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# Longitudinal Analyses of Nurse Staffing and Patient Outcomes

## *More About Failure to Rescue*

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**Background:** Numerous studies have examined cross-sectional data to determine the relationships between nurse staffing and patient outcomes. Questions have been raised about some of the studies now in the literature regarding the use of the hospital as the unit of analysis and the cross-sectional design of the studies. Additionally, there is a concern that the primary outcomes being studied are negative.
**Objective:** Objectives of this study are to (1) compare the relationships between nurse staffing and positive patient outcomes for 3 adult medical-surgical nursing units in one university teaching hospital across 4 years (16 fiscal quarters); and (2) explore the use of 2 new failure-to-rescue (FTR) rates as outcomes, specifically FTR from medication errors and FTR from decubitus ulcers.
**Design:** This study uses secondary analyses of data viewed retrospectively with a longitudinal repeated-measures design to estimate the relationships between nurse staffing and the outcomes of interest.
**Results:** Accounting for total dollars and case mix, all patient satisfaction measures increased as total hours of care per patient day increased, and as the skill mix became richer (more RN hours/total hours) there was a higher satisfaction with pain management and physical care requests. There was an increase in FTR from medication error as the non-RN (Other) hours of care per patient day increased and there was an increase in FTR from decubitus ulcers as patient severity increased.
**Conclusion:** The overall conclusion is that it will likely be necessary to vary staffing hours and staffing mix depending on which positive patient outcome or outcomes you wish to achieve.

Recent studies[1-3] have put to rest the debate about whether nurse staffing is related to patient outcomes and the general conclusion, some would say causal relationship (J. Needleman, personal communication, March 2005), is that more nurse hours are related to a number of better patient outcomes. Because legislated nurse-to-patient staffing ratios are in place in California and are being discussed and considered in other states, hospital nurse staffing has been studied closely in the last 5 years. Reports[4,5] have clarified what staffing levels existed in some hospitals prior to legislated ratios, what costs were predicted from potential staffing changes, and have proposed various alternatives.[6] A structured analysis of the literature[7] and other studies[8-10] of nurse staffing and patient safety in acute care hospitals provide summaries of staffing ratios and the relationships to patient safety variables.

Two of the questions that have been raised about some of the studies now in the literature are the use of the hospital as the unit of analysis and the cross-sectional design of the studies. Most scientists would agree that there is a need for further research using the patient care unit/ward as the unit of analysis and for using a longitudinal

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design.[11-14] A number of researchers have used the patient care unit/ward as the unit of analysis[9,15,16] and others have looked at data longitudinally,[13,17,18] but because of cost and limited data access, few have been able to do both in one study. A third problem that is troublesome for some nurse scientists is the use of primarily negative patient outcomes (mortality, falls, medication errors) to measure the impact of the work of nurses. These adverse events are indeed critically important to both clinicians and patients, however, there are positive patient outcomes (patient satisfaction with pain management, patient satisfaction with physical care) that are impacted daily by nurses and the work of nurses in hospitals. This study seeks to address these issues, specifically; the purposes of this study are to measure nurse staffing and positive patient outcomes in 3 nursing units in one hospital over 48 months and to use positive patient events as the outcomes of the study, including the introduction of 2 new measures.

## Background of Research Design

The issue of unit of analysis is one that has perplexed organizational scientist in many studies using numerous measures.[19-21] There is no doubt that studying nurse staffing and patient outcomes at the hospital level is important and can provide information about the functioning of the systems that comprise the overall work of the hospital. The hospital data are also more readily available in public use databases such as the American Hospital Association Annual Survey and various state databases. But nurses and others are also interested in knowing about the functioning of specific patient care units/wards within a hospital. Several issues limit the creation of this knowledge. First, data for specific patient care units are typically not reported in public use databases so the researcher must obtain or collect primary data from the hospital unit. In this study, we chose to employ secondary analyses of primary data that had been collected from the same patient care units over time. The strengths of this choice are that the units are located in the same hospital (which help account for confounding organizational factors) and the methods of variable collection vary similarly for the units (ie, for any overall hospital change in the way variables were collected, the change occurred in all the units). The weakness of the choice is that the units are only in one hospital so inference to other hospitals is limited.

