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# Impact of California Mandated Acute Care Hospital Nurse Staffing Ratios: A Literature Synthesis

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## Abstract

California is the first state to enact legislation mandating minimum nurse-to-patient ratios at all times in acute care hospitals. This synthesis examines 12 studies of the impact of California's ratios on patient care cost, quality, and outcomes in acute care hospitals. A key finding from this synthesis is that the implementation of minimum nurse-to-patient ratios reduced the number of patients per licensed nurse and increased the number of worked nursing hours per patient day in hospitals. Another finding is that there were no significant impacts of these improved staffing measures on measures of nursing quality and patient safety indicators across hospitals. A critical observation may be that adverse outcomes did not increase despite the increasing patient severity reflected in case mix index. We cautiously posit that this finding may actually suggest an impact of ratios in preventing adverse events in the presence of increased patient risk.

## Keywords

hospital quality, nurse staffing, impact of nurse staffing ratios

## Background and Aim of This Literature Synthesis

Although 15 states and the District of Columbia have adopted regulations or enacted legislation intended to improve the adequacy of hospital nurse staffing, in 1999 California became the first and only state in the nation to enact legislation mandating minimum licensed nurse-to-patient ratios at all times in acute care hospitals. The impetus for this legislation, advanced and advocated by organized labor, and opposed by the hospital industry, included a growing body of research linking nurse staffing to better patient outcomes or fewer adverse events (California State Dept. of Health Services, 2003). The California legislative remedy, Assembly Bill (AB) 394, adding to existing licensing regulations that mandated minimum ratios, established in critical care units in 1975; AB 394 expanded minimum ratios to medical-surgical units, step-down, specialty, and telemetry units (California State Dept. of Health Services, 2003). The intent of the legislation was to build on the previously required use of patient classification systems, mandated in California since 1997, used to ensure that staffing was aligned with patient needs (California State Dept. of Health Services, 2003). As stated in the legislative proposal, this initiative was explicitly undertaken to “remediate the hospitals with the leanest staffing, effectively raising the bar for the standard of acceptable staffing” (California Statutes, 1999). It is noteworthy that AB 394 was implemented despite

acknowledging in its preamble that there was insufficient empirical evidence to guide public policy efforts to prescribe safe staffing (California State Dept. of Health Services, 2003).

California's mandated ratios were implemented in January 2004 in a planned two-phase process. In the first phase, the mandated minimum ratio was one licensed nurse (Registered Nurse or Licensed Vocational Nurse, also known as Licensed Practical Nurse in other states), with at least 50% of the licensed direct care staff registered nurses, to six patients on medical surgical units; in January, 2005 (Phase 2) this was further reduced to one licensed nurse to five patients on medical-surgical units. The implementation of AB 394 in 2004 created, in effect, a “natural experiment” in California, in which the impacts of mandated minimum ratios as a regulatory intervention could be observed.

Hospitals throughout California began preparing for the mandated ratios prior to their actual required implementation. Investigators reported seeing reductions in nurse-to-patient ratios as early as 2002 (Bolton et al., 2007; Cook, 2009)

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however, this response was not limited to hospitals with the lowest staffing ratios and included hospitals already staffing at the soon-to-be mandated levels. As a result, the most reliable baseline for measuring key factors related to evaluating the impact of ratios essentially became 2002.

Despite legislative language requiring the California Department of Health Services to evaluate the impact of the ratios law, there has not been a systematic evaluation conducted by or on behalf of the State of California. The Collaborative Alliance for Nursing Outcomes (CALNOC), established in 1996 and formerly known as the California Nursing Outcomes Coalition, was the first independent investigative team to report preliminary pre-post analysis of the impacts of this legislation on both staffing and outcomes. (Donaldson et al., 2005). Other investigative teams (Aiken et al., 2010; Mark, Harless, & Spetz, 2009; Spetz, 2006, 2008, 2009) using surveys and large public administrative datasets have also contributed to the emerging body of literature evaluating the California experiment, and one team integrated qualitative methods into one such study. (Chapman et al., 2009). Other investigative teams have included health economists (Antwi, Gaynor, & Vogt, 2009), an emergency physician (Weichenthal, 2009) doctoral candidates (Cook, 2009; Serrat, 2009) and a master's student in nursing (Mitchell, 2008). Collectively, the investigators are multidisciplinary and multimethod in their approach, clearly diverse in aims and yet bound together in the common quest to explore evidence revealing the impact of California's mandated nurse staffing ratios on patient care quality.

This research synthesis systematically summarizes findings from published and nonpublished research examining the impact of California's legislatively mandated ratios on cost, quality, safety, and outcomes of patient care in acute care hospitals. The questions guiding this review were as follows:

*Research Question 1:* What have been the impacts of the California mandatory nurse-to-patient ratio legislation on acute care hospitals in terms of their nursing structures, processes, clinical outcomes, and costs of patient care?

*Research Question 2:* What has been the impact of ratios on the nursing workforce in California hospitals?

*Research Question 3:* What has been impact on hospital operations?

*Research Question 4:* What other impacts of mandatory nursing ratios have been studied and reported?

## Synthesis Method

Our methods, including the development of the knowledge synthesis protocol, literature search strategies, critical appraisal of the evidence, and synthesis were consistent with

and guided by the standards and methods of the Joanna Briggs Institute (JBI; The Joanna Briggs Institute, 2008) a highly regarded independent source of evidence synthesis in nursing and health care globally. Key steps in the JBI literature synthesis methods included generating a focused literature search strategy and selecting citations for review based on explicit inclusion and exclusion criteria. Selected citations were further screened by the authors, and the final sample of research reports was then subjected to data extraction, followed by critical appraisal and evaluation of internal and external validity. In the absence of published evidence permitting computational meta-analyses, an integrative and narrative approach was used to synthesize both the quantitative and qualitative evidence gleaned from the studies reviewed for this report.

The resulting synthesis includes qualitative studies, quantitative studies, mixed methods, and economic analyses. To be included in this synthesis, studies had to report California data, and include explicit pre- and post-ratios data, or employ a similar longitudinal design. Studies were excluded if they did not provide longitudinal or pre-post data points, did not take place in California, or did not report findings temporally associated with the implementation of AB 394 ratios.

## Literature Search Strategy

The literature search was conducted by a university-based Health Science Reference Librarian. The appendix contains the search strategy and notes the database specific (MeSH and CINAHL) search terms used. In addition to listed search terms, the following keywords were used to search PubMed, CINAHL, Web of Science, Scopus, and Google. Scopus allows simultaneous searching of databases and web sites. Keywords used included affect, California, effect, falls, job satisfaction, hospital, impact, legislation, law, mandatory nurse ratio, mandated nurse ratio, minimum nurse-to-patient ratio, minimum nurse staffing legislation, minimum nurse staffing regulation, nurse-patient ratio, nurse satisfaction, outcome, patient care, patient outcome, pressure ulcer, registered nurse (RN), regulation, salary, patient safety, and workload.

Web sites searched for relevant grey literature included California Hospital Association, California HealthCare Foundation, Kaiser Family Foundation, California Nurses Association, American Nurses Association, and the National Database for Nursing Quality Indicators.

