Nurse Staffing – A Summary of Current Research, Opinion and Policy

A report of the Ruckelshaus Center Nurse Staffing Steering Committee (State of Washington)

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The Nurse Staffing Steering Committee is composed of the Northwest Organization of Nurse Executives; SEIU Healthcare, 1199 NW; United Staff Nurses Union, Local 141, UFCW; the Washington State Hospital Association (WSHA); and the Washington State Nurses Association. The William D. Ruckelshaus Center, a joint service of the University of Washington and Washington State University for assisting with complex state level policy issues, has convened the parties and facilitated the work of the Nurse Staffing Steering Committee. www.ruckelshauscenter.wsu.edu

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Executive Summary

This paper was commissioned by the Nurse Staffing Steering Committee of the William D. Ruckelshaus Center, which is comprised of representatives of the Northwest Organization of Nurse Executives; SEIU Healthcare 1199 NW; United Staff Nurses, UFCW 141; the Washington State Hospital Association; and the Washington State Nurses Association.

In 2008, these organizations worked collaboratively for the successful passage of the Safe Nurse Staffing Legislation (Substitute House Bill 3123). The new law required each hospital, by September 1, 2008, to establish, where they do not exist, a nurse staffing committee with staff nurses composing at least half of the committee. This committee is charged with the development of unit and shift specific nurse staffing plans based on specific criteria and requires hospitals to post the staffing plan information in the hospital.

Additionally, the parties signed a memorandum of agreement to work together to address issues of nurse staffing and other nursing care issues in relation to implementation of Substitute House Bill 3123. The agreement requires collection of five nurse sensitive quality indicators from Washington hospitals, collection of nurse staffing committee information, modification of the state's adverse events form to include nurse staffing information, an immediate staffing alert pilot project, and continued dialogue among the participating organizations on nurse staffing issues. The steering committee's work is facilitated by the William D. Ruckelshaus Center of Washington State University and the University of Washington.

The purpose of this paper is to summarize the various schools of thought in research, policy, and current practice regarding nurse staffing and related issues of patient safety and outcomes, impact on quality of work life for nurses, and impact on hospital management and finances. We present current research, surveyed opinion, and prevailing policy views concerning the issues and approaches to hospital nurse staffing in the United States, and have summarized the applicability of some descriptions of current practices of interest.

The current concerns about the impact of nurse staffing on quality of care and patient safety stem from a convergence of recurring nursing shortages, cost-containment measures in the 1990s, and the upswing of public concerns about patient safety in the

wake of the Institute of Medicine's series on the Quality Chasm. This literature asks four questions pertinent to this paper:

(1) Does staffing matter -- is there a consistent relationship between higher ratios of patients to nurses (or fewer hours of direct nursing care per patient day) and adverse patient outcomes?
(2) Do changes to nurse staffing improve patient care outcomes?
(3) How does staffing matter -- what might account for this relationship? Are there other organizational and clinical structures or processes that logically link the numbers of nurses and the outcomes of patient?
(4) What are the financial implications of various levels of nurse staffing?

Current systematic reviews point to a strong and consistent relationship between nurse staffing and specific adverse events, particularly in intensive care units and with surgical patients. Hospital acquired infections, urinary tract infections, blood stream infections, pneumonia, falls, medication errors, pressure ulcers, and longer than expected stays have been associated with poorer staffing (more patients per nurse or fewer hours of nursing care per patient day) in more than one study. However, the influence of organizational and other variables that mediate these relationships is still not clearly delineated, nor is there much data regarding *changes* in outcomes with *changes* in staffing or care delivery models. A different body of research suggests that some of these intermediate variables include work environment, type and quality of equipment, individual nurse experience, competency and education, clinical and organizational processes of care, and ability to communicate with team members.

The research is clear that having fewer patients per nurse or more direct nursing care hours per patient day is associated with fewer adverse outcomes, in particular mortality, failure to rescue and some specific adverse events, particularly among surgical patients. This association is no longer in dispute. There is, however, limited research to guide understanding of *how* to improve nurse staffing to reduce nursing workload and adverse patient outcomes. Health services researchers indicate an urgent need to examine facility level strategies to improve staffing and relate those efforts to both patient and organizational outcomes. In addition, evaluation of regulated strategies such as mandated nurse-patient ratios is needed. There is an equally urgent need for health care facilities to be conducting systematic and regular evaluations of the impact of staffing plans and models of care that are in place or about to be implemented. Just as clinicians are expected to be practicing evidence based care, health care organizations should be using the available research to practice evidence-based management.

This should not be read as a message of "more research is necessary before new attempts are made to improve the impact of staffing plans and policies on nurses and patients," but as a message regarding interesting variables and tools that can be used to improve the results of staff planning, as well as important variables to measure. Further, recognizing the lack of such data and analysis in the present literature, these gaps suggests the value of measurement in assessing and learning from what is attempted in this important area.

The literature points to important variables that need to be measured and compared continuously in order to determine the effectiveness of any staffing plan. These include skill mix, patient acuity, nurse outcomes such as satisfaction and turnover, and patient outcomes such as mortality, pressure sore prevalence and falls incidence. The steering committee's plan to collect some of these data before and after implementation will serve all parties well in evaluating the impact of the plans.

Many strategies are being used throughout the country to improve staffing and create innovative care delivery models. To date, few have included robust evaluation of the effects. Washington has the opportunity to evaluate the impact of particular innovations used at any given hospital, the extent of staff nurse involvement in the development of staffing plans, and to compare outcomes. For example, within the steering committee's mandate, the state-wide measurement of nurse sensitive quality indicators has the potential to contribute to the existing body of research; the pilot project on staffing alerts may also result in useful findings; and work in both areas offers pre- and post-intervention data.

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This paper was commissioned by the Steering Committee comprised of representatives of the Northwest Organization of Nurse Executives, SEIU Healthcare 1199 NW, United Staff Nurses UFCW 141, the Washington State Hospital Association, and the Washington State Nurses Association, who signed a memorandum of agreement to work together to address issues of nurse staffing and other nursing care issues in relation to implementation of SHB 3123. This law requires the establishment, where they do not exist, of hospital level committees to produce and review staffing plans. The Steering Committee's work is facilitated by the William D. Ruckelshaus Center of Washington State University and the University of Washington.

The purpose of the paper is to summarize the various schools of thought in research, policy, and current practice regarding nurse staffing and related issues of patient safety and outcomes, impact on quality of work life for nurses, and impact on hospital management and finances. We present current research, surveyed opinion and prevailing policy views concerning the issues and approaches to hospital nurse staffing in the United States and other industrialized countries as applicable. We also summarize some current care delivery practices of interest.

Primarily, the paper describes the research about the impact of nurse staffing and related variables, such as skill mix, nurse outcomes such as satisfaction and turnover, and patient care outcomes. The paper also provides a summary of existing views on the issues of nurse staffing in hospitals from the perspectives of various stakeholders groups, accrediting agencies and other authorities, existing arguments and controversies, and existing ideas and policies in use or under consideration for achieving effective nurse staffing.

In accord with the initial work plan of the Steering Committee, this paper serves as a product, but also as a process, to generate a common base of understanding not only of the views of outside experts, but also to help the steering committee members understand more clearly each other's specific views and concerns. The ongoing research will allow research on academic and policy views of the issues in response to the questions and concerns of committee members.

Nurse Staffing and Patient Safety

The current concerns about the impact of nurse staffing on quality and patient safety stem from a convergence of recurring nursing shortages, cost-containment measures in the 1990s and the upswing of public concerns about patient safety in the wake of the Institute of Medicine's series on patient safety and quality. There has been data linking the

organization of nursing care to patient mortality and morbidity since 1855 when Florence Nightingale documented a huge reduction in mortality in the Crimea following the introduction of trained nurses into military hospitals (Goldie 1987). A comparison of death rates under varying nurse-patient ratios as long ago as 1935 suggested that having fewer patients per nurse, presumably in post-anesthesia recovery, greatly reduced the postoperative death rate (Mac-Eachern 1935, p.384). Citations regarding optimal nurse-patient ratios appear in the US and Canadian literature in the 1930s and 1940s (1938; Hall 1945).

However, a large body of sound research has accumulated only in the past 20 years. The following summary of that body of research is organized around four questions that have been asked in that literature:

1) Does staffing matter: Is there a consistent relationship between higher ratios of patients to nurses (or fewer hours of direct nursing care per patient day) and poor patient outcomes?
2) Do changes to nurse staffing improve patient care outcomes?
3) How does staffing matter: What do we think accounts for the relationships? Are there other organizational and clinical structures or processes that logically link the numbers of nurses and the outcomes of patient?
4) What are the financial implications of various levels of nurse staffing?

Methods of Systematic Review

We began the search for relevant information in the same manner that one would approach a systematic review of research literature. However, because the information identifying issues and current policy thinking goes beyond formal research studies, we broadened the search strategy to include opinion research and surveys, websites, newsletters and other accessible documents of key stakeholders as well as interviews of key informants. Within the thousands of citations from the keywords “nurse staffing” we found two excellent, recent systematic reviews of the research linking nurse staffing to patient outcomes covering 1980-2003, United States (US) only (Lang, Hodge et al. 2004) and US & Canada, 1990-2007 (Kane, Shamliyan et al. 2007; Kane, Shamliyan et al. 2007). We therefore concentrated our focused retrieval on the literature published since those reviews, using the search terms “nurse staffing,” “nurse staffing and quality of health care,” “medical-surgical units and nurse staffing.” These were limited to English, but not to the United States. We also used a selected review commissioned by the Washington State Nurses Association (Washington State Nurses Association 2007), did hand searches of links to papers cited in the reviews or primary papers, interviewed experts in the field via teleconference, and outlined relevant summaries of those perspectives.

Does staffing matter: Is there a consistent relationship between higher ratios of patients to nurses (or fewer hours of direct nursing care per patient day) and adverse patient outcomes?

The renewed interest in the relationship of nurse staffing to patient and nurse outcomes stemmed from two societal forces in the 1990s. The first was the growing concern among nurses that the cost-containment strategies of the 1990s were falling disproportionately on nursing staff, as the largest component of hospital workers (Norrish and Rundall 2001). A series of commentators including journalist Suzanne Gordon and nurse economist Peter Buerhaus outline the impact of cost-cutting strategies (often called re-engineering or redesign) in the 1990's on the work of nursing and the nursing profession here and in other industrialized countries (Norrish and Rundall 2001; Gordon, Buchanan et al. 2008; Buerhaus, Staiger et al. 2009). The emphasis on managing costs by reducing length of stay, eliminating nursing positions, and consolidating middle management positions led to intensification of the nursing workload, while simultaneously reducing the supports available to nurses. All this while patient acuity (indexed by case mix) was rising (Weinstein et al, 1999). Gordon and colleagues note the parallels between the cost-containment strategies and impact in California, USA and Victoria, Australia (Gordon, Buchanan et al. 2008). Norrish and Rundall, writing contemporaneously with these redesign strategies noted the serious damage done to trust between staff nurses and nursing and hospital management (Norrish and Rundall 2001).

The second societal force was the release of the Institute of Medicine's *Crossing the Quality Chasm* series on quality of care (Berwick 2002). The first report in this series startled the public and health professionals by highlighting the large number of deaths attributed to medical error in hospitals (Kohn, Corrigan et al. 2000). Aiken and colleagues built on the public health professionals' awareness of the safety issues involved in nurse staffing as well as attempting to model possible impact of the proposed California nurse-patient ratios. Their landmark study analyzed 1999 data on surgical patients from 168 Pennsylvania hospitals, linked to surveys of nurses in Pennsylvania. They found, after appropriate adjustments for patient and hospital characteristics, that the odds of dying increased by 7% for each additional patient in a nurse's workload. Further, each additional patient increased the odds of emotional exhaustion (burnout) in nursing staff (Aiken, Clarke et al. 2002b). Because this was a cross-sectional study (data taken at one point in time), it was not possible to determine if changing the nurse-patient ratio would increase or decrease the likelihood of a surgical patient's death, nor was there any way to know if these findings would be true in other states.

