsylvania (40 percent), and New Jersey (50 percent). Licensure lists have no information about employment, so respondents include nurses in all employment settings and those not in the workforce but maintaining an active license. Our target population in this analysis was hospital staff nurses. We asked nurses to provide the name of their employing hospital, information on their work environments including their patient workloads, and the numbers of nurses and patients on their unit on their last shift. We then aggregate responses by hospital thus creating hospital level and within hospital specialty-related empirical measures of patient-to-nurse workloads and other nurse-assessed outcomes related to quality of care for the majority of hospitals in the three states of over 100 beds. This method of obtaining information about hospitals practically eliminates response bias at the hospital level, which is the greatest potential threat to validity in studies of hospital performance involving primary data collection.

A modified Dillman approach using two survey mailings and a reminder postcard yielded a response rate of 35.4 percent (Dillman 1978). This cannot necessarily be interpreted as the response rate of the target population of hospital staff nurses because the sample included all nurses holding active licenses even though a large proportion were not working. To determine the extent to which possible response bias existed in the sample, a random sample of nonresponders ($n = 650$ in Pennsylvania; $n = 650$ in California) was drawn. Nurses in the second sample received a shortened survey, telephone reminders, and a monetary incentive to encourage their responses. The second sample response rate was 91 percent. Demographic differences in race/ethnicity, age, and

experience were found between the nurses who responded to the initial survey (responders) and those who subsequently responded to the follow-up survey (nonresponders); however, there were no differences between responders and nonresponders on the workload measures and nurse-reported outcome measures used in these analyses (Smith 2008). The data presented here are restricted to the original sample of nurses, specifically to the 22,336 nurses who were working in 604 adult nonfederal acute care hospitals in California ($N = 9,257$ RNs in 353 hospitals), New Jersey ($N = 5,818$ RNs in 73 hospitals), and Pennsylvania ($N = 7,261$ RNs in 178 hospitals).

Nurse workloads were derived by asking each hospital RN how many patients they were assigned on their last shift. Although the California legislation allows the mandates to be met by either RNs or LVNs, we found that most hospitals met the ratios with RNs and therefore restricted our attention to RNs who provided direct bedside care in these hospitals. Their responses were used to derive average (mean) nurse workloads for all staff nurses and average workloads for nurses working on different types of units (e.g., medical–surgical, pediatric) in each state. Our data pertain to unit type but not to specific units. We first look at mean differences in nurse workloads across the three states, overall, and by unit type. We consider whether differences in nurse workloads across these states may result from differences in the acuity of patients across states. Our previous research demonstrated the predictive validity of nurses' reports of their patients' needs for assistance with activities of daily living (ADLs) and actual hospital mortality outcomes (Justice et al. 1996). We then calculated the percentage of nurses in each hospital across all three states that report that their workload on their last shift was at or below the unit-type levels mandated by the California legislation. We use this hospital-level measure in logistic regression models to determine whether the likelihood of nurses reporting unfavorable outcomes for patients and nurses is lower in hospitals that have higher percentages of nurses working within staffing levels congruent with the benchmark established by the California-mandated nurse ratios. In our final analyses, we use logistic regression models to estimate the effects of nurse staffing on 30-day inpatient mortality and FTR, or mortality for patients with complications using Silber's method, in the hospitals in each of the three states, taken one at a time (Aiken et al. 2002). The effects of nurse workloads on mortality and FTR are estimated before and after adjusting for differences in other hospital characteristics (size, technology, and teaching status), and differences in patient characteristics.

Hospitals bed size categories include small (< 100 beds), medium (101–250 beds), and large (> 251 beds). Teaching status is the ratio of residents and

fellows to hospital beds and defined as follows: no postgraduate trainees (nonteaching), 1:4 or smaller trainee:bed ratio (minor teaching) and those higher than 1:4 (major teaching). High-technology hospitals are those performing open heart surgery and/or organ transplants. These analyses are restricted to surgical cases for which risk-adjustment models have been well developed, and to patients in those hospitals (233 in California, 72 in New Jersey, and 139 in Pennsylvania) with substantial numbers of nurses (mean = 47) to provide estimates of patient-to-nurse workloads. Data on patient characteristics, complications, mortality, and FTR for these analyses are secondary data from state agencies. They were merged with data from our survey of nurses and with American Hospital Association data on hospital size, teaching status, and technology. The analyses follow a protocol similar to that described in detail in prior work on a single state (Pennsylvania), which is modified slightly here to allow us ultimately to estimate how many fewer patients would have died in New Jersey and Pennsylvania hospitals had the average nurse workload in those states been equivalent to the average workload across California hospitals (Aiken et al. 2002). All analyses were conducted with *STATA* version 10, using robust estimation procedures to take account of the clustering of nurses and patients within hospitals (StataCorp 2007).

