Hawai'i State Center for Nursing

Nurse Staffing and Patient Outcomes:
Examining the Evidence in Acute Care and Nursing Homes

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I. Introduction

The Senate Concurrent Resolution (S.C.R. NO.76, S.D.1) is titled "Urging Healthcare Facilities in the State of Hawaii to Implement the '*Utilization Guide for the American Nurses Association Principles for Safe Staffing.*"'

The Institute of Medicine's (IOM) report, "*To Err is Human: Building a Safer Health System*" (2000) [1] acknowledges

> 'the availability of nurses, the organization of nursing care, and the types of nursing interventions vary by institution. Structuring nurse staffing (e.g., availability of nurses, organizational models of nursing care) and care interventions to meet "safe thresholds" could be considered a patient safety practice. However, no studies have evaluated thresholds explicitly.' (p. 424.)

Many are concerned with the capacity of registered nurses to maintain patient safety. The registered nurse role encompasses both surveillance and care for early identification and intervention of complications and problems in care. As Aiken [2] has reports 'as the registered nurse shortage continues, with burdensome nurse workloads, high turnover, and many unfilled hospital positions, concern is growing about the ability of nurses to fill the role effectively'.

In 2000, the American Nurses Association [3] reported that health care containment costs were affecting hospitals in three ways. First, patients have a higher acuity throughout their inpatient stay compared to previous years and require more intense nursing care. Second, the number of patients cared for by the nursing workforce (i.e., registered nurses (RNs), licensed practical nurses (LPNs), and certified nurse assistants or nurse assistants (CNA/ NAs) has increased in many settings. Third, the education and training requirements of many nurses in clinical settings is not sufficient. Since this time, staffing issues facing the profession have grown more complex as a result of numerous issues such as the shortage of registered nurses. There is concern as to whether the increased acuity of patients, the increased workload, the declining levels of training among nursing staff, and the nursing workforce shortage threatens the quality of care in acute care settings.

Table 1. The Nurse Workforce and Nurse Staffing Levels

The nurse workforce consists of licensed registered nurses (RNs), licensed practical nurses (LPNs), and nurses aides (NAs). Both RNs and LPNs are licensed by the State of Hawaii. RNs assess patient needs, develop patient care plans, and administer medications and treatments; LPNs carry out specified nursing duties under the direction of RNs. Nurses' aides typically carry out non-specialized duties and personal care activities. RNs, LPNs, and nurses' aides all provide direct patient care.

RNs have obtained their education through three different routes: 3-year diploma programs, 2-year associate degree programs, and 4-year baccalaureate degree programs. Almost a third of all RNs have a baccalaureate degree, and 7.6 percent of hospital nurses have advanced practice credentials (either a master's or doctoral degree). LPNs receive 12-18-month training programs that emphasize technical nursing tasks. Nurses' aides are not licensed but many acquire certified nurse aide or nursing assistant (CNA) status after proving they have certain skills related to the requirements of particular positions.

A number of states across the country have engaged in dialogue concerning the implementation of nurse-patient ratios. In 1999, the California State Legislature passed Assembly Bill 394 and became the first state in the nation to establish minimum nurse-patient ratios. Thus, limiting the number of patients that a registered nurse (RNs) or licensed practical nurse (LPN) may care for at any one time. That legislation, AB 394, charged the California Department of Health Services (CDHS) with determining those staffing standards. The CDHS regulations implementing the new ratios requirements went into effect in January, 2004. The bill's proponents cited a growing body of research linking nurse staffing levels and positive patient care outcomes.

However, the quality of the research evidence concerning the impact of nurse staffing levels on patient outcomes requires rigorous evaluation to inform policy. Thus, the primary purpose of this paper is to identify and discuss the quality of evidence concerning effects of nurse staffing on patient outcomes and determine whether the literature supports setting specific nurse-patient ratios in acute care hospitals. The paper will also identify work related to staffing levels and quality in nursing homes. Three systematic reviews and other supporting evidence will be used to appraise the evidence concerning nurse staffing levels and patient outcomes primarily in acute care and secondarily in nursing homes.

Measuring Staff Levels and Patient Outcomes

The challenge faced in attempting to synthesize information, and establishing what the evidence is concerning staff levels and impact on patient safety, is the lack of standardization in definition

and measurement of constructs such as 'nurse staffing levels'. This lack of consistency creates major limitations when attempting to compare variables across studies. As shown in Table 3 studies can use a variety of variables to measure nurse staffing. Of these measures, many investigators choose to examine the *structural elements of nursing care.* [1,4-7] However, a variety of different concepts can be used to represent this construct including number of nurses, number of nurse hours, percentage or ratios of nurses to patients, skill mix, organization of nursing care delivery or organizational culture, nurse workload, nurse stress, or qualification of nurses.

Table 2. Measures of Nurse Staffing

Nurse Staffing Measure	**Definition**
Nurse to patient ratio	Number of patients cared for by one nurse typically specified by job category (RN, LPN); this varies by shift and nursing unit; some researchers use this term to mean nurse hours per inpatient day
Total nursing staff or hours per patient day	All staff or all hours of care including RN, LPN, aides counted per patient day (a patient day is the number of days any one patient stays in hospital, ie., one patient staying 10 days would be 10 patient days)
RN or LPN FTEs per patient day	RN or LPN full time equivalents per patient day (FTE is 2080 hours per year and can be composed of multiple part-time or one full-time individual)
Nursing skill (or staff) mix	The proportion or percentage of hours of care provided by one category of caregiver divided by the total hours of care (e.g., a 60% RN skill mix indicates that RNs provide 60% of the total hours of care)
Proportion of hospital staff RNs with higher levels of education	The percentage of RNs with a bachelor's, master's or another degree compared to percentage of RNs holding diploma or associate degrees.