Second, scientists agree that understanding what happens inside a hospital requires controlling the patient's condition upon admission to the hospital. Depending on the study variable/s of interest, hospital level data are often parsed by medical diagnosis in order to account for patient medical acuity. However, much of the nursing care provided is not specifically related to the patient's medical diagnosis but rather related to the surveillance and vigilance provided by the nursing staff, the patient's symptom management, and needs of daily living. Additionally, patients are assigned a location in a hospital based on a gross, although often implicit, acuity system and/or admitting diagnoses (intensive care, intermediate care, medical-surgical, obstetrics) and age (pediatric vs. adult). In larger or specialized hospitals, patient admissions to medical-surgical patient care units are often further organized by medical diagnoses or disease systems (cardiac, oncology, transplant). So, unless the unit patient population changes, controlling for patient diagnosis/diagnoses when studying patient outcomes related to nursing care provided on the patient care unit may be unnecessary.

Using a unit-based patient classification system might be a method to control for patient condition severity or nursing intensity (rather than medical acuity),[22,23] but this seems tautological. By controlling using a patient classification score, you are controlling for nurse work, which is what you are measuring. Also, because the staffing matrix of medical-surgical units vary based on budget and other factors, most patient classification systems are unit specific and it is often difficult to use them to compare across units.[24] In this study, we elected to use a case-mix index to account for average patient acuity in the individual units. A case-mix index is assigned to each patient at discharge so an average patient care unit case mix can be calculated in the same way as an average hospital case-mix index. Case mix is a gross measure that is really a measure for estimating Medicare charges, but it provides a standard way to compare and control for acuity across units. Another way to account for work intensity of nurses might be by using the total dollar amount of direct care labor for the patient during the stay on the unit.[25,26] Organizational and/or contextual factors that were not specifically measured for these analyses, such as nurse competency level or turnover, might be accounted for using total labor dollars. Therefore, in order to account for patient severity/work intensity in this study, we added total direct care dollar amount to our models.

Third, there is tendency for readers to take the nurse staffing per patient ratio from the studies using the hospital as the unit of analysis and

concluding that this staffing ratio is what should be applied to the unit direct care providers. However, this reasoning ignores how or whether the hospital is using the work of nurses in ways other than as direct care providers to influence the patient outcomes being measured. For example, the hospital may employ clinical nurse specialists, discharge planners, quality control nurses, or infection control nurses who influence mortality, hospital-acquired infection, or other outcomes. This study seeks to measure the impact of the direct care providers on the patients in patient care units. This will ideally account for nurse resources varying consistently across units and time in this hospital. The unit of analysis in this study is the relationship between staffing and the outcome of interest across time and clustered within the unit. This brings us to the next important problem, longitudinal versus cross-sectional studies.

There is a general awareness that cross-sectional studies provide an accurate picture of the single point in time under investigation, however, the studies do not necessarily provide an accurate picture of events over time. There have been many cross-sectional studies that have substantiated the positive relationship between staffing and patient outcomes. We selected a longitudinal design for this study in order to examine the *variation* in the relationship between staffing and the outcomes of interest over time within a given unit, and to compare that variance across units. One reason there have been few nurse staffing studies using longitudinal designs is because of the analytic problem of dealing with the lack of independence of the data in a clustered and repeated-measures design. We have selected an analytic method (described later) that seeks to address these limitations.

## Background for Study Variables

Many hospital-level and patient care unit-level studies have used adverse events (mortality, medication errors, fall, decubitus ulcers) as the outcome of interest. These events are used because they provide critical information about patient safety in hospitals, they are systematically collected by the hospital incident reports as part of ongoing quality assurance programs, and can be made available to researchers for study. Using data collected by incident reporting has well-known limitations related to self-report bias and/or lack of awareness of the event. However, because direct observation of clinicians is generally not possible or very expensive, the incident report has been commonly used in both operational quality assurance programs and research. Data for this study were collected from the incident reporting system of the hospital for the adverse events, medication errors, decubitus ulcers, and falls. In the reporting system, the reporter categorizes medication errors and falls as minor, moderate, or severe based on the error-related level of injury to the patient. Decubitus ulcers are classified as mild, moderate, or severe based on the stage of development at the time of ulcer discovery.

