

## Chapter 39. Nurse Staffing, Models of Care Delivery, and Interventions

**Jean Ann Seago, PhD, RN**

University of California, San Francisco School of Nursing

### Background

Unlike the work of physicians, the work of registered nurses (RNs) in hospitals is rarely organized around disease-specific populations. Rather, patients are generally grouped by age and/or intensity of nursing care (eg, pediatrics or intensive care). Adult patients who require the least amount of nursing care (the largest proportion of hospitalized patients), may be separated into medical or surgical units but may also be combined on one unit. Because the work of RNs and other nurses is organized differently than the work of physicians, this chapter explores the literature related to nursing structure and process variables that may affect outcomes that relate to patient safety.

Investigations of patient outcomes in relationship to nurses and their professional responsibilities in hospitals commonly involve *structural measures* of care<sup>1-4</sup> including numbers of nurses, number of nurse hours, percentage or ratios of nurses to patients, organization of nursing care delivery or organizational culture, nurse workload, nurse stress, or qualification of nurses. Less commonly, studies involve *intervention or process measures* of care including studies based on the science of nursing and others using nurses as the intervention.<sup>1-5</sup> The use of structural variables rather than process measures to study the impact of nursing activities reflects the greater availability of data relating to the former (often obtainable from administrative sources) compared with the latter (typically requiring chart review or direct observation). A number of structural measures have received considerable attention, specifically measures of staffing levels in the face of major cost cutting and other changes in health care over the past 15-20 years. In 1996, the Institute of Medicine<sup>6</sup> reported that there were insufficient data to draw conclusions about the relationship between nurse staffing and inpatient outcomes. However later studies have revisited this issue, allowing us to review the literature relating patient outcomes to various measures of nurse staffing levels, such as full time equivalents (FTEs), skill mix (proportion of RN hours to total hours), or RN hours per patient day.

This chapter does not address patient outcomes as they relate to various “patient classification systems” (PCSs), although the prevalence of the use of such systems deserves mention. PCSs predict nursing care requirements at the individual patient level in order to determine unit staffing, project budgets, define an objective measure for costing out nursing services, and to maintain quality standards.<sup>8</sup> Although PCSs are used for multiple purposes, they are an inadequate tool for determining unit staffing on a daily or shift basis.<sup>9-11</sup> In addition, there are numerous patient classification systems<sup>12-14</sup> and most are specific to one hospital or one nursing unit. The validity and reliability of PCSs are inconsistent and the systems cannot be compared with each other.<sup>8-10,15-28</sup> Thus, rather than reviewing studies that analyze various PCS scores to patient outcomes, we review studies addressing the question of whether or not “safe thresholds” exist for levels of nursing care.

## Practice Description

The availability of nurses, the organization of nursing care, and the types of nursing interventions vary by institution. Structuring nurse staffing (eg, 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. This chapter reviews the precursor evidence from observational studies about the strength of the relationship between nursing variables and patient outcomes, so that possible safe thresholds may be inferred. We assess evidence that relates patient outcomes to:

- 1) *specific numbers, proportions, or ratios of nurses to patients (nurse staffing)*; Nurse availability variables generally characterize the number of hours nurses spend with patients. Typically, the time is not measured for each patient, but rather averages are measured based on the census of nurses to patients at a particular point in time. There are several common ways of accounting for this nurse staffing and no standardized way to measure it (Table 39.1).
- 2) *specific organization of nursing care delivery, nursing models of care, or organizational culture*; Organization of nursing care variables (Table 39.2) may also include various nursing care delivery models, nursing unit or hospital culture, or governance structures. An issue of governance that has been studied by Aiken<sup>29</sup> and others<sup>30</sup> includes how much autonomy a nurse has to make practice decisions, how much control she has over practice decisions, how much collaboration occurs between physicians and nurse in the organization, and communication patterns; and
- 3) *specific nursing interventions*; Although nursing interventions are frequently studied in outpatient setting,<sup>31,32-39</sup> perhaps because these venues provide nurses more flexibility to make independent decisions,<sup>40-42</sup> studies in the inpatient setting have included measures of *education, training, or retraining of nurses, providing audit data* to nurses, and capturing nurse *assessment* of patient outcomes.

