1. TITLE PAGE

Title: Changes in Hospital Care Organization and Outcomes

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2. STRUCTURED ABSTRACT

Purpose: The purpose of this K08 award was to prepare the recipient for an independent health services research career, with a special focus on nursing outcomes research. The aims of the study were to examine the effect of changes over time in nurse staffing, nurse education, nurse practice environments, and patient characteristics within hospitals on medical-surgical patient outcomes and on nurse outcomes related to nurse retention.

Scope: Few longitudinal analyses have studied the relationship between hospital nursing organization, including nurse staffing, nurse education and the nurse practice environment, and patient and nurse outcomes. Longitudinal analyses may strengthen the argument for a causal relationship between nursing and outcomes.

Methods: This study employed a retrospective, observational, two-stage panel design to assess effects of changes in nurse staffing, nurse education, practice environments, and patient characteristics on patient and nurse outcomes using secondary data sources in a sample of Pennsylvania hospitals.

Results: Increases in the proportion of nurses with a baccalaureate degree within hospitals was associated with concurrent reductions in surgical patient mortality rates over time. Increases in the proportion of complex surgical patients (having at least three comorbid chronic conditions) treated in a hospital were associated with increases in mortality for all patients. Rates of adverse nurse job outcomes increased in hospitals where the work environment worsened over time, whereas hospitals that improved their work environments reduced the rates of these adverse nurse outcomes.

Key Words: hospital, nursing, nurse practice environments, nurse education, patient mortality, nurse retention, outcomes research

3. PURPOSE

The purpose of this K08 Mentored Clinical Scientist Award was to prepare the recipient for an independent health services research career with a special focus on nursing outcomes research. The career development plan entailed three approaches to achieve the immediate and long-term career goals of the candidate, including 1) the completion of training dedicated to acquiring skills in advanced health services research methods and statistics, and gaining additional content knowledge in the area of chronic illness, 2) the enlistment of an expert mentorship team, and 3) the conduct of a study to evaluate the longitudinal effects of changes in hospital care organization and patient characteristics (specifically chronic conditions), on patient and nurse outcomes.

The specific aims of the research project were 1) to examine the effect of changes over time in nurse staffing, nurse education, nurse practice environments, and patient characteristics within hospitals on medical-surgical patient outcomes and 2) to examine the effect of changes over time in nurse staffing, nurse education, nurse practice environments, and patient characteristics within hospitals on nurse outcomes related to nurse retention.

4. SCOPE

A recent systematic review commissioned by AHRQ empirically confirms the general consensus of the health services research field that nurse staffing levels are associated with patient outcomes. However, doubt still remains regarding the nature of the relationship and causality. To help ascertain the true nature of the relationship, longitudinal examinations are warranted. Few longitudinal analyses of nurse staffing and patient outcomes have been performed. Therefore, there is a need to further test this relationship over time on a variety of outcomes. Nurse education and nurse practice environments have also been associated with patient outcomes; however, few, if any, studies to date have examined the effects of changes in these features of hospital care organization over time on outcomes.

As a result of the documented adverse effects of widespread hospital restructuring and re-engineering on quality of care and nurse satisfaction in the late 1980s and 1990s and the intense national focus in reducing medical errors following the Institute of Medicine (IOM)'s landmark study published in 1999, nurse staffing levels and the condition of nurse practice environments have been a topic of debate. As evidence of the connection between patient outcomes and nursing care emerged, the federal government called for formal reports by the IOM on the adequacy of hospital nurse staffing and on the impact of nurse practice environments on patient safety in its quality series. As the evidence continues to grow today, some 23 states have passed or are considering legislation or regulatory actions governing hospital nurse staffing, and California adopted minimum hospital nurse staffing mandates in 2004. Given the priority of improving patient safety over the past decade and the implication of nurse workforce factors in patient safety, it is timely to evaluate to what extent nursing factors have improved, especially considering several recent reports suggesting that care quality in hospitals has improved. A less acknowledged change over the past decade, but an important one to consider, is the increasingly complex nature of hospital patients, especially due to the increasing prevalence of comorbid chronic conditions, such as diabetes. In light of these changes in hospitals and their patients,

along with evidence of a continuing nurse shortage, policymakers and hospital administrators will be most interested to learn which types of nursing resource investments deliver the most value in terms of patient outcomes and nurse retention.