Although not entirely satisfactory, adverse events are frequently counts standardized for comparison using patient discharges or patient days; although medication errors have also been standardized using doses ordered or doses administered. Using standardized adverse events provides useful information about the systems in the hospital or in the patient care unit. However, information that would also be useful would be how well the hospital or patient care unit staff members were able to prevent the adverse event or correct the errors to minimize or block injury to the patient. This would be particularly important information to nurses because a large part of the work of nurses in hospitals is vigilance and surveillance, critically analyzing information, and acting to intervene based on data collected. So, a measure that captures the number of injuries that *did not* happen out of those injuries that *could have* happened would be useful to nurses.

Conceptually, this idea is similar to a commonly accepted measure, failure to rescue (FTR), which was introduced by Silber et al[27,28] for the purpose of capturing the ability or inability of a hospital to "rescue" a patient from complications that occur after the patient's admission to the hospital (the more complete name is FTR from complications). The FTR rate is calculated by using the total number of complications as the denominator and the number of deaths caused by those complications as the numerator. This rate represents the hospital's inability to respond successfully to complications or to rescue the patient from complications. The FTR metric is used after controlling for patient severity on admission, typically using diagnoses and/or comorbid conditions. The use of this outcome has gained in popularity as a measure of organizational effectiveness, with nurse staffing accounting for a large component of a hospital's performance.[2,29-31] Although Clarke and Aiken[32] discuss nurse surveillance as a component of FTR, there has been little attempt to expand this idea. Additionally, because the notion of FTR from complications is an outcome that involves multiple

units and services in a hospital, reasonably, it must be used as a hospital-level outcome, not a nursing unit-level outcome.

Taking the ideas of FTR and medication error, fall, and decubitus ulcer rates together, there is the potential to create new rescue or FTR measures. It would be possible to calculate a "FTR" from medication error rate or "FTR" from falls rate (or conversely a successful rescue from error or adverse event). This takes Silber's notion of FTR from complications and applies the idea to other measures that might be more useful when measuring characteristics of a nursing unit. The idea of FTR from medication errors or FTR from decubitus ulcer are direct extensions of the idea of surgical complication FTR and approximate the success of the critical analysis and interventions taken by nursing staff when a medication error or near-miss has occurred or when a decubitus ulcer has been identified. The definition of FTR from decubitus ulcer could also include the count of nosocomial stage I pressure ulcers as part of the numerator. This would allow for the staff to intervene in order to prevent the ulcer from progressing.

The FTR from falls is the most problematic extension of the FTR from complications concept. It is reasonable to assume that increased surveillance/vigilance would prevent total fall counts/1,000 patient days but might not prevent injury once the fall has occurred. It might be possible to speculate that increased surveillance/vigilance would lead to quicker intervention once that fall has occurred, but it is not clear that it would be related to decreased injury resulting from the fall. It might be possible to use this measure if the total fall risk counts were used as the denominator and the total injury fall counts were the numerator.

To calculate the FTR from medication error measure, the number of injuries from medication errors would be the numerator and the total medication errors would be the denominator. The same method would be used to calculate the FTR from decubitus ulcers. Because the conceptualization of falls is more problematic, falls should likely continue to be counted per patient day or patient discharge or using the fall risk count, if available. This, of course, does not rid the measures of the potential for self-report bias or inconsistent definitions, however, it would measure how effectively or ineffectively a nursing unit staff team was able to prevent injuries (or rescue patients) from certain adverse events and errors.

One way to assess positive patient indicators is to use measures of patient satisfaction which most hospitals have as part of a quality assurance program. Based on long-standing tradition, the work of nurses providing direct patient care includes patient pain management, teaching patients about their disease, and providing assistance with the patients' physical care needs.[33-36] The hospital in this study uses the Press-Ganey Company survey to examine patient satisfaction in a sample of all discharged patients. Proprietary management of patient satisfaction surveys is not entirely satisfactory for the hospital or for researchers because of the usual limitations of survey data collection. The method typically involves a mailed patient survey that occurs from 1 to 3 months after discharge, so response bias is a concern. However, we elected to use responses related to the medical-surgical unit function for this study. We selected the responses to the questions, "How well your pain was controlled," "How well the nurses kept you informed," and "Nurses attitude toward your requests," as measures of patient satisfaction with pain management, patient satisfaction with instruction, and patient satisfaction with physical care, respectively. Thus, although the FTR measures are stated in the negative, we attempted to include positive outcomes of nursing care in hospital nursing units. In summary, the study is designed to examine the variation in the relationship between nurse staffing and positive patient outcomes in 3 patient care units in one hospital over 48 months, controlling for patient acuity and hospital factors.