A substantial number of studies followed the Pennsylvania analysis, ultimately resulting in 96 such studies reviewed in an Agency for Healthcare Research and Quality (AHRQ) evidence report that concluded: "Higher registered nurse staffing was associated with less hospital-related mortality, failure to rescue, cardiac arrest, hospital acquired pneumonia, and other adverse events. The effect of increased registered nurse staffing on patients safety was strong and consistent in intensive care units and in surgical patients" (Kane, Shamliyan et al. 2007a, p.v).

Surveys of Nurses' Perceptions Regarding Staffing and Quality of Care

Nurses were voicing their concerns about the impact of redesign and re-engineering on their work from the beginning of these cost-containment efforts. Anecdotal reports of

nurses' concerns about rising ratios of patients to nurses, substitution of unlicensed personnel and the impact on patient welfare, as well as their own were captured systematically in several surveys, beginning in 1996 (Shindul-Rothschild, Berry et al. 1996). Staff perceptions of reduced quality of care and increased workplace dissatisfaction were captured both nationally and internationally, with US nurses being the most dissatisfied with their working environment. Aiken and international colleagues have compared staff nurses' reports of hospital staffing, organization and quality of care across the US, Canada, England, Scotland and New Zealand (Aiken, Clarke et al. 2002a). The initial surveys reported on over 10,000 nurses from 303 hospitals in the U.S. (Pennsylvania), Canada (Ontario and British Columbia), England, and Scotland. Those in the US reported the most quality of care problems with 20.8% of the Pennsylvania nurses rating the quality of care on their units as fair or poor, compared to 14.4% of the nurses from Ontario and 15.5% of the nurses from British Columbia, 16.2% of the nurses from England and 11.4% of the nurses from Scotland (Aiken, Clarke et al. 2002a). When the International Hospital Outcomes Study was replicated in 2001 in New Zealand, which has undergone hospital restructuring in the past 12 years, results were similar to those in the other countries. However, New Zealand nurses reported the highest levels of job stress and intent to leave nursing of all 6 countries (Finlayson, Aiken et al. 2007).

Rafferty expanded analysis of data from the English cohort in the International Hospital Outcomes study and linked patient outcomes to nurses' reports of quality and staffing. They found that: "patients and nurses in the quartile of hospitals with the most favourable staffing levels (the lowest patient-to-nurse ratios) had consistently better outcomes than those in hospitals with less favourable staffing." Mortality was 26% higher in those hospitals in the quartile with the highest patient to nurse ratios. Further, those nurses were twice as likely to report job dissatisfaction, high burnout levels, and to report low quality of care (Rafferty, Clarke et al. 2007).

US surveys over the period 2002-2006 showed an increasing number of respondents perceiving that demand for nursing care exceeded supply. These respondents believed that the ongoing nursing shortage caused delays in care, increased patient complaints, and interfered with staff communication. Sixty percent or more felt the shortages of staff adversely affected early detection of complications, the ability of nurses to maintain patient safety, quality of patient care, quality of nurses' work life, and the time nurses can spend with patients. The percent of nurses endorsing these negative factors declined from 2004 to 2006 but were still above 60% (Buerhaus, Donelan et al. 2007a). Comparative surveys in 2004 and 2005 showed areas in which staff nurses and chief nursing officers shared common perceptions that were not shared by physicians and hospital chief executive officers. These areas are issues of patient safety and the quality of nurses' work environment. The majority of staff nurses and CNOs surveyed were highly concerned about the staff shortages with respect to the early detection of patient complications and nurses' ability to maintain patient safety. The majority of surveyed physicians and CEOs did not share this perceived concern (Buerhaus, Donelan et al. 2007b).

Several observers commented that the ongoing shortages of registered nurses, restructuring of work to reduce costs and lack of staff nurse input into their working

conditions led to the call for mandated regulation of staffing to protect both patients and nurses (Gordon, Buchanan et al. 2008; Buerhaus, Staiger et al. 2009). As Norrish and Rundell put it:

> When reducing hospital costs became the underlying purpose of hospital restructuring, conflicts between nurses and managers increased greatly. The conflicts often centered on a reduction of hospital nursing positions and on many of the nursing work issues discussed in this article. In many hospitals, as each side challenged the motives of the other—including their commitment to patient care—interpersonal trust diminished along with individuals' trust in the institution (Norrish and Rundall 2001).

Surveys of Patients Perceptions Regarding Staffing and Quality of Care

Despite many years of research creating patient satisfaction surveys, there has been very little research that has attempted to link patient satisfaction with care and nurse staffing. In the 1980's Hinshaw and colleagues measured patient satisfaction with nursing care as one of several outcomes in evaluating a shift to all RN staffing in an Arizona university medical center hospital. They found that patient satisfaction increased with regard to overall trust in nurses, and satisfaction with patient education, while remaining stable for satisfaction with technical care (Hinshaw, Scofield et al. 1981).

No further studies were found until the year 2000, when concerns about nursing shortage and the effects of reduced nurse staffing on patient outcomes prompted Burnes-Bolton and colleagues to examine staffing data from the California Nursing Outcomes Database (CALNOC), linked with a statewide database reporting patient experiences, derived from the Picker Institute survey (PEP-C). Data from 40 hospitals that had both CALNOC and PEP-C data for the period August-October 2000 were analyzed. All together these data comprised 6200 medical-surgical patients. Lower nursing hours per patient day were significantly associated with a higher percentage of patient reporting problems in the dimension of respect for patient preferences, values and expressed needs. However, there was no clear point of staffing at which the negative patient perceptions emerged (Bolton, Aydin et al. 2003).

In contrast, a recent Finnish study of four university hospitals showed a clear 'cut-point' at eight patients per RN when the overall satisfaction decreased (Tervo-Heikkinen, Kvist et al. 2008). The ratio of eight patients per nurse in the Finnish study was higher than any reported in the above referenced California study.

A nationwide study, using the Press Ganey patient satisfaction instrument, compared state performance in patient satisfaction with the state's supply of registered nurses. This study did not link the data from 827,430 patients and 733 hospitals in 25 states with actual nurse staffing in those states, but rather used data from the Department of Health and Human Services national survey sample of nurses to infer nursing availability for staffing. Interestingly, patients' positive evaluations of their care experience were

significantly related to the supply of RNs in the hospital's state (Clark, Leddy et al. 2007).

Vahey and colleagues demonstrated a strong relationship between high patient satisfaction, nurse perception of adequate staff, good administrative support for nursing care, and good relations between doctors and nurses. Higher self-reported nurse burnout was also associated with lower patient satisfaction. These data were reported in a 1991 national study of 20 hospitals with medical-surgical units or specialized units with AIDS patients (Vahey, Aiken et al. 2004).

Most recently, July 2006 through June 2007 data from the Hospital Consumer Assessment of Healthcare Providers and Systems (HCAPS) from 2429 U.S. hospitals were linked with hospital quality indicators, including nurse staffing. Patient satisfaction was significantly greater in hospitals in the highest quartiles of clinical process quality indicators, and in hospitals with higher ratio of nurses to patient days (calculated as number FTE nurses/1000 patient days). The biggest differences between lowest and highest quartiles in patient ratings was noted in communications with nurses around pain control, medications and discharge instructions, suggesting that the interpersonal component of nursing care is a key factors in the relationship of staffing levels and patient perception of quality (Jha, Orav et al. 2008).

Systematic Reviews of Cross-Sectional Studies of Nurse Staffing and Patient Outcomes

Systematic reviews of research on the topic are superior to the more casual reviews of literature that may be selective of studies that support a particular point of view or review only the most immediately accessible citations. True systematic reviews thoroughly search not only the published literature, but also dissertations, unpublished reports and the like. The authors also have a set of criteria against which they compare the retrieved citations. The 1996 IOM report regarding nurse staffing was initiated from concerns about the impact of the cost-containment efforts outlined earlier. This semi-systematic review concluded that there was insufficient evidence to link nurse staffing to adverse outcomes in hospitals (Wunderlich, Sloan et al. 1996). More recent formal systematic reviews have moved from this earlier inconclusive evidence to finding 'probable' relationships for some outcomes (Lang, Hodge et al. 2004) to endorsing strong and consistent relationship between nurse staffing and specific adverse events, particularly in intensive care units and with surgical patients (Kane, Shamliyan et al. 2007a). The 1996 IOM report set the stage for the burgeoning research on nursing staffing by recommending "scientifically sound research on the relationships between quality of care and nurse staffing levels and mix, taking into account organizational variables" (Wunderlich, Sloan et al. 1996, p. 17).

The two most recent systematic reviews were helpful in narrowing the studies we reviewed independently. Together, these reviews covered the period 1980-2006, for research conducted in the United States and Canada. The earlier review by Lang, et al (Lang, Hodge et al. 2004) was focused on determining if there was sufficient research literature to support setting specific nurse-patient ratios in acute care hospitals. The

specific research question asked was "whether variations in nurse staffing levels were associated with differences in patient outcomes; in outcomes related to nurses in their role as employees, such as retention or job-related stress; and in hospital outcomes, such as length of stay" (Lang, Hodge et al. 2004, p.327).

A medical reference librarian searched the MEDLINE, CINAHL, Web of Science, and ABI/Inform databases. Search terms were not specified in the publication. Citations that met the criteria of research describing the methods of data collection and analysis, conducted in acute care, rehabilitation or psychiatric hospitals in the US, and examining the variables of interest were retrieved. They retrieved 2897 titles and abstracts, resulting in review of 490 articles. Forty-three met the inclusion criteria. The majority of studies used data at the hospital level, which tends to mix the ICU richer staffing with the leaner staffing for the rest of acute care. They noted only one study that addressed minimum nurse staffing ratios. This was the Aiken study cited earlier (Aiken, Clarke et al. 2002b), in which statistical regression models were used to extrapolate what the rate of death would be at different nurse patient ratios. Overall, the authors of the 2004 review conclude that: "evidence suggests that richer nurse staffing is associated with lower failure-to-rescue" (Lang, Hodge et al. 2004, p.326).

The strongest evidence for probable relationships of richer nurse staffing with outcomes existed for:

(1) lower failure to rescue rates among surgical patients
(2) lower inpatient mortality rates in many but not all instances
(3) shorter hospital stays for medical patients (Lang, Hodge et al. 2004, p. 335).

At the time of the above referenced review, the authors concluded there was limited evidence to support probable relationships between fewer patients per nurse and (1) lower rates of needlestick injuries and (2) lower rates of nurse burnout. The evidence was neutral (neither confirmed nor ruled out) regarding relationships with pneumonia and urinary tract infections. At that time the review did not support relationships between nurse staffing and the incidence of pressure ulcers, patient falls, nosocomial infections, and nursing documentation (Lang, Hodge et al. 2004, p.355). The authors further concluded there was minimal support for *specific* minimum nurse-patient ratios for nursing units, because there was only one study that actually addressed ratios. They identified the following variables as important in further research and in institutional attempts to identify optimal staffing models: patient acuity, skill mix (of nursing personnel), nurse competence, nursing process variables, technological sophistication, and institutional support of nursing.

The most recent systematic review was conducted by the Minnesota Evidence-based Practice Center on behalf of the Agency for Healthcare Research and Quality (AHRQ). This report was released in March 2007 (Kane, Shamliyan et al. 2007a). The objective was to "assess how nurse to patient ratios and nurse work hours were associated with patient outcomes in acute care hospitals, factors that influence nurse staffing policies, and nurse staffing strategies that improved patient outcomes." Data sources were more extensive than in the previously cited systematic review and included MEDLINE®

(PubMed®), CINAHL, Cochrane Databases, EBSCO research database, BioMed Central, Federal reports, National Database of Nursing Quality Indicators, National Center for Workforce Analysis, American Nurses Association, American Academy of Nurse Practitioners, and Digital Dissertations. The search terms were included in Appendix A of the full report. Out of 2858 citations, they identified 94 eligible studies presented in 96 reports; 7 percent were case control studies; 3 percent were case series; 44 percent were cross sectional studies; 46 percent evaluated the association between nurse staffing and patient outcomes.