Other, less frequently used constructs are the *intervention or process measures of care* including studies based on the 'science of nursing' or 'nurses as the intervention'. For the purposes of this paper the intervention or process measures of care will not be discussed in this paper.

Systematic Reviews

Healthcare providers, consumers, researchers, and policy makers are inundated with unmanageable amounts of information. We need systematic reviews to efficiently integrate valid information and provide a basis for rational decision making. [8] Systematic reviews establish where the effects of healthcare are consistent and where they may vary significantly. Systematic reviews are valuable in informing policy and decision making. They are useful where there is uncertainty regarding the potential benefits or harm of an intervention and when there are variations in practice. By locating and synthesizing evidence from primary studies, systematic reviews provide empirical answers to focused questions.

Systematic Reviews versus Traditional Reviews

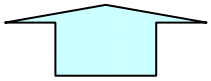
Systematic reviews differ from other types of review in that they adhere to a strict scientific design in order to make them more comprehensive, to minimize the chance of bias, and so ensure their reliability. They use a replicable, scientific and transparent approach which seeks to minimize bias. Rather than reflecting the views of the authors or being based on only a (possibly biased) selection of the published literature, they contain a comprehensive summary of the available evidence. The techniques used to ensure the reliability of the review results will vary according to whether the review is quantitative or qualitative. However, the techniques are comparable and serve to define the systematic review genre, regardless of whether it is intended to be qualitative or quantitative. All systematic reviews will include some qualitative elements. However, not all systematic reviews contain statistical analysis or synthesis.

The Hierarchy of Evidence

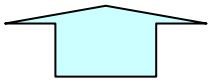
A simple assessment of the appropriateness of a study design is often used to guarantee a minimum level of quality. Study designs that are included in a review should be clearly stated in the inclusion/exclusion criteria in the protocol of the systematic review. As shown in Table 1 the quality threshold of primary studies can be determined by generating a hierarchy of study designs and setting a cut-off level for study selection. This hierarchy of study designs in Table 1 will be cited in tables of evidence used throughout this paper.

Table 3. Hierarchy of study designs*

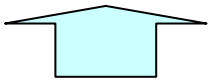
Level 1. Randomized controlled trials – includes quasi-randomized processes such as alternate allocation.



Level 2. Non-randomized controlled trial – a prospective (pre-planned) study, with predetermined eligibility criteria and outcome measures.



Level 3. Observational studies with controls – includes retrospective, interrupted time series (a change in trend attributable to the intervention), case-control studies, cohort studies with controls, and health services research that includes adjustment for likely confounding variables.



Level 4. Observational studies without controls (e.g., cohort studies without controls and case series).

* Systematic reviews and meta-analyses are assigned to the highest level study design included in the review, followed by an "A" (e.g., a systematic review that includes at least one randomized controlled trial was designated "Level 1A")

Table 4. The Hierarchy of outcome measures

Level 1. Clinical outcomes - morbidity, mortality, adverse events.

Level 2. Surrogate (proxy) outcomes - observed errors, intermediate outcomes (eg, laboratory results) with well-established connections to the clinical outcomes of interest (usually adverse events).

Level 3. Other measurable variables with an indirect or un-established connection to the target safety outcome (e.g., pre-test/post-test after an educational intervention, operator self-reports in different experimental situations).

Level 4. No outcomes relevant to decreasing medical errors and/or adverse events (e.g., study with patient satisfaction as only measured outcome; article describes an approach to detecting errors but reports no measured outcomes).

II. Acute Care Settings

Nurse Staffing and Patient Outcomes in Acute Care

Three systematic reviews were identified that examine nurse staffing and patient outcomes. The three systematic reviews include the Institute of Medicine's [1] report 'To Err is Human: Building a Safer Health System' published in 2000, Lang et al. [9] 2004 'Systematic review on the effects of nurse staffing on patient, nurse employee, and hospital outcomes', and the latest systematic review authored by Lankshear et al. [10] 2005 titled 'Nurse staffing and healthcare outcomes a systematic review of the international research evidence'.

Nurse Staffing Levels

As shown in Table 5, most studies tend to be correlational in nature. Although there is a paucity of evidence that tends to suggest that nurse staffing is negatively associated with unplanned hospital readmission and failure to rescue. [117,119-121] There remains no substantive evidence supporting a cause and effect relationship between these measures based on the correlational nature of the studies. This is also true for evidence that suggests that nurse staffing is negatively associated with increased length of stay, nosocomial infection (urinary tract infection, postoperative infection, and pneumonia), and pressure ulcers. [122-125]

Study results are inconsistent as to whether higher nurse staffing levels have a positive effect on patient outcomes. Although six [30,89,118,120,129] of the seventeen studies in Table 5 reported no association between richer nurse staffing and positive patient outcomes, the other 11 that report an association tend to be more recent, with larger samples and more sophisticated methods for accounting for confounders. However, these studies examined a variety of different types and acuities of patients which may not be representative of other patient populations. Within some patient groups such as common surgical patients there appears to be some correlational evidence that nurse staffing is associated with patient outcomes. None of the studies specifically identify the ratios or hours of care that produce the best outcomes for different groups of patients or different nursing units

Table 5 Structural Measures (adapted from Seago, 2000)