We note that while nurse self-reports of workloads may be prone to the types of biases associated with self-reports generally, our prior research with these self-reported methods (Aiken et al. 2002, 2008) have shown them to have considerable predictive validity, and better predictive validity than AHA measures of nurse staffing. Our survey-based measures, unlike administrative measures of staffing, allow us to focus explicitly on staffing at the patient bedside. And finally, in our multivariate models, we rigorously control for a substantial number of the characteristics of nurses that might affect their reports such as education and experience, as well as the characteristics of patients and hospitals that might affect our results.

RESULTS

Table 1 shows the average number of patients assigned per RN per shift, overall, and by unit type, for the three states. Mean workloads for California RNs are on average at or below the levels mandated by the California legislation for all nurses except those working on intensive care units, where the average patients assigned was 2.1, only very slightly higher than the mandated

Table 1:   Average Workloads Reported by Hospital Nurses, Overall, and by
Specialty, in California (CA), New Jersey (NJ), and Pennsylvania (PA)

| Specialty | *Patient/Nurse Workload Mandated by California Legislation* | *Mean Patients per Shift (Nurse Sample Size)* | | |
		CA	*NJ*	*PA*
All staff nurses		4.1[a,b]	5.4	5.4
		(9,257)	(5,818)	(7,261)
Medical–surgical	5:1	4.8[a,b]	6.8[b]	6.5
		(1,311)	(802)	(1,069)
Pediatric	4:1	3.6[a,b]	4.6	4.4
		(192)	(129)	(137)
Intensive care units	2:1	2.1[a,b]	2.5[b]	2.3
		(2,011)	(1,041)	(1,272)
Telemetry	5:1	4.5[a,b]	5.9[b]	5.7
		(515)	(389)	(483)
Oncology	5:1	4.6[a,b]	6.3[b]	5.7
		(200)	(121)	(133)
Psychiatric	6:1	5.7[a,b]	7.0[b]	7.9
		(122)	(160)	(215)
Labor/delivery	3:1	2.4[b]	2.6	2.8
		(674)	(325)	(290)

Notes. Intensive care units include adult, neonatal, and pediatric intensive care units.
[a]Significantly different from New Jersey at $p < .05$.
[b]Significantly different from Pennsylvania at $p < .05$.

2:1 ratio. Mean workloads in New Jersey and Pennsylvania on all unit types
are higher than in California and are generally above California-mandated
staffing levels.

Table 2 shows a substantial degree of compliance with the benchmark
staffing levels mandated by the California legislation for the nurses in that
state. By comparison, when these benchmark levels are applied to nurses in
the other states, smaller percentages of nurses were found to have workloads
that were at or below these benchmark levels. For example, while 88 percent
of the medical–surgical nurses in California cared for five patients or less on
their last shift, the same was true of only 19 and 33 percent of medical–surgical
nurses in New Jersey and Pennsylvania, respectively.

In addition to asking nurses about the number of patients assigned to
them on their last shift, our survey asked them about the number of patients
they cared for who required assistance with ADLs and the numbers of
patients who were high acuity and required intensive monitoring. Their
responses suggest that the better nurse staffing in California hospitals is not

Table 2:   Percentage of Nurses Reporting Patient Assignments at or below California Benchmark Levels, by Specialty, in California (CA), New Jersey (NJ), and Pennsylvania (PA)

Unit Type	Patient/Nurse Workload Mandated by California Legislation	Mean Patients per Shift (Nurse Sample Size)		
		CA (%)	NJ (%)	PA (%)
Medical–surgical	5:1	88[a,b]	19[b]	33
Pediatric	4:1	85[a,b]	52	66
Intensive care units	2:1	85[a,b]	63[b]	71
Telemetry	5:1	93[a,b]	35[b]	52
Oncology	5:1	90[a,b]	29[b]	55
Psychiatric	6:1	81[a,b]	56[b]	42
Labor/delivery	3:1	94[a,b]	88	89

Notes. Sample sizes for each specialty in each state are given in Table 1.

