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The Relationship Between Nurse Staffing and Patient Mortality in Medical-Surgical Units

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The Relationship between Nurse Staffing and Patient Mortality in Medical-Surgical Units: A Pilot Study

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Abstract

The purpose of this research was to investigate the relationship between patient mortality and nurse staffing and patient variables. A retrospective, quantitative, cross-sectional design was used, and the sample contained nearly 35,000 patients from 11 medical-surgical units from 4 hospitals. The effect of RN hours per patient day and RN skill mix were compared individually to mortality using binary logistical regression analysis. Patient variables including age, complication index, severity category, and total number of adverse outcomes were also compared to patient mortality. Data was obtained from administrative databases from 8 quarters between July 2005 to June 2007.

Findings from the study suggest that there may be a relationship between mortality and nurse staffing variables (RN hours per patient day and RN skill mix), but results were not consistent across all 11 units. Patient variables, especially age, severity category, and complication index were more consistent across units and therefore seemed to be better predictors of mortality than were nurse staffing variables. These results, along with similar results reported by other researchers, suggest that there is a need to further study the relationship between nurse staffing variables and patient outcomes.

A USA Today-Gallup pole recently found that for the seventh year in a row, nurses were recognized by the public for being the most trusted profession (Saad, 2008). In fact, the positive image of nursing probably attracts many new nurses, as does the desire to help people achieve wellness. Nurses are expected to adhere to the principles of beneficence and nonmaleficence outlined in the Code of Ethics by advocating for "the delivery of dignified and humane care" (American Nurses Association, 2005). Nurses are bound by the Code of Ethics to provide good care, and hospital clients expect their care to result in positive outcomes. However, studies show that poor outcomes often occur in the hospital (Aiken, 2002; Needleman, 2002; Stanton, 2004). Such outcomes include catheter-associated urinary tract infections, pneumonia, falls, infection, pressure ulcers, hospital-acquired injuries, air embolism, blood incompatibility, failure to rescue, and mortality. So when nurses are armed with the best of ethical intentions and professional guidelines, why do poor outcomes occur?

One line of research aimed to answer the question about outcomes focuses on nurse staffing. Because nurses are health care providers with 24 hour 7 day per week responsibility for patient care in hospitals, there is a logical reason to consider the influence of nurse staffing on patient outcomes. Specifically, this study examined whether or not mortality rates increase significantly when there is a decrease in time spent by registered nurses being responsible for patient care. Patient variables were also examined to ascertain their effect on patient mortality.

Literature Review

Enhanced interest in patient safety, managing cost, and staffing nursing units has lead researchers to more closely examine the relationships between nursing care and patient outcomes. A 2007 study by Van den Heede, Clarke, Sermeus, Vleugels, and Aiken solicited and synthesized the opinions of researchers recognized as experts in the area of staffing-outcomes

research in order to determine the most salient research variables. They found that in the area of nurse-staffing variables, there was almost unanimous agreement: nursing hours per patient day and proportion of RNs to total nursing staff are important variables. In the areas of patient outcomes and background variables, adverse outcomes, age, severity of illness, and co-morbidities were all important areas to investigate.

Early studies on nurse staffing and patient outcomes showed promising results. One frequently cited study by Needleman, Buerhaus, Mattke, Stewart, and Zelevinsky (2002) found that higher levels of patient care performed by registered nurses was associated with lower rates of adverse patient outcomes. A second influential study, by Aiken, Clarke, Sloanne, Sochalski, and Silber (2002), revealed that for each additional patient a nurse was assigned, there was an associated 7% increase in the probability of mortality within 30 days of hospitalization. These studies contained limitations though. Both studies used the hospital as the unit of analysis, which can obscure differences from one unit to another. In the Needleman *et al.* study, nurse staffing data lacked standardization, while patient data lacked reliable coding for secondary diagnosis present at hospital admission. The Aiken *et al.* study connected self-reported nurse-to-patient ratios to hospital-level reported mortality.