## Design and Method

There may be variation in nurse staffing, patient acuity, and other organizational factors among nursing units even within one hospital. This study uses secondary analyses and a retrospective repeated-measures design to compare variation in the relationship between nurse staffing and patient outcomes across time in 3 acute care patient care units in a large urban tertiary care teaching hospital. This hospital provides all services associated with teaching hospitals that partner with medical schools and resident training facilities. The medical-surgical units did not have a major change in type of patient population during the time of the data collection period. Other unit variables are displayed in the Results section. Data from each calendar month (48 months) for the fiscal years 1999-2002 were gathered from internal hospital databases. The study variables of interest included patient satisfaction with pain management, patient satisfaction with instruction, patient satisfaction with physical care, and the new measures, FTR

*Table 1. Outcome Variables, Definitions, Data Sources, Distribution Family, and Within-Group Correlation Structure*

| Variable Name | Definition | Source | Distribution Family | Correlation Structure |
|---|---|---|---|---|
| Satisfaction with pain management (painsat) | Patient perception of how well pain was managed in the unit | Patient surveys | Gaussian | AR(1) |
| Satisfaction with instruction (instrsat) | Patient perception of how well they were taught about what to expect | Patient surveys | Gaussian | AR(1) |
| Satisfaction with response to requests (reqsat) | Patient perception of how well the staff responded to requests for help | Patient surveys | Gaussian | AR(1) |
| Failure-to-rescue from med errors (failresm) | Number of injuries from med errors divided by total number of med errors | Incident reporting (computed) | Negative binomial | AR(1) |
| Failure-to-rescue from decubitus ulcers (failresu) | Number of moderate or sever decubitus ulcers divided by the total number of ulcers | Incident reporting (computed) | Negative binomial | AR(1) |

from medication error, and FTR from decubitus ulcers. Predictor variables were direct care RN staff hours, direct care total staff hours, and skill mix (Tables 1 and 2). Control variables included unit case-mix index average and total direct care dollar average.

One of the most significant challenges in the study was abstracting data from different databases. Like most present-day hospitals, there is not one database, there are many databases "owned" and managed by different departments and designed for disparate purposes. As is typical, none of the databases were designed for the purpose of research so after the data were abstracted, there was a need to clean and recode some of the elements in order to be able to produce meaningful analyses.

## Analyses

Staffing data were collected from the ANSOS system, patient data and financial data were collected from the TSI system, adverse event data were collected from the online incident reporting systems, and satisfaction data were collected from the Press-Ganey raw data. Because we were interested in comparisons of the relationships between nurse staffing and patient outcomes over time, it was necessary to select an analytic method that would allow us to observe changes in those relationships. The method had to allow for comparison of the relationships between nurse staffing and the outcome variable of interest; it had to account for the repeated measures over time and the clustering of the data by unit and by time. Generalized estimating equations are methods that can be used to estimate parameters for correlated data across successive points in time and can take into account repeated measures (lack of independence) and clustering.[37] Therefore, we decided to analyze the data using Stata software and the xtgee[38] series of commands. Xtgee "fits population-averaged panel data models, specifically general linear models and allows specification of within-group correlation structures for the panels."[38(p63)] Because of the different probability distributions of the dependent variables, we specified different "families" for the various models: Gaussian for normal distributions, negative binomial if the variance is greater than the mean, and Poisson if the standard deviation is equal to the mean.[38] Because of the measurement of the variables over time and the assumption that the sampling interval length did not vary between observations, we

*Table 2. Predictor and Control Variables, Definitions, and Data Sources*

| Variable Name | Definition | Source |
|---|---|---|
| Skill mix | Proportion of RN hours divided by total hours | ANSOS/TSI (computed) |
| RNHPPD | Total RN hours divided by total patient days | ANSOS/TSI (computed) |
| All Other HPPD | All non-RN hours divided by total patient days | ANSOS/TSI (computed) |
| Total HPPD | Both RN and non-RN hours divided by total patient day | ANSOS/TSI (computed) |
| Case-mix index | Relative severity value assigned to each patient at discharge | TSI |
| Total labor dollars | Total labor dollars for direct care | TSI |