Intensive care units include adult, neonatal, and pediatric intensive care units.

[a]Significantly different from New Jersey at $p < .05$.

[b]Significantly different from Pennsylvania at $p < .05$.

explained by patients in that state requiring greater nursing care. Nurses in California care for fewer patients who required assistance with all ADLs on each shift than do nurses in New Jersey and Pennsylvania (2.1 per nurse per shift versus 2.8 and 2.7, respectively), fewer high acuity patients (2.1 per nurse per shift versus 2.5 and 2.4, respectively), and fewer patients who required hourly or more frequent monitoring or treatments (2.2 per nurse per shift versus 2.9 and 2.8, respectively).

Table 3 shows that the lower workloads for California nurses translate into better evaluations of their work environment. Higher percentages of hospital nurses in California than in New Jersey or Pennsylvania report that their workloads were reasonable, that they received substantial support in doing their jobs, that there were enough nurses to get their work done and provide high-quality care, and that 30-min breaks were part of their typical workday. A smaller percentage of nurses in California than in the other states indicated that their workloads caused them to miss changes in patient conditions.

The survey questionnaire sent to California nurses also included a series of questions about the changes they had detected in their hospitals since the staffing legislation was implemented. Table 4 shows that four times as many nurses report decreases (relative to increases) in the number of patients assigned to them since the legislation was implemented. Only 15 percent

Table 3: Percentage of Hospital Nurses in California (CA), New Jersey (NJ), and Pennsylvania (PA) Agreeing That Selected Practice Environment Characteristics Were Present in Their Jobs

	Percentage of Nurses Agreeing Characteristic Is Present		
Practice Environment Characteristic	*CA*	*NJ*	*PA*
A reasonable workload	73[a,b]	59	61
Adequate support services allow me to spend time with patients	66[a,b]	53	55
Enough registered nurses on staff to provide quality patient care	58[a,b]	41	44
Enough staff to get work done	56[a,b]	40	44
30-minute breaks during workday	74[a,b]	51[b]	45
Workload causes me to miss changes in patient conditions	33[a,b]	41[b]	37

Notes. All tests of significance adjust for clustering of nurses within hospitals.
Samples sizes as per "All Staff Nurses" in Table 1.
[a]Significantly different from New Jersey at $p < .01$.
[b]Significantly different from Pennsylvania at $p < .01$.

reported an increase in use of LVNs, while 25 percent of the nurses reported decreased use. One-third of nurses reported a decrease in the use of unlicensed personnel to provide direct patient care. Increases in float coverage by nurses from other units and the use of supplemental or agency nurses were reported

Table 4: California Hospital Nurses' Reports of Changes in Compliance Strategies

	Percentage Indicating Compliance Strategy		
Compliance Strategy	*Increased*	*Remained the Same*	*Decreased*
Patients assigned per nurse	10	49	42
Relief nurses to cover breaks	35	51	14
Nurses floating to cover other units	30	59	11
Use of supplemental/agency nurses	43	42	15
Use of licensed practical nurses (LVNs)	15	60	25
Use of unlicensed personnel	10	56	34
Non-nursing support services (e.g., housekeeping, unit clerks)	7	66	27

Note. Samples sizes as per "All Staff Nurses" for California in Table 1.

by 30 and 43 percent of nurses, respectively. Approximately half of California hospital nurses reported that nurse-to-patient ratios had not changed in their institutions since the legislation. This is consistent with reports that over half of hospitals were already in compliance with the mandated ratios at the time of the legislation (Coffman, Seago, and Spetz 2002).

In our sample, 94 percent of nurses are staff nurses, 6 percent are front-line nurse managers or assistant nurse managers (or direct supervisors), and 1 percent are nursing administrators/supervisors (or mid- or executive-level supervisors). Supervisory and line staff alike generally agreed that the legislation produced its intended effects regarding quality of care, nurse workloads, nurse retention, and the relative attractiveness of employment in California hospitals (not shown in tabular form). For example, 74 percent of staff nurses, 68 percent of front-line nurse managers or assistant nurse managers, and 62 percent of mid- or executive-level nursing administrators agreed that the quality of care in California hospitals has increased as a result of the legislation. Likewise, two-thirds of staff nurses agreed that California nurses are more likely to stay in their jobs as a result of the legislation, and 58 percent of front-line managers and 49 percent of nurse executives agreed. We also find (not shown in tabular form) that a significantly lower proportion of California nurses experience high burnout: 29 percent, compared with 34 and 36 percent in New Jersey and Pennsylvania, respectively. Nurses in California are also less likely to report being dissatisfied with their jobs (20 percent, compared with 26 and 29 percent in New Jersey and Pennsylvania, respectively).