## Results of the Literature Search

The literature search yielded 27 titles that were subjected to further screening. The initial results were evaluated against inclusion/exclusion criteria; abstracts for each of the remaining studies were then thoroughly reviewed and 8 articles were selected for in-depth, full-text review, and evidence

appraisal. The reference lists for all included studies were also hand searched for any fugitive literature not identified through the data bases or grey literature search. Two articles not yet indexed were identified through this method. One was an unpublished dissertation (Cook, 2009) and another was a very recent National Bureau of Economic Research publication (Antwi et al., 2009). An unpublished "fugitive" citation was found among poster presentations at a California State University Fullerton Sigma Theta Tau International conference (Mitchell, 2008) representing the work of a graduate student using a single hospital/single unit pre-post descriptive design. A final unpublished citation, a 2009 doctoral dissertation by Serrat, was identified in conducting the validation review of the working final draft of this report (see below, *Validation of Synthesis Narrative*).

During the initial screening process, it was observed that the Donaldson et al. (2005), preliminary report of pre-post ratios impacts, was replicated and extended by Bolton et al. (2007). We observed that other authors had cited Donaldson and Bolton as two distinct studies (Spetz, 2008); (Cook 2009; Spetz et al., 2009). Concerned that Donaldson et al. and Bolton et al. included data that could be considered duplicative, we conferred with three independent reviewers not involved in this synthesis. It was the unanimous opinion of this advisory group that Donaldson et al. and Bolton et al. constituted separate research reports and that each report made an independent contribution to the literature, requiring they be treated as separate research reports. A final sample of 12 research reports was systematically reviewed, subjected to appraisal, and synthesized for this report.

We note that a 2010 Aiken et al. report was published as we conducted this synthesis and clearly viewed as influential to the field (Aiken, 2010). We concluded, however, that because this study did not include explicit pre- and post-implementation measures, it did not meet the inclusion criteria for this synthesis. Cross sectional designs, such as theirs, although effective in revealing the prevalence of factors at a point in time, were excluded, as the impacts of the ratios on dependent variables over time, before and after the legislative intervention, for example, could not be assessed with a single point of measurement.

### *Extraction of Empirical Elements of Included Studies*

Table 1 presents a summary evidence table and displays key empirical elements extracted from each of the 12 included studies; it is the foundation for our evidence appraisal and synthesis.

### **Overview of Data Sources, Measures, and Level of Analyses**

The breadth of variables examined in the 12 studies (see Table 2) provides a sweeping view of the impact of ratios on

the deployment of patient care staff, the effect on nurse sensitive measures of patient care quality and safety, and the financial consequences to hospitals. Sources of data and units of analyses varied widely across studies. Although studies examining the impact of nurse staffing and outcomes are customarily aggregated in narrative summaries, it is important to note that the impact of data source variation on measurement precision is unknown, and the potential for measurement error has been repeatedly acknowledged by investigators and those that critique their work (Clarke & Donaldson, 2008). Thus, for example, while hospital acquired pressure ulcers was a dependent variable in 3 of the 12 studies in this synthesis, the operational definitions and data sources varied from prospective prevalence data obtained through direct observation of patients in their beds (Bolton et al., 2007) to extraction of pressure ulcer related diagnostic codes obtained retrospectively from California Office of Statewide Health Planning and Development (OSHPD) hospital discharge datasets (Cook, 2009; Spetz et al., 2009) and thus may actually constitute completely different variables.

It is also noteworthy that the studies reviewed for this synthesis explored the impact of mandated ratios on a wide number of structure, process, outcome, workforce, and financial variables. Nursing sensitive measures endorsed by the National Quality Forum (NQF; National Quality Forum, 2004, 2009) were used for structure and outcome measures in four of the multisite studies (Bolton et al., 2007; Cook, 2009; Donaldson et al., 2005; Spetz et al., 2009) and one single unit/single hospital study (Mitchell, 2008). Table 3 lists NQF Nursing Sensitive Core Measures from the initial set endorsed in 2004 and re-endorsed in 2009. One of these NQF endorsed measures includes percent RN staff and hours of care provided by RNs. Using the California OSHPD Annual Hospital Financial Disclosure Report, Spetz et al. (2009), Cook (2009), and Serrat (2009) operationalized and computed these nurse staffing variables from accounting data, creating a financially derived approximation for hospital patient care staffing. Although sharing the conceptual definition of the measure, the studies by Donaldson et al. (2005) and Bolton et al. (2007), as well as investigators who examined impacts on single units (Armstrong, 2004; Mitchell, 2008; Weichenthal & Hendey, 2009) captured staffing variables directly from hospital staffing systems and as a result were able to differentiate direct care and productive hours of care from other paid hours such as indirect clinical activities and nonproductive hours. This challenge to measurement precision inherent in large administrative data sets was noted by investigators using these methods.

Levels of analyses also varied among the included studies, ranging from single case unit level designs (Armstrong, 2004; Mitchell, 2008; Weichenthal & Hendey, 2009) to matched pre-post multihospital unit level designs (Bolton et al., 2007; Donaldson et al., 2005), to hospital level designs in which staffing and outcomes were abstracted from large

**Table 1.** Summary of Empirical Elements of Articles Included in Review and Synthesis

Author, title, journal, & aim	Sample and setting	Variables & measures	Design & methods	Results & findings	Limits of study
<p>Armstrong (2004) Mandated staffing ratios: Effect on nurse work satisfaction, anticipated turnover, and nurse retention in an acute care hospital. PhD Dissertation, George Mason University, Fairfax, VA. Aim: To examine the effect of mandated ratio on nurse work satisfaction, anticipated turnover and actual retention</p>	<p>3 California hospitals selected randomly and 1 hospital agreed to participate in 2003 101 RNs Responded to Pre Survey (36%) 96 RNs Responded to Post Survey (29%) Unmatched respondents Hospital level of analysis</p>	<p>Index of Work Satisfaction (IWS) Anticipated Turnover Scale (ATS) Demographic characteristics of respondents</p>	<p>Single hospital pre-post ratios implementation case study Presurvey 12/2003 Postsurvey 5/2004 (4 months post Phase I)</p>	<p>No significant differences in IWS Increase in ATS Increased actual turnover</p>	<p>Single site Unmatched respondents Limited experience with Phase I ratios Unknown staffing prior to ratios, thus unknown effect of change on nurse's experience with work environment and staffing impacts</p>
<p>Antwi, Gaynor, and Vogt (2009). A bargain at twice the price? California hospital practices in the new millennium National Bureau of Economic Research Working Paper No. 15134. Issued July 2009 Aim: To explore factors that may explain significant hospital price increases in California 1994-2004</p>	<p>CA OSHPD annual financial disclosure report data required of all nonfederal hospitals N = 330 hospitals in 2000 Hospital level of analysis aggregated to statewide</p>	<p>Principal price measure = net revenue per discharge for 3<sup>rd</sup> party payers aggregated across the population of community hospitals Capital expenses Revenue and quantity information by payer type Ownership from CA Hospital Data Project Seismic risk from United States Geological Survey (USGS) CMI from PSHPD</p>	<p>Descriptive and longitudinal retrospective using large administrative datasets Case mix adjusted, and sensitivity analyses performed Data from OSHPD data for the period 1992-2006</p>	<p>Prices fell 1992-1999, then began rapid increase, by 84% from 2000 to 2006 Hospital costs rose from 1995 to 2005 Price changes differed by ownership class; Inpatient prices for Medicare and MediCal did not increase rapidly Capital expenditures increased Per discharge increases in operating and labor expenses "dwarfed by increased prices" "Increasing costs do not explain rise in hospital prices" "Seismic retrofit caused fixed cost shock but do not explain price increases" "Patients were sicker (CMI increased), but this had minimal effect on price run-up" Despite increased cost and sicker patients, intensity of treatment decreased from 0.84 procedures per discharge to 0.77</p>	<p>One explanation for results is decrease in competitiveness because of merger—not confirmed by data. Endogeneity concerns related to unknown or unobserved hospital-specific differences that bias estimates of effects across hospitals</p>