The varieties of intervention studies require some comment. Education interventions are popular in nursing research because they involve less risk than interventions that directly involve patients and are more readily approved by hospitals and physicians.<sup>43-51</sup> Unfortunately, some investigators have made the assumption (which led to the failure to measure clinical outcomes) that increasing nursing knowledge or changing a practice, such as handwashing, automatically improves outcomes.<sup>52,46,48,53</sup>

Because a large part of a nurse’s job is assessment, investigators have used various nursing assessments as interventions, such as fall risk assessment, pressure ulcer risk assessment, or identification of patients at high risk for malnutrition,<sup>55-60</sup> to reduce adverse events. In multidisciplinary protocols, the nursing activity is often assessment, rather than a nursing process or procedure.<sup>49</sup>

Other process-oriented interventions that lack sufficiently rigorous data to evaluate here, include *specialty nurses*,<sup>61,62-65</sup> and *interventions based on nursing science* in the realm of nurse decision making in acute care hospitals (eg, mouth care to reduce mucositis, nonpharmaceutical

interventions to reduce pain, nausea and vomiting, increase sleep, and improve wound healing).<sup>31,66-73</sup>

### **Prevalence and Severity of the Target Safety Problem**

The target safety problems are patient adverse events such as mortality and morbidity. The challenge is to create an optimum practice environment so that nurses can ideally reduce safety problems.

Commonly studied adverse hospital events such as falls (Chapter 26), medication errors (Part III, Section A), and pressure ulcers (Chapter 27), are often used as outcome indicators for nursing practice.<sup>83-90</sup> Less commonly studied are issues related to improving basic symptom management (eg, symptoms related to poor sleep, nutrition, or physical activity, or anxiety, pain, distress and discomfort caused by symptoms, or distress caused by diagnostic tests). In the last decade there has been increasing public and legislative pressure to improve hospital environments and address some of the heretofore ignored issues.<sup>91-93</sup>

### **Opportunities for Impact**

Unfortunately, there is no definitive evidence as to specific thresholds for RN or total nursing staff hours per patient day, or nursing skill mix for various patient populations or nursing unit types. The lack of empirical evidence has been problematic for politicians, the public and the nursing community. Because decisions about nurse staffing do not have a scientific basis and are instead based on economics and anecdotes, nurse executives and managers are frequently at odds with staff nurses; especially those represented by labor unions, over staffing. Nurse executives are charged with providing safe patient care at a responsible cost. The need to constrain budgets by reducing nursing hours is in conflict with the needs of the unions and, some allege, in conflict with the needs of patients.

Based in part on some limited data, New York and Massachusetts have passed legislation requiring formulae to be developed that ensure safe patient care.<sup>95,96</sup> New Jersey has regulations which state that licensed nurses shall provide at least 65% of the direct care hours and requires an acuity system for patient classification.<sup>97</sup> California Assembly Bill 394 directs the California Department of Health Services to establish nurse-to-patient staffing ratios for acute care hospitals by January 1, 2002. Sixteen states other than California have nurse staffing legislation on the calendar but have not implemented ratios.<sup>94</sup>

Staffing and ratios are items for collective bargaining and contract negotiations in some areas.<sup>98-104</sup> Registering complains about “unsafe staffing” may be the nurses’ only recourse unless there is a negotiated agreement between the union and the hospital.