Table 5 provides evidence of the effects of better staffing on a variety of practice outcomes. In these analyses, we pooled data across states to estimate, using logistic regression models, how much these outcomes differed in hospitals with higher versus lower percentages of nurses whose workloads were in conformity with the California legislation. The odds ratios in the first two columns of Table 4 are the estimated effects of a 10 percentage-point increase in the number of nurses with workloads in compliance with a benchmark established by the California legislation. Estimates in the first column are the bivariate relationship between extent of compliance with the benchmark staffing levels and these outcomes. Estimates in the second column include controls for both characteristics of hospitals (location [state], size, technology, and teaching status) and characteristics of nurses (age, sex, race, degree, experience, and type of unit assigned to). The fixed effects (dummy variables) for state assure that the estimated odds ratios are not due to unspecified differences between states, either in the practice of nursing or the conduct of the surveys. Adjustment for other hospital characteristics reduces the likelihood

Table 5:   Odds Ratios Indicating the Effects on Different Nurse-Reported Outcomes of a 10–Percent Increase in Nurses with Workloads at or below the California Benchmark Level

Nurse-Reported Outcome	*Odds Ratios Associated with Each Nurse-Reported Outcome*		
	No Controls	*Controls for Hospital and Nurse Characteristics*	*Implied Difference between Hospitals at 25th and 75th Percentiles*
Complaints from patients or families	0.96**	0.95***	1.2
Verbal abuse by patients	0.93**	0.94***	1.3
Verbal abuse by staff	0.94**	0.96**	1.2
Burnout higher than norm for all health care workers	0.92**	0.91***	1.5
Dissatisfaction with current job	0.89**	0.90***	1.5
Work environment poor or fair	0.89**	0.89***	1.6
Quality of care poor or fair	0.92**	0.87***	1.8
Not confident patients can manage care after discharge	0.97**	0.94***	1.3
Workload causes me to miss changes in patient condition	0.93**	0.91***	1.5
Workload cause me to look for new position	0.91**	0.89***	1.6

Notes. Hospital characteristics include location (state), teaching status, technology status, and bed size. Nurse characteristics include age, sex, race, degree, experience, and type of unit assigned to. All tests of significance adjust for clustering of nurses within hospitals.

Samples sizes as per "All Staff Nurses" in Table 1.

**$p < .01$.

***$p < .001$.

that the effects we estimate do not pertain to nurse staffing levels, but to other hospital characteristics with which these staffing levels are correlated. Adjustment for nurse characteristics has a similar effect with respect to possible correlations between the types of nurses in a hospital and the way in which they evaluate their hospitals.

We find for every outcome that higher percentages of nurses in a hospital reporting patient-to-nurse ratios in line with the benchmark set by the California mandates are significantly associated with lower reports of unfavorable outcomes. These results obtain—and often increase—with the extensive controls for characteristics of both hospitals and nurses and for state-level fixed effects. Many of these differences are sizable; in the third column of the table, we show how much higher the odds on reporting these

outcomes are for nurses in hospitals at the 25th percentile of patient-to-nurse compliance (in which roughly 50 percent of nurses have workloads lower than the mandated levels) than for nurses in hospitals at the 75th percentile (in which roughly 90 percent of nurses have patient assignments lower than the mandated levels). Nurses in the former hospitals have significantly higher odds than nurses in the latter hospitals of reporting complaints from patients or families and verbal abuse by patients or staff, by factors ranging from roughly 1.2 to 1.3. They also have significantly higher odds on reporting high burnout, job dissatisfaction, and poor or fair work environments and quality of care (as opposed to good or excellent work environments and quality of care), by factors ranging from 1.5 to 1.8. Additionally, nurses in the former (poorer staffed) hospitals have significantly higher odds than nurses in the latter (better staffed) hospitals of expressing little or no confidence that their patients can manage their care after being discharged, and significantly higher odds on reporting that their workloads cause them to miss changes in patient conditions and to look for a new position, by factors ranging from 1.3 to 1.6.