(continued)



Table 1. (continued)

Author; title, journal, & aim	Sample and setting	Variables & measures	Design & methods	Results & findings	Limits of study
Bolton et al. (2007), <i>Policy, Politics, &amp; Nursing Practice</i> Aim: To examine the impact of ratios on key measures of staffing and nursing quality	Convenience Sample of CA CALNOC Hospitals N = 252 units from 108 total hospitals including 67 matched hospitals for pre-post unit level of analysis Focus is adult medical surgical and step down units Matched medical surgical units from <ul style="list-style-type: none"> <li>pre-implementation January-June 2002</li> <li>post-implementation January-June, 2006</li> </ul>	Self-reported unit-level measures of <ul style="list-style-type: none"> <li>HPPD</li> <li>skill mix</li> <li>Ratios</li> <li>falls incidence</li> <li>Hospital acquired pressure ulcer (HAPU)</li> <li>restraint use</li> <li>prevalence</li> </ul>	Descriptive cohort design	Post-ratio—Significant changes in staffing noted in following outcomes: Productive HPPD increased significantly medical - surgical and step-down units RN-to-patient ratio decreased Percentage of LVNs decreased <ul style="list-style-type: none"> <li>5% increase in care provided by RNs on step down units.</li> </ul> No significant changes in falls; falls with injury; HAPU; and restraint prevalence. 11% increase in % care provided by RNs on medical - surgical units; 5% increase in step down units	Self-reported data from convenience sample; converging confounding historic factors impacting dependent variables Endogeneity concerns related to unknown or unobserved hospital-specific differences that bias estimates of effect across hospitals
Chapman et al. (2009), <i>Journal of Healthcare Management</i> Aim: To assess how CA hospitals responded to staffing ratios; to investigate how staffing and financial challenges were addressed by hospitals; to explore perceptions of how ratios impacted quality of patient care from hospital leadership perspective	N = 20 hospitals approached and 12 agreed to participate in onsite or telephone interviews with a total of 23 hospital leaders (chief executive officers, chief nursing officers, chief operating officers, department managers etc) Inclusion criteria focused on hospitals with either strong or weak financial position before implementation of ratios. Hospital level of findings. Pre-Post changes derived from respondent recall	Semistructured interviews with respondents recalling events, issues, perceptions and actions Criteria for the extent of their experience with ratios and impact are unknown	Qualitative design using single-level thematic analysis	Thematic analysis included anticipated themes as well as those emerging from interview data. Respondents reported <ul style="list-style-type: none"> <li>difficult and costly to hire RNs to meet ratios</li> <li>negative impacts include increase in ED wait</li> <li>no reported impact on patient care quality</li> <li>decrease in hiring ancillary staff and in hiring RNs</li> <li>decrease use of LVNs because of "limited scope of practice"</li> <li>concerns re: "at all times" requirement</li> </ul>	Convenience sample Rationale for identifying initial 20 hospitals not specified Few exemplars provided and those reported contained limited content. Access to interview content limited to brief descriptive narrative Timing of interviews post implementation of ratios is not known Unable to determine if respondents had continuous exposure to hospital operations as the basis for confirming the reliability of recall for determining pre-post impacts of ratios

(continued)

**Table 1. (continued)**

Author; title, journal, & aim	Sample and setting	Variables & measures	Design & methods	Results & findings	Limits of study
Cook (2009) Chapter 3, Dissertation Defense Manuscript, Carnegie Mellon University. (Unpublished) Aim: To use the AB 394 legislation to estimate the effect of increases in hospital nurse staffing on adverse patient health outcomes for general medical surgical cost/centers	Sample size unspecified, but includes all hospitals in CA who contribute data to OSHPD Medical Surgical units aggregated to hospital level of analysis pre-implementation used data from 2000 to 2001 Post-implementation used data from 2005 to 2008	OSHPD Hospital Disclosure Reports and Patient Discharge Abstracts Variables included • HPPD • Ratios • Failure to rescue • Decubitus ulcer • Infections due to medical care • Selected economic effects	Descriptive case series design	Focus on pre-ratios staffing noting compliance with ratios prior to implementation Post ratios • RN-to-Patient ratios declined • Increase in RN productive HPPD • Decrease in HPPD for aids and orderlies • No change in patient load based on number of discharges • No reduction in LOS • No significant effects on adverse event PSIs • Increase in annual hospital capital and labor costs Majority of pre-ratio noncompliant hospitals increased their staffing as did most previously compliant hospitals	Measurement error associated with use of large administrative databases Imprecision of staffing hours, resulting in over predicting direct care hours Approximation of ratio Unable to isolate units most affected by legislation because pre-ratios compliances did not predict degree of change post-ratios Endogeneity concerns related to unknown or unobserved hospital-specific differences that bias estimates of effects across hospitals Unmatched pre-post data sets and no consideration of hospital attrition 1999-2006
Donaldson et al. (2005), Policy, Politics, & Nursing Practice Aim: To examine the preliminary impacts of ratios on key measures of staffing and nursing quality	Convenience sample of CA CALNOC Hospitals N = 268 units from 162 hospitals including 68 matched hospitals for pre-post unit level of analysis Adult medical-surgical, step down and critical care unit level of analysis Matched medical surgical units from	Self-report, concurrent unit level measures of • HPPD • skill mix • RN/patient ratios • falls incidence • HAPU • restraint use prevalence	Descriptive cohort design	90% of units already in compliance to ratios prior to implementation 97% units staffed in compliance with ratios in first six months of 2004 Significant changes noted post-implementation: • Increased productive HPPD in medical-surgical and step-down units • RN-to-patient ratio decreased on medical surgical units	Self-reported data from convenience sample Converging confounding historic factors impacted dependent variables. Endogeneity concerns related to unknown or unobserved hospital-specific differences that bias estimates of effects across hospitals

(continued)

**Table 1. (continued)**

Author, title, journal, & aim	Sample and setting	Variables & measures	Design & methods	Results & findings	Limits of study
	<ul style="list-style-type: none"> <li>pre-implementation January-June 2002</li> <li>post-implementation January-June, 2004</li> </ul>			<ul style="list-style-type: none"> <li>11% increase in percent care provided by RNs on medical-surgical units; 5% increase in step down units</li> <li>% care provided by LVNs decreased.</li> </ul>	
<p>Mark, Harless, and Spetz, (2009). Health Affairs            Aim—To estimate short term changes in RN metropolitan (metro) wages after implementation of ratios</p>	<ul style="list-style-type: none"> <li>RN wages in CA metropolitan areas were analyzed using four large data sets:</li> <li>HRSA sample of RNs from 26 CA metropolitan (metro) areas and 330 non-CA metro areas (N = 10,382 for 2000 and N = 10,426 for 2004)</li> <li>Current Population Survey (CPS) of 21 CA metro areas and 206 non-CA metro areas (N ranged from 830 to 933 depending on year</li> <li>National Compensation Survey of 6 CA metro areas and 71 non-CA metro areas); data aggregated to metro level</li> <li>Occupational Employment Survey (OES) for 22 CA metro areas and 242 non CA metro areas); data aggregated to metro level</li> <li>California RN population level of analysis</li> </ul>	<ul style="list-style-type: none"> <li>RN wages at CA metro level analyzed by cohorts of nurses</li> <li>Other variables included productive hours and union affiliation</li> <li>Current Population Survey</li> <li>National Compensation Survey</li> <li>Occupational Employment Survey</li> </ul>	<ul style="list-style-type: none"> <li>Descriptive survey design</li> <li>“Difference in Difference” (DD) estimator used to eval impact of ratios on wages.</li> <li>Data subjected to a variety of analyses and conversions to allow for cross comparisons prior to including in analytic models</li> <li>Two analytic models used: Model 1 was a simple analysis; Model 2 incorporated measures of CA hospital market concentration</li> </ul>	<ul style="list-style-type: none"> <li>2000-2006 CA metro RNs real wage growth 12% more than metro RNs outside CA</li> <li>Estimates vary by data source</li> <li>Competing reasons for results presented by authors</li> </ul>	<ul style="list-style-type: none"> <li>All data from large national data sets with attendant limitations</li> <li>Quality of data varied by source</li> </ul>