Current utilization of practices using nursing interventions to make an impact on adverse hospital events is most likely limited due to uncertainty about effectiveness of specific interventions. Resources necessary for conducting systematic studies of nursing care provided in hospitals and then implementing the practices found to be helpful are scarce.<sup>105-109</sup>

### **Study Designs**

Searches of MEDLINE from 1990, CINHALL from 1966, documents published by the American Nurses Association, and the Cochrane Collaboration Library identified no randomized clinical trials or non-randomized controlled trials analyzing nurse staffing and adverse events. The study designs for nurse availability (Table 39.3) and organization of care (Table 39.4) are

Level 2 or 3 designs. Mitchell et al<sup>111</sup> references several randomized trials in her review article. However, the articles mentioned used advanced practice nurses such as clinical nurse specialists, or home care visits as the intervention.<sup>62,112,113</sup> The study by Jorgensen et al<sup>114</sup> was set in a hospital but the comparison was between a specialty stroke unit and a regular care unit. The difference was between the different organization of stroke treatment, not nurse skill mix. The studies abstracted are observational studies that are case control, cohort, before-after, or health services research using data from large public databases.

The study designs for nurse interventions (Table 39.5) vary from Level 1 to 3. Five studies use education of nurses as the intervention, and an additional 3 studies cover enhancements to education efforts (ie, providing data to nurses about adverse events in their units).

### **Study Outcomes**

The studies of structural measures reported Level 1 or 2 outcomes, along with various other outcomes such as length of stay, patient satisfaction or nurse satisfaction. Most of the studies corrected for potential confounders and most adjusted outcomes based on patient acuity. The process measure studies vary between Level 2 and 3 outcomes. The studies also often included Level 4 outcomes, such as nurse knowledge, but these did not meet inclusion criteria. Most of the studies used adverse events such as falls, nosocomial infection, pain, phlebitis, medication errors or pressure ulcers as outcomes.

### **Evidence for Effectiveness of the Practice**

#### Nurse Staffing

Table 39.4 summarizes the findings of studies exploring measures of nurse availability. When measured at the hospital level, there is mixed evidence that nurse staffing is related to 30-day mortality.<sup>30,83,115-118</sup> There is scarce but positive evidence that leaner nurse staffing is associated with unplanned hospital readmission and failure to rescue.<sup>117,119-121</sup> There is strong evidence that leaner nurse staffing is associated with increased length of stay, nosocomial infection (urinary tract infection, postoperative infection, and pneumonia), and pressure ulcers.<sup>122-125</sup>

Results are conflicting as to whether richer nurse staffing has a positive effect on patient outcomes. Although 5<sup>30,89,118,120,129</sup> of the 16 studies in Table 39.3 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. These studies had various types and acuities of patients and, taken together, provide substantial evidence that richer nurse staffing is associated with better patient outcomes. Although the optimum range for acute care hospital nursing staffing is most likely within these ranges, 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.

#### Models of Nursing Care Delivery

The 7 studies in Table 39.4 provide mixed evidence about the relationship between organization of nursing care and patient outcomes. Aiken et al<sup>29</sup> found that hospitals with “magnet” characteristics have lower mortality in one study, but not in another,<sup>115</sup> and Shortell et

al<sup>30</sup> also does not find an association in ICUs. Seago<sup>79</sup> found a reduction in medication errors after a change to patient-focused care and Grillo-Peck et al<sup>130</sup> found a reduction in falls after a change to a RN-UAP (unlicensed assistive personnel) partner model was introduced. The 2 review articles<sup>111,131</sup> reported mixed results about whether nursing models, nurse surveillance or work environment is associated with patient outcomes. Thus, the evidence is insufficient to direct practice.