*Table 3. Means (SD) Per Month*

| | Unit A | Unit B | Unit C |
|---|---|---|---|
| Patient days | 1,012 (48) | 947 (57) | 952 (41) |
| RN hour per patient day | 6.0 (0.22) | 8.0 (0.24) | 5.4 (0.32) |
| Other hours per patient day | 2.1 (0.22) | 0.31 (0.32) | 2.09 (0.31) |
| Total hours per patient day | 8.1 (0.34) | 8.3 (0.34) | 7.49 (0.56) |
| Skill mix | 0.75 (0.02) | 0.96 (0.04) | 0.72 (0.02) |
| Case-mix index | 1.99 (0.21) | 2.63 (0.43) | 1.23 (0.09) |
| Direct care labor dollars | 380,504 (44,602) | 391,688 (46,115) | 327,622 (47,149) |
| Medication errors per 1,000 patient days | 5.9 (3.0) | 6.67 (3.4) | 5.96 (3.6) |
| Falls per 1,000 patient days | 3.5 (2.0) | 2.94 (1.9) | 4.50 (2.5) |
| Decubitus ulcers per 1,000 patient days | 0.78 (0.9) | 0.22 (0.48) | 0.48 (0.81) |
| Satisfaction with pain management (out of 100 points) | 84.2 (3.5) | 89.28 (6.4) | 80.54 (6.7) |
| Satisfaction with being kept informed (out of 100 points) | 81.5 (3) | 86.8 (9.6) | 78.2 (5.7) |
| Satisfaction with attitude to requests (out of 100 points) | 87.4 (3.3) | 93.3 (4.5) | 83.5 (5.4) |
| Failure-to-rescue from med errors (med injuries/total med errors) | 0.07 (0.12) | 0.09 (0.19) | 0.07 (0.15) |
| Failure-to-rescue from ulcers (severe ulcers/total ulcers | 0.08 (0.28) | 0.04 (0.20) | 0.05 (0.20) |

specified the within-group correlation structure with a lag, auto regression of the first order (AR(1))[38] (Table 1). Additionally, we used the Huber/White correction to control the standard errors, even if the hypothesized correlation structure was not correct.[38] The xtgee command also allowed us to specify a grouping variable (unit) and a time variable (the 48 months) to account for that lack of independence and clustering. We were able to use xtgee because our interest was in comparing 48 relationships (our unit of analysis) in 3 units and the method accounts for a number of the potential source of error (repeated measure, clustering, correlated data) we encountered in this data set.

Because of the potential co-linear status of RN staff hours, total staff hours, other hours, and skill mix, we decided to run 2 sets of models. For model set 1, the predictor variables included total nursing hours per patient day and skill mix (omitting RNHPPD and Other HPPD). For model set 2, the predictor variables included RN hours per patient day and all other nursing staff hours per patient day (excluding total hours per patient day and skill mix) (Table 2). In model set 2, we included dummy variables for two of the nursing units. We did not include them in model set 1 because skill mix was co-linear with and a proxy for one of the units. Control variables included patient acuity/severity as measured by case-mix index and total labor dollars (Table 2). There were 5 outcome variables: patient satisfaction with pain management; patient satisfaction with instructions for home; patient satisfaction with requests for assistance; FTR from medication errors; and FTR from decubitus ulcers (Table 1).

## Results

The 3 nursing units are acute medical-surgical units but vary based on patient severity, hours of care, and skill mix (Table 3). We do not specifically describe other unit characteristics because the nurse managers and administrators stated that the

*Table 4. Model Set 1*

| | PainSat Coefficient (SE) | ReqSat Coefficient (SE) | InstrSat Coefficient (SE) | FailResM Coefficient (SE) | FailResU Coefficient (SE) |
|---|---|---|---|---|---|
| Total HPPD | 2.44 (0.62)* | 2.21 (0.86)* | 3.18 (0.74)* | 0.98 (0.12)* | –0.872 (0.95) |
| Skill mix | 13.63 (3.6)* | 22.9 (5.0)* | 9.84 (4.8) | –1.3 (0.55) | –5.7 (2.8) |
| Case mix | 2.74 (0.99)* | 1.5 (1.4) | 4.02 (0.63)* | 0.08 (0.21) | 1.01 (0.91) |
| Total dollars for labor | 0.000002 (0.000006) | 0.00001 (0.000009) | –0.00002 (0.00002) | –0.000001 (0.000002) | 0.00001 (0.000004)* |
| Intercept | 47.8 (1.9)* | 44.4 (9.5)* | 48.7 (1.1)* | –9.1 (1.3)* | 1.9 (6.7) |

*$P < .01$.