A growing trend in healthcare is to discharge less acute patients to home care or skilled facilities. New technology and medical innovations allow more acute patients to remain at the hospital. The combination of these trends leads to sicker patients – who inherently require more care – comprising a larger portion of hospital nurses' patient loads (Stanton, 2004). Higher patient loads may lead to insufficient surveillance, which results in poor patient outcomes (Kalisch, 2006). Poor patient outcomes can also be attributed to omission of necessary patient assessments, basic care needs, medication administration, patient teaching, and overall planning

(Kalisch, 2009). Tourangeau (2005) points out that an increase in nursing skill mix will lead to better surveillance, allowing nurses to catch signs of patient problems quicker, leading to fewer poor patient outcomes. Researchers argue that increased RN staffing may contribute to better patient outcomes and more research is needed.

The theoretical framework guiding this study is the revised patient mortality model by Tourangeau (2005). This model portrays patient mortality as an outcome that is affected by multiple, dynamic, interrelated variables including nurse staffing, patient characteristics, physician expertise, and hospital environment. According to this model, mortality is directly affected by patient characteristics (age, sex, comorbidity, socioeconomic status, chronicity), physician expertise, nurse capacity to work, nursing skill mix, nursing experience, and conditions affecting the nursing practice environment. Direct variables are also impacted by other direct variables, as is the case with nursing skill mix affecting conditions of the nursing practice environment. Mortality is affected by indirect variables that influence the direct variables mentioned above. For example, hospital location and teaching hospital status impact the experience level of physicians and nurses caring for patients. Professional role support influences the nursing practice environment.

Based on results from past studies and the theoretical framework, two hypotheses were developed. (1a) Higher RN hours per equivalent patient day (HPEqPD) will be significantly negatively related to mortality. (1b) Higher percentages of RNs staffed will be significantly negatively related to mortality. (2) Patient factors including (a) age, (b) log of complication index, (c) severity score, and (d) total number of bad outcomes will be significantly positively related to mortality.

Methods

Participants and Data Source

This retrospective, quantitative study included 34,838 patient cases from 11 medical-surgical units in 4 hospitals from the Catholic Health Initiatives Corporation (CHI). CHI is a non-profit organization with 120 hospitals and community-based facilities in 20 states. This study is part of a larger pilot study by Frith, Tseng, and Anderson (2008). Units excluded from this study administered intravenous vasoactive drips, were classified as intensive care step-down units, or contained more than 10 percent pediatric population. Data spans 8 quarters from July 2005 to June 2007. One of the 11 units was not opened until the last 2 quarters of the study period, but all units remained in the final data set. This study used de-identified data and was therefore exempt from a full human subjects review by a university Institutional Review Board.

Secondary data came from two administrative databases: Solucient® Operational Insights (ACTION O-I®) and Data from Source. ACTION O-I® is a proprietary system used by CHI to collect and analyze quarterly data including data on nurse staffing hours and staff mix. This data was normalized to correct for differences in personnel roles. Data from Source is an enterprise information management database used for regulatory reporting to agencies such as Joint Commission and Centers for Medicare and Medicaid Services (CMS) and for internal reporting. This second datasource provided information on patient outcomes, including mortality. Permission to conduct research using this data was granted to the primary investigator of the pilot study (Frith, Tseng, Anderson, 2008) by the Senior Vice President and Chief Nursing Officer of CHI.

Variables

Nurse staffing terms used include registered nurse (RN), licensed practical nurse (LPN), and unlicensed assistive personnel (UAP). An RN has usually received 2 or more years of post-secondary education and passed a national certification exam. An LPN usually attends one year of training and has passed a different certification exam. UAPs refer to employees who provide direct patient care but may or may not have special training or certification. Nurse staffing variables included in this study were RN hours per equivalent patient day (RN HPEqPD) and percentage of RNs in the Skill Mix (RN %). RN HPEqPD was operationally defined as the average number of RN hours per average number of patient days. RN % was defined as the proportion of RNs to all nursing staff (RN/ RN+LPN+UAP). Mortality was defined as a death that occurred during the hospitalization. Patient variables included in this study were: age, complication index, severity score, and total number of adverse events. Each patient had a complication index and a severity score based on their diagnosis related group (DRG). Complication indicies were transformed to log values to adjust for a non-normal distribution. Total number of adverse events were defined as the total number of hospital-acquired injuries, pressure ulcers, and catheter-associated urinary tract infections..