### Nursing Interventions

Table 39.5 provides details about studies using nurse interventions. The first 3 studies provide support for the idea that added education of nurses reduces infection and thrombophlebitis. The subsequent 2 studies, however, found no difference in bloodstream infection or medication error before and after added education. The overall evidence indicates that using education as the sole intervention does not always change patient outcomes. Educational interventions were related to changes in nurse practices and, in some studies, also related to decreasing adverse events.<sup>44,47,54</sup> However adding another intervention such as providing feedback data or benchmarking results, was more likely to be associated with improved patient outcomes,<sup>55-57</sup> including decreased infection rates, pressure ulcer rates, and fall rates.<sup>55-57</sup>

### **Potential for Harm**

The potential for harm of patients associated with structural interventions such as too few nurses has been documented.<sup>83-85,124,125</sup> Studies involving process interventions such as using education of nurses, providing data to nurses, and interventions based on nursing science, seem to have a low probability of harm, but that is as yet unknown.

### **Costs and Implementation**

Few of the abstracted studies mentioned cost, although several measured length of stay as an outcome variable. Pratt et al<sup>63</sup> found no difference in quality of care measures using a 100% RN skill mix and an 80% RN skill mix in 2 wards in one hospital in the United Kingdom. The cost was less with the 80% skill mix but the nurses who worked with less experienced staff reported an increase in workload and increase in stress. California is faced with impending legislated minimum nurse staffing ratios in the acute care hospitals. Based on early studies,<sup>149</sup> at least 40% of California hospitals may see a negative financial effect because of the need to increase staffing. Additionally, based on a number of predictions,<sup>150,151</sup> there is now, and there will continue to be, a significant shortage of registered nurses in the US. Thus, implementing any increase in RN staffing may be very difficult.

One investigator who provided data to nurses as the intervention related to urinary catheter infection reported an estimated cost savings of \$403,000.<sup>55</sup> Another investigator who also provided data to nurses related to nosocomial pressure ulcer rates estimated implementation costs but not cost saving.<sup>57</sup> The investigator who studied adding an IV team (specialty nurses) reported a savings of \$53,000/saved life and \$14,000/bloodstream infection. Using clean rather than sterile dressings on open postoperative wounds saved \$9.59/dressing with no change in rate of wound healing. Based on these studies, it is likely that some nursing interventions can save costs.

## Comment

The studies evaluated in this review include only medical, surgical and ICU nursing units. Other data from more specialized units, the outpatient setting, and those pertaining to subsets of patients tend to mirror the findings of the evidence evaluation, and are cited in this section alongside those abstracted and presented in the evidence tables.

The relationship of hospital environment to patient outcomes is still being debated. However, evidence using *hospital-level* data indicates increasing the percentage of RNs in the skill mix, increasing RN FTEs or hours per patient day or average daily census is associated with decreased risk-adjusted mortality.<sup>116,131,152,153</sup> Other studies, also aggregating data to the hospital level, found that increasing RN hours per patient day is associated with decreased nosocomial infection rates,<sup>121,154</sup> decreased urinary tract infections, thrombosis and pulmonary complications in surgical patients,<sup>124</sup> decreased pressure ulcers, pneumonia, postoperative infection and urinary tract infection.<sup>122,125</sup> Hunt<sup>117</sup> found that decreasing ratios were related to increasing readmission rates but were not related to mortality rates.

The cost of primary data collection has limited the number of studies using data aggregated to the individual *nursing unit*. There is some evidence that decreased nurse-to-patient ratios in the ICU was associated with an increase in blood stream infections associated with central venous catheter,<sup>126</sup> while an increase in agency nurses was related to other negative patient outcomes.<sup>156</sup> A study in the NICU setting found understaffing and overcrowding of patients led to an outbreak of *Enterobacter cloacae*.<sup>155</sup> In 42 ICUs Shortell et al. found that low nurse turnover was related to shorter length of stay<sup>30</sup>; in 65 units an increase in nurse absenteeism was related to an increase in urinary tract infection and other patient infections but not to other adverse events.<sup>157</sup> Amaravadi et al.<sup>158</sup> found that night nurse-to-patient ratio in ICUs in 9 hospitals for a select group of patients who had undergone esophagectomy was not associated with mortality but was associated with a 39% increase in length of stay and higher pneumonia rates, reintubation rates, and septicemia rates. As noted previously, Blegan et al found that as the percentage of RNs per total staff (skill mix) increased there was a decrease in medication errors, decubitus ulcers, and patient complaints up to a skill mix of 85-87% RNs.<sup>83,84</sup>