Study Setting	Study design; Outcomes	Availability of Nurse	Effect Size (coefficient, mean difference, OR*)
1. Case control study in one tertiary teaching hospital in St Louis, Missouri in 2002.	Level 3; Level 1	Patient to nurse ratio obtained from nurse staffing records (≤3; 4-6; ≥7)	Multivariate model with patient related factors for falling included increasing patient to nurse ration (OR 1.6% CI: 1.2-2.0
1. Cross sectional data were collected on 232,342 surgical patients (general, orthopedic, and vascular surgery) discharged from 168 general hospitals in Pennsylvania between April 1998 – November 1999[11,12]	Level 3; Level 1&3	50% of hospitals had nurse-patient ratio that was 1:5 or lower; 39.6% nurses had BSN or higher	Controlling for patient and hospital characteristics nurse to patient ratio was significantly associated with 30-day mortality (OR 1.07, 95% CI: 1.03-1.12, p<0.001) and failure to rescue (OR 1.07, 95% CI: 1.02-1.11, p<0.001).
2. Prospective data collected from 1,205 consecutively admitted AIDS patients in 40 units in 20 acute care hospitals. 820 (86%) RNs & LPNs were also surveyed. Hospitals from 11 US states participated[13]	Level 3; Level 1&3	0.8 mean nurses/ patient day with a range of (0.5-1.5) nurses/ patient day	RN/LPN Nurse to patient ratio was significantly associated with 30-day mortality (OR 0.46, 95% CI: 0.22-0.98, p<0.01). An additional nurse per patient day reduced the odds of dying by one-half.
3. All SICU patients who developed a central venous catheter bloodstream infection during an infection outbreak period (January 1992 through September 1993) and randomly selected controls. Cohort study: all SICU patients during the study period (January 1991 through September 1993)[14]	Level 3; Level 1	1.2 patient/ nurse and 20 nursing hours per patient day (HPPD) 1.5 patient/ nurse and 16 nursing HPPD 2 patient/ nurse and 12 nursing HPPD	There was a significant relationship between nurse to patient ratios and nursing hours and central venous catheter bloodstream infection in the SICU. For 1.2 patient/ nurse and 20 HPPD the adjusted odds ratio was 3.95 (95% CI: 1.07-14.54). 1.5 patient/ nurse and 16 nursing HPPD, 15.6 (95% CI: 1.15-211.4), and for 2 patients/ nurse and 12 HPPD, 61.5 (95% CI: 1.23-3074).
4. Cross sectional data from 39 nursing units in 11 hospitals for 10 quarters of data between July, 1993 and December, 1995 in the US[15]	Level 3; Level 1&2	Proportion of direct care RN hours; total direct care hours; Up to 87.5% RN skill mix	With patient acuity controlled, direct care RN proportion of hours was inversely associated with medication errors (-0.525, p<0.05) and decubiti (-0.485, p<0.05). Total direct care hours was positively associated with mortality (0.491, p<0.05). A curvilinear relationship was found so that as RN proportion increased, rates of all adverse events decreased up to a proportion of 88% RNs. Above that level, as RN proportion increased, the adverse outcomes increased.

5. 42 inpatient units in one 880-bed hospital in the US[16]	Level 3; Level 1&2	8.63 mean total hours of care; 69% RN skill mix; Up to 85% skill mix	With patient acuity controlled, direct care RN proportion of hours was inversely associated with medication errors/doses (-0.576, $p<0.05$) and falls (-0.456, $p<0.05$). Total direct care hours was positively associated with medication errors/doese (0.497, $p<0.05$). A curvilinear relationship was found so that as RN proportion increased, medication error rates decreased up to a proportion of 85% RNs. Above that level, as RN proportion increased, the medication error increased.
6. Cross sectional data from hospital cost disclosure reports and patient discharge abstracts from acute care hospitals in California and New York for fiscal years 1992 and 1994[17]	Level 3; Level 1&2	7.56-8.43 mean total hours of care/ nursing intensity weight (NIW); 67.7% to 70.5% RN skill mix	Total hours/NIW was inversely associated with pressure ulcer rates (-15.59, $p<0.01$). RN hours in California, but not New York, was inversely associated with pneumonia (-0.39, $p<0.01$).
7. Cross sectional data from hospital cost disclosure reports, patient discharge abstracts and Medicare data from acute care hospitals in Arizona, California, Florida, Massachusetts, New York, and Virginia for 1996[18]	Level 3; Level 1&2	5.76 mean licensed hours of care/83.3% RN skill mix	Skill mix was inversely associated with pneumonia (-0.20, $p<0.01$), postoperative infection (-0.38, $p<0.01$), pressure ulcers (-0.47, $p<0.01$), and urinary tract infections (-0.61, $p<0.01$).
8. Cross sectional data from hospital cost disclosure reports, patient discharge abstracts fro acute care hospitals in California, Massachusetts, and New York for 1992 and 1994[19]	Level 3; Level 1&2	7.67-8.43 mean total hours of care; 67.7-70.5% skill mix	RN hours were inversely associated with pneumonia (-0.39, $p<0.01$), pressure ulcer rates (-1.23, $p<0.01$), and postoperative infection (-0.47, $p<0.01$).
9. Cross sectional data from HCFA Medicare Hospital Mortality Information 1986 and the American Hospital Association 1986 annual survey of hospitals[20]	Level 3; Level 1	0.9 mean RN/ADC (average daily census); 60% skill mix	Controlling for hospital characteristics, proportion of RNs/all nursing staff was significantly associated to adjusted 30-day mortality rate (adjusted difference between lower and upper fourth of hospitals -2.5, 95% CI: -4.0 to -0.9).
10. Cross sectional data from the American Hospital Association 1986 annual survey of hospitals and medical record reviews from July 1987 to June 1988 in 6 large PPOs[21]	Level 3; Level 3	52.2 (Texas) – 67.6% (California) skill mix	Controlling for hospital characteristics, proportion of RNs/ all nursing staff was significantly related to lower problem rates (California lower rates 3.58, upper rates 2.30 $p<0.0001$)
11. Cross sectional data from the American Hospital Association Annual Survey of	Level 3; Level 1	67.8% mean skill mix	Proportion of RN FTE/ all nursing FTEs was inversely related to thrombosis after major surgery

Hospitals for 1993 and the Nationwide Inpatient Sample from the Agency for Health Care Policy and Research for 1993 (HCUP)[22]			(beta -33.22, 95% CI: -57.76 to -8.687), urinary tract infection after surgery (beta -159.41 to -421.15), and pneumonia after major surgery (beta -159.41, 95% CI: -252.67 to -66.16).
12. Cross sectional data were collected from March 1 to June 7, 1986 and included 497 patients[23]	Level 3; Level 2	Adequate staffing	The adequately staffed unit had fewer complications than the inadequately staffed unit.
13. 390 patients admitted within 1 week after stroke onset in 9 acute care hospitals in The Netherlands. Surviving patients were interviewed 6 months post stroke and asked about falls. Fall and other patient data were collected from medical records. Ward characteristics were provided by senior nurses. Complete data on 340 patients[24]	Level 3; Level 2	0.04 mean difference in nurse to patient ratios	No significant differences in falls between case and control groups in number of nurses or nurse ratios on any shift.
14. Cross sectional data for 17,440 patients across 42 ICUs in the US[25]	Level 3; Level 1-3	Mean 0.66 patient/ nurse with a range of 0.31-1.31	Neither nurse to patient ratio nor caregiver interaction was found to be significantly associated with risk-adjusted mortality.
15. Cross sectional data were collected from April, 1994-March, 1995 from 23 trusts (groups of hospitals) in Scotland[26]	Level 3; Level 1	Mean RN FTE was 1.21 per patient	There was no association between RN FTE per occupied hospital bed and mortality
16. Cross sectional data were collected from the American Hospital Association Annual survey of Hospitals in 1989-1991, the observed and predicted 30-day post-admission mortality for patients with a primary diagnosis of COPD from the HCFA Hospital Information Reports from 1989-1991 and the Medicare Case Mix Index[27]	Level 3; Level 1	RN FTE/ 100 adjusted admissions	No association between RN FTE/100 adjusted admissions and 30-day post-admission mortality for patients with COPD
17. Cross sectional data from staffing and accounting records of 60 community hospitals across the US in 1985, hospital and nursing unit surveys, 1981 case mix indexes from the Federal Register, and the Health Area Resources File[28]	Level 3; Level 3	52% RN skill mix; 33% LPN mean nursing HPPD was 4.93	No significant associations between staffing variables, medication errors, patient injuries, IV administration errors, and treatment errors.

***OR=odds ratio**

Associations between Staffing and Patient Outcomes

Failure to rescue

The incidence of failure to rescue (death within 30 days among patients who experienced complications) was lower among surgical, but not medical, patients at higher levels of RN hours per day and higher total nursing hours per day [13,29] and at lower patient loads per nurse. [12] Aiken et al. [11,12] reporting two different analyses conducted on the same Pennsylvania data identified that lower post surgical patient mortality was associated with a) lower patient-to-registered nurse ratios and b) a higher proportion of BS and MS prepared RNs.

Tourangeau et al. [30] after adjusting for case mix and patient care need found that a richer skill mix of RNs was associated with lower 30-day mortality for surgical patients whereas the total amount of nursing staff was not related. The evidence, although equivocal, supports a potential inverse association between nurse staffing and failure to rescue among surgical patients (Table 6). However, longitudinal evidence is required to support these findings in surgical patients.

In-patient mortality

In a longitudinal study, Mark et al. [31] analyzed data collected from 422 hospitals (in 11 US states) and found that an increase in RN staffing levels was associated with reduced rates of mortality. Manheim et al., [32] after adjusting for case mix, found that more RNs per admission and a richer skill mix were each associated with lower mortality rates in 3,796 hospitals in 1992. Hartz et al. [20] also reported that more RNs and a stronger RN skill mix were associated with lower mortality among 3,100 hospitals. Krakauer et al. [33] compared 2 predictive models constructed from different data sets. Both models supported a relationship between a richer RN skill mix and lower inpatient mortality. Aiken et al. [34] found similar relationships in 22 Magnet hospitals but not in a control group of 314 nonfederal hospitals. Finally, in recent analyses, Aiken et al. [11,12] found that better RN staffing was associated with improved mortality in surgical patients. (These studies analyze the same Pennsylvania data.) Bond et al. [35] found, in examination of 3,763 hospitals, weak significant relationships between the proportion of RNs per occupied bed and mortality rates among Medicare patients, adjusted for severity. Needleman et al. [29] reported no association in medical or surgical patients, and Robertson and Hassan, [27] analyzing 1989 to 1991 data, found no association between the proportion of RNs, LPNs, or NAs and 30-day post admission mortality from chronic obstructive pulmonary disease. The evidence remains inconclusive. Standardized nurse staffing measures and longitudinal evidence are required to support these findings (Table 6).

Pneumonia

The evidence between skill mix and pneumonia reported by 3 key studies is mixed: the American Nurses Association (ANA) [17,18,36] study found a relationship for California hospitals in 1992 and 1994 but not for New York hospitals for the same year, and Needleman et al. [29] found a relationship for both medical and surgical units. Mark et al. [31] reported an inverse relationship between RN staffing levels and pneumonia. Kovner and Gergen [22] found an inverse relationship between the number of RNs per patient day and pneumonia in patients after surgery but not after invasive vascular procedures. However, three studies by Cho et al., [37] Kovner et al., [38] and Unruh [39] did not find this relationship. Thus, the evidence remains unclear whether a significant inverse relationship exists between nurse staffing and pneumonia rates among medical–surgical patients (Table 6).

Urinary tract infections

The ANA study [18] found a relationship between nurse staffing and urinary tract infection (UTI) rates in California hospitals for both 1992 and 1994 and for New York hospitals only in 1994. Needleman et al. [29] reported a relationship in medical patients but not in surgical patients. Mark et al. [31] found an inverse relationship between RN staffing levels and incidence of urinary tract infections. Sovie et al. [40] found that total nursing hours per patient day was associated with a decrease in UTI rates among medical students. This finding was present only in 1998 data, however, not in 1997 data, and the clinical importance of the effect could not be assessed as a result of discrepant data. Kovner and Gergen [22] found that a higher number of RN full-time equivalents (RN FTEs) per patient day was statistically associated with lower rates, but the clinical importance of the lower rates was marginal. Recent studies report no relationship: Cho et al. [37] found no relationship between UTI rates and total nursing staffing, total RN hours, and percent of RN staffing, and Kovner et al. [38] found no association between UTI rates and RN hours per severity adjusted patient day or LPN hours per severity-adjusted patient day. There are mixed findings concerning the relationship between UTI rates and nurse staffing (Table 6).

Pressure ulcers

The 1997 ANA report found that richer skill mixes were associated with lower rates of pressure ulcers in California and New York hospitals in 1992 and 1994. [36] Total nursing hours were associated with lower rates of ulcers in New York in 1992 but not in 1994, and in California in 1994 but not in 1992. Mark et al. [31] found inverse relationships between rates of pressure ulcers and RN staffing levels. Blegen et al. [15,16] also found that a higher skill mix, up to 87.5% RN, was associated with lower rates in forty-two nursing units from one hospital. Needleman et al. [29] reported no association. Most findings from the five studies using this endpoint show no association. Whitman et al. [41]

examined staffing and patient outcomes in 95 patient care units across 10 hospitals in the Eastern US and found no significant relationships between staffing and rate of pressure ulcers. In 2005, Donaldson et al [42] reported on the first analysis of the impact of mandated minimum staffing ratios in a convenience sample of 68 acute hospitals in California. The data indicated that assessment of the impacts of the mandated ratios on the prevalence of decubiti did not reveal significant changes. The evidence is inconsistent and is not strong enough to support a relationship between nurse staffing and the incidence of pressure ulcers (Table 6).

Falls

Donaldson et al. [42] reporting on the mandated minimum staffing ratios in California found there was no significant impact on the incidence of patient falls. A case-control study of patient, education, and care-related risk factors for inpatient falls took place in one tertiary teaching hospital in St Louis, Missouri in 2002. The study examined 6 predictors of inpatient falls using multivariate analysis and found patient-to-nurse ratio as significantly associated (OR 1.6% CI: 1.2-2.0) with fall rates. However, the significance of effect was not reported. Dunton et al. 2004 [43] using 2002 data from 1,751 hospital units in the National Database of Nursing Quality Indicators found that percent of registered nurse hours had a significant inverse association with fall rates for step-down ($p<0.01$) and medical units ($p<0.05$), but not for surgical and combined medical-surgical units. However, it is unclear whether these findings are clinically significant. The paucity of evidence concerning impact of staffing levels on fall rates is equivocal and further research is required.

Other patient outcomes

Other than the single report by Needleman et al. [29] of a significant relationship between lower staffing and shock in medical patients, the evidence indicates that associations between nurse staffing and other patient outcomes studied are unclear (Table 6).

Table 6. Clinical and Statistical Significance of Findings from Studies on the Effects of Nurse Staffing on Patient Outcomes (adapted from Lang et al. 2004 [9], pp. 330-331)

Outcome	Effect Size Judged to Be Unimportant		Importance of Effect Size Uncertain		Effect Size Judged to Be Important	
	NS	P<0.05	NS	P<0.05	NS	P<0.05
1. Failure to Rescue	**Needleman, 2001*[29,44]** **Needleman, 2001*[29,44]** Silber, 1995[45]					**Aiken, 2002†[∞12]** **Needleman, 2001†[29,44]** **Needleman, 2001†[29,44]** **Aiken, 1999[‡13]** Tourangeau, 2002[30]
2. In-patient Mortality	**Needleman, 2001*[29,44]** **Needleman, 2001*[29,44]** **Needleman, 2001†[29,44]** **Needleman, 2001†[29,44]** Robertson, 1999[27] Robertson, 1999[27] Robertson, 1999[27] Silber, 1995[45] Bradbury, 1994[46] Bradbury, 1994[46] Shortell, 1988[47]	**Aiken, 2000[34]** Bond, 1999[35] Bond, 1999[35]		(Silber, 1995)[45]	(Blegen, 1998A)[16] (Blegen, 1998A)[16] Blegen, 1998A[16] Bradbury, 1994[46] Manheim, 1992[32]	**Mark, 2004[31]** **Aiken, 2002†[∞12]** **Aiken, 2000[34]** Manheim, 1992[32] Krakauer, 1992[33] Krakauer, 1992[33] Hartz, 1989[20] Hartz, 1989[20] Hartz, 1989[20]
3. Pneumonia	**Cho, 2003[37]** **Unruh, 2003[39]** **Unruh, 2003[39]** **Kovner, 2002[38]** **ANA, 2000‡[18]** **ANA, 2000‡[18]** **Kovner, 1998[22]**	**Kovner, 2002[38]** **Kovner, 1998[22]**		**Cho, 2003[37]** **Cho, 2003[37]**		**Mark, 2004[31]** **Needleman, 2001*[29,44]** **Needleman, 2001*[29,44]** **Needleman, 2001†[29,44]** **Needleman, 2001†[29,44]** **ANA, 2000§[18]** **ANA, 2000§[18]** **Kovner, 1998[22]**
4. Urinary Tract Infections	**Unruh, 2003[39]** **Unruh, 2003[39]** **Cho, 2003[37]** **Cho, 2003[37]** **Cho, 2003[37]** **Kovner, 2002[38]** **(Kovner, 2002)[38]** **Sovie, 2000[40]** **Sovie, 2000[40]** **Sovie, 2000[40]** **Sovie, 2000[40]** **Sovie, 2000[40]** **ANA, 2000[18]**	**Needleman, 2001†[29,44]** **Kovner, 1998[22]**		**Sovie, 2000[40]** **Needleman, 2001†[29,44]** **Kovner, 1998[22]**		**Mark, 2004[31]** **Needleman, 2001*[29,44]** **Needleman, 2001*[29,44]** **ANA, 2000[18]** **ANA, 2000[18]** **ANA, 2000[18]**
5. Pressure Ulcers	**Donaldson, 2005[42]** **Cho, 2003[37]** **Cho, 2003[37]** **Whitman, 2002[41]** **Needleman, 2001[29,44]** **Needleman, 2001[29,44]** **Needleman, 2001[29,44]** **Needleman, 2001[29,44]** **Sovie, 2000[40]** **Sovie, 2000[40]** **Sovie, 2000[40]** **ANA, 2000[18]** **ANA, 2000[18]** (Blegen, 1998A)[16]	**(Cho, 2003)[37]**		**Unruh, 2003[39]** **Unruh, 2003[39]** **Sovie, 2000[40]**	(Blegen, 1998A)[16]	**Mark, 2004[31]** **ANA, 2000[18]** **ANA, 2000[18]** **ANA, 2000[18]** **ANA, 2000[18]** **ANA, 2000[18]** **ANA, 2000[18]** Blegen, 1998A[16]

Findings in parentheses indicate worse outcomes with better nurse staffing.
Findings in bold are from the 12 key studies.
NS, not statistically significant at the .05 level; ANA, American Nurses Association.
*Medical patients. †Surgical patients. ‡AIDS patients.
‡New York hospitals. §California hospitals. ∞ Pennsylvania hospitals.

Table 6. Clinical and Statistical Significance of Findings from Studies on the Effects of Nurse Staffing on Patient Outcomes (Continued) (adapted from Lang et al. 2004 [9], pp. 330-331)

Outcome	Effect Size Judged to Be Unimportant		Importance of Effect Size Uncertain		Effect Size Judged to Be Important	
	NS	P<0.05	NS	P<0.05	NS	P<0.05
6. Falls	**Donaldson, 2005[42]** Dunton, 2004†[43] **Cho, 2003[37]** **Cho, 2003[37]** **Cho, 2003[37]** Arbesman, 1999[48] Taunton, 1994[49] Ceria, 1992[50] Blegen, 1989A[16] Blegen, 1989A[16] (Blegen, 1989A)[16] Blegen, 1989B[15] Wan, 1987[28] Wan, 1987[28] Kustaborder, 1983[51] Kustaborder, 1983[51]			Krauss, 2005[52] Dunton, 2004*[43] **Unruh, 2003[39]** **(Unruh, 2003)[39]** **Sovie, 2000[40]** **Sovie, 2000[40]**	**Sovie, 2000[40]** **Sovie, 2000 [40]**	Krauss, 2005[52] (Grillo-Peck, 1995)[53] Blegen, 1989B[15]
7. Nosocomial Infections	**Unruh, 2003[39]** **Unruh, 2003[39]** **Cho, 2003[37]** **Cho, 2003[37]** **Cho, 2003[37]** **Cho, 2003[37]** **Cho, 2003[37]** **Cho, 2003[37]** Whitman, 2002[41] **ANA, 2000‡**[18] (Blegen, 1998A)[16] Blegen, 1998A[16] (Grillo-Peck, 1995)[53] Shukla, 1983[54]	Taunton, 1994[49]				**ANA, 2000§**[18] ANA, 2000§[18] Haley, 1982[55]
8. Treatment Errors	Blegen, 1998B[15] (Blegen, 1998A)[16] (Blegen, 1998B)[15] Grillo-Peck, 1995[53] Grillo-Peck, 1995[53] Taunton, 1994[49] Taunton, 1994[49] Wan, 1987[28] Wan, 1987[28] Wan, 1987[28] Wan, 1987[28]	Blegen, 1998B[15] (Blegen, 1998A)[16] (Blegen, 1998B)[15] (Blegen, 1998B)[15]		Blegen, 1998A[16]		(Blegen, 1998B)[15]
9. Patient Satisfaction	Blegen, 1998A[16] (Blegen, 1998A)[16] Bostrom, 1993[56] Shukla, 1983[54] Shukla, 1983[54] Shukla, 1983[54] Hinshaw, 1981[57] Hinshaw, 1981[57]	**Sovie, 2000[40]** **Sovie, 2000[40]** Hinshaw, 1981[57] Hinshaw, 1981[57] Hinshaw, 1981[57]		Seago, 2006[58]		(Shukla, 1983)[54]
10. Unspecified Complications	**Kovner, 1998[22]** Flood, 1988[23]	(Silber, 1995)[45]			Behner, 1990[59] Flood, 1988[23]	Behner, 1990[59]
11. Venous Thrombosis	**Needleman, 2001*** [29,44] **Needleman, 2001***[29,44] **Needleman, 2001†**[29,44] **Needleman, 2001†**[29,44] **Kovner, 1998[22]** **Kovner, 2002[38]** **(Kovner, 2002)[38]**			**Kovner, 1998[22]** **Kovner, 1998[22]**		

Findings in parentheses indicate worse outcomes with better nurse staffing.
Findings in bold are from the 12 key studies.
NS, not statistically significant at the .05 level; ANA, American Nurses Association.
*Medical patients. †Surgical patients. ‡AIDS patients.
‡New York hospitals. §California hospitals. ∞Pennsylvania hospitals.

Table 6. Clinical and Statistical Significance of Findings from Studies on the Effects of Nurse Staffing on Patient Outcomes (Continued) (adapted from Lang et al. 2004 [9], pp. 330-331)

Outcome	Effect Size Judged to Be Unimportant		Importance of Effect Size Uncertain		Effect Size Judged to Be Important	
	NS	P<0.05	NS	P<0.05	NS	P<0.05
12. Pulmonary Compromise	**Unruh, 2003[39]** **Kovner, 2002[38]** **Kovner, 2002[38]** **Needleman, 2001[29,44]** **Needleman, 2001[29,44]**	**Unruh, 2003[39]** **Kovner, 1998[22]**				
13. Gastrohemorrhage	**Needleman, 2001†[29,44]** **Needleman, 2001†[29,44]** **Kovner, 1998[22]**	**Needleman, 2001*[29,44]**				**Needleman, 2001*[29,44]**
14. Shock	**Needleman, 2001†[29,44]** **Needleman, 2001†[29,44]**					**Needleman, 2001*[29,44]** **Needleman, 2001*[29,44]**
15. Morbidity	Bradbury, 1994[46] Bradbury, 1994[46]		Bradbury, 1994[46]			
16. Adverse Drug Events	**Cho, 2003[37]** **Cho, 2003[37]** **Cho, 2003[37]**					
17. Intravenous Errors	**Wan, 1987[28]** **Wan, 1987[28]**					
18. Cardiac Arrests	**Kovner, 1998[22]** Blegen, 1998B[15] Blegen, 1998B[15]					
19. Patient Injuries	(Wan, 1987)[28] (Wan, 1987)[28]					

Findings in parentheses indicate worse outcomes with better nurse staffing.
Findings in bold are from the 12 key studies.
NS, not statistically significant at the .05 level; ANA, American Nurses Association.
*Medical patients. †Surgical patients. ‡AIDS patients.
‡New York hospitals. §California hospitals. ∞Pennsylvania hospitals.

III. Nursing Homes

Appropriateness of Minimum Nurse Staffing Ratios in Nursing Homes

The Centers for Medicare & Medicaid Services (CMS) mandates certain nurse staffing requirements under the statutory authority of The Omnibus Budget Reconciliation Act of 1987 (OBRA '87). The general requirement is that nursing homes must provide "*...sufficient nursing staff to attain or maintain the highest practicable ... well-being of each resident...*" Many healthcare professionals argue this requirement, when implemented in practice, is too vague to serve as an adequate Federal standard. There are also specific minimum requirements of 8-hours of registered nurse and 24-hours of licensed nurse coverage per day. However, since this minimum is the same for all facilities (e.g., the same minimum standard for a 60 bed facility or a 600 bed facility), many professionals also agree this requirement as inadequate; they argue for a required minimum nurse staffing to resident *ratio*.

The evidence concerning nurse staffing and quality in nursing homes is minimal when compared to that found examining nurse staffing and quality outcomes in acute care settings. However correlational studies have revealed associations between nurse staffing (particularly RNs) and a number of resident outcomes. The types of outcomes examined include lower death rates, higher rates of discharges to home, improved functional outcomes; fewer pressure ulcers, fewer urinary tract infections, lower urinary catheter use, and less antibiotic use. [60-68]

Inadequate nurse staffing has been associated with inadequate feeding assistance during meals, poor skin care, lower activity participation, and less toileting assistance. [67,69-71] The results of these correlational studies led two Institute of Medicine committees to recommend higher nurse staffing in nursing facilities, including 24-hour registered nursing care. [72,73]

Institute of Medicine

In 1996, the IOM report "*Nursing Staff in Hospitals and Nursing Homes: Is it Adequate?*"[73] concluded:

> The preponderance of evidence, from a number of studies, using different types of quality measures, shows a positive relationship between nursing staff levels and quality of nursing home care, which in turn, indicates a strong need to increase the overall level of nursing staff in nursing homes. (p.153) [73]

The report, however, did not recommend appropriate levels of nursing staff, identifying that the

research literature did not define an optimal staffing level, nor how to account for varying circumstances among nursing homes, including differences in the types of care needed by individual facilities' residents (also referred to as "case-mix"). [73]

The 2000 IOM report *"Improving the Quality of Long Term Care"* [74], reiterated

> The research evidence suggests that both nursing-to-resident staffing levels and the ratio of professional nurses to other nursing personnel are important predictors of high quality of care in nursing homes. The research literature, however, does not answer the question of what particular skill mix is optimal. [73] Nor does it take into account possible substitutions for nursing staff and ways to best organize all staff. Moreover, nurse staffing levels alone are a necessary, but not a sufficient, condition for positively affecting care in nursing homes. Training, supervision, environmental conditions, leadership and management, and organizational culture (or capacity) are essential elements in the provision of quality care to residents. Overall, there is a need for sufficient, well-trained, and motivated staff to provide consumer-centered care in nursing homes, as required in OBRA 87. (p.190) [74]

Few studies have specifically examined the association between staffing and the implementation of daily care processes and none of the correlational studies including the CMS study directly measured specific care processes that may be better implemented in higher staffed homes and could explain the effects on resident outcomes.

Centers for Medicare & Medicaid Services

The most notable study done to date, by the Centers for Medicare & Medicaid Services (CMS) published in 2001 [68], titled "*Appropriateness if Minimum Nurse Staffing Ratios in Nursing Homes*" examined relationships between nurse staffing and a number of resident outcomes during its two phase study.

Phase I

Phase I established that there are critical ratios of nurses to residents below which nursing home residents are significantly at risk of quality problems. These critical ratios exist for certified nurse aides, total licensed staff, and registered nurses. This conclusion was based on analyses that were specifically designed to identify critical nurse staffing ratio thresholds, evidence that was not provided in other analyses, including the Institute of Medicine's (IOM) studies published in 1996 [73] and 2001. [72] The 2001 IOM report called for the federal government to develop minimum staffing

levels (that specify number and skill mix) for direct care that are based on case mix-adjusted standards. To develop these standards, the IOM recommended that the U.S. Department of Health and Human Services fund research to examine the actual time and staff mix required to provide adequate processes and outcomes of care consistent with the needs and variability of consumers in these settings.

CMS Phase I analyses indicated that to meet the staffing thresholds, staffing levels would have to be increased in a substantial portion of facilities. However, a major limitation of this study was that the minimum staffing levels required were projected only for an average nursing home. Many nursing homes are not average in the sense that facilities vary widely in terms of the residents they serve and the care requirements of these residents. Thus, study limitations indicate the specific thresholds identified in Phase I were tentative.

Phase II

The purpose of the CMS Phase II study [68] was to replicate the prior analyses with more recent and better quality data, and a larger, more nationally representative sample of nursing homes.

The Phase II study [68] examined associations between nursing staffing and quality of care at more than 5,000 nursing facilities in 10 states. The data revealed that among long-term residents, nurse staffing levels below 4.1 hours per resident day (below 1.3 hours per resident day for licensed nurses (RNs, LPNs) and below 2.8 hours per resident day for nurse aides and assistants could have adverse consequences such as pressure sores and urinary incontinence. [75] Thus, there appears to be evidence supporting the relationship between increases in nurse staffing ratios and avoidance of critical quality of care problems. Above identified nurse staffing thresholds, however, increased staffing did not result in improved quality. Depending on the nursing home population, the thresholds ranged between 2.4 - 2.8, 1.15 - 1.30, and 0.55 - 0.75 hours/ resident day for nurse aides, licensed staff (RNs and LPNs combined), and Registered Nurses, respectively. Although no significant quality improvements were observed for staffing levels above these thresholds, quality was improved with incremental increases in staffing up to and including these thresholds.

IV. Conclusion

Over the past 20 years the bulk of studies examining associations between nurse staffing and patient outcomes have occurred in acute care settings. However, some work has examined correlations between nurse staffing and resident outcomes in nursing facilities.

Acute Care

Predominantly cross-sectional studies with fewer longitudinal studies have been conducted examining associations between nurse staffing levels and patient outcomes (i.e., failure to rescue, inpatient mortality, medication errors, falls, decubitus ulcers, etc.). Three systematic reviews[9,10,76] and recently published peer-reviewed articles examining nurse staffing and patient outcomes provide comprehensive results that minimize the chance of bias and ensure reliability of the available evidence.

The evidence indicates that the research to date remains inconclusive of whether patient safety is significantly affected by nurse staffing levels in acute care settings. Numerous major limitations have been identified such as inconsistencies in study designs, methodology, and nursing staff measurement hampering efforts to compare findings across studies. Thus, the literature continues to remain inconclusive in supporting specific minimum nurse-patient ratios for hospitals, especially in the absence of adjustments for skill and patient mix. [9] This is highlighted by preliminary findings which suggest there may be associations between hospital staff nurses level of education and patient outcomes. Aiken [11] reports that a higher proportion of hospital staff nurses with bachelor's, master's or other type of degree is related to reductions in mortality and failure-to-rescue following common surgical procedures. Although these findings are preliminary they do begin to underscore the '*point that having more nurses, rather than more of the right ones and in the right environment, does not necessarily achieve better outcomes*'. [77] In conclusion, further research is required to substantiate significant cause and effect relationships between nurse-to-patient ratios and subsequent adverse patient outcomes.

Nursing Facilities

The phase II study conducted by the Centers for Medicare and Medicaid Services (CMS) [68] examining relationships between nurse staffing and quality of care at more than 5,000 nursing facilities in 10 states has revealed that among long-term residents, nurse staffing levels below 4.1 hours per resident day (below 1.3 hours per resident day for licensed nurses (RNs, LPNs) and below 2.8 hours per resident day for nurse aides and assistants could have adverse consequences such as

pressure sores and urinary incontinence. However, further research is required to uncover the relationship between nurse staffing levels and other important quality of care domains that adversely impact nursing home residents.

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