*Table 5. Model Set 2*

| | PainSat Coefficient (SE) | ReqSat Coefficient (SE) | InstrSat Coefficient (SE) | FailResM Coefficient (SE) | FailResU Coefficient (SE) |
|---|---|---|---|---|---|
| RN HPPD | 2.0 (2.0) | 1.23 (1.8) | .88 (3.1) | 1.3 (0.7) | 2.4 (2.4) |
| Other HPPD | 1.3 (0.98) | 0.40 (1.2) | 4.1 (2.9) | 1.0 (0.4)* | –3.3 (2.3) |
| Case mix | 1.8 (1.0) | –0.016 (0.49) | 3.5 (1.3)* | 0.23 (0.41) | 4.2 (1.1)* |
| Total dollars for labor | 0.000002 (0.000007) | 0.00001 (0.00001) | –0.00001 (0.00002) | 0.000001 (0.000002) | 0.00001 (0.000005) |
| Unit A | –2.03 (5.4) | –4.3 (2.8)* | –9.2 (10.8) | 0.80 (2.3) | 16.4 (10.5) |
| Unit C | –3.89 (7.08) | –7.4 (2.8)* | –10.9 (11.5) | 1.2 (2.9) | 21.2 (12.7) |
| Intercept | 67.11 (16.44)* | 78.6 (16.5) | 76.4 (15.4)* | –12.9 (6.4)* | –39.7 (23.6) |

*$P < .01$.

patient population and nurse characteristics within each unit had not changed substantially over the data collection period. There is also variation of mean dollars spent on direct care labor, as well as number of adverse events and patient satisfaction scores (Table 3). When evaluating the means of various efficiency measures for the 3 units, Unit B has the fewest patient days, the highest average RN hours per patient day, the lowest Other hours per patient day, the highest total hours per patient day, the highest labor dollars, case mix, and skill mix. When evaluating efficacy measures, Unit B has the highest scores on all the patient satisfaction measures, the fewest falls and decubitus ulcers per 1,000 patient days, but the highest number of reported medication errors per 1,000 patient days. When evaluating the new measures, Unit B has the highest failure rate for medication errors but the lowest failure rate for decubitus ulcers.

The regression model results for sets 1 and 2, including coefficients and standard errors, are shown in Tables 4 and 5. In model set 1 (Total HPPD and skill mix), when accounting for total dollars and case mix, all patient satisfaction measures increase as total hours of care per patient day increases, and as the skill mix becomes richer (more RN hours/total hours), there is a higher satisfaction with pain management and physical care requests. As a reminder, skill mix is a proxy for Unit B, so the patients on Unit B were more satisfied with pain management and responses to their physical care requests. Interestingly, as case-mix index increased, satisfaction with pain management and satisfaction with instructions scores increased. In the FTR outcomes, as total hours per patient day increases, there is an increase in FTR from medication errors; and as total labor dollars increases, there is an increase in FTR from decubitus ulcers.

In model set 2 (RN HPPD and Other HPPD with Units A and C included and Unit B as a referent), when accounting for case-mix index and total dollars, both Units A and C have lower satisfaction with responses to requests compared to Unit B. Neither satisfaction with pain management scores nor satisfaction with instruction scores is significantly different among the units. As case mix increases, there is an increase in satisfaction with instruction. For the FTR outcomes, there is an increase in FTR from medication error as the non-RN (Other) hours of care per patient day increases. There is an increase in FTR from decubitus ulcers as patient severity increases.

## Conclusion

The most interesting finding in this study is that, controlling for patient severity/acuity, as total hours of care per patient day increase and as skill mix becomes richer (more RN hours), there are higher levels of patient satisfaction. These findings provide evidence to support the numerous cross-sectional studies that have found this same result. RN hours of care per patient day, by itself, is not statistically related to patient satisfaction scores. However, the finding provides direct evidence that there is need for a rich RN skill mix but also a need for higher total hours of care, if patient satisfaction is a priority.