As in the earlier review, observational studies were reviewed to examine the relationship between nurse staffing and outcomes. *They did not find any controlled trials testing variations in staffing and outcomes.* This group also conducted meta-analyses to test the consistency of the association between nurse staffing and patient outcomes with various types of patients and various hospital characteristics (Kane, Shamliyan et al. 2007a).

This study confirmed the findings of prior studies and reviews as follows:

- Higher registered nurse staffing (fewer patients per nurse) was associated with less:
    - hospital-related mortality,
    - failure to rescue, cardiac arrest,
    - hospital acquired pneumonia, and
    - other adverse events.
- The effect of increased registered nurse staffing on patients safety was strong and consistent in intensive care units and in surgical patients.
- Greater registered nurse hours spent on direct patient care were associated with decreased risk of hospital-related death and shorter lengths of stay.
- Limited evidence suggested that the higher proportion of registered nurses with BSN degrees was associated with lower mortality and failure to rescue.
- More overtime hours were associated with an increase in hospital related mortality, nosocomial infections, shock, and bloodstream infections.
- No studies directly examined the factors that influence nurse staffing policy (Kane, Shamliyan et al. 2007, p. v).

They recommended for future research that data be collected about the potential intermediate factors that affect both the nurse staffing and the outcomes of interest. These would include concomitant medical care, patient characteristics, and organization of nursing units and staffs.

The results of this systematic review are available as the full report on the AHRQ website: http://www.ahrq.gov/downloads/pub/evidence/pdf/nursestaff/nursestaff.pdf as well as a condensed paper in the journal *Medical Care* (Kane, Shamliyan et al. 2007b).

This review included a mixture of studies analyzing staffing at the hospital level, as well as a few at the nursing unit level. A large study of Veteran's Administration hospitals that was not completed at the time of the Kane et al analysis calls into question the wisdom of conclusions about the relationships of staffing and outcomes at the care unit level that are

based on aggregated data at the hospital level. Sales and colleagues (Sales, Sharp et al., 2008) used cross-sectional patient-level data from all inpatient admissions to acute care (intensive care and non-intensive care) units in 124 Veterans Administration (VA) Medical Centers in the US in 2003. Staffing and skill mix variables at the unit level came from VA national accounting and payroll databases, patient in-hospital mortality outcomes and other characteristics for risk adjustment came from VA's National Patient Care Databases. The data were analyzed using hierarchical multi-level multiple regression models to adjust for patient, unit, and hospital characteristics. This study confirmed a statistically significant association of nurse staffing and in-hospital mortality for medical-surgical unit patients but not for patients who had been treated in ICUs. The comparison of these associations at hospital level only with unit level led the authors to conclude that "it is not absolute staffing levels but staffing relative to patient need and nursing organization at unit and facility level that influence outcomes" (Sales, Sharp et al. in press, 2008). The intermediate variables that surfaced in this study are similar to those recommended in the early systematic reviews: patient acuity, nursing skill mix, complexity of care.

In an editorial commentary on the state of the science, Sean Clarke offers the following:

> A connection between staffing levels and outcomes has now been identified often enough that it is difficult to dismiss out of hand, particularly because the results square with a line of logic that says if staffing levels affect the amount and quality of work that nurses can do, and if nurses' work affects patient welfare, staffing levels should affect patient outcomes, at least at the lowest margins. ….there are still a great many unanswered questions about mechanisms and causality in the staffing-outcomes relationship. When staffing levels are higher, are better outcomes generally observed because patients receive more nursing care? Is the nursing care being delivered superior in quality? Or does the relationship when observed actually reflect the operation of external variables not thoroughly accounted for by studies to date (Clarke 2007, p.1126)?

Do changes to nurse staffing improve patient care outcomes?

Given the strengthening evidence about relationships of poor staffing (more patients per nurse or fewer hours of nursing care per patient day) to poor outcomes (increased mortality or morbidity) the logical test of a cause-effect relationship would be to examine whether or not outcomes improve when staffing improves. This requires systematic collection of data over time, including the period before as well as after a staffing change was made.

Changes in Staffing and Outcomes in California

The mandated minimum ratios in California provide a natural experiment in which this hypothesis can be tested. Three reports examined the extent to which staffing changed in response to the law (Donaldson, Bolton et al. 2005; Bolton, Aydin et al. 2007; Conway, Tamara Konetzka et al. 2008). Two of these also examined selected outcomes

(Donaldson, Bolton et al. 2005; Bolton, Aydin et al. 2007). Two additional reports examined changes in outcomes with changes in staffing prior to implementation of minimum ratios, based on longitudinal data from 1990-1995 (Mark, Harless et al. 2005) and 1993-2001(Sochalski, Konetzka et al. 2008). Aiken and colleagues have a study in progress to examine these changes in detail, but the results have not yet been reported (Aiken 2008).

A convenience sample of hospitals in the California Nursing OutComes (CalNOC) database showed over 90% compliance at the hospital level, an increase in RN hours, a decrease in use of other licensed personnel and temporary personnel, and no change in falls or pressure sores comparing the two years before and the first year after implementation (Donaldson, Bolton et al. 2005). A more complete dataset from California's Office of Statewide Health Planning and Development (OSHPD) demonstrated a marked shift toward better nurse-patient ratios at 2004 and confirmed the findings of increasing use of RNs when the law was implemented (Conway, Tamara Konetzka et al. 2008).

The research findings are mixed with respect to the impact on adverse patient events. The initial analysis from the CalNOC database did not show any statistically significant change in falls or pressure sore prevalence within the first year following implementation (Donaldson, Bolton et al. 2005). The follow-up, extending to 2006, showed non-significant decreases in the incidence of falls, prevalence of pressure sores and restraint use. The largest decreases began to appear in 2006. Several factors could account for the lack of change, despite the association of these measures with nurse staffing in the cross-sectional literature. Since the CalNOC participation is voluntary, perhaps only the hospitals already delivering high quality care are the ones participating and have already achieved ceiling effects. Or perhaps these variables are not quickly sensitive to changes in staffing. Or perhaps the key staff in preventing falls and pressure sores are the assistive personnel, whose numbers declined after ratios were implemented.

In a separate analysis, using California Office of Statewide Health Planning and Development (OSHPD) data, within-hospital variation over time was used to determine if hospitals with increased nurse staffing levels over that time period also had improvements in 30-day mortality among acute myocardial infarction (AMI) patients and surgical failure to rescue (FTR) patients. The data include patients discharged from California hospitals between 1993 and 2001, the period immediately *before* the mandatory staffing ratio legislation (Sochalski, Konetzka et al. 2008). This longitudinal study confirmed findings reported in prior cross-sectional studies—fewer RN hours per patient day were statistically significantly associated with greater AMI mortality and FTR after controlling for patient and hospital characteristics and other staff. However, by using a sophisticated statistical model, the authors were able to demonstrate that the reduction in mortality and FTR was achieved at a meaningful level only in the hospitals with the worst ratios to begin with. They could not rule out the influence of other unmeasured characteristics in addition to staffing that contribute to better outcomes. These characteristics could include changes in the work environment or changes in nursing skill mix. To the extent that benefits occurred with increased staffing, they were

greatest for hospitals with the lowest initial ratios (Sochalski, Konetzka et al. 2008). This finding was supported by an analysis by Mark and colleagues for children's hospitals in California (Mark, Harless et al. 2007). These investigators used California OSHPD data to examine changes in mortality and other adverse outcomes in children with changes in staffing 1990-1995. They also adjusted the staffing data to reflect differing intensity of care required by children. They concluded that, while mortality was not related overall to resource-adjusted hours of care provided by RNs, there significantly reduced post-operative pulmonary complications, postoperative pneumonia, and postoperative septicemia with increased RN hours of care at hospitals that initially provided lower hours of care (Mark, Harless et al. 2004).

Mark and colleagues also conducted the third longitudinal study that investigated the relationship of nurse staffing, mortality and LOS in the context of health maintenance organization (HMO) penetration (Mark, Harless et al. 2005). This is the only study that has examined structural differences in the relationship between nurse staffing and measures of quality, contingent upon the level of managed care penetration. They used administrative data from the American Hospital Association, Centers for Medicare Services, and Healthcare Cost and Utilization Project (HCUP) National Inpatient Sample (NIS) for 422 acute care hospitals in 11 states from 1990 to 1995. They used a sophisticated economic statistical model to stratify the data into quartiles ranging from low to high HMO penetration. They found significant differences in the relationship between nurse staffing and both mortality and length of stay depending upon the level of HMO penetration in the hospital's market. Specifically, increases in RN staffing for hospitals in higher HMO penetration markets were associated with lower mortality and length of stay ratios, but not for hospitals in low HMO, perhaps because these low HMO hospitals already had better staffing. In discussion of these findings, the authors echo the suggestion of earlier observers of HMO redesign on nursing work and staffing:

> … widespread re-structuring transformed the nature of nursing work through reallocation of human resources, including nurse staffing, to maximize nursing time and cost–efficiency. These changes may have reduced slack resources, making the effects of increases in nurse staffing on reducing LOS and mortality ratios more readily discernible. With nursing having been identified as the 'primary surveillance system' in hospitals, …its proper operation depends upon having a sufficient number of registered nurses to observe patients directly, recognize an impending patient problem, and mobilize an intervention that often requires coordinating others' activities to save a patient's life (reducing mortality ratio) or to ensure a smooth transition at discharge (reducing LOS ratio)… From a policy perspective, the findings from our study indicate that increasing RN staffing achieves reduced mortality and LOS primarily for hospitals in high HMO penetration markets that are at lower levels of RN staffing, suggesting that policy recommendations and administrative decisions about nurse staffing, rather than being uniform and unvarying, should instead be responsive to local conditions (Mark, Harless et al. 2005).

Most recently the California HealthCare Foundation (2009) studied how minimum staffing regulations affected hospitals in California OSHPD data sets from 410 acute care hospitals, 1999-2007 and interviews conducted at 12 hospitals (Spetz, Chapman, Herrera et al, 2009). They examined three areas, 1) how hospitals met the requirements, 2) if the ratios were associated with changes in the hospitals' financial status, and 3) if the ratios improved the quality of care. They found administrators had difficulties meeting the requirements, especially the "at all times" requirement that mandated ratios at all times, even during meal breaks. Float pools were created to cover breaks, and one hospital hired a nurse to cover breaks. Other hospitals cross-trained their nurses to do this. Financially, the study found the regulations did not have a major impact on the hospitals compared to changes in Medicare and Medi-Cal and costs for seismic improvements. The ratios did not appear to affect the quality of care. The overall average length of patient stay remained the same as before they were implemented, and nursing sensitive measures including decubitus ulcers, failure to rescue after a surgical complication, deep vein thrombosis, pulmonary embolism, pneumonia mortality and post-op sepsis also remained similar. Hospital ownership, financial position or patient mix did not appear to affect these findings.

Given the frequency with which organizational factors and working conditions are mentioned as potential intermediate variables in the staffing literature, it is reasonable to ask if the adoption of minimum nurse: patient ratios in California has resulted in changes in nursing satisfaction with the work environment. Spetz reported the results of a statewide sample survey of registered nurses. She linked the survey data with regional data about the extent of actual staffing increase in regions. Over 2000 registered nurses participated in the survey in 2004 and in 2006. Staffing data were obtained from the OSHPD dataset, and a 'shortfall' variable estimated for each region based on the reported productive hours versus those expected if the minimum ratios were in place. Nurse satisfaction improved significantly between 2004 (the year of ratio implementation) and 2006 in a number of components of the satisfaction survey including perceived adequacy of RN staff, time for patient education, benefits, clerical support, and relationships with other nurses and physicians. This increased satisfaction was true even when controlling for personal, job and family characteristics that might have independently explained the increase. There was also a significant increase in overall job satisfaction between 2004 and 2006. However, the improvements in satisfaction were no greater in regions with a greater increase in staffing than in those with little change. Since it was not possible to link survey respondents with specific hospitals, it was not clear what this finding means. Perhaps the changes in satisfaction are specific to the employing hospital and wash out when hospitals are aggregated to a region or perhaps the amount of staffing change is not as important as the fact that change occurred at all (Spetz 2008).