(continued)



**Table 1. (continued)**

Author, title, journal, & aim	Sample and setting	Variables & measures	Design & methods	Results & findings	Limits of study
Mitchell (2008). Nursing Ratio: Before and After Assembly Bill 394. Unpublished Poster Presentation; California State University Fullerton, Sigma Theta Tau Spring Conference Aim: To explore the impact of mandated ratios on a single unit drawn from one hospital	1 hospital/1 unit Pre-implementation data from first quarter 2003 Post-implementation data from first quarter 2006	Voluntary turnover Reported falls Emergency resuscitation events Staffing ratios	Single case, pre-post descriptive design	Post-implementation showed nonsignificant 61% to 63% reduction in patient load based on nurse-to-patient ratio Pre-implementation reported 16 voluntary resignations from unit; post-implementation reported 0 Reported falls reduced by nearly 50% post-implementation Number of resuscitations doubled in post-implementation period RN productive HPPD increased by 30 min Registry RN productive HPPD increased by 30 min Increase in diagnostic radiology and respiratory therapy staff 9% increase in RN wages LVN and aid levels of staffing unchanged. Greater hospital size predicted an increase in mean RN productive hours per patient day 35% of hospitals staffing below ratios at baseline	Single case/single unit Sources of data varied; reliability and validity of data not reported No tests of significance Competing explanations for findings not considered
Serrat (2009) Staffing patterns before and after mandated nurse-to-patient ratios in California hospitals PhD Dissertation, University of California, San Francisco, School of Nursing, San Francisco, CA Aim: to identify and describe changes in RN and other staffing in hospitals related to AB 394	N = 273 Hospitals in California in CA OSHPD data set with complete data from pre- and post-implementation date ranges Pre-implementation data from 1999 to 2000 Post-implementation data from 2005 to 2006 Hospital level unit of analysis	Data source was California OSHPD Hospital/Annual Financial Disclosure Report Outcome variables include <ul style="list-style-type: none"> <li>Medical-surgical unit RN and registry RN productive HPPD</li> <li>Productive HPPD for other categories of patient care workers and ancillary staff</li> <li>RN wages computed from OSHPD data</li> </ul> Three measures of market characteristics Predictor Variables include <ul style="list-style-type: none"> <li>Size</li> <li>CMI</li> <li>LOS</li> <li>Occupancy rate</li> <li>Saidin Index</li> </ul>	Descriptive retrospective, secondary analysis with pre-post measures Hospitals matched in pre- and post-implementation data sets	Attrition of hospitals from OSHPD dataset (n = 69) from 1999 to 2006 Excluded smallest hospitals (n = 15) Computed staffing variables subject to limitations of quality of OSHPD data Converging confounding historic factors (ie. CMI) may have impacted dependent variables. Endogeneity concerns related to unknown or unobserved hospital-specific differences that bias estimates of effects across hospitals	

(continued)

Table 1. (continued)

Author, title, journal, & aim	Sample and setting	Variables & measures	Design & methods	Results & findings	Limits of study
Spetz (2008), Policy, Politics, & Nursing Aim: to examine whether nurses who worked in CA perceived improvements in working conditions, satisfaction with staffing, and job attributes between 2004 and 2006	RNs surveyed in 2004 (N = 5168) and 2006 (N = 5066) as part of CA Board of Registered Nursing work surveys; 2006 sample stratified by region to account for variability in distribution Hospital level analysis. Pre-2004 Post-2006	OSHDP Hospital Disclosure Report used to compute pre-2004 hospital staffing levels and productive hours Required hours of care per patient day Productive hours provided by nurses Shortfall hours (estimate of difference between pre-2004 staffing levels and legislated ratios) comparing required and actual hours of care provided	Descriptive longitudinal cross sectional survey design	Significant overall increase in RN satisfaction with many aspects of work environment 2004-2006 Significant increase in RN perception of adequacy of nursing staff and time for patient education Pre-ratios staffing levels not related to RN satisfaction Nonsignificant association between regional staffing and survey scores Nonsignificant association between satisfaction and extent of changes in staffing Increased RN employment Increased RN productive HPPD LVN and aid levels of staffing unchanged Hiring peaked in 2002 No change in rates of FTR; DVT and post op pneumonia or sepsis. Hospitals decreased operating margins Increase LOS in public hospitals Baseline level of staffing not associated with changes in staffing post ratios	Limitations of using OSHDP Hospital Disclosure Report to compute staffing variables. Unable to link survey respondents to hospitals. Both the results and conclusions limited by the content and methods used in the primary data sets
Spetz et al. (2009), California Healthcare Foundation Issue Brief (Nonpeer reviewed) Aim: to investigate strategies used by hospitals to meeting ratio staffing mandate; to examine association and hospital financial variables; to explore whether ratios improved patient care	N = 410 CA Hospitals in OSHPD dataset N = 244 Employers in California Employment Development Department (EDD) dataset 23 leaders in 12 hospitals for interviews Hospital level of analysis Impacts of ratios were traced 1999 to 2007	Quantitative data from OSHPD hospital disclosure report and OSHPD hospital discharge abstracts; CA EDD dataset used to capture changes in employment. AHRQ nursing sensitive metrics as clinical outcome variables • pressure ulcers • failure to rescue (FTR) • deep vein thrombosis (DVT) • Post op pneumonia • Post op sepsis. Qualitative data from interview with selected hospital leaders	Multimethod, exploratory and longitudinal descriptive	Attrition of hospitals from OSHPD dataset from 1999 to 2006 Unmatched pre-post analyses Data were abstracted retrospectively and unable to differentiate RNs from all hospital employees in EDD sample Multiple concurrent factors impacting hospital financial status Endogeneity concerns related to unknown or unobserved hospital-specific differences that bias estimates of effects across hospitals Qualitative analysis uses same sample and reports same results as Chapman, Spetz, Seago, Kaiser, Dower, & Herrera, 2009	

(continued)