The new FTR measures were also interesting and respond in the expected way. As total hours of care per patient day increased, FTR from medication error also increased. So having more non-RN hours is related to a decreased ability to rescue from medication error. Although not reaching significance, as skill mix becomes leaner, the FTR from medication error rate increased. Taken

together, these findings suggest that a richer skill mix but fewer total hours of care create an environment with the greatest chance of success in rescuing patients from medication errors. There was an increase in FTR from decubitus ulcers, as the case mix increased and as the total dollars increased. This makes intuitive sense as the higher patient acuity would predict the highest FTR from decubitus ulcers, perhaps based on the patient's diminished ability to heal the wound.

The overall conclusion we draw from these results is that it will likely be necessary to vary staffing hours and staff mix depending on which patient outcome or outcomes you wish to achieve. If patient severity/acuity can be measured with measures more discrete than case mix or total labor dollars, perhaps it will be found that different patient severity groups require different staffing hours and/or staff mix in order to maximize positive patient outcomes. Additionally, if patient care unit characteristics other than staffing hours and skill mix can be captured, it may be possible to identify other variables that can be varied to achieve positive patient outcomes.

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## References

1. Aiken LH, Clarke SP, Sloane DM, Sochalski J. Cause for concern: nurses' reports of hospital care in five countries. *LDI Issue Brief*. May 2001;6(8):1-4.
2. Aiken LH, Clarke SP, Sloane DM, Sochalski J, Silber JH. Hospital nurse staffing and patient mortality, nurse burnout, and job dissatisfaction. *JAMA*. October 23-30, 2002; 288(16):1987-1993.
3. Needleman J, Buerhaus PI, Mattke S, Stewart M, Zelevinsky K. *Nurse Staffing and Patient Outcomes in Hospitals*. Boston, MA: US Department of Health and Human Services, Health Resources and Service Administration; February 28, 2001. Contract 230-99-0021.
4. Spetz J, Seago JA, Coffman J, Rosenoff E, O'Neil E. *Minimum Nurse Staffing Ratios in California Acute Care Hospitals*. San Francisco, CA: California Healthcare Foundation; December 4, 2000.
5. Spetz J. What should we expect from California's minimum nurse staffing legislation? *J Nurs Adm*. 2001;31(3):132-140.
6. Seago JA. The California experiment: alternatives for minimum nurse-to-patient ratios. *J Nurs Adm*. January 2002; 32(1):48-58.
7. Seago JA. Nurse staffing, models of care, and interventions. In: Shojania KG DB, McDonald KM, Wachter RM, eds. *Making Health Care Safer: A Critical Analysis Patient Safety Practices*. Washington, DC: Agency for Healthcare Research and Quality, 2001:427-451.
8. Needleman J, Buerhaus P. Nurse staffing and patient safety: current knowledge and implications for action. *Int J Qual Health Care*. August 2003;15(4):275-277.
9. McGillis Hall L, Doran D, Pink GH. Nurse staffing models, nursing hours, and patient safety outcomes. *J Nurs Adm*. January 2004;34(1):41-45.
10. Sochalski J. Is more better?: the relationship between nurse staffing and the quality of nursing care in hospitals. *Med Care*. February 2004;42(2 suppl):II67-II73.
11. Yeh SH, Lee LN, Ho TH, Chiang MC, Lin LW. Implications of nursing care in the occurrence and consequences of unplanned extubation in adult intensive care units. *Int J Nurs Stud*. March 2004;41(3):255-262.
12. Sullivan J, Brust P, Wren PJ, Rich V. A staffing-effectiveness methodology for analyzing human resource and clinical/service screening indicator data. *Jt Comm J Qual Saf*. June 2004;30(6):322-330.
13. Spetz J. Hospital nurse wages and staffing, 1977 to 2002: cycles of shortage and surplus. *J Nurs Adm*. September 2004;34(9):415-422.
14. Wan TT. Nursing care quality in nursing homes: cross-sectional versus longitudinal analysis. *J Med Syst*. June 2003;27(3):283-295.
15. Blegen MA, Goode CJ, Reed L. Nurse staffing and patient outcomes. *Nurs Res*. 1998;47(1):43-50.
16. Blegen MA, Vaughn T. A multisite study of nurse staffing and patient occurrences. *Nurs Econ*. 1998;16(4): 196-203.
17. Seago JA, Ash M, Spetz J, Coffman J, Grumbach K. Hospital registered nurse shortages: environmental, patient, and institutional predictors. *Health Serv Res*. October 2001; 36(5):831-852.
18. Wang BB, Ozcan YA, Wan TT, Harrison J. Trends in hospital efficiency among metropolitan markets. *J Med Syst*. April 1999;23(2):83-97.
19. Hughes LC, Anderson RA. Issues regarding aggregation of data in nursing systems research. *J Nurs Meas*. 1994;2(1): 79-101.
20. Fennell ML, Flood AB. Key challenges in studying organizational issues in the delivery of healthcare to older Americans. *Health Serv Res*. 1998;33(2 Pt II):424-433.
21. Seago JA. Organizational culture in hospitals: issues in measurement. *J Nurs Meas*. 1997;5(2):165-178.
22. American Nurses Association. *Implementing Nursing's Report Card: A Study of RN Staffing, Length of Stay, and Patient Outcomes*. Washington, DC: American Nurses Publishing; 1997.
23. Lichtig LK, Knauf RA, Milholland DK. Some impacts of nursing on acute care hospital outcomes. *J Nurs Adm*. 1999; 29(2):25-33.
24. Seago JA. A comparison of two patient classification instruments in an acute care hospital. *J Nurs Adm*. May 2002;32(5):243-249.
25. Crockett MJ, DiBlasi M, Flaherty P, Sampson K. Activity-based