Evidence of the favorable effects of better nurse staffing can be found not only in the comparison of nurse reports from better and poorer staffed hospitals but also in differences between these hospitals in the severity-adjusted likelihood that the patients being treated in these hospitals will be discharged alive. The appendix table describes, separately for each state, the characteristics of the 1,100,532 patients in the set of 444 larger hospitals with sizable numbers of nurse respondents that were used in our analyses of mortality and FTR. Overall mortality was just under 1 percent in each state. FTR was roughly 3 percent in each state. The predominant comorbidities among the surgical patients in all three samples of patients were hypertension, diabetes, and cancer, and the most prevalent major diagnostic categories involved the musculoskeletal, digestive, and hepatobiliary systems.

Table 6 shows odds ratios, which estimate the effects of hospital nurse staffing (average patients per nurse) on 30-day inpatient mortality and FTR, separately for each state. We show both unadjusted odds ratios, from bivariate robust logistic regression models which look at the effect of nurse staffing without taking account of patient characteristics or other hospital characteristics, and adjusted odds ratios, which estimate the effect of nurse staffing in multivariate models that include 130 patient-level controls, including age, gender, admission type, comorbidities, and type of surgery, as well as hospital-level controls, for bed size, teaching status, and technology. The unadjusted effects of staffing on mortality are significant in all three states, and while the unadjusted effect of staffing on FTR is not significant in Pennsylvania, the

Table 6:   Odds Ratios Indicating the Effect of Nurse Staffing on 30-Day Inpatient Mortality and Failure to Rescue, in California, New Jersey, and Pennsylvania

| Hospital Sample | Model Type | *Odds Ratios Estimating the Effect of Nurse Staffing on* | |
		30-Day Inpatient Mortality	*Failure-to-Rescue*
California	Unadjusted	1.10**	1.15***
		(1.03–1.17)	(1.08–1.23)
	Adjusted	1.13***	1.15***
		(1.07–1.20)	(1.09–1.21)
New Jersey	Unadjusted	1.12**	1.09*
		(1.03–1.22)	(1.01–1.19)
	Adjusted	1.10*	1.10*
		(1.01–1.22)	(1.01–1.21)
Pennsylvania	Unadjusted	1.06*	1.02
		(1.00–1.12)	(0.97–1.07)
	Adjusted	1.06*	1.06*
		(1.00–1.12)	(1.00–1.12)

Notes. The numbers of patients and hospitals used in the analyses in each state are shown in the appendix.

Unadjusted odds ratios are from bivariate robust logistic regression models. Adjusted odds ratios are from multivariate robust logistic regression models that controlled for 132 patient characteristics, including age, gender, admission type, dummy variables for comorbidities and type of surgery, and interaction terms, and three hospital characteristics—bed size, teaching status, and technology.

*, **, ****Odds ratios which are significant at the .05, .01, and .001 levels, respectively.

adjusted effects of staffing on FTR, as well as on mortality more generally, are significant in all three states. Even after these extensive adjustments for differences between, the effect of adding an additional patient to hospital nurse workloads increases the odds on patients dying by a factor of 1.13 in California, 1.10 in New Jersey, and by a factor of 1.06 in Pennsylvania. The effects of increased workloads on FTR were substantially similar, with odds ratios of 1.15 in California, 1.10 in New Jersey, and 1.06 in Pennsylvania.

DISCUSSION

Nurse workloads in California hospitals in 2006, 2 years after the implementation of mandated nurse staffing ratios, were significantly lower than in New

Jersey and Pennsylvania hospitals. Nurses in California care for an average of one fewer patient each, and these lower ratios have sizable effects on surgical patient mortality. In medical and surgical units, where nurse recruitment and retention has long been difficult nationally, nurses in California on average care for over two fewer patients than nurses in New Jersey and 1.7 fewer patients than nurses in Pennsylvania.

When we use the predicted probabilities of dying from our adjusted models to estimate how many fewer deaths would have occurred in New Jersey and Pennsylvania hospitals if the average patient-to-nurse ratios in those hospitals had been equivalent to the average ratio across the California hospitals, we get 13.9 percent (222/1,598) fewer surgical deaths in New Jersey and 10.6 percent (264/2,479) fewer surgical deaths in Pennsylvania.