**Table 1. (continued)**

Author, title, journal, & aim	Sample and setting	Variables & measures	Design & methods	Results & findings	Limits of study
Weichenhath & Hendey, (2009), Journal of Emergency Medicine Aim: to examine the association between nursing ratios and quality of care in one urban Calif. emergency department (ED)	One urban university teaching medical center ED in California with annual census ranging between 56,000 and 59,000 visits per year Pre-implementation data from calendar year 2003; post-implementation data from 2004	ED wait time Percent of patients who left without being seen (LWBS) Reported medication errors Percent of acute cardiac syndrome (ACS) patients receiving aspirin (ASA) while in the ED Time to first antibiotics for patients with pneumonia Data obtained from retrospective chart review and unit-based quality monitoring	Descriptive single case design conducted over 2 years	No change in number of full time equivalent nursing positions (includes all nursing positions, not just RNs) Pre-implementation range of 1 RN to from 3 to 8 patients depending on assignments; post-implementation ranged from 1 to 4 patients per RN Significant improvement in time to antibiotic administration in patients with pneumonia Increase in ED wait time Decrease in percent of patients who LWBS No change in ASA administration for patients with ACS or reported medication errors	Single case study of one ED in one hospital Reported on ED-specific outcomes only No widely accepted standardized operational definitions of chosen outcomes Reported medication errors subject to multiple sources of bias Accuracy of time interval metrics based on self-report

Note: AHRQ = Agency for Healthcare Research and Quality; CA = California; CALNOC = Collaborative Alliance for Nursing Outcomes (formerly known as CalNOC – California Nursing Outcomes Coalition); CMI = Case mix index; HAPU = Hospital acquired pressure ulcer(s); HPPD = Hours per patient day; HRSA = Health Resources and Services Administration; LOS = Length of stay; OSHPD = (California) Office of Statewide Health Planning and Development; PSIs = Patient safety indicators.

**Table 2.** Variables Examined in Literature Reviewed for Literature Synthesis

Structure measures	Process measures	Outcome measures	Workforce specific metrics	Hospital financial indicators
<p>Unit-based measures:</p> <ul style="list-style-type: none"> <li>• RN Hours of direct care per patient day</li> <li>• RN Productive hours of care per patient day</li> <li>• RN Registry hours of direct care per patient day</li> <li>• Skill mix</li> <li>• LVN/Aide direct hours per patient day</li> <li>• LVN/Aide productive hours per patient day</li> <li>• % Agency staff</li> <li>• Ratio RN-to-patient</li> <li>• Patient days</li> <li>• Patient census volume</li> </ul> <p>Hospital-level measures:</p> <ul style="list-style-type: none"> <li>• Patient volume (Discharges)</li> <li>• Hours of RN care per patient day</li> <li>• Hours of LVN/ aide care Per Patient Day</li> <li>• Ratio RN-to-patient</li> <li>• Skill Mix—% RN, LVN and others</li> <li>• Use of agency nurses</li> <li>• Ratio RN-to-patient</li> </ul>	<p>Emergency department-specific:</p> <ul style="list-style-type: none"> <li>• Wait time to be seen</li> <li>• Time to first dose antibiotic for pneumonia patients.</li> <li>• % Acute Cardiac Syndrome Patients who receive aspirin</li> <li>• Patients left without being seen (LWBS)</li> <li>• Reported medication errors</li> </ul> <p>Definitive Observation Unit Specific:</p> <ul style="list-style-type: none"> <li>• Emergency resuscitation</li> </ul>	<p>Unit-based outcomes:</p> <ul style="list-style-type: none"> <li>• Falls incidence</li> <li>• Falls with injury</li> <li>• % Prevalence hospital-acquired pressure ulcer (HAPU)</li> <li>• % Prevalence restraint use</li> </ul> <p>Hospital-level</p> <ul style="list-style-type: none"> <li>• length of stay</li> </ul> <p>ICD9 Hospital Outcomes:</p> <ul style="list-style-type: none"> <li>• Incidence failure to rescue</li> <li>• Incidence HAPU</li> <li>• Incidence hosp acquired infections</li> <li>• Incidence DVT</li> <li>• Incidence Post op pneumonia</li> <li>• Incidence post op sepsis</li> </ul>	<p>Unit-based measures</p> <ul style="list-style-type: none"> <li>• Full-time equivalent RN employees</li> </ul> <p>Hospital-level measures:</p> <ul style="list-style-type: none"> <li>• RN Voluntary turnover rate</li> <li>• Anticipated turnover</li> <li>• RN retention</li> <li>• Work satisfaction (IWS)</li> </ul> <p>Statewide Measures</p> <ul style="list-style-type: none"> <li>• RN employment</li> <li>• RN Wage Growth</li> <li>• RN Satisfaction with work environment</li> <li>• RN demographics</li> <li>• RN plans for emp.</li> </ul>	<p>Hospital-level measures:</p> <ul style="list-style-type: none"> <li>• Ownership/ concentration measures</li> <li>• Operating margin</li> <li>• Capital expenses</li> <li>• Labor costs</li> <li>• Gross charges</li> <li>• Net revenues</li> <li>• Revenue quality and source(s)—payer mix</li> <li>• Revenue per discharge</li> <li>• Seismic risk</li> <li>• Net revenue per discharge</li> <li>• Inpatient days/ discharges</li> <li>• Case mix index</li> <li>• Inpatient hospital prices</li> <li>• Urban/rural location</li> <li>• HMO penetration</li> <li>• Saidin and Herfindahl Indexes</li> </ul> <p>Statewide Measures—Aggregation of above measures, plus</p> <ul style="list-style-type: none"> <li>• Self-report gross annual earnings from National Sample Survey of RNs</li> <li>• Labor force participation and employment status census data</li> <li>• Weekly hours worked and wages (Self-report)</li> <li>• Employer report of hours and wages</li> </ul>

public datasets (Cook 2009; Spetz, 2008; Spetz, et al., 2009; Serratt, 2009). As a result, sample sizes varied from a single unit in one hospital (Mitchell, 2008; Weichenthal & Hendey, 2009), to a convenience sample of self-reporting, matched pre-post hospitals (Bolton et al., 2007; Donaldson et al., 2005) to every California hospital submitting data to the California OSHPD (Antwi et al., 2009; Cook 2009; Mark et al., 2009, p. 1431; Spetz et al., 2009). It is noteworthy that Serratt (2009), although using hospital level OSHPD administrative data, carefully matched pre-post datasets and noted the

challenge posed by the attrition of hospitals over time from baseline to post-ratio analysis.

### The Issue of Temporal Order

Any attempt to assess the impact of an “intervention” such as a legislative mandate must address the issue of timing related to pre- and post-implementation measures. With the passage of the AB 394 legislation in 1999, hospitals were put on notice that mandated ratios were on the horizon. The precision

**Table 3.** National Voluntary Consensus Standards for Nursing Sensitive Care: Performance Measure Set (National Quality Forum [NQF], 2009)

1. Death among surgical inpatients with treatable serious complications
2. Pressure ulcer prevalence
3. Patient falls
4. Falls with injury
5. Restraint prevalence (vest and limb)
6. Urinary catheter-associated urinary tract infection rate
7. Central line-associated bloodstream infection rate
8. Ventilator-associated pneumonia rate
9. Skill mix
10. Nursing care hours per patient day
11. Practice environmental scale—nursing work index
12. Voluntary turnover

of baseline measures clearly presented methodological concerns: We note that 4 studies ultimately included in the synthesis reported baseline data collection in 2003 ( $n = 3$ ) and 2004 ( $n = 1$ ), which although prior to implementation of the ratios mandate may have been confounded by the observed movement of hospitals toward the new staffing standard beginning in 2002. Taking this into account, several investigators began pre-ratio data collection in 2002, prior to this statistically observable anticipatory shift in staffing (Bolton et al., 2007; Cook, 2009; Donaldson et al., 2005; Serratt, 2009). In fact two studies, using large administrative data sets that included longitudinal historical data, traced changes in key variables from the 1990s through the implementation of the ratios (Antwi et al., 2009; Spetz et al., 2009). In contrast, other investigators tapped baseline measures 6 months prior to the 2004 required implementation (Armstrong, 2004; Mitchell, 2008), which may have biased findings since it is likely hospitals were already anticipatorily increasing their staffing, moving toward alignment with the mandated ratios.