Changes in Staffing and Outcomes in Victoria, Australia

The other natural experiment with mandated ratios occurred in Australia, at roughly the same time as in California. This model mandated a ratio of 5 nurses for each 20 beds, rather than a ratio of patients per nurse. It also provided funds to enrich the nurse staffing

in the state. Gordon, Buchanan and Bretherton (Gordon, Buchanan et al. 2008) provide case studies of both the California and Victoria experiments, with a rich description of the similar cost-containment initiatives in each country, the nursing union efforts to achieve mandated ratios, and interviews with nurses in each country describing their satisfaction with work life after the ratios were initiated. Some statistics were provided in a *Nursing Standard* commentary, including 3000 extra nurses employed in hospitals, lower nurse turnover and absenteeism, a 25% increase in nursing school applicants and more public approval for the state government (Parish 2002). There is no record of any evaluation of the impact of this staffing change on patient care or nursing outcomes (Gerdtz and Nelson 2007).

Prospective Studies Evaluating Staffing Innovations

Staff nurses' job satisfaction and group cohesion improved in a 1976 change to all RN staffing, as did the nurses' views of care quality and patients views of trust in the care they received. Costs remained neutral (Hinshaw, Scofield et al. 1981). The AHRQ evidence report searched for controlled trials examining the effect of changing staffing on outcomes but found none. We examined reports from the 1990's regarding the impact of 'redesign' or cost-containment strategies that included staffing changes on nurse and patient outcomes. Although the move to managed care and other cost-containment strategies were widespread in the 1990's, there was very little effort to compare patient, nurse and organizational experiences prior to and following these changes. Sovie and Jawad report changes in 29 University Hospital Consortium hospitals over fiscal years 1997 and 1998 in relation to multiple redesign changes. The number of RNs dropped, with more LPNs and unlicensed personnel in the skill mix. The prevalence of pressure sores decreased, but urinary tract infections rose. Patient satisfaction scores were relatively unchanged. Although greater RN hours were associated with lower fall rates and higher patient satisfaction with pain management scores, the study design did not allow sorting out the particular staffing pattern most strongly related to the positive outcomes (Sovie 1995; Sovie and Jawad 2001).

Evaluation in a large Ontario Canada hospital found that widespread "depression, anxiety, emotional exhaustion, and job insecurity were seen among employees, particularly during the first year of the change process. By the end of the second year, employees reported deterioration in team work, increased unclarity of role, and increased use of distraction to cope." Perceptions of deterioration in patient care began to appear in the second and third year (Woodward, Shannon et al. 1999). However, patient outcomes were not directly measured in this study (beyond staff perceptions).

Bostrum and Zimmerman report stable patient satisfaction and quality of care indicators following introduction of nurse's aides and changes in medication administration and documentation system. Overall costs decreased with nursing time spent more with professional activities. Patient satisfaction and incident reports (a proxy for care quality) did not change. The authors acknowledge that outcome measures sensitive to nursing care need to be found (Bostrom and Zimmerman 1993).

More recently McGillis-Hall and colleagues have evaluated the effects of nurse directed work life improvement interventions on both nurses' perceptions of their work environment and patient satisfaction with care. Each of 16 units in eight public hospitals in Canada chose a particular change in staffing or work process to implement. Overall nurses' perceptions of their work environments were more positive following the change process, but this change seemed overwhelmed by other fixed factors in their work environment such as staffing ratios, flexibility in scheduling and the like (Hall, Doran et al. 2008).

A variety of initiatives have been reported by individual hospitals aimed at reducing variation in demand or providing mobile staffing groups to assist where demand briefly increases. Examples include rapid response teams for staff needs (Daly, Powers et al. 2007), crisis nurses (Green, Beeney et al. 1998), lift teams (Edlich, Woodard et al. 2001; no authors listed 2007), 'stat' nurse pools (Stearley 1996), self-scheduling (Bradley and Martin 1991; no authors listed 2008; Downton 2008; Bailyn, Collins et al. 2007), self-directed work teams (McHenry 1994), and nurse initiated 'red light, green light' for unit bed availability (Rutherford, Lee et al. 2004). In one example of self-scheduling Valentine reports cost savings of nearly $900,000 through open shift automated technology that allowed staff nurses to choose working times and sites. Managers were saving up to 4-5 hours per week in scheduling. Recruitment has improved, with a 26% reduction in vacancies and turnover decreased by 30%. No patient or quality outcomes were reported (Valentine, Nash et al. 2008).

The red light-green light system was first developed at Luther Midelfort-Mayo Health System in Eau Claire, WI, and is described in its implementation at Seton Northwest Hospital (Rutherford, Lee et al. 2004). The traffic-light system indicates the staff nurses' availability for additional patient care. At four check-in times during each shift, front-line nurses indicate on a centrally located whiteboard their capacity to care for new admissions, based on available care, not empty beds. A green magnet shows they are able to take on new patients; yellow means they are nearing their capacity; and red means they cannot safely accept another patient. According to the Transforming Care at the Bedside (TCAB) initiative: "Not only does this respect nurses' professional judgment, but nurses at Seton Northwest report that knowing which of their colleagues are working at full capacity at any given time enhances teamwork. A nursing capacity-traffic light system can be implemented at an individual nurse level or at the unit level. Tracking data associated with this system can also help detect units that are chronically under- or over-burdened" (Rutherford, Lee et al. 2004). This model appears similar to that currently being evaluated by the Washington State Steering Committee.

However, despite the recommendation of the 2004 Institute of Medicine Committee on the Work Environment for Nurses that healthcare organizations increase evidence-based management practices in fostering change in staffing and care delivery systems (Institute of Medicine 2004), the innovations currently underway continue to provide anecdotal and after-only evaluations of the outcomes of these innovations. Ten such innovations are described at the website: http://www.innovativecaremodels.com/care_models/10. These include various models of nurse teams, care coordination models, and patient-centered

models for care delivery at the nursing unit level. One is in Washington State, the Virginia Mason Model RN line that has teams of RN, patient care technician and Clinical Nurse Leader. There are descriptions of key elements, implementation considerations and results from the innovation units or hospitals. None have evidence of systematic data collection before and after implementation or comparisons with like hospitals or units that did not use the innovation. Very few of these innovations have been evaluated either within a single institution or across institutions. For example, although rapid response teams were widely incorporated as part of the Institute for Healthcare Improvement (IHI) campaign to save '100,000 Lives' there is little firm research evidence of the effectiveness of this strategy in reducing mortality or the incidence of cardiac or respiratory arrest (Winters, Pham et al. 2006; Winters, Pham et al. 2007). Consequently, there is no way to determine if the positive results presented are due to the Hawthorne Effect (positive changes related to simply being studied), temporal trends unrelated to the innovation, or a direct result of the organizational change.

Since the Washington State plan emphasizes comparable data collection over time, there will be a basis for determining what impact various local staffing plans have on nurse and patient outcomes. For example, state-based measurement of nurse sensitive quality indicators has the potential to contribute to the existing body of research; the pilot project on staffing alerts may also result in useful findings; and work in both areas offers pre- and post-intervention data.

Both the US and Canada have identified similar issues and solutions to the nursing shortage and staffing problems. McGillis-Hall and colleagues interviewed nurse executives and summarized pros and cons of various approaches, including the use of (a) staffing principles and frameworks, (b) nursing workload measurement systems, (c) nurse-to-patient ratios, and (d) the need for uptake of evidence related to nurse staffing. They also recognized the lack of systematic data collection to provide evidence regarding impact of newer or revived models of care. (McGillis Hall, Pink et al. 2006).

What Stakeholders are Doing

The increasingly strong correlations between staffing levels and patient outcomes have led 22 states to propose or enact legislation to either regulate staffing through mandated nurse: patient ratios, to require public posting of staffing, or to establish staffing committees with direct care staff nurse input. Some states are considering all three approaches (Thrall 2008). See Figure 1 below. Descriptions of the legislation in Texas and Oregon are similar to Washington's effort, with staffing plans, direct care nurse input (Artz 2005). Cox and colleagues recently surveyed over 4000 nurses in 10 states, both with and without mandatory staffing legislation. Those who were most satisfied with their professional environment were those in states with mandated staffing committees, followed by mandated ratios. The least satisfied were those with no legislated plan (Cox, Anderson et al. 2005).

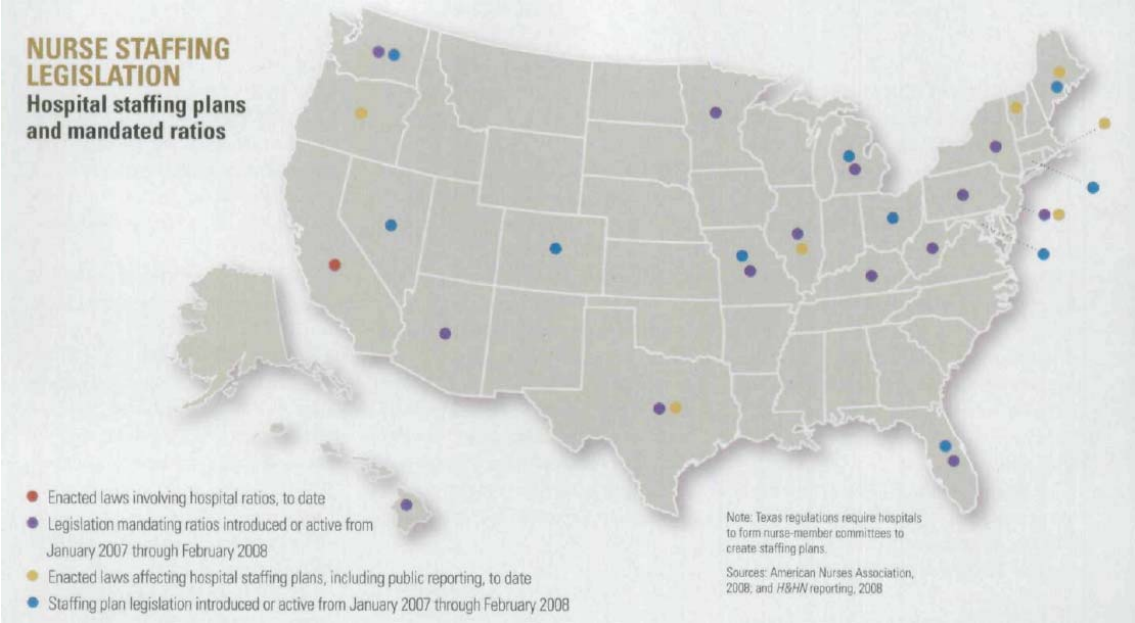


Figure 1. Map of states with staffing legislation (from Thrall 2008, p.38).