Instrumentation and Data Analysis

Descriptive statistics show the distribution of patient and nurse staffing variables across the eleven units studied. Binary logistic regression models were used to estimate the relationship between mortality and nurse staffing variables (RN HPEqPD and RN %). Use of binary logistic regression analysis requires that independent variables be absolutely independent of each other, so RN HPEqPD was run separately from RN %. Patient variables (age, log complication, severity index, and total number of bad outcomes) were also analyzed with respect to their

effects on the outcome of mortality. All analyses were performed using SPSS version 17.0, and $p < 0.05$was considered statistically significant in all analyses.

Results

Description of Units

Descriptive statistics of mortality, staffing variables, and patient variables for the eleven units studied are shown in Table 1.

Table 1. Mortality, Staffing Variables, and Patient Variables in Eleven Units.

Unit	N	Mortality (%)	RN HPEqPD	RN % in Skill Mix	Age	Comp. Index	Severity Score	Number of Adverse Events
1	1793	4%	4.63 ±0.53	44.5% ±3.5	65.8 ±22.5	-1.95	2.35	0.11 ±0.33
2	812	1 %	4.29 ±0.24	42.3% ±2.4	57.4 ±20.5	-1.43	1.65	0.13 ±0.34
3	3978	2%	4.95 ±0.29	50.0% ±1.9	59.5 ±21.0	-1.75	1.98	0.04 ±0.21
4	689	0%	5.78 ±0.50	52.9% ±3.7	60.37 ±18.0	-1.47	1.73	0.20 ±0.40
5	7755	3%	4.60 ±0.43	49.6% ±1.6	65.8 ±18.9	-1.94	2.43	0.06 ± .24
6	2907	0%	5.11 ±0.60	50.8% ±2.8	57.5 ±19.5	-1.49	1.68	0.15 ±.36
7	3392	11%	3.59 ±0.21	38.8% ±3.3	66.6 ±16.6	-1.81	2.25	0.08 ±.28
8	2833	2%	3.60 ±0.32	38.6% ±0.6	65.3 ±17.3	-1.86	2.33	0.08 ±0.28
9	2677	1%	3.71 ±0.20	43.4% ±1.3	57.0 ±18.8	-1.46	1.85	0.07 ±0.26
10	2876	1%	3.67 ±0.30	39. 6% ±1.6	66.4 ±17.2	-1.54	1.89	0.30 ±0.47
11	3068	1%	4.16 ±0.34	43.2% ±3.3	62.9 ±18.4	-1.81	2.02	0.14 ±0.36

Average mortality per unit ranged from 0% to 11% and the average mortality across all units was 2.36%, with eight of the units reporting 2% or lower. Average RN hours per equivalent patient day ranged from about 3.6 to 5.8 hours. Average RN Skill Mix ranged from about 38% to 53% across the eleven units. Patient age ranged from 0 to 107 years, with average patient age per unit ranging from 57 to 67 years with a standard deviation of about 20 years for each unit.

Significance values for the relationship between staffing variables and mortality and patient variables and mortality are shown in Tables 2 and 3 respectively, and are described in greater detail below.

Table 2. Significance Values for Relationship between Mortality and Staffing Variables.

Unit	RN % in Skill Mix	RN HPEqPD
1	0.119	0.009*
2	0.625	0.099
3	0.384	0.296
4	0.581	0.945
5	0.149	0.744
6	0.350	0.521
7	0.049*	0.006*
8	0.037*	0.053
9	0.932	0.142
10	0.252	0.671
11	0.999	0.725

* indicates $p < 0.05$

Table 3. Significance Values for Relationship between Mortality and Patient Variables.

