Using an Electronic Health Record to Examine Nurse Continuity and Pressure Ulcers

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THESIS

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LIST OF ABBREVIATIONS

ADN	Associate Degree in Nursing
APU	Admission Pressure Ulcer
BSN	Bachelor of Science in Nursing
CNO	Chief Nursing Officer
EHR	Electronic Health Record
FT	Full-Time
HANDS	Hands on Automated Nursing Data System
HAPUs	Hospital-Acquired Pressure Ulcers
LCH	Large Community Hospital
LOS	Length of Stay
NANDA-I	North American Nursing Diagnosis Association International
NOC	Nursing Outcomes Classification
NIC	Nursing Interventions Classification
NNN	NANDA-I NOC NIC
POC	Plan of Care
PT	Part-Time
PU	Pressure Ulcer
SCH	Small Community Hospital
SNT	Standardized Nursing Terminology
UH	University Hospital
VPT	Very Part-Time
Whppd	Worked hours per patient day

Abstract

The influence of nurse staffing on patient outcomes is an increasing focus of research as hospital administrators reorganize nursing care delivery to contain costs. One nurse-staffing variable, nurse continuity, and its influence on patient outcomes has been infrequently studied, in part due to multiple continuity definitions and difficulty in measuring this concept. This dissertation first presents literature support for a new conceptual model of nurse continuity to guide research. A review of the worldwide, English language research literature on nurse continuity was performed and evidence supporting the proposed conceptual model was described. We then present findings from applying this conceptual model to examine the influence of nurse continuity on hospital-acquired pressure ulcers (HAPUs). A secondary data analysis of the Hands on Automated Nursing Data System (HANDS), an electronic nursing plan of care database with standardized nursing terminologies, was conducted. The database contained 42,403 episodes documented by 787 nurses in four hospitals on nine units to include nurse staffing and patient characteristics. Data mining created an analytic dataset of 840 care episodes, 210 with and 630 without HAPUs, matched by patient characteristics, patient age, and with nursing units. Logistic regression analysis estimated the influence of nurse continuity and additional nurse-staffing variables on HAPUs. Nurse continuity was not significantly associated with HAPU development. Similarly, none of the interaction terms created with nurse continuity and the additional nurse-staffing variables generated statistically significant relationships with HAPU