Of similar methodological concern is the timing for measurement tapping the post-implementation effects of the mandated ratios. Donaldson et al. (2005) purposely measured early impacts and intentionally reported preliminary findings following the first 6 months of the Phase I implementation; Armstrong (Armstrong, 2004) also limited measurement to the first 4 months post-implementation. Tracing the cumulative impacts of Phase I and Phase II implementation, other investigators captured effects of the ratios from 2005 to 2008, essentially observing impacts accruing following complete implementation of the legislative mandated ratios. The timing of pre-post data capture may be a design factor in this particular body of literature that has not been fully appreciated.

### *Strengths and Limitations of the Evidence*

The research included in this synthesis arises from a natural experiment, and its baseline measures were limited to metrics

available, somewhat serendipitously, during the period prior to ratios implementation or to measures that could be constructed or computed from data available during the period prior to implementation. As a result, the 12 studies in this synthesis relied on descriptive case series designs and case study methods, which are considered by most typologies for evidence grading to be minimally robust (Agency for Health Care Research and Quality [AHRQ], 2002; Shapiro, 2010). Leveling this evidence, essentially drawn from a narrow methodological field, and discerning distinctions in research rigor and thus the strength of results, was particularly challenging. We therefore did not grade the strength of the evidence, noting that findings from this cluster of studies did not produce recommendations for practice or public policy that are broadly generalizable. That said, we propose that the body of evidence included in this synthesis reveals findings that are drawn from several well-designed studies and that the results within and between studies have the potential to contribute to informing public policy. The absence in this cluster of studies of designs typically considered more robust in managing confounding variables, such as quasi experiments, has been highlighted as a serious limitation of the larger stream of nursing sensitive outcomes research. This has been candidly discussed elsewhere (Bolton et al., 2007; Clarke & Donaldson, 2008; Cook, 2009; Serratt, 2009). As we also noted above, the timeline for premeasurement was confounded by anticipatory changes in staffing that occurred well in advance of the actual date for mandated compliance. Although noted and accounted by several investigators (Bolton et al., 2007; Donaldson et al., 2005), this resulted in a lack of precision of baseline measurement across studies.

In addition to the above considerations, a number of historical threats plausibly influenced the ability of investigators to tease out the effects of ratios or demonstrate statistically significant associations. For example, concurrent with the implementation of ratios in California, voluntary public reporting of a key outcome variable (hospital acquired pressure ulcers) was spreading statewide through the California Hospital Assessment and Report Taskforce (CHART). During this same period, “the patient safety revolution was gaining intensity, with hospitals concurrently engaged in dynamic and aggressive efforts to reduce adverse events” (Bolton et al., 2007, p. 247), many of which were measured by investigators in these studies.

Although limitations arising from the threats to measurement precision and aggregation across these studies must be acknowledged, the variation in measures and data sources noted earlier in this report may also be viewed as a strength of the literature. For example, although using very different pressure ulcer variables, neither Cook (2009) nor Bolton et al. (2007) found that the mandatory ratios reduced the incidence or prevalence of hospital acquired pressure ulcers, a current focal patient outcome measure for the Center for Medicare and Medicaid Services (National Quality Forum,



2004, No. 549; Federal Register, 2010). Likewise, although using disparate data sources, all investigators found that ratios did increase the hours of care RNs provided to patients and did achieve the stated legislative aim of reducing the number of patients assigned to each RN. These findings, although based on measures gleaned from different data sources, represents convergence of findings, validating the results across studies, and ultimately strengthening confidence in them.

It is also observed that financial variables used in studies in this synthesis were drawn from large public datasets and a majority of the metrics were computed from the same data source (California Office of Statewide Health Planning and Development, 2009) reducing measurement heterogeneity and reducing the potential for error across studies (Antwi et al., 2009; Cook, 2009; Serratt, 2009; Spetz et al., 2009). An intriguing limitation of the multisite studies included in this synthesis was raised by Cook (2009) who noted the threat of bias posed by endogeneity—the unknown and unobservable differences between hospitals that may exert an effect. Although Cook's related hypotheses were not affirmed, his explication of this issue must be acknowledged, noting that at least one study employed analytic methods to statistically address this issue (Bolton et al., 2007).

Another interesting limitation of this literature is the observation that investigators were generally, with the exception of Serratt (2009), not able to explicate a differential effect for ratios between hospitals that were compliant with the ratios prior to 2004 and those whose staffing varied significantly from the mandated ratios prior to implementation. One explanation for this may be findings from Bolton et al. (2007) and Serratt (2009), observing a high degree of Phase I ratio compliance at baseline (90%-65% respectively) that improved to nearly absolute compliance (97%-91% respectively) in the 2006 Phase II post-implementation period. Thus it is likely that outliers accounted for the most extreme variation in staffing ratios, and since the majority of hospitals were already operating near the mandated target, the gap between pre- and post-ratio staffing was quite narrow.

Finally, we believe certain contextual variables reported by investigators may be important to consider in interpreting study results. For example, one crucial finding noted by Antwi et al. (2009) was that the Case Mix Index (CMI), a common metric used as a proxy indicator for patient complexity and clinical acuity, increased in California during the time mandated staffing was implemented. While noting that this finding wasn't consistent across studies (Serratt, 2009), we posit that an unappreciated impact of California's mandated staffing ratios may be that patient care outcomes and adverse events measured across these studies did not worsen during this period, despite a possible increase in patient complexity and acuity that would have been expected to result in concomitant increases in adverse events associated with

patient acuity, for example, hospital acquired pressure ulcers, which are associated with greater patient acuity (Reed, Blegen, & Goode, 1998).

### **Impact of Mandated Minimum Ratios on Structure, Process, Outcomes, Quality, Safety, and Costs of Patient Care**

A summary of the impacts of ratios and related findings is presented in Table 4. The clearest and cleanest finding that can be gleaned from this synthesis is that the implementation of mandated minimum nurse-to-patient ratios achieved the policy aim of reducing the number of patients assigned per licensed nurse and increased the number of worked nursing hours per patient day in acute care hospitals, two key structural measures. The productive hours of direct patient care provided by RNs, the percentage of care provided by registered nurses, and the overall hours of patient care increased significantly. Every study that measured these variables ( $N=6$ ) consistently reported this finding. Two investigators also reported that the percentage of care provided by non-RN staff significantly decreased (Bolton et al., 2007; Donaldson et al., 2005).

Another consistent finding is that there were no significant impacts of these improved staffing measures on NQF measures of nursing quality and Agency for Health Care Research and Quality Patient Safety Indicators across hospitals, whether using concurrently collected unit level data (Bolton et al., 2007; Donaldson et al., 2005) or large administrative datasets (Cook, 2009; Spetz et al., 2009). However, based on the above discussion regarding possible increases in CMI, a critical observation may be that adverse outcomes did not increase despite the increasing patient severity reflected in CMI. We cautiously posit that this finding may actually suggest an impact of ratios in preventing adverse events in the presence of increased patient risk.