In several studies, increasing skill mix was associated with decreasing falls, length of stay, postoperative complications, nosocomial pneumonia, pressure ulcer rates, urinary tract infection, and postoperative infection.<sup>122-125,130</sup> Several studies with varying sample sizes have found skill mix to be unrelated to mortality.<sup>111,118,159,160</sup> Others have found skill mix to be unrelated to treatment problems, postoperative complications, unexpected death rates, or unstable condition at discharge<sup>129</sup> and found no relationship between skill mix or nursing hours per patient day and medication errors, falls, patient injuries, and treatment errors.<sup>161</sup> In an early study of primary (all RN) and team (skill mix) nursing care delivery models, there was no relationship between percent of RNs and quality of care as measured by nurse report<sup>162</sup> and in 23 hospitals in the Netherlands, there was no relationship between RN-to-patient ratio and incidence of falls.<sup>89</sup>

Although mixed, the overall evidence seems to indicate that proportion of RN hours per total hours and richer RN-to-patient ratios likely do not affect 30-day mortality, may be

associated with in-hospital mortality, and are probably associated with adverse events such as postoperative complications, nosocomial infection, medication errors, falls, and decubitus ulcers.

Based on recent work, nurse staffing was examined in “best practices” hospitals. This included hospitals recognized by the American Nurses Association’s Magnet Hospital program, those commended by the Joint Commission on Accreditation of Healthcare Organizations (JCAHO), those listed in *USA Today’s* Top 100 Hospitals, those listed in *US News and World Report’s* set of high-quality hospitals, those noted for having better than expected mortality for heart attacks and newborn readmission rates by the Pacific Business Group on Health (PBGH), and those recognized by the Bay Area Consumer Checkbook for high quality. There is significant variation in nurse staffing among these best practices hospitals. The staffing data for best practices hospitals do not consistently demonstrate that hospitals rated highly for quality of patient care have uniformly richer staffing than do other hospitals.<sup>74</sup> Because units within hospitals vary widely in nurse staffing and outcomes, results from data aggregated to the hospital level are difficult to interpret.

At present the literature is insufficient to make a reasoned judgment about organization of the work environment of nurses. Further work is needed in the area of nurse interventions. If there truly is to be an emphasis on reducing adverse events in hospitals and creating hospital environments that promote health and healing, resources for research related to nurses and nursing interventions must be found.

**Table 39.1. Measures of nurse staffing**

<b>Nurse Staffing Measure</b>	<b>Definition</b>
Nurse to patient ratio	Number of patients cared for by one nurse typically specified by job category (RN, Licensed Vocational or Practical Nurse-LVN or 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, LVN, aides counted per patient day (a patient day is the number of days any one patient stays in the hospital, ie, one patient staying 10 days would be 10 patient days)
RN or LVN FTEs per patient day	RN or LVN full time equivalents per patient day (an 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 (A 60% RN skill mix indicates that RNs provide 60% of the total hours of care)

**Table 39.2. Models of nursing care delivery**

<b>Nursing Care Delivery Models</b>	<b>Definition</b>
Patient Focused Care	A model popularized in the 1990s that used RNs as care managers and unlicensed assistive personnel (UAP) in expanded roles such as drawing blood, performing EKGs, and performing certain assessment activities
Primary or Total Nursing Care	A model that generally uses an all-RN staff to provide all direct care and allows the RN to care for the same patient throughout the patient's stay; UAPs are not used and unlicensed staff do not provide patient care
Team or Functional Nursing Care	A model using the RN as a team leader and LVNs/UAPs to perform activities such as bathing, feeding, and other duties common to nurse aides and orderlies; it can also divide the work by function such as "medication nurse" or "treatment nurse"
Magnet Hospital Environment/Shared governance	Characterized as "good places for nurses to work" and includes a high degree of RN autonomy, MD-RN collaboration, and RN control of practice; allows for shared decision making by RNs and managers