The purpose of this study was to explore the relationships between longitudinal changes in hospital care organization, patient characteristics, and patient and nurse outcomes since the 1999 landmark IOM report on medical errors. Changes in nurse staffing, nurse education, nurse practice environments, and patient characteristics within hospitals were assessed using unique nurse survey data collected in Pennsylvania at two time points: 1998-1999 and 2006. Patient data from the Pennsylvania Healthcare Cost Containment Council (PHC4) were obtained for the years coinciding with the administration of the comprehensive surveys of nurses practicing in all of the state's hospitals. Two primary patient outcomes were studied, including 30-day mortality and failure-to-rescue. Nurse outcomes that have been empirically linked to nurse retention were studied, and included job satisfaction, burnout and intentions to leave positions.

5. METHODS

Study Design

This study employed a retrospective, observational, two-stage panel design to assess longitudinal effects of changes in nurse staffing, nurse education, practice environments, and patient characteristics on patient and nurse outcomes using secondary data sources. Hospital-level analyses were performed to assess the effect of changes in hospital care organization and patient characteristics on the selected patient and nurse outcomes.

Data Sources

Nurse Survey Data. In both 1998-1999 and 2006, nurses completed a self-administered paper survey mailed to their homes and returned them directly to a data processing center. Major categories of questions included 1) characteristics of the respondent's present position, work experience, highest degree earned in nursing, and detailed demographic information; 2) the Nursing Work Index-Revised; 3) nurse outcomes, including job satisfaction, intentions to leave their current position, and the Maslach Burnout Inventory; and 4) number of patients cared for on last shift and information about those patients. Using a technique field-tested in PA, respondents who work in hospitals identified the hospital where they are employed using a code from a list of all hospitals in the state.

Administrative Patient Outcomes Data. Hospitals in Pennsylvania are required to submit information on all administrative inpatient claims to the Pennsylvania Healthcare Cost Containment Council (PHC4), an independent state agency. PHC4 compiles and edits these data quarterly and makes them available for use in approved studies. Records in these data files include facility identification, patient demographics, admission information, principal ICD-9-CM diagnosis and procedure codes and up to eight secondary diagnoses and procedures, payer, length of stay, discharge status (alive/dead) and destination, and CMS-DRG assignment. The PHC4 discharge files also contain an admission severity-of-illness code, which can be used to adjust hospital mortality rates. In addition, death record files were linked to the patient discharge

records so that 30-day mortality rates that included deaths outside the hospital could be calculated. Patients 20-85 years of age and older with a principal diagnosis of acute myocardial infarction or with a diagnosis-related group (DRG) classification of general, orthopedic, and vascular surgery were included in the study. Patient selection was based on previous work by Drs. Linda Aiken and Jeffrey Silber.

Administrative Hospital Data. The American Hospital Association (AHA) Annual Survey collects information on organizational structure, facilities and services, and total beds for all hospitals in the U.S., including non-AHA members.

Measures

Patient Outcomes. Using the patient discharge data, two primary outcome variables were examined: 30-day mortality and failure-to-rescue (death following a complication). Patient outcomes were examined at the hospital level. Risk-adjusted rates for each outcome were calculated at both time points. The risk adjustment model included age, sex, a set of 27 comorbidities as defined by Elixhauser and colleagues (excluding fluid and electrolyte problems and coagulopathy), transfer status, and DRGs. This risk adjustment model has been used in previous work by Drs. Jeffrey Silber and Linda Aiken, who were both mentors on this K Award.

Nurse outcomes. Three nurse job outcomes related to retention were assessed in this study: burnout, job dissatisfaction, and intention to leave current position. The nine-item emotional exhaustion subscale of the Maslach Burnout Inventory was used to measure nurse burnout. Nurses were considered to have "high" burnout who had a score of 27 or above on the emotional exhaustion subscale, the published norm for health professions. A single item on the nurse survey that asked about the degree to which nurses were satisfied with their jobs was used to measure job satisfaction. Intention to leave was measured using a single survey item that asked whether the respondent was planning on changing jobs in the next year. Risk-adjusted rates for each of the nurse outcomes were calculated for each year. The risk adjustment model included individual nurse characteristics of age, sex, education, full-time status, and unit type.