The impact of ratios on hospital financial performance has not been significant. Although Serratt (2009) reported a 9% increase in RN wages in her sample of 272 hospitals, and Mark et al. (2009) reported a significant increase in California RN wages among those working in metropolitan areas compared to RNs outside California, Antwi et al. (2009) and Cook (2009) concluded increases in labor costs observed could not be attributed to ratios alone and as they appeared associated with a generalized pattern of increasing capital expenses, operating expenditures, and rising hospital costs overall. Confounding factors that have affected the reported financial variables included the concurrent legislative mandate requiring substantial capital expenditures to retrofit California hospitals for seismic safety compliance. In addition, hospitals were confronting federally mandated investments in electronic record keeping systems related to patient privacy and data security.



**Table 4. Summary of Impacts of Ratios, Contextual Findings, and Other Findings**

Antwi, Gaynor and Voght (2009)	Armstrong (2004)	Bolton et al. (2007)	Chapman et al. (2009)	Cook (2009)	Donaldson et al. (2005)*	Mark, Harless, and Spetz (2009)	Mitchell (2008)	Serrat (2009)	Spetz (2008)	Spetz et al. (2009)	Weichenthal and Hendex (2009)
<p>↑ Inpatient prices except Medicare and MediCal</p> <p>↑ Capital expenditures</p> <p>↑ Operating expenditures per discharge</p> <p>↑ Labor expenditures/ per discharge</p> <p><b>Additional Findings</b></p> <p>↑ CMI and ↓ Intensity of Treatment</p>	<p>↑ RN Turnover</p> <p>↑ Anticipated Turnover Scale (ATS)</p> <p>Pre-ratios correlation between IWS and ATS sustained post ratios. 22% ATS is predicted by IWS; &gt;ATS assoc. with &gt;age of nurse</p>	<p>↑ RN PHPPD increased</p> <p>↓ RN to Pt. ratio</p> <p>↑ % RN</p> <p>↓ % LVN</p>	<p>"Difficult to hire RNs to meet ratios"</p> <p>"↑ ED wait time"</p> <p>"↓ Hiring LVNs; Ancillary Staff"</p> <p>"Concerns re: at all time requirement"</p>	<p>↑ RN PHPPD</p> <p>↓ RN to Pt. Ratio</p> <p>↑ Non-RN PHPPD</p> <p>↑ Hospital costs</p> <p>↑ Capital costs (expenditures)</p> <p>↑ Labor costs (expenditures)</p> <p><b>Additional findings</b></p> <p>Geographic and ownership factors impact variables</p>	<p>↑ RN PHPPD increased</p> <p>↓ RN-to-Patient ratio</p> <p>↑ % RN</p> <p>↓ % LVN</p> <p>* First 6 months post-ratios implementation</p>	<p>↑ RN wages in metropolitan areas &gt; 12% than RNs outside CA</p>	<p>↓ RN to Pt. Ratios</p> <p>↓ Resignations</p> <p>↓ Falls Incidence</p> <p>↑ Emergency Resuscitations</p>	<p>↑ RN PHPPD</p> <p>Medical-Surgical units</p> <p>↑ RN Registry PHPPD</p> <p>Medical-surgical units</p> <p>↑ % RN</p> <p>↑ % RN wages</p> <p>↑ PHPPD</p> <p>radiology and respiratory therapy staff</p> <p>Hospital size predicted &gt; ↑ in RN PHPPD</p> <p><b>Additional findings</b></p> <p>CMI Stable; ↓ LOS ↑ occupancy</p>	<p>↑ RN work environment satisfaction</p>	<p>↑ RN employment</p> <p>↑ RN HPPD</p> <p>↓ Hospital operating margin</p> <p>↑ LOS in public hospitals</p>	<p>↓ RN to Pt. Ratios in Ed</p> <p>↓ In time to administer first ABX with pneumonia in ED</p> <p>↑ Wait time in ED</p>
<p>No Changes Observed</p>	<p>No changes in Index Work Satisfaction (IWS)</p> <p>No assoc. between IWS and demographics</p>	<p>ns HAPU decreasing</p> <p>ns Restraint prevalence decreasing</p> <p>No change falls</p> <p>No change falls with injury</p>	<p>No impact on quality</p>	<p>No change pt. load</p> <p>No change LOS</p> <p>ns effect on FTR, decubitus ulcer; hospital acquired infection</p> <p>No change in number of discharges</p>	<p>No change HAPU, falls, restraint prevalence</p> <p>No change falls with injury</p>			<p>No change in LVN, aides; clerical staff hours.</p> <p>All other hospital factors studied not associated with changes in PHPPD</p>	<p>Pre-ratios staffing &amp; regional staffing NOT related to IWS</p> <p>NS impacts on FTR DVT Post Op Post op Sepsis</p>	<p>No change in nursing FTE in ED</p>	

Note: HPPD = Hours of care per patient day; ED = Emergency dept.; LOS = Length of stay; DVT = Deep vein thrombosis; CMI = Case mix index; ns = nonsignificant; ↑ = increased; ↓ = decreased; ABX = Antibiotics; FTE = Full time equivalent; FTR = Failure to rescue; Post op = After surgery; Intensity of treatment = No. of procedures performed per discharge.

### *Impact of Mandated Minimum Ratios on Nursing Workforce—RN Work Satisfaction and Voluntary Turnover*

Three studies explored the impact of ratios on job satisfaction and work environment perceptions of nurses, using different well established measures. Armstrong's 2004 single unit case study found no change in work satisfaction; however, Spetz's 2008 more robustly designed report of a large, convenience sample of nurse responses to the California Board of Registered Nursing Survey (2004, 2006) found significant improvement in RN perceived work environment and overall job satisfaction. Of note was that Spetz did not find an association between the pre-ratio regional hospital staffing patterns and post-ratios regional nurse perceptions of the work environment. Thus the degree of pre-implementation variance from mandated staffing ratios was not found to affect the nurses' post-ratios perceptions. More specifically Spetz et al. (2009) found that RNs reported increased satisfaction with nursing staff adequacy and time available to spend with patients post-ratio implementation, key factors in overall job satisfaction; and Armstrong (2004) found RN job satisfaction to be strongly related to anticipated turnover (which was found to be strongly associated with actual turnover). Interestingly, Armstrong found post-ratio increases in both anticipated and voluntary turnover, although the limitations of her single hospital case study design lends caution to these results. Mitchell (2008), another single unit case study, described a dramatic decrease in post-implementation resignations on her study unit.

### *Impact of the Ratios on Hospital Operations*

The ripple effect of mandated nurse-to-patient ratios on hospital operations was observed by several investigators. Weichenthal and Hendey (2009) in a single hospital case study, noted that patient-to-RN ratios in the emergency department (ED) were reduced, improving a key process measure, time to administration of first dose of antibiotic in pneumonia patients. However, this same investigator found increased wait times in the ED, a concern hospital leadership respondents voiced in qualitative interviews conducted by Chapman et al. (2009). Increased wait times in EDs may reflect the inherent operational need to control the flow of patients admitted through the ED to acute care beds given the requirement to adhere to mandated ratios *at all times*. Admitting a patient requires recalculating the nurse staffing equation on the unit, aligning patient acuities and needs with staffing, and adding staff as needed to meet regulatory requirements. As a result, Californians may find themselves in the ED waiting for an inpatient bed while the hospital calls in the additional nurse it needs to meet mandated minimum staffing.