The Joint Commission introduced standards that require health care organizations (HCO) to regularly assess their staffing effectiveness, including measures of skill mix, patient acuity and measures of both nurse and patient outcomes. The standards were the result of several roundtables of nursing and hospital leaders who gathered in response to the increasing evidence about the impact of staffing on patient safety and health care outcomes. The standards require organizations "to use data from the use of nursing-sensitive clinical and human resources indicators, such as adverse drug events, patient falls, use of overtime, staff turnover rate, patient and family complaints, and staff injuries on the job. Organizations are required to select two each of human resources and clinical indicators, half of which must be taken from a list of 21 established indicators in these two areas. Although not mandating specific staffing levels or ratios, the Joint Commission standards do, in essence, require organizations to determine their own staffing ratios based on their own evidence and experience" (Joint 2002). http://www.jointcommission.org/AccreditationPrograms/Hospitals/Standards/FAQs/Manage+Human+Res/Planning/staff_effectiveness.htm

In 2004 the National Quality Forum (NQF) released indicators of care quality shown to be sensitive to nursing care http://www.qualityforum.org/nursing/#endorsed (Forum 2004). These indicators form the basis for a number of those recommended to be used by the Joint Commission. Those chosen by the steering committee are among the 14 recommended by this group to monitor safety and quality. An example of transparency of staffing information, hospitals in Massachusetts have joined together to post their staffing plans, National Quality Forum (NQF) outcome measures and other elements of patient safety at a publicly accessible website. http://www.patientsfirstma.org/index.cfm

The American Nurses Association (ANA) first proposed *Principles for Nurse Staffing* in 1999, following the cost-containment problems of the 1990s. These principles call for balancing a number of these of factors including numbers of patients, their levels of

intensity, architecture and geography of the patient care environment, level of preparation and experience of providers, and organizational policies supporting nurse staffing (Gallagher, Kany, Rowell & Peterson, 1999). These components are incorporated into the Washington State Law.

The International Council of Nurses (ICN) proposed similar principles in 2003, focusing on countries undergoing rapid change of staffing models in response to cost-containment. Their website includes a summary of pro and con statements about mandatory ratios. Pros of mandatory ratios include: safer patient environments, provides reasons for more nurses to return to direct care, helpful in collecting useful nursing data, and illumination of complex the issue of safe staffing is. The cons of mandatory ratios are concerns that the floor becomes the norm, not accounting for nurse's expertise, and lack of data collection and comprehensive workload measurement tools. The ICN fact sheet notes that with the introduction of nurse-patient ratios there needs to be careful monitoring of patient outcomes, nurse retention and recruitment, the financial impacts need to be studied in relation to patient impacts, nurse's workload and skill mix and how they affect patient safety. This statement also emphasizes the need to standardize data on nurse patient ratios as well as nursing data statistics on local, national and international levels (International 2008).

In a speech to the American Organization of Nurse Executives, Peter Buerhaus strongly discouraged using regulation, such as mandated minimum ratios, to solve the staffing problems. As he noted in his recent book, he and other economists believe that ratios increase inefficiency, increase labor costs, and do not solve the underlying problems of fluctuating workload (Buerhaus, Staiger et al. 2009, p. 288).

Buchan sums up this perspective:

> …the main weaknesses of the use of nurse: patient ratios as being their relative inflexibility and their potential inefficiency, if they are wrongly calibrated. Their strength is their simplicity and their transparency. Their impact will be most pronounced when ratios are mandatory and where they offer a mechanism to improve and then to maintain staffing levels at some pre-determined level. The biggest challenges in their use are calibration (what is 'safe'? or 'minimum'?) and achieving the support of all stake-holders…nurse: patient ratios are a blunt instrument for achieving employer compliance, where reliance on alternative, voluntary (and often more sophisticated) methods of determining nurse staffing have not been effective (Buchan 2005).

How Does Staffing Matter?

Corollary questions include: Are there other organizational and clinical structures or processes that logically link the numbers of nurses and the outcomes of patient? The 2004 IOM committee on nursing work environments and patient safety broached the broad idea that "as the numbers of nursing staff increase these nurses are proportionately able to

provide increasing amounts of necessary care." They further hypothesized, based on findings in nursing homes, that once the optimal amount of 'necessary care' was provided, further increases in staff would not further improve care outcomes (Institute of Medicine 2004, p.169-170). This hypothesis was supported more than 10 years later in Sochalski et als analysis of California staffing (Sochalski, Konetzka et al. 2008).

Mitchell and Shortell provide a more specific proposition. Nursing, as the most consistent group of professionals present in the hospital environment, has both a direct care influence and a coordinating one. There is considerable evidence that institutions providing a greater opportunity for nurses to influence both clinical care and their immediate working environment retain nurses (and therefore expertise) and have higher quality collaborative and coordinating processes necessary for high quality clinical care. This would suggest that the 'dose' of nursing care (in terms of staffing, RN hours of care) as well as the clinical and organizational processes of care (monitoring patient condition, coordinating care with others, communicating with team members and the like) are among the 'unmeasured attributes' that define how nurse staffing influence outcomes (Mitchell and Shortell 1997).

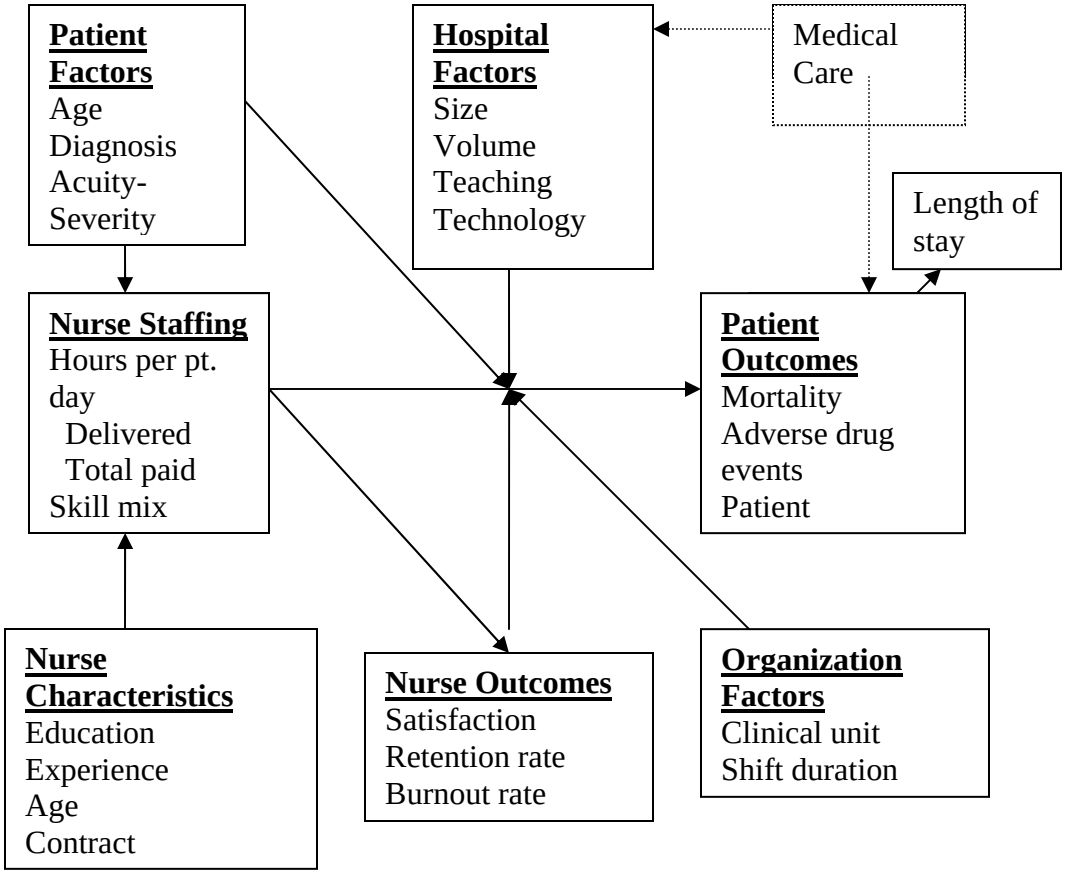
However, there are very few studies that even attempt to examine the mechanisms by which this relationship works. This is primarily because establishing the mechanisms of causality requires prospective collection of data that are simply not available in the administrative and hospital coalition databases used for the majority of this research. The small number of such studies conducted in the 1990s were able to distinguish intensive care units that had better or worse working environments and retention of nurses (organizational outcomes), but could not relate these working environments to variations in staffing and outcomes or had insufficient variation in both outcomes and staffing to complete the link. The extant studies essentially operate with a 'black box' between staffing (numbers) and patient or nurse outcomes. Further, these studies implicitly assume that staffing (numbers or ratios) are a reasonable approximation of workload. A separate body of research about working environments, working conditions and components of workload suggest there are a number of factors that might reasonably be included in that 'black box'. Seago summarized the factors that need to be included in addition to RN hours of care as follows: Nurse workload varies as a function of RN staff expertise, patient acuity, MD availability, work intensity, availability of support staff and unit physical layout (Seago 2002). Industrial psychology and human factors engineering research suggests five components of the work system that are relevant here: task; organizational factors; environment; equipment and technology; and individual (Gurses & Carayon, 2007; Carayon, 2006; Carayon & Smith, 2000). Unruh and Fottler's (2006) analysis of late 1990's Pennsylvania data documents the profound effect of patient turnover on estimates of adequacy of nurse staffing. Patient turnover is the inverse of length of stay and can be visualized as the number of admissions and discharges to a bed in a 24 hour period, sometimes called 'churn'. This frequent turnover contributes to the sense that acuity is rising, even if the severity of illness of individual patients remains relatively constant (Unruh & Fottler, 2006). Based on the workload literature and other work already cited (Mark, Salyer et al. 2002; Mark, Hughes et al. 2007; Schmalenberg

and Kramer 2007), additional factors that are recommended to be considered are as follows:

- Nursing expertise
- Skill mix (types of nursing staff)
- Physician expertise
- Dimensions of workload
  - cognitive,
  - emotional,
  - quantitative – e.g # patients, tasks;
  - qualitative –eg. patient acuity, variability and turnover
- Support staff available
- Working relationships
- Physical layout of the work environment
- Hospital characteristics

Some of these elements some have incorporated into staffing formulas (Hurst 2006; Upenieks, Akhavan et al. 2007; Upenieks, Kotlerman et al. 2007; Hurst, Smith et al. 2008), however, no staffing formulas reflect the complexity suggested above. Further, there are no reports of changes in either nurse or patient outcomes related to use of these formulas.

The AHRQ evidence paper proposed a conceptual model that incorporates much of the work to date, indicating how these unmeasured factors should link to staffing and outcomes. The figure below illustrates how patient, hospital, care organization and nursing factors might affect staffing policies and subsequent outcomes for both nurses and patients. The figure is redrawn from (Kane, Shamliyan et al. 2007).



Some of these work environment characteristics have been described in relation to positive nurse perceptions of their working environments (Rathert and May 2007), or have linked nurses' perceptions of these characteristics to perceived quality of patient care and outcomes (Leiter and Spence Laschinger 2006; Spence Laschinger and Leiter 2006). Specific management practices, such as collaborative decision-making have been linked to both better staffing and more positive perceptions of the work environment (Adams and Bond 2003; Adams and Bond 2003). However no prospective studies were found linking changes in the work environment (including staffing) to both nurse and patient outcomes.

What are the financial implications of various levels of nurse staffing?

As noted earlier, the most recent nursing shortage and concerns about inadequate nurse staffing were driven by cost-cutting strategies in the move to managed care in the 1990s. Registered nurse positions in both middle management and direct care were targeted as the largest and therefore most costly component of hospital workforce. While the costs of nursing turnover in response to working conditions have been put forth over the past 20 years it is only with the advent of a body of research linking poor direct care staffing

with poor patient outcomes has allowed calculation of the true costs of inadequate staffing.

Nurse Staffing and Financial Outcomes

Relatively few studies have examined the relationship between hospital nurse staffing and financial outcomes Unruh conducted a literature review of nurse staffing articles from 1980 to 2006 that focused on patient outcomes, nurse outcomes and financial outcomes of nurse staffing. Of 117 studies reviewed only 18 included costs. There were four approaches within these 18 papers: 1) RN-patient staffing ratios and RN-non-RN skill mix in relation to costs, 2) nurse staffing levels in relation to lengths of hospital stay 3) changes to nurse staffing levels and the rate of adverse events and, therefore, cost savings and 4) costs in relation to nursing turnover rate (Unruh 2008, p.68).