Other than reports of less support from unlicensed clinical and support personnel, we find little evidence of unintended consequences of the California legislation that are likely to negatively affect the quality of the nurse work environment or patient care, as have been anticipated (Buerhaus 1997; Coffman, Seago, and Spetz 2002; AONE Board of Directors 2003). Despite being able to meet the mandated ratios with either RNs or LVNs, 85 percent of nurses reported the same or decreased use of LVNs. A substantial share of nurses report decreased use of unlicensed personnel (34 percent) and decreased availability of non-nursing support services such as housekeeping and unit clerks (27 percent). However, there is little evidence in the research literature that having more unlicensed personnel in hospitals adversely affects patient outcomes. The nursing skill mix in California hospitals appeared to improve and there is much research evidence that more RNs relative to others are associated with better patient outcomes. There is the possibility that reductions in ancillary workers will increase nurses' workloads, but we found no evidence in our study to suggest that was the case. Over 40 percent of California nurses report increased use of supplemental agency nurses. Our previous research does not find supplemental nurses to be responsible for adverse outcomes (Aiken et al. 2007), and a study of California hospitals finds that the use of more supplemental nurses is associated with fewer falls with injuries (Bolton et al. 2007).

Most California nurses, bedside nurses as well as managers, believe the ratio legislation achieved its goals of reducing nurse workloads, improving recruitment and retention of nurses, and having a favorable impact on quality of care. Although our data are cross sectional and lack baseline measures, our positive findings are bolstered by other research showing improved nurse staffing in California hospitals between 2004 and 2006 (Bolton et al. 2007) and

increases in satisfaction of California nurses between 2004 and 2006 (Spetz 2008).

Outcomes are better for nurses and patients in hospitals that meet a benchmark based on California nurse staffing mandates whether the hospitals are located in California. The higher the proportion of nurses in hospitals whose patient assignment is in compliance with the benchmark set on California-mandated ratios, the lower the nurse burnout and job dissatisfaction, the less likely nurses are to report the quality of their work environment as only fair or poor, the less likely nurses are to report that their workload causes them to miss changes in patients' conditions, and the less likely nurses are to intend to leave their jobs. Similarly, the higher the percentage compliance with benchmark based on California ratios, regardless of the hospital state location, the less likely nurses are to report complaints from patients or families, verbal abuse of nurses by staff or patients, quality of care that is poor or only fair, and lack of confidence that their patients can manage after discharge.

The use of the same nurses to assess the impact of the California legislation and to report on quality of care and job satisfaction may be construed as a study limitation. We have tried to minimize this source of potential bias by obtaining reports from nurses in states without legislation and by using independent patient data to validate the better outcomes for California hospitals. Our study is cross sectional and we cannot establish causality in the associations we observe.

From a policy perspective, our findings are revealing. The California experience may inform other states that are currently debating nurse ratio legislation including Massachusetts (Coalition to Protect Massachusetts Patients 2008) and Minnesota (Ostberg 2008), or other strategies for improving nurse staffing, such as mandatory reporting of nurse staffing, as enacted in New Jersey (New Jersey Revision of Statutes 2005; Rainer 2005) and Illinois (Kevin and Stickler 2007), and mandating the process by which hospitals determine staffing as in Oregon (Oregon Revision of Statutes 2005). There are multiple strategies to improve hospital nurse staffing; state-mandated nurse staffing ratio is one. Improved nurse staffing, however it is achieved, is associated with better outcomes for nurses and patients.

ACKNOWLEDGMENTS

Nursing Research, National Institutes of Health (R01NR04513), the Robert Wood Johnson Foundation, and AMN Healthcare Inc.

Role of Sponsor: The funding organizations had no role in the design and conduct of the study, in the collection, management, analysis, and interpretation of the data, or in the preparation, review, or approval of the manuscript.

Institutional Review Board approval: This study (Outcomes of Nurse Practice Environments, NIH/NINR, Linda H. Aiken, PI) has been approved by the Institutional Review Board of the University of Pennsylvania (protocol no. 176400).

Disclosures: None.

Disclaimers: None.

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SUPPORTING INFORMATION

Additional supporting information may be found in the online version of this article:

Appendix SA1: Author Matrix.

Appendix SA2: Patient Characteristics in the Study Hospitals in California, New Jersey, and Pennsylvania.

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