Another operational impact of mandated RN-to-patient ratios is related to the reduction in use of licensed vocational

nurses and unlicensed assistive personnel, such as nursing aides and assistants, on medical-surgical units (Bolton et al., 2007; Chapman et al., 2009; Donaldson et al., 2005). Although this shift in skill mix increased RN hours of care, it is likely that it also reduced the opportunities for RNs to delegate appropriate tasks to ancillary personnel, limiting the availability of the RN for the higher level work of the professional nurse such as following up with providers to clarify questionable orders; responding to questions and concerns of patients, families, and health care team members; and completing discharge teaching and counseling (American Nurses Association, 2010).

Finally, AB 394 mandated minimum ratios institutionalized a "head count" for licensed direct care nurses at the bedside without regard for the unique needs of patients at various points in their hospitalization, for example, at admission, discharge, or transfer, and without regard for the competencies of the nurses providing care. Regulatory compliance is measured only in numbers, while the operational imperative of ensuring alignment of patient need and nurse capacity to meet those needs, although required by mandated patient acuity systems, is not standardized and likely varies within and between hospitals.

### *Impact of the Ratios on Additional Factors*

Studies included in this synthesis revealed little impact of mandated minimum RN staffing on other variables. For example, although it might have been reasonable to suspect that improved RN staffing could reduce hospital length of stay (LOS) because of greater availability of RN expertise in preparing patients for discharge, the one study that looked at LOS (Cook, 2009), found no such relationship.

## **Discussion and Recommendations for Further Study and Public Policy**

This synthesis reveals both the challenges of evaluating natural experiments arising from major public policy initiatives and the opportunities to learn from them. The synthesis did not find evidence of an expected effect of mandated minimum staffing ratios on clinical and specific nursing sensitive outcomes. Efforts by investigators to explore these possible relationships are important, given the robust body of work derived from cross-sectional studies of large data sets that reports just such relationships (Aiken et al., 2002; Hickam et al., 2003; Kane, Shamliyan, Mueller, Duval, & Wilt, 2007; Lang, Hodge, Olson, Romano, & Kravitz, 2004; Needleman 2002). It is important to consider the basis for these widely differing findings.

One possible reason why findings from this synthesis differ from those of other investigators may be the lack of variability in staffing levels. Even before minimum staffing levels were mandated, RN-to-patient ratios in California had

begun to migrate toward the mandated ratios, so by 2004, when Phase 1 was implemented, there was already little variation in staffing between medical surgical units, both within and between hospitals. This may have effectively eliminated the possibility of observing results similar to those of other investigators.

Before any state had mandated minimum nurse-to-patient ratios, some investigators used large data sets and statistical modeling to predict that mandatory nurse-patient ratios, such as those adopted in California, would significantly affect nursing sensitive indicators, such as failure to rescue, RN turnover and RN job satisfaction (Aiken, et al., 2002, p. 1992). Taking advantage of the natural experiment that is the California mandatory nurse-patient ratio law, studies included in this synthesis report actual changes in nursing sensitive outcomes beginning before mandatory ratios were implemented, during the transition period, and for several years after the mandated ratios were in place. By tracking both the structural variables, for example, hours of nursing care per patient day, percent RN staff, and so on, concurrently with nursing sensitive outcome variables on the same units and in the same hospitals over time, these studies paint a different picture from the view arising from cross sectional study designs, while they affirm selected predictions, for example, predicted improvements in RN work satisfaction.

One of the criticisms of mandated minimum nurse-to-patient ratios is the issue of equating numbers of nurses with the “dose” or adequacy of nursing care. We posit that issues of nurse competency as reflected by assessment validity and intervention fidelity are just a few of the unexplored factors that may be determinants of outcomes. The concept of “nursing dose,” a yet-to-be explicated measure of the quantity and quality of nursing care that captures the content of nursing interventions as well as the frequency, is not considered at all in the head count approach to staffing represented by mandated nurse-to-patient ratios.

Finally, it is important for future public policy initiatives intended to improve health care costs, quality and outcomes to integrate explicit evaluation methods a priori into regulations. This can be done by incentivizing and enabling stakeholders to evaluate the impacts of patient care delivery mandates. This synthesis revealed significant difficulties in measuring and evaluating the impacts of the California legislation when implementation occurred prior to establishing the metrics of effectiveness and prior to collecting baseline data. For example, emerging from a cluster of other state-based legislative activities related to nurse staffing in hospitals, legislators in Washington (HB 3123) and Oregon (HB 2800), after considering the option of mandated ratios, adopted an alternative approach which engages direct care staff in systematically analyzing microsystem level nurse staffing effectiveness and adopting staffing patterns that optimize the effectiveness of variable and customized ratios.

This unit specific approach to addressing concerns about staffing adequacy in hospitals integrates the aim of mandated ratios with the requirement for staffing effectiveness accountability and transparency. We are hopeful that a systematic evaluation of the Oregon and Washington legislative initiatives will be forthcoming.

### *Validity of the Synthesis Narrative*

To ensure the validity of this synthesis, we asked two independent experts to review and affirm that all relevant research has been considered for inclusion and that the evidence tables represented reliable extraction of the empirical elements. Feedback from this validation process was used to further strengthen and finalize this literature synthesis.

## **Appendix**

### *Literature Search Strategy*

The following MeSH terms were used to search PubMed:

- Accidental falls
- California
- Health care costs
- Hospital mortality
- Hospitals/manpower
- Job satisfaction
- Mandatory Programs/legislation & jurisprudence, Nurses, Nursing Staff, Hospital/ legislation & jurisprudence/supply & distribution, Outcome Assessment (Health Care), Patient Satisfaction, Personnel, Staffing and Scheduling, Legislation & Jurisprudence, Pressure Ulcer, Quality Assurance, Health Care Quality Indicators, Health Care Safety, Salaries and Fringe Benefits, Workload

The following CINAHL Headings were used to search CINAHL:

- Accidental falls
- California
- Health care costs
- Hospital mortality
- Hospitals/administration
- Job satisfaction
- Nurse-patient ratio, legislation & jurisprudence, California, nurses, nursing outcomes, nursing staff, hospital outcomes, (health care)-California, patient safety, patient satisfaction, personnel Retention, personnel staffing and scheduling, legislation & jurisprudence, personnel turnover, pressure ulcer, quality of health care, quality of nursing care, registered nurses salaries and fringe benefits, workload

The following web sites were searched for relevant grey literature:

California Hospital Association  
 California HealthCare Foundation  
 Kaiser Family Foundation  
 California Nurses Association  
 American Nurses Association  
 National Database for Nursing Quality Indicator

The following keywords were used to search PubMed, CINAHL, Web of Science, Scopus, and Google.

affect, California, effect, falls, job satisfaction, hospital, impact, legislation, law, mandatory nurse ratio, mandated nurse ratio, mortality, minimum nurse-to-patient ratio, minimum nurse staffing legislation, minimum nurse staffing regulation, nurse-patient ratio, nurse satisfaction", outcome, patient care, patient outcome, pressure ulcer, registered nurse (RN), regulation, salary, patient safety, workload.

Note: Scopus allows simultaneously search of databases and web sites.

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## Bios

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## Errata

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In this article, Dr. Shapiro's credentials were listed incorrectly in the article byline. She should have been listed as Susan Shapiro, PhD, RN.

On p.188 of the same article, in the column labeled "Results and Findings," the words "11% increase in % care provided by RNs on medical surgical units; 5% increase in step down units" were included in error.

In the same article, the following acknowledgments were inadvertently omitted:

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*PPNP* regrets the errors.