Three studies from the 1980s that examine RN-patient staffing ratios and RN-non-RN skill mix in relation to costs produced mixed results. These studies were all attempting to examine the impact of the move to an all RN staff on costs. Halloran used nursing diagnoses to estimate patient acuity and documented nursing direct care through time and motion technique, finding that units with a higher proportion of RNs in the skill mix reduced salary costs for the unit by reducing the need for assistive personnel (Halloran 1983). Shukla compared the quality of care delivered among an all RN primary nursing model with a team and modular models of care delivery in a single hospital. Quality (defined by process measures) was equal, but costs were greater in the all RN model (Shukla 1983). Glandon and colleagues used the Medicus Systems multihospital database, examining 392 medical-surgical units in 62 hospitals (Glandon, Colbert et al. 1989) finding that nursing labor costs per day were influenced by nursing unit size, care delivery model, and the proportion of RNs in the skill mix. An all RN staff was the most costly in this study also (Glandon, Colbert et al. 1989). None of these studies included patient outcomes.

More recent studies relating nursing skill mix to costs have used more sophisticated measures of operating costs and have found that the increased cost of a higher proportion of RNs is also a function of ratio of RNs to patients, skill mix of types of nursing staff, nursing care intensity (hours of RN care per patient per shift), hospital and unit type. Welton, Unruh & Halloran used the publicly available data on hospital staffing in Massachusetts to estimate labor costs per day in relation to planned patient-nurse ratios, comparing across the 65 community hospitals and 9 medical centers (Welton, Unruh et al. 2006). There was considerable variability across units and hospitals. On the average RN daily labor costs were $45 greater per day in the units with lower patient to nurse ratios. However these same units had greater intensity of care and variability in skill mix. The authors conclude that mandating specific patient-nurse ratios across hospitals does not take this variability into account. They further note that the current models of reimbursing hospitals for nursing care also do not account for variability in care intensity and skill mix, therefore posing disincentives to hospitals to improve staffing.

In recent years, Titler and colleagues have added considerable sophistication to the methods used to examine components of overall hospital costs, including measures of nurse staffing. They have used administrative and clinical databases from the University of Iowa hospitals to estimate costs and outcomes of multiprofessional care for older adults. Their multivariate analyses have provided estimates of the interactions of interventions provided by medicine, pharmacy and nursing with staffing of overall hospital care for older patients. While the results may or may not be generalizable to other medical centers in the US, the methodology clearly demonstrates the complex interactions among staffing patterns, complexity of patient needs and interventions from multiple disciplines. The studies have shown that overall costs are greater for elderly patient who have been hospitalized on multiple units in any given stay (Titler, Dochterman et al. 2005; Kanak, Titler et al. 2008; Titler, Jensen et al. 2008), on units with where the availability of RN hours is below that unit's average (Titler, Dochterman et al. 2005; Titler, Dochterman et al. 2007; Titler, Jensen et al. 2008), who have more medical procedures and medications prescribed, and have a greater number of nursing interventions (Titler, Dochterman et al. 2005; Titler, Jensen et al. 2008). However, there were several nursing interventions which use was associated with cost *savings*, namely Fluid Management, Oral Health Restoration, Bowel Management, Infection Protection, and Medication Management (Titler, Dochterman et al. 2005; Titler, Dochterman et al. 2007; Titler, Jensen et al. 2008). Average RN staffing ratios were not significantly related to costs in any of the Iowa analyses.

Studies examining nurse staffing levels in relation to lengths of hospital stay and, therefore costs were systematically reviewed by (Thungjaroenkul, Cummings et al. 2007). Seventeen studies published between 1990 and 2006 included nurse staffing and length of stay and/or costs. Differing definitions of nurse staffing, length of stay and costs made comparisons across studies problematic. However, even given this limitation the majority of studies reviewed by these authors found lower costs associated with higher nurse to patient ratios. Similarly, higher ratios of RNs to patients, RNs to other nursing staff and nursing hours per patient day were associated with shorter length of hospital stay in most studies (Thungjaroenkul, Cummings et al. 2007; Unruh 2008). As noted earlier in the Titler studies, hospitalization on multiple units, particularly those with reduced staffing, was also associated with more complications, greater length of stay and greater cost (Kanak 2007; Kanak, Titler et al. 2008).

Unruh characterizes the third approach to studying staffing-cost relationships as exploring how changes in nurse staffing affect the rate of adverse events and therefore, potential cost savings. However, none of the studies in the literature are prospective and intended to examine actual changes in staffing. Rather, they all compare adverse events in units or hospitals with different staffing ratios. For example, Dimick used a Maryland statewide administrative database from 1994-1998 and found that ICUs with nurse patient ratios of 1:3 or greater had 14% higher costs due to more complications ($1,248 per patient) than hospitals with lower ICU nurse-patient ratios. The increased ratios were more common during the night shift (Dimick, Swoboda et al. 2001). Cho and colleagues used the California OSHPD hospital database and the State Inpatient Databases (SID) California-1997 released by the Agency for Healthcare Research and Quality (AHRQ)

for the calendar year 1997 to determine the relationship of differing staffing and skill mix variables on the incidence of adverse events and length of hospital stay. They used multivariate logistic regression models to examine the joint contributions of various staffing variables to cost and adverse events outcomes. They found that each hour increase in the RN hours per patient day (RN HPPD) or a 10% increase of RNs in the skill mix decreased patients' risk of pneumonia by 8.9% or 9.5% respectively and shortened length of hospital stay and decreased costs. Increasing RN HPPD was also associated with increased rates of pressure ulcers, which the authors attribute either to inadequate risk adjustment measures in the databases, or perhaps to more monitoring and better rates of detection (Cho, Hwang et al. 2008).

Pappas provided data regarding the cost of adverse events in relations to staffing for 3200 patients extracted from a two-hospital system's administrative and clinical databases. The nursing-sensitive outcomes studied were medication errors, patient falls, urinary tract infection (UTI), pneumonia, and pressure ulcers. The time frame for data extraction was not specified (Pappas 2008). When adverse events were combined in one variable, the cost per case was approximately $1,000. The significant cost per case increases were found for UTI ($1,005, $p = .027$) and pressure ulcers ($2,384, $p = .037$) in the medical group and for UTI ($1,044, $p = .001$) and pneumonia in the surgical group (Pappas, 2008). The study used unit level data and found the only significant relationship with unit staffing was for the occurrence of pneumonia in surgical cases. The cost for pneumonia was approximately $1,631 per case. The odds of pneumonia occurring in patients decreased with an additional RN HPPD (OR = .40, $p = .008$).

Overall, the more recent studies (1990-2008) reviewed above suggest that, when patient condition, adverse events and complexity of care are taken into account, fewer patients per nurse or more RN hours per patient day is not more costly. Moreover, there is good reason to expect that the costs of adverse events will increase when the treatment for eight hospital-acquired adverse events are no longer paid for by the Centers for Medicare and Medicaid (CMS). See that discussion below.

Statistical Modeling of Various Options for Nurse Staffing and Cost

Needleman and colleagues took another approach to studying the cost of various ratios of patients to nurses. Using an existing, national database, they statistically modeled various options to changing nurse staffing (Needleman, Buerhaus et al. 2006) and estimated the costs of increasing nurse staffing and the resulting savings resulting from decreased mortality, decreased length of hospital stay and decreased rates of adverse events. Three different options are compared: 1) raising the proportion of RNs from the 75th percentile without changing the number of licensed hours, 2) raising the number of licensed hours to the 75th percentile without changing the proportion of RNs, and 3) raising both the proportion of RNs and the number of licensed hours to the 75th percentile. They reviewed data from 799 nonfederal acute care general hospitals and included 26 percent of the discharges from these hospitals in 1997.

They conclude that the there was "an unequivocal business case for hospitals to improve nurse staffing under one option" (Needleman et al., p. 209). The least costly option was to raise the proportion of RNs without changing licensed hours. This option was estimated to cost $811 million and result in short term savings of $242 million. This option was estimated to lead to a decrease of 4,997 in-hospital patient deaths, 1,507,493 avoided hospital days and 59,938 fewer adverse events.

Option 2 (raising the number of licensed hours to the 75th percentile without changing the proportion of RNs) would result in a larger decrease in hospital days (2,598,339), fewer reduced adverse events (10,813) and fewer avoided deaths (1,801). The costs associated would not be offset by cost savings. Option 3 (raising both the proportion of RNs and the number of licensed hours to the 75th percentile) would result in the biggest reduction in adverse events (70,416) hospitals days (4,106,315) and patient deaths (6,754) but it would have the highest staffing costs, which would not be off set by savings.

Ninety percent of the cost savings from increasing nurse staffing would result from decreases in patient lengths of stay. As noted in Unruh and Fottler's analysis, reducing the length of stay increases patient turnover ('churn'), thereby increasing nursing workload (Unruh & Fottler, 2006). This was not accounted for in Needleman's analysis since staffing was used as the only proxy for workload. The Needleman analysis also did not consider decreased costs associated with decreased patient morbidity, fewer adverse events or the decreased costs associated with lower nurse turnover. Needleman's subsequent article argues that incentives need to be reorganized to benefit both the patient and the hospital (Needleman 2008).

Needleman examines the business and social cases for quality as they relate to nursing. Patients are hospitalized principally because they need nursing care. "The overwhelming impression that emerges from the literature is that nurse staffing has been found to be associated with a wide range of outcomes" (Needleman, 2008, p. 81) and that adequate nurse staffing can decrease a patient's length of hospital stay, adverse events and costs. Given this information, hospital administrators with low levels of nurse staffing need to ask how much it would increase costs to increase nurse staffing? Would the hospital be able to offset these costs? If they did increase their nurse staffing would they be able to attract more lucrative patients? Would there be additional savings besides those from providing higher quality nursing care?

In the previous article he discussed the financial benefits of increasing the number of nurses below the 75th percentile to that level and increasing the number of RNs, decreasing the number of LVNs and keeping the total hours of nursing care constant (Needleman, Buerhaus et al. 2006). Over the short term hospitals would only recover 40% of the variable costs of avoided care due to reduced hospital length of stay for patients, however they would eventually recover their full costs as hospitals adjust to reduced patient volume and or began to offer new services.

Although Needleman (2008) only looked at some patient complications, adding more to his model would not add to the cost savings associated with improved patient care as a

result of better nurse staffing. The results of his analyses are "sensitive to judgments about how to deal with fixed costs," to recover the fixed costs that are reduced by the decrease in patient length of stay, hospitals could close units or restructure them to provide new services. Increasing proportion of RN hours without increasing nursing hours "recovers its costs" but it can only be used as a business case if the hospital can obtain the savings, which depends on how it is reimbursed. The two other options (increasing nursing hours per pt day keeping the same proportion of RNs and both increasing the number of nursing hours and increasing RN hours) cost the hospital money because there is not a direct cost savings in patient care. However, from a social perspective the increased costs would be justified because they would save peoples' lives. There would be increased value to patients from being discharged earlier and having fewer complications. Subsequent reduced nursing turnover could also save hospitals an estimated $60,000 per nurse. He notes that hospitals must be able to retain the savings resulting from higher quality care, if they do not it will weaken their business incentive even if their economic and social incentives are strong. Therefore, in his view, the only way to align patient and hospital incentives is to change the way payments are made (Needleman, 2008).

The Lewin group recently published an analysis commissioned by the American Nurses Association that estimated the economic value of professional nursing (Dull, Chen, Seifert et al, 2009). They used the same studies reviewed in the systematic reviews cited above and calculated the estimated cost savings at three staffing levels (hours per patient day) for each additional RN in reduced specific adverse events. Overall this analysis supports the contention that the added cost of each RN is offset by the reduced costs of care for complications, and the costs to society of premature death related to these complications. However, the authors point out that the cost savings do not necessarily accrue to the hospital under our current payment system. As they point out, “the economic value of nursing is greater for payers than for individual healthcare facilities” (Dull et al, 2009, p. 103).