**Table 39.3 Structural measures: availability of nurses and patient outcomes (First 11 studies showed positive associations; final 5 studies detected no significant effect)**

Study Setting	Study Design, Outcomes	Availability of Nurses	Effect Size (coefficient, mean differences, OR)
1. Data were collected from 1,205 consecutively admitted patients in 40 units in 20 acute care hospitals and on 820 nurses in the US <sup>115</sup>	Level 3, Level 1&3	0.8 mean nurse/patient day with a range of 0.5-1.5 nurses/patient day	This measure was significantly associated with 30-day mortality (OR .46, 95% CI: 0.22-0.98). An additional nurse per patient day reduces the odds of dying by one-half.
2. All 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) <sup>126</sup>	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 patients/nurse and 20 HPPD the adjusted odds ratio was 3.95 (95% CI: 1.07-14.54), 1.5 patients/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).
3. 39 nursing units in 11 hospitals for 10 quarters of data between July, 1993 and December, 1995 in the US <sup>84</sup>	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), decubiti (-0.485 p<0.05), and complaints (-0.312, p<0.10). Total direct care hours was positively associated with decubiti (0.571, p<0.10), complaints (0.471, p<0.10), and 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.

4. 42 inpatient units in one 880-bed hospital in the US <sup>83</sup>	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/doses (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
5. 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 <sup>125</sup>	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) Nonsignificant association with postoperative infection rates.
6. 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 <sup>123</sup>	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).
7. Data from hospital cost disclosure reports, patient discharge abstracts from acute care hospitals in California, Massachusetts, and New York for 1992 and 1994 <sup>122</sup>	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) but not significant for urinary tract infections.

<p>8. Data from HCFA Medicare Hospital Mortality Information 1986 and the American Hospital Association 1986 annual survey of hospitals<sup>116</sup></p>	<p>Level 3, Level 1</p>	<p>0.9 mean RN/ADC (average daily census); 60% skill mix</p>	<p>Controlling for hospital characteristics, number of RNs/ADC was not significantly related to adjusted 30-day mortality rate but proportion of RNs/all nursing staff was significantly related to adjusted 30-day mortality rate (adjusted difference between lower and upper fourth of hospitals -2.5, 95% CI: -4.0 to -0.9)</p>
<p>9. 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<sup>128</sup></p>	<p>Level 3, Level 3</p>	<p>52.2 (Texas)- 67.6% (California) skill mix</p>	<p>Controlling for hospital characteristics, number of RNs/ADC was not significantly related to problem rate but proportion of RNs/all nursing staff was significantly related to lower problem rates (California lower rates 3.58, upper rates 2.30 p&lt;0.0001)</p>
<p>10. Data from the American Hospital Association Annual Survey of Hospitals for 1993 and the Nationwide Inpatient Sample from the Agency for Health Care Policy and Research for 1993 (HCUP-3)<sup>124</sup></p>	<p>Level 3, Level 1</p>	<p>67.8% mean skill mix</p>	<p>Proportion of RN FTEs/all nursing FTEs was inversely related to thrombosis after major surgery (beta -33.22, 95% CI: -57.76 to -8.687), urinary tract infection after surgery (beta -636.96, 95% CI: -852.78 to -421.15), pneumonia after major surgery (beta -159.41, 95% CI: -252.67 to -66.16), and pulmonary compromise after major surgery (beta -59.69, 95% CI: -117.62 to 1.76).</p>