Nurse staffing. Nurses were asked to report the number of patients cared for on their last shift on the survey. Nurses who reported caring for at least one but no more than 20 patients on their last shift were included in the staffing measure. Responses were aggregated so that a mean number of patients cared for on the last shift was created for each hospital at both points in time.

Nurse education. On the survey, nurses were asked to report the highest degree earned in nursing. The percentage of nurses who reported a baccalaureate degree as their highest degree in nursing was calculated for each hospital at both points in time.

Nurse practice environment. The nurse practice environment was measured by the Practice Environment Scale of the Nursing Work Index (PES-NWI), developed by Dr. Eileen Lake. The PES-NWI, derived from the Nursing Work Index-Revised, has been adopted by the National Quality Forum as the standard for measuring hospital nurse practice environments. Participants respond on a four-point Likert scale of strongly agree, somewhat agree, somewhat disagree, and strongly disagree. Hospital-level measures of the nurse practice environment were created by aggregating the individual nurses' responses for each subscale.

Then, hospital nurse practice environments were categorized as "better" (highest quartile), "mixed" (middle quartiles), or "poor" (lowest quartile) in each year. To classify how hospitals changed over the two time points, hospitals were identified as "improved" if they moved from "poor" to "mixed," "mixed" to "better," or "poor" to "better." Hospitals "worsened" if they moved from "better" to "mixed," "mixed" to "poor," or "better" to poor." Hospitals that did not change categories were classified as "no change."

Chronic conditions. Comorbid chronic conditions of interest were derived from secondary diagnoses fields on the patient discharge record. The comorbid chronic conditions were based on 30 conditions identified by Elixhauser and colleagues as being associated with increased length of stay and mortality. Examples include diabetes, mental illness, obesity, and chronic pulmonary disease. "Complex chronic illness" was measured by the proportion of surgical patients in each hospital with at least three chronic health conditions.

Covariates. Hospital structural characteristics were drawn from the 1999 and 2006 AHA Annual Survey data for each year. Variables included hospital size, teaching status (ratio of resident/fellow physicians to beds), and technology status (capability for open heart surgery and/ or organ transplants).

Data Analysis

Two panel datasets were constructed. The first contained 137 hospitals and hospital-level measures of nursing organization and rates of nurse outcomes in each year. The second dataset contained 134 hospitals and hospital-level measures of nursing organization and rates of patient outcomes in each year. In each dataset, difference measures for each hospital were derived to measure the direction and magnitude of the change in each variable of interest (except for change in practice environment that was previously described). The data set also included codes for the (largely) fixed hospital characteristics (size, technology, and teaching status) and for the compositional characteristics of the patients (i.e., percent with chronic conditions) in the different hospitals in the 2 years. Measures of the changes in these compositional characteristics were also derived from the yearly measures.

We chose to use a two-period difference model to estimate the changes in both nurse and patient outcomes that were associated with changes in nurse staffing ratios, education, practice environment, and patient characteristics. Using a difference model approach effectively accounted for all unmeasured variables that did not change over time.

Limitations

This study was limited by two time points of data. Three or more time points are often necessary to provide a more complete assessment of causal trends. Even though a fixed effects difference model approach was employed, the potential for unmeasured variable bias exists. Hospitals may have changed over time in ways that affected changes in mortality that were not captured by our data. The study was also limited to hospitals in Pennsylvania. Although this state is large and geographically diverse, these relationships deserve further study in broader contexts.

Mortality rates improved significantly over time. This trend may have limited our ability to detect effects for all three hospital care organization variables of interest. Also, average nurse staffing levels did not change significantly over the time period, therefore limiting our ability to assess how changes in staffing might affect changes in outcomes.

6. RESULTS

Patient Outcomes

Surgical Patients. Although the average percentage of nurses in a hospital with a baccalaureate degree did not change significantly between the two time points, how individual hospitals changed over time in terms of their nurses' educational composition was associated with changes in surgical patient mortality and failure-to-rescue. A 10% increase in the number of nurses with a baccalaureate degree was associated with an average decrease of 2.1 deaths per 1000 patients ($p<0.01$) and an average decrease in the number of deaths following a complication by 7.5 deaths per 1000 patients ($p=0.001$). Changes in patient outcomes were not associated with changes in staffing or practice environment over time (see limitations).