The decision by the Centers for Medicare and Medicaid (CMS) not to reimburse hospitals after October 1, 2008 for the costs of treating eight specific hospital-acquired conditions may well change the above described equation in terms of incentives to hospitals to improve nurse staffing (Kurtzman and Buerhaus 2008; Welton 2008). An analysis using 2006 data from 1.719 million discharges at 194 hospitals in New York's Statewide Planning and Research Cooperative System's calculated that preventing four events (pressure ulcers, pulmonary embolism/deep vein thrombosis, sepsis and ventilator-associated pneumonia) could net hospitals from $500,000 to $5 million depending on the size and type of hospital involved. The president of Reynolds & Co. calculated that reducing the frequency of the four ‘never event’ hospital-acquired conditions could potentially produce $82.8 million in aggregated net income while freeing up 116,863 days of bed capacity(Robeznieks 2008).

An additional indirect cost described by Unruh is to estimate costs in relation to nurse turnover rate, which may be related to dissatisfaction with staffing levels (Unruh 2008). Jones (2005) estimated it cost between $62,100 and $67, 100 to replace one RN in 2002

dollars (Jones 2004; Jones 2005). According to Unruh (2008) this represented between 120-130% of an RN's average salary in 2002. Jones points to recent studies suggesting that nurse turnover contributes to greater organizational costs and may compromise quality of care (Jones 2004; O'Brien-Pallas, Griffin et al. 2006). Cost estimates in the early 2000s ranged from approximately $22,000 to more than $64,000 per nurse turnover, based on whether studies captured the less obvious costs of nurse turnover such as productivity losses (Jones 2005). She further provided a methodology to update older turnover figures using the current Consumer Price Index for All Urban Consumers (CPI-U). Applying this method to the 'baseline' 2002 data she concludes that in fiscal year 2007 per RN turnover cost would range from approximately $82,000 (if vacancies were filled by experienced RNs with a shorter new-employee learning curve) to $88,000 (if vacancies are filled by new graduate - longer learning curve). Total nurse turnover costs were estimated at $7,875,000 to $8,449,000 (Jones 2008).

Mark, Harless, & Spetz (2009) recently reviewed data from the National Sample Survey of Registered Nurses, the Current Population Survey, the National Compensation Survey, and the Occupational Employment Statistics Survey to determine the impact of implementing nurse staffing ratios on the wages of registered nurses in California. These surveys all pointed "to a consistent and sizable differential growth in RNs' wages in California after the staffing regulations were implemented" (p. w333). This wage growth was higher than in other states where staffing was not mandated. "it is consistent with the economic argument that the minimum staffing regulations increased demand for nurses which contributed to an increase in RNs' wages in California" (p. w333).

Other factors may have contributed to the wage increase other than the regulations, California hospitals have many financial pressures, including implementing seismic safety standards by 2030 and this may have decreased their ability to raise wages to compete for RNs compared to other states. However, the state also has a severe nursing shortage and this may have caused hospitals to increase RN wages regardless of the new regulations.

Conclusion

The research is clear that fewer patients per nurse or more nursing hours per patient day is associated with fewer adverse outcomes -- in particular mortality, failure to rescue, and some specific adverse events among surgical patients. This association is no longer in dispute. However, there is little research to guide understanding of the specific impact of variables that may combine with staffing to affect health outcomes, particularly at a facilities level. The data with which most studies have worked have been at an aggregated state or system level. Reflecting this, many health services researchers indicate an urgent need to examine facility level strategies to improve staffing and relate those efforts to patient and organizational outcomes.

Most of the existing studies have only examined staffing and outcome variables, without directly measuring aspects of the patient status, workload measures beyond staffing, and organizational environment that many believe to be important intermediate factors. The

literature recommends that additional variables need to be part of the new efforts to appropriately apply the research about staffing levels. These variables need to be continuously measured and compared to determine the effectiveness of any staffing plan. These variables include skill mix; patient acuity (including severity of illness and patient turnover); nurse education; experience, and competency, nurse outcomes such as satisfaction and turnover; and patient outcomes such as mortality, pressure sore prevalence, and falls incidence. The lack of definitive research regarding the impact of these and other more facility level variables such as work culture and work environment suggests the value of attempting to address the relationship between staffing and patient outcomes with the benefit of the Ruckelshaus Steering Committee's plan to collect such data before and after implementation of expected new approaches. This will serve all parties well, including our regional and national colleagues, in evaluating the impact of the plans.

With the present approach to hospital-based measurement of nurse sensitive quality indicators in Washington State, the state has the opportunity to evaluate the impact of plans used at any given hospital and to compare outcomes within, and potentially across units and hospitals. Washington also can contribute by serving as an example to other states as it attempts to work from evidence to problem solve and innovate in the area of nurse staffing.

References

(1938). "Nurse lists 5 factors of bedside nursing." Hospital Progress **19**(June): 195-196.
(2007). "Weighing in on lift teams." Nursing **37**(6): 48hn8.
(2008). "Bidding systems address U.S. nursing shortage." Healthcare Benchmarks and Quality Improvement **15**(3): 31-2.
Adams, A. and S. Bond (2003). "Staffing in acute hospital wards: part 1. The relationship between number of nurses and ward organizational environment." Journal of Nursing Management **11**(5): 287-92.
Adams, A. and S. Bond (2003). "Staffing in acute hospital wards: part 2. Relationships between grade mix, staff stability and features of ward organizational environment." J of Nursing Management **11**(5): 293-8.
Aiken, L. H. (2008). "Outcomes of Nurse Practice Environments." Policy Politics & Nursing Practice **9**(2): 73-9.
Aiken, L. H., S. P. Clarke, et al. (2002a). "Hospital staffing, organization, and quality of care: Cross-national findings." Nursing Outlook **50**(5): 187-94.
Aiken, L. H., S. P. Clarke, et al. (2002b). "Hospital nurse staffing and patient mortality, nurse burnout, and job dissatisfaction." JAMA **288**(16): 1987-93.
Artz, M. (2005). "Solutions to RN staffing: Texas and Oregon are models for other states addressing the crisis." American Journal of Nursing **105**(11): 33.
Bailyn, L., R. Collins, et al. (2007). "Self-scheduling for hospital nurses: an attempt and its difficulties." Journal of Nursing Management **15**(1): 72-7.
Berwick, D. M. (2002). "A user's manual for the IOM's 'Quality Chasm' report." Health Affairs (Millwood) **21**(3): 80-90.

Bolton, L. B., C. E. Aydin, et al. (2003). "Nurse staffing and patient perceptions of nursing care." Journal of Nursing Administration **33**(11): 607-14.

Bolton, L. B., C. E. Aydin, et al. (2007). "Mandated nurse staffing ratios in California: a comparison of staffing and nursing-sensitive outcomes pre- and postregulation." Policy, Politics, & Nursing Practice **8**(4): 238-250.

Bostrom, J. and J. Zimmerman (1993). "Restructuring nursing for a competitive health care environment." Nursing Economic$ **11**(1): 35-41, 54.

Bradley, D. J. and J. B. Martin (1991). "Continuous personnel scheduling algorithms: a literature review." Journal of Social & Health Systems **2**(2): 8-23.

Buchan, J. (2005). "A certain ratio? The policy implications of minimum staffing ratios in nursing." Journal of Health Services Research & Policy **10**(4): 239-244.

Buerhaus, P. I., K. Donelan, et al. (2007a). "Trends in the experiences of hospital-employed registered nurses: results from three national surveys." Nursing Economic$ **25**(2): 69-80.

Buerhaus, P. I., K. Donelan, et al. (2007b). "Impact of the nurse shortage on hospital patient care: comparative perspectives." Health Affairs **26**(3): 853-862.

Buerhaus, P. I., D. O. Staiger, et al. (2009). The Future of the Nursing Workforce in the United States: Data, Trends and Implications. Sudbury, MA, Jones and Bartlett.

Carayon, P. (2006). “Human factors of complex sociotechnical systems”. Applied Ergonomics, **37**(4), 525-535.

Carayon, P., & Smith, M. J. (2000). “Work organization and ergonomics.” Applied Ergonomics, **31**(6), 649-662.

Cho, S. H., J. H. Hwang, et al. (2008). "Nurse staffing and patient mortality in intensive care units." Nursing Research **57**(5): 322-30.

Clark, P. A., K. Leddy, et al. (2007). "State nursing shortages and patient satisfaction: more RNs--better patient experiences." Journal of Nursing Care Quality **22**(2): 119-27.

Clarke, S. P. (2007). "Registered nurse staffing and patient outcomes in acute care: looking back, pushing forward." Medical Care **45**(12): 1126-8.

Conway, P. H., R. Tamara Konetzka, et al. (2008). "Nurse staffing ratios: trends and policy implications for hospitalists and the safety net." Journal of Hospital Medicine **3**(3): 193-9.

Cox, K. S., S. C. Anderson, et al. (2005). "Nurses' work environment perceptions when employed in states with and without mandatory staffing ratios and/or mandatory staffing plans." Policy Politics & Nursing Practice **6**(3): 191-7.

Dall, T. M., Chen, Y. J., Seifert, R. F., Maddox, P. J., & Hogan, P. F. (2009). “The economic value of professional nursing.” Medical Care, **47**(1), 97-104.

Daly, M. L., J. Powers, et al. (2007). "Innovative solutions: leading the way: an innovative approach to support nurses on general care units with an early nursing intervention team." Dimensions of Critical Care Nursing **26**(1): 15-20.

Dimick, J. B., S. M. Swoboda, et al. (2001). "Effect of nurse-to-patient ratio in the intensive care unit on pulmonary complications and resource use after hepatectomy." American Journal of Critical Care **10**(6): 376-82.

Donaldson, N., L. B. Bolton, et al. (2005). "Impact of California's licensed nurse-patient ratios on unit-level nurse staffing and patient outcomes." Policy Politics & Nursing Practice **6**(3): 198-210.

Downton, S. (2008). "How does your institution help you maintain work-life balance? Self-scheduling enables staff to pick shifts that work for them." ONS Connections **23**(4): 13.

Edlich, R. F., C. R. Woodard, et al. (2001). "Disabling back injuries in nursing personnel." JEN: Journal of Emergency Nursing **27**(2): 150.

Finlayson, M., L. Aiken, et al. (2007). "New Zealand nurses' reports on hospital care: an international comparison." Nursing Praxis New Zealand **23**(1): 17-28.

National Quality Forum. (2004). National Voluntary Consensus Standards for Nursing-Sensitive Care: An Initial Performance Measure Set: A Consensus Report Washington DC, National Quality Forum**:** 40.

Gerdtz, M. F. and S. Nelson (2007). "5-20: a model of minimum nurse-to-patient ratios in Victoria, Australia." Journal of Nursing Management **15**(1): 64-71.

Glandon, G., K. W. Colbert, et al. (1989). "Nursing delivery models and RN mix: cost implications." Nursing Management **20**(5): 30-3.

Goldie, S. (1987). "I have done my duty": Florence Nightingale in the Crimean War, 1854-56. Manchester, UK, Manchester University Press.

Gordon, S., J. Buchanan, et al. (2008). Safety in Numbers: Nurse-to-Patient Ratios and the Future of Health Care. Ithaca, NY, Cornell University Press.

Green, A., J. Beeney, et al. (1998). "Action STAT! The crisis nurse." Nursing Management **29**(10): 41-2.

Gurses, A. P., & Carayon, P. (2007). “Performance obstacles of intensive care nurses”. Nursing Research, **56**(3), 185-194.

Hall, G. (1945). "Estimating the patient-nurse ratio." Canadian Hospital **22**(February): 48, 62.

Hall, L. M., D. Doran, et al. (2008). "Outcomes of interventions to improve hospital nursing work environments." Journal of Nursing Administration **38**(1): 40-6.

Halloran, E. J. (1983). "RN staffing: more care--less cost." Nursing Management **14**(9): 18-22.

Hinshaw, A. S., R. Scofield, et al. (1981). "Staff, patient, and cost outcomes of all-registered nurse staffing." Journal of Nursing Administration **11**(11-12): 30-6.

Hurst, K. (2006). "Nursing by numbers." Nursing Standard **21**(7): 22-5.

Hurst, K., A. Smith, et al. (2008). "Calculating staffing requirements." Nursing Management (Harrow) **15**(4): 26-34.