11. Data were collected form March 1 to June 7, 1986 and included 497 patients <sup>127</sup>	Level 3, Level 2	Adequate staffing	The adequately staffed unit had fewer complications than the inadequately staffed unit.
12. 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. There is complete data on 349 patients <sup>89</sup>	Level 3, Level 2	0.04 mean difference in nurse to patient ratios	There was no statistical difference in falls between case and control groups in number of nurses or nurse ratios on any shift. Days (mean difference -0.06, CI: -0.51 to 0.39); Evening (mean difference -0.24, 95% CI: -0.97 to 0.50); Nights (mean difference 1.24, 95% CI: 0.28 to 2.20); All shifts (mean difference 0.04, 95% CI, -0.33 to 0.40).
13. 17,440 patients across 42 ICUs in the US <sup>30</sup>	Level 3, Level 1-3	Mean .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.
14. Data were collected from April, 1994-March, 1995 from 23 trusts (groups of hospitals) in Scotland <sup>117</sup>	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
15. Data were collected form 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 <sup>118</sup>	Level 3, Level 1	RN FTE/100 adjusted admissions	There was no association between RN FTE/100 adjusted admissions and 30-day post-admission mortality for patients with a primary diagnosis of COPD
16. 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 <sup>129</sup>	Level 3, Level 3	52% RN skill mix; 33% LPN mean nursing HPPD was 4.93	None of the staffing variables of interest were associated with medication errors, patient injuries, IV administration errors, or treatment errors.

**Table 39.4 Structural variables: nursing organization models and patient outcomes**

<b>Study Setting</b>	<b>Study Design, Outcomes</b>	<b>Organization of Care/Models</b>	<b>Effect Size (coefficient, mean differences, OR)</b>
Data were collected from 39 "magnet" hospitals, which are hospitals designated as good places for nurses to work, and 195 nonmagnet matched hospitals <sup>29</sup>	Level 3, Level 1	Magnet hospitals	Magnet hospitals had a 4.6% lower adjusted Medicare mortality rates (p=0.026, 95% CI: 0.9-9.4 fewer deaths per 1,000)
Data were collected from 1,205 consecutively admitted patients in 40 units in 20 acute care hospitals and on 820 nurses in the US <sup>115</sup>	Level 3, Level 1&2	Magnet hospitals (nurse control over practice variable)	Nurse control over practice was not significantly associated with any clinical outcomes, but was significantly associated with patient satisfaction (coefficient 0.56 (95% CI: 0.16-97)
17,440 patients across 42 ICUs in the US <sup>30</sup>	Level 3, Level 1-3	Magnet hospitals (nurse unit culture captured in caregiver interaction variable)	Caregiver interaction was not significantly associated with clinical outcomes, but was significantly associated with lower risk-adjusted length of stay (-0.16, p<0.05) and lower nurse turnover (-0.21, p<0.05)
Data were collected at 3 points in time; 6 month before the intervention, 6 months, and 12 months after the introduction of the new model and included the time between October 1996 to December 1997 <sup>79</sup>	Level 3, Level 2	Patient Focused Care	There was a significant reduction in medication errors between the pre-model change (0.97%) and the post-model change (0.78%, p=0.016) and no difference in the other measures
Data were collected 6 months before and 6 months after the introduction of the new model and included the time between January-June, 1992 and January-June, 1993 <sup>130</sup>	Level 3, Level 2	RN-UAP Partnership similar to Patient Focused Care	There was a significant reduction in falls (4.7732, p< 0.05) and no difference in the other measures between the pre- and post-measures.
Review article: Pierce, 1997 <sup>131</sup>	Level 3A, Level 1&2	Nursing Environment	There are mixed results in studies about whether the predictor variables related to nurses and nursing are related to the outcomes of interest or whether the conceptual models being used are incomplete.