Medical Patients. Among patients who had experienced an acute myocardial infarction (AMI), mortality rates increased slightly in hospitals where staffing worsened over time (the number of patients per nurse was increased), although this effect was marginally significant ($p=.10$).

Complex Chronic Illness. The percentage of patients with at least three comorbidities increased from 12% in 1999 to 19% in 2006. Increases in the proportion of complex surgical patients (having at least three comorbid chronic conditions) treated in a hospital were associated with increases in mortality for all patients. A 10% increase in the proportion of patients with at least three comorbidities in a hospital was associated with increased rates of mortality for all patients by an additional 53 deaths per 1,000 patients ($p=0.001$).

Nurse Outcomes

Changes in nurse practice environments were associated with changes in rates of nurse burnout, job satisfaction, and intentions to leave their current job over time. The rates of burnout, intent to leave, and job satisfaction increased in hospitals where the practice environment got worse over time. Hospitals that improved their practice environments reduced the rates of these adverse nurse outcomes. Improvements in nurse staffing were associated with reduced rates of nurse burnout.

Complex Chronic Illness: Changes in nurse outcomes (burnout, job dissatisfaction, and intent to leave) were not associated with changes in complexity.

Discussion

This study sought to understand how patient and nurse outcomes over time may be a function of both changes in hospital care organization, including nurse staffing, education, and practice environments, and changes in the complexity of hospital patient populations. Results from this study offer policymakers and administrators stronger evidence to support nursing in hospitals. Our analysis of patient outcomes revealed that increases in the proportion of baccalaureate-prepared nurses were associated with reduction in 30-day surgical mortality and failure to rescue rates over time. This was the first longitudinal study to demonstrate such a relationship. This study showed that improvements in nurse practice environments and nurse staffing were associated with a range of nurse job outcomes related to nurse retention. Hospitals where nurses felt increasingly supported in their work, had stronger collegial relations with physicians, and participated more in the larger affairs of the hospital experienced significant decreases in rates of job dissatisfaction, intentions to leave, and burnout, which are of paramount importance to administrators, especially during a nursing shortage. The growth of comorbid chronic conditions in the general population has raised concern about the treatment of these complex patients in hospitals. Results of this study indicated that rates of comorbid complex chronic illness among hospitalized patients increased significantly between 1999 and 2006, with negative implications, particularly for all patients in a hospital. It will be critical in future work to understand the underlying mechanisms of this relationship and how to most effectively and efficiently organize care delivery to optimize outcomes for all patients.

7. LIST OF PUBLICATIONS AND PRODUCTS

Brooks Carthon JM, Jarrin O, Sloane DM, Kutney-Lee A. Racial, ethnic & gender disparities in the incidence of postsurgical complications among older adults. *Under review*

Brooks Carthon M, Kutney-Lee A, Jarrín O, et al. Nurse staffing and post-surgical outcomes in older Black patients. *J Am Geriatr Soc* 2012; 60(6): 1078-1084.

Brooks Carthon JM, Kutney-Lee A, Sloane D, et al. Quality of care and patient satisfaction in hospitals with high concentrations of Black patients. *J Nurs Scholarsh* 2011; 43(3): 301-310.

Kutney-Lee A, Kelly D. (2011). The effect of hospital electronic health record adoption on nurse-assessed quality of care and patient safety. *J Nurs Adm* 2011; 41(11): 466-472.

Kutney-Lee A, Melendez-Torres GJ, McHugh MD et al.. Distinct enough? A national examination of Catholic hospital affiliation and patient perceptions of care. *Under review*

Kutney-Lee A, Quinn L, Witkoski Stimpfel A, et al. The Magnet transformation: Changes in nurse and patient outcomes in emerging Magnet hospitals. *In preparation*

Kutney-Lee A, Sloane DM, Aiken LH. Investment in baccalaureate prepared nurses improves patient outcomes: A longitudinal perspective. *Under review*

Kutney-Lee A, Wu ES, Sloane DM, et al. Effect of changes in hospital nurse work environments on nurse job outcomes: an analysis of panel data. *Int J Nurs Stud* 2012; http://dx.doi.org/10.1016/j.ijnurstu.2012.07.014

McHugh MD, Kutney-Lee A, Cimiotti JP, et al. Nurses' widespread job dissatisfaction, burnout and frustration with health benefits signal problems for patient care. *Health Aff* 2011 Feb; 30(2): 202-210.