Institute of Medicine (2004). Keeping patients safe—Transforming the work environment of nurses. Washington, DC, National Academy Press.

International Council of Nurses. (2008). "Nursing Matters: Nurse: Patient Ratios." Retrieved September 7, 2008, from http://www.icn.ch/matters_rnptratio.htm.

Jha, A. K., E. J. Orav, et al. (2008). "Patients' perception of hospital care in the United States." New England Journal of Medicine **359**(18): 1921-31.

Joint Commission on the Accreditation of Healthcare Organizations. (2002). Health Care at the Crossroads: Strategies for Addressing the Evolving Nursing Crisis. Public Policy Series. Chicago, Joint Commission on the Accreditation of Healthcare Organizations**:** 47.

Jones, C. B. (2004). "The costs of nurse turnover: part 1: an economic perspective." Journal of Nursing Administration **34**(12): 562-70.

Jones, C. B. (2005). "The costs of nurse turnover, part 2: application of the Nursing Turnover Cost Calculation Methodology." Journal of Nursing Administration **35**(1): 41-9.

Jones, C. B. (2008). "Revisiting nurse turnover costs - Adjusting for inflation." Journal of Nursing Administration **38**(1): 11-18.

Kanak, M. F. (2007). Nurse staffing, patient turnover, and patient incidents in an older hospitalized heart failure population. , , United States -- Iowa. Retrieved September 7, 2008, from Dissertations & Theses: A&I database. (Publication No. AAT 3265957). Iowa City, IA, The University of Iowa. Ph.D. dissertation.

Kanak, M. F., M. Titler, et al. (2008). "The effects of hospitalization on multiple units." Applied Nursing Research **21**(1): 15-22.

Kane, R., T. Shamliyan, et al. (2007a). Nurse staffing and quality of patient care: Evidence report/Technology assessment No. 151. Rockville, MD: Agency for Healthcare Research and Quality. AHRQ Publication No. 07-E005**.:** 115.

Kane, R. L., T. A. Shamliyan, et al. (2007b). "The association of registered nurse staffing levels and patient outcomes - Systematic review and meta-analysis." Medical Care **45**(12): 1195-1204.

Kohn, L. T., J. M. Corrigan, et al., Eds. (2000). To err is human: Building a safer health system. Washington, D.C., National Academy Press.

Kurtzman, E. T. and P. I. Buerhaus (2008). "New Medicare payment rules: danger or opportunity for nursing?" American Journal of Nursing **108**(6): 30-5.

Lang, T. A., M. Hodge, et al. (2004). "Nurse-patient ratios: a systematic review on the effects of nurse staffing on patient, nurse employee, and hospital outcomes." Journal of Nursing Administration **34**(7-8): 326-37.

Leiter, M. P. and H. K. Spence Laschinger (2006). "Relationships of work and practice environment to professional burnout: testing a causal model." Nursing Research **55**(2): 137-46.

Mac-Eachern, M. T. (1935). Hospital Organization and Management. Chicago,, Physicians Record Co.

Mark B., Harless D.W.& Spetz J. (2009) California's minimum-nurse-staffing legislation and nurses' wages. Health Affairs (Millwood). 28(2):w326-34. Epub 2009 Feb 10.

Mark, B. A., D. W. Harless, et al. (2007). "Nurse staffing and adverse events in hospitalized children." Policy Politics & Nursing Practice **8**(2): 83-92.

Mark, B. A., D. W. Harless, et al. (2005). "The impact of HMO penetration on the relationship between nurse staffing and quality." Health Economics **14**(7): 737-53.

Mark, B. A., D. W. Harless, et al. (2004). "A longitudinal examination of hospital registered nurse staffing and quality of care." Health Services Research **39**(2): 279-300.

Mark, B. A., L. C. Hughes, et al. (2007). "Does safety climate moderate the influence of staffing adequacy and work conditions on nurse injuries?" Journal of Safety Research **38**(4): 431-46.

Mark, B. A., J. Salyer, et al. (2002). "What explains nurses' perceptions of staffing adequacy?" Journal of Nursing Administration **32**(5): 234-42.

McGillis Hall, L., L. Pink, et al. (2006). "Decision making for nurse staffing: Canadian perspectives." Policy Politics & Nursing Practice **7**(4): 261-9.

McHenry, L. (1994). "Implementing self-directed teams." Nursing Management **25**(3): 80I-80J, 80L.

Mitchell, P. H. and S. M. Shortell (1997). "Adverse outcomes and variations in organization of care delivery." Medical Care **35**(11): NS 19-NS 32.

Needleman, J. (2008). "Is what's good for the patient good for the hospital?" Policy Politics & Nursing Practice **9**(2): 80-87.

Needleman, J., P. I. Buerhaus, et al. (2006). "Nurse staffing in hospitals: is there a business case for quality?" Health Affairs (Millwood) **25**(1): 204-11.

Norrish, B. R. and T. G. Rundall (2001). "Hospital restructuring and the work of registered nurses." Milbank Quarterly **79**(1): 55-79, IV.

O'Brien-Pallas, L., P. Griffin, et al. (2006). "The impact of nurse turnover on patient, nurse, and system outcomes: a pilot study and focus for a multicenter international study." Policy Politics & Nursing Practice **7**(3): 169-79.

Pappas, S. H. (2008). "The cost of nurse-sensitive adverse events." Journal of Nursing Administration **38**(5): 230-6.

Parish, C. (2002). "Minimum effort." Nursing Standard **16**(42): 12-3.

Rafferty, A. M., S. P. Clarke, et al. (2007). "Outcomes of variation in hospital nurse staffing in English hospitals: cross-sectional analysis of survey data and discharge records." International Journal of Nursing Studies **44**(2): 175-182.

Rathert, C. and D. R. May (2007). "Health care work environments, employee satisfaction, and patient safety: care provider perspectives." Health Care Management Review **32**(1): 2-11.

Robeznieks, A. (2008). "Saving lives, money. New model focuses on 'never events'." Modern Healthcare **38**(22): 16.

Rutherford, P., B. Lee, et al. (2004). Transforming Care at the Bedside. Innovation Series 2004. Cambridge, MA, Institute for Healthcare Improvement.

Sales, A., Sharp, N., Li, Y. F., Lowy, E., Greiner, G., Liu, C. F., et al. (2008). “The association between nursing factors and patient mortality in the Veterans Health Administration: the view from the nursing unit level.” Medical Care, **46**(9), 938-945.

.Schmalenberg, C. and M. Kramer (2007). "Types of intensive care units with the healthiest, most productive work environments." American Journal of Critical Care **16**(5): 458-68.

Seago, J. (2002). "The California Experiment: Alternatives for Minimum Nurse-to-Patient Ratios." Journal of Nursing Administration **32**(1): 48-58.

Shindul-Rothschild, J., D. Berry, et al. (1996). "Where have all the nurses gone? Final results of our Patient Care Survey." American Journal of Nursing **96**(11): 25-39.

Shukla, R. K. (1983). "All-RN model of nursing care delivery: a cost-benefit evaluation." Inquiry **20**(2): 173-84.

Sochalski, J., R. T. Konetzka, et al. (2008). "Will mandated minimum nurse staffing ratios lead to better patient outcomes?" Medical Care **46**(6): 606-13.

Sovie, M. D. (1995). "Tailoring hospitals for managed care and integrated health systems." Nursing Economic$ **13**(2): 72-83.

Sovie, M. D. and A. F. Jawad (2001). "Hospital restructuring and its impact on outcomes: nursing staff regulations are premature." Journal of Nursing Administration **31**(12): 588-600.

Spence Laschinger, H. K. and M. P. Leiter (2006). "The impact of nursing work environments on patient safety outcomes: the mediating role of burnout/engagement." Journal of Nursing Administration **36**(5): 259-67.

Spetz J., Chapman, S., Herrera, C., Kaiser, J., Seago, J.A. & Dower, C. (February 2009). Assessing the impact of California's nurse staffing ratios on hospitals and patient care. A report prepared by the Center for California Workforce Studies for the California HealthCare Foundation. Issue brief found at http://www.chcf.org/topics/view.cfm?itemID=133857 (last accessed April 3, 2009)

Spetz, J. (2008). "Nurse satisfaction and the implementation of minimum nurse staffing regulations." Policy Politics & Nursing Practice **9**(1): 15-21.

Stearley, H. E. (1996). "Stat nursing--the final analysis." Nursing Management **27**(5): 48F, 48H, 48J.

Tervo-Heikkinen, T., T. Kvist, et al. (2008). "Patient satisfaction as a positive nursing outcome." Journal of Nursing Care Quality **23**(1): 58-65.

Thrall, T. H. (2008). "Nurse staffing laws: should you worry?" Hospital Health Network **82**(4): 36-9, 1.

Thungjaroenkul, P., G. G. Cummings, et al. (2007). "The impact of nurse staffing on hospital costs and patient length of stay: A systematic review." Nursing Economic$ **25**(5): 255-265.

Titler, M., J. Dochterman, et al. (2007). "Cost of care for seniors hospitalized for hip fracture and related procedures." Nursing Outlook **55**(1): 5-14.

Titler, M., J. Dochterman, et al. (2005). "Cost of hospital care for elderly at risk of falling." Nursing Economic$ **23**(6): 290-306, 279.

Titler, M. G., G. A. Jensen, et al. (2008). "Cost of hospital care for older adults with heart failure: medical, pharmaceutical, and nursing costs." Health Services Research **43**(2): 635-655.

Unruh, L. (2008). "Nurse staffing and patient, nurse, and financial outcomes." American Journal of Nursing **108**(1): 62-71.

Unruh, L. Y., & Fottler, M. D. (2006). "Patient turnover and nursing staff adequacy." Health Services Research, **41**(2), 599-612.

Upenieks, V. V., J. Akhavan, et al. (2007). "Value-added care: a new way of assessing nursing staffing ratios and workload variability." Journal of Nursing Administration **37**(5): 243-52.

Upenieks, V. V., J. Kotlerman, et al. (2007). "Assessing nursing staffing ratios: variability in workload intensity." Policy Politics & Nursing Practice **8**(1): 7-19.

Vahey, D. C., L. H. Aiken, et al. (2004). "Nurse burnout and patient satisfaction." Medical Care **42**(2 Suppl): II57-66.

Valentine, N. M., J. Nash, et al. (2008). "Achieving effective staffing through a shared decision-making approach to open-shift management." Journal of Nursing Administration **38**(7-8): 331-5.

Washington State Nurses Association. (2007). Summary of Selected Research on Nurse Staffing and Outcomes. White paper available from WSNA.

Weinstein, J. W., Mazon, D., Pantelick, E., Reagan-Cirincione, P., Dembry, L. M., & Hierholzer, W. J., Jr. (1999). “A decade of prevalence surveys in a tertiary-care center: trends in nosocomial infection rates, device utilization, and patient acuity.” Infection Control Hospital Epidemiology, **20**(8), 543-548.

Welton, J. M. (2008). "Implications of Medicare reimbursement changes related to inpatient nursing care quality." Journal of Nursing Administration **38**(7-8): 325-30.

Welton, J. M., L. Unruh, et al. (2006). "Nurse staffing, nursing intensity, staff mix, and direct nursing care costs across Massachusetts hospitals." Journal of Nursing Administration **36**(9): 416-25.

Winters, B. D., J. Pham, et al. (2006). "Rapid response teams--walk, don't run." JAMA **296**(13): 1645-7.

Winters, B. D., J. C. Pham, et al. (2007). "Rapid response systems: a systematic review." Critical Care Medicine **35**(5): 1238-43.

Woodward, C. A., H. S. Shannon, et al. (1999). "The impact of re-engineering and other cost reduction strategies on the staff of a large teaching hospital: a longitudinal study." Medical Care **37**(6): 556-69.

Wunderlich, G. S., F. A. Sloan, et al. (1996). Nursing staff in hospitals and nursing homes: Is it adequate? Washington, D.C., National Academy Press.