Unit	Age	Complication Index	Severity Score	Total No. Adverse Events
1	0.000*	0.027*	0.000*	0.028*
2	0.311	0.235	0.003*	0.996
3	0.000*	0.260	0.000*	0.717
4	0.314	0.251	1.000	0.991
5	0.000*	0.001*	0.000*	0.335
6	0.010*	0.011*	0.201	0.652
7	0.000*	0.000*	0.000*	0.603
8	0.000*	0.000*	0.006*	0.008*
9	0.006*	0.361	0.182	0.784
10	0.003*	0.749	0.000*	0.177
11	0.000*	0.036*	0.227	0.793

* indicates $p < 0.05$

Effect of Staffing Variables on Mortality

Among the staffing variables studied, there was insufficient evidence to determine a strong relationship with mortality. For both RN HPEqPD and RN % in skill mix, only 3 out of 11 units demonstrated a significant negative relationship with mortality.

Hypothesis 1a. RN HPEqPD was found to be significantly negatively related to mortality for units 1 and 7 (P=.009 and P=.006). Interestingly, these units reported the highest average mortality rates (4% and 11%, respectively). The relationship between RN HPEqPD and mortality was not significant for the remaining 9 units. However, it is interesting to note that units 4 and 6 were the only units with a mortality average of 0% and also were the only two units with an RN HPEqPD greater than 5 hours.

Hypothesis 1b. RN % Skill Mix was significantly negatively related to mortality for units 7 and 8 (P=.049 and P=.037), and the average mortality of these units was 11% and 2%, respectively. Significance was not found in the remaining 9 units. Unit 7 was the only unit for which mortality was significantly affected by both staffing variables studied (RN HPEqPD and RN % in skill mix).

Effect of Patient Variables on Mortality

Patient variables studied shared a stronger relationship with mortality compared to staffing variables based on number of units with a significant relationship. Of the 11 units studied, patient variables in 10 units total were significantly positively related with mortality.

Hypothesis 2a. Patient age was significantly positively related to mortality in the following nine units: unit 1 (P=.000), unit 3 (P=.000), unit 5 (P=.000), unit 6 (P=.010), unit 7 (P=.000), unit 8 (P=.000), unit 9 (P=.006), unit 10 (P=.003), unit 11 (P=.000).

Hypothesis 2b. Complication index was significantly positively related to mortality in the following six units: unit 1 (P=.027), unit 5 (P=.001), unit 6 (P=.011), unit 7 (P=.000), unit 8 (P=.000), unit 11 (P=.036).

Hypothesis 2c. The severity score was significantly positively related to mortality in the following seven units: unit 1 (P=.000), unit 2 (P=.003), unit 3 (P=.000), unit 5 (P=.000), unit 7 (P=.000), unit 8 (P=.006), unit 10 (P=.000).

Hypothesis 2d. The total number of adverse events was significantly positively related to mortality in only units 1 and 8 (P=.028 and P=.008, respectively).

Discussion

Summary

This study found that although there was evidence for a significant relationship between nurse staffing variables and patient mortality, the relationship was not consistent across the 11 units studied. Because this was part of a pilot study, it is important to identify how to strengthen the next, larger study. Results would probably be more conclusive if more hospitals and units were included in the study. Although each unit contained a large number of patients, there are likely more variables (Tourangeau, 2005) that affect patient mortality than just these two staffing measures. Additionally, indirect variables that affect staffing patterns and nursing skill mix, such as teaching hospital status and location, will vary among different hospitals. Including a larger number of units in the sample from a larger variety of hospitals would provide more variation in nurse staffing and more variation in the characteristics of the nursing units in hospitals.

Implications

Future research should be planned to include nurse staffing and patient outcome from a variety of hospital systems. Because different hospital systems use different management and

strategies and make different financial decisions, nurse staffing and indirect variables that affect patient mortality might have more variability in the independent and dependent variables. However, collecting data from different hospital systems introduces the threat of inconsistent data. There is a need for consistent nurse staffing and patient outcome definitions to be proposed and accepted in the nursing profession. The National Quality Forum (NQF, 2007), National Database for Nursing Quality Indicators (Mumolie, Lichtig, & Knauf, 2007) and the California Nursing Outcomes Coalition (Aydin, Bolton, Donaldson, Brown, & Mukerji, 2008) have begun this work. Hospitals and hospital systems need to collect administrative data in forms that are consistent with these emerging sets of definitions.

The dependent variable, mortality, may also need to be addressed in future research. The data used in this study was not 30-day mortality (patient death in hospital or within 30 days of discharge), which has been commonly used by other researchers. Because the patient mortality model clearly indicates that more variables than just nurse staffing affect patient mortality, and death related to error in care can occur after discharge, it is also important to extend the definition of mortality in future studies to include death within 30 days of discharge from a hospitalization.

Findings from this study and existing literature on the subject of nurse staffing and patient outcomes suggest the importance of adequate RN staffing, but are not conclusive as to how much is the "right dose." Utilization of multiple statistical tools, standard definitions, and large data sets is needed to determine where the "sweet spot" lies for nurse staffing to achieve the best patient outcomes.

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References

Aiken, L. H., Clarke, S. P., Sloane, D. M., Sochalski, J, & Silber, J. H. (2002). Hospital nurse staffing and patient mortality, nurse burnout, and job dissatisfaction [Electronic version]. *Journal of the American Medical Association, 288*, 1987-1993.

American Nurses Association. (2005). Code of ethics for nurses with interpretive statements. Retrieved March 31, 2009, from http://www.nursingworld.org/MainMenuCategories/ThePracticeofProfessionalNursing/EthicsStandards/CodeofEthics.aspx

Aydin, C., Bolton, L., Donaldson, N., Brown, D., & Mukerji, A. (2008). *Beyond Nursing Quality Measurement: The Nation's First Regional Nursing Virtual Dashboard.* from http://www.ahrq.gov/qual/nurseshdbk/

Frith KH, Tseng F, Anderson F. The effect of nurse staffing on patient outcomes in acute care hospitals. In 2008 Mini Grant Proceedings. Huntsville, AL: University of Alabama in Huntsville. 2008.

Mumolie, G., Lichtig, L., & Knauf, R. (2007). The Implications of Nurse Staffing Information: The Real Value of Reporting Nursing Data. *Nursing Economics, 25*(4), 212-215,227.

National Quality Forum. (2007). Tracking NQF-Endorsed Consensus Standards for Nursing-Sensitive Care: A 15-Month Study [Electronic Version], from http://www.qualityforum.org/pdf/reports/Nursing70907.pdf

Needleman, J., Buerhaus, P., Mattke, S., Stewart, M., Zelevinsky, K. (2002). Nurse-staffing levels and the quality of care in hospitals. *The New England Journal of Medicine, 346*(22), 1715-1722.

Saad, L. (2008, November 24). Nurses shine, bankers slump in ethics ratings: Annual Honesty and ethics poll rates nurses best of 21 professions. *USA Today/Gallup.* Retrieved March 31, 2009, from http://www.gallup.com/poll/112264/Nurses-Shine-While-Bankers-Slump-Ethics-Ratings.aspx#1

Stanton, M. W. (2004). Hospital nurse staffing and quality of care. *Research in Action, Issue 14* (AHRQ Publication No. 04-0029). Rockville, MD, Retrieved September 7, 2008, from http://www.ahcpr.gov/research/nursestaffing/nursestaff.pdf

Tourangeau, A. E. (2005). A theoretical model of the determinants of mortality. *Advances in Nursing Science, 28*(1), 58-69.

Van den Heede, K., Clarke, S. P., Sermens, W., Vleugels, A., & Aiken, L. H. (2007). International expert's perspectives on the state of the nurse staffing and patient outcomes literature. *Journal of Nursing Scholarship, Fourth Quarter*, 290-297.