resource allocation: a system for predicting nursing costs. *Rehabil Nurs*. 1997;22(6):293-298, 302.
26. Diers D, Bozzo J. Nursing resource definition in DRGs. RIMS/Nursing Acuity Project Group. *Nurs Econ*. 1997; 15(3):124-130, 137.
27. Silber J, Williams S, Krakauer H, Schwartz J. Hospital and patient characteristics associated with death after surgery. *Med Care*. 1992;30(7):615-627.
28. Silber JH, Rosenbaum PR, Schwartz JS, Ross RN, Williams SV. Evaluation of the complication rate as a measure of quality of care in coronary artery bypass graft surgery [see comments]. *JAMA*. 1995;274(4):317-323.
29. Needleman J, Buerhaus P, Mattke S, Stewart M, Zelevinsky K. Nurse-staffing levels and the quality of care in hospitals. *N Engl J Med*. 2002;346(22):1715-1722.
30. Boyle SM. Nursing unit characteristics and patient outcomes. Nurs Econ. May-June 2004;22(3):111-119, 123, 107.
31. Lang TA, Hodge M, Olson V, Romano PS, Kravitz RL. Nurse-patient ratios: a systematic review on the effects of nurse staffing on patient, nurse employee, and hospital outcomes. *J Nurs Adm*. July-August 2004;34(7-8):326-337.
32. Clarke SP, Aiken LH. Failure to rescue. *Am J Nurs*. January 2003;103(1):42-47.
33. Currell R, Urquhart C. Nursing record systems: effects on nursing practice and health care outcomes. *Cochrane Database Syst Rev*. 2003: CD002099.
34. Goodman GR. How can nurses help patients work more effectively with nurses to improve the safety of patient care? Nurs Econ. March-April 2004;22(2):100-102, 170.
35. Robinson L, Hughes LC, Adler DC, Strumpf N, Grobe SJ, McCorkle R. Describing the work of nursing: the case of postsurgical nursing interventions for men with prostate cancer. *Res Nurs Health*. 1999;22(4):321-328.
36. Ron R, Bar-Tal Y. Quality nursing care survey, 1988-1990. *Qual Assur Health Care*. 1993;5(1):57-65.
37. Burchill C. Generalized estimating equations (GEE). University of Manitoba Centre for Health Policy. Available at: http://www.umanitoba.ca/centres/mchp/concept/dict/Statistics/gee.html. Accessed May 31, 2005.
38. Stata Corporation. *Stata Base Reference Manual*. Vol Cross-Sectional Time-Series. Release 8 ed. College Station, Tex: Stata Press Publication; 1985-2003.