<p>Review article: MEDLINE from 1966-1996, CINAHL from 1982-1996, Expanded Academic Index from 1989-1996, search by author for investigators known to be working in the field, manual searches of the bibliographies of review articles and monographs (Mitchell)<sup>111</sup></p>	<p>Level 3A, Level 1&amp;2</p>	<p>Nursing Environment</p>	<p>Mixed results in studies about whether nursing surveillance, quality of working environment, and quality of interaction with other professionals predict hospitals with lower mortality. With more sophisticated risk adjustment, evidence suggests that mortality and complications are related more to patient variables and adverse events may be more closely related to organizational characteristics.</p>
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**Table 39.5 Process measures: nurse intervention and patient outcomes**

<b>Study Setting</b>	<b>Study Design, Outcomes</b>	<b>Intervention</b>	<b>Effect Size (coefficient, mean differences, OR)</b>
Data were collected from 60 hospitalized patients on 1 surgical service in a university hospital in Turkey between September 1996 and September 1997 <sup>44</sup>	Level 2, Level 2&3	Added education to intervention group	Positive colonization of catheter hub was 68.6% in the control group and 25% in the intervention group (chi square=5.75, p<0.05); mean positive nurse practice scores in control group was 45.7 and 66.5 after education (p<0.05)
2 surgical and 2 medical wards in one hospital in Sweden were randomly assigned to either a control or experimental group. 18 nurses on the experimental wards and 18 nurse on the control wards; 90 patients on the experimental wards and 39 patients on the control wards; 112 Peripheral IVs on the experimental wards and 60 PIVs on the control wards <sup>47</sup>	Level 1, Level 2&3	Added education to intervention group	50% of the PIV lines in the control group had thrombophlebitis/complications compared with 21% in intervention (p<0.001); positive association observed for nurse practices related to care of PIV lines was 12% in the control group and 72% in the experimental group; there was complete nursing documentation in 10% of the control group and 66% of the experimental group.
One hospital in Spain; all nosocomial infection data between March 1982 and December 1990 <sup>54</sup>	Level 3, Level 1	Added education to intervention group	Additional training was associated with a significant 3.63% decrease (p<0.01) in nosocomial infection rates.
One university hospital in Washington, DC; all adult patients with bloodstream Infections between July 1984 and February 1994 (n=432) <sup>45</sup>	Level 3, Level 2	Added education	No significant difference in total BSI rates or central line BSI rates before, during or after the program.
One general hospital in Illinois; all omitted and wrong dose medication errors between October 1992 and March 1993 <sup>43</sup>	Level 3, Level 2	Added education	No difference in wrong dose IV medication errors for 12 months after training; there was a decrease in omitted dose IV medication errors for 12 months after training (p<0.01).

All urinary catheter-patient-days between January 1995 and September 1996 in 1 VA hospital <sup>55</sup>	Level 3, Level 2	Provided infection rate data to nurses	Pre-intervention there were 32/1000 catheter-patient days (95% CI: 22.9-43.7); for the 5 quarters post intervention, there was a significant decrease (p<0.01) in the average infection rate (17.4/1000 catheter-patient-days (95% CI: 14.6-20.6)) compared to pre-intervention
Stanford University Hospital; all pressure ulcers and nosocomial pressure ulcers during 1992 through 1996 <sup>57</sup>	Level 3, Level 2	Provided nosocomial pressure rate data to nurses plus added education	After Intervention #1, total pressure ulcer rate went from 20% to 21%; nosocomial pressure ulcer rates went from 19% to 21%. After Intervention #2 total pressure ulcer rates stayed at 21% but nosocomial pressure ulcer rates went from 21% to 13%. One-year later, total pressure ulcer rates were 10.9% and nosocomial pressure rates were 8.1%.
8. Stanford University Hospital 52 bed medical surgical unit; all falls between 1995 through 1996 <sup>56</sup>	Level 3, Level 2	Provided fall rate data to nurses and added education	Pre-intervention the fall rate ranged from 4.2 to 3.7 fall per thousand patient days (FPTPD); after Intervention #1 the fall rate was 5.2 FPTPD; after Intervention #2 the fall rate ranged from 5.1 to 3.7 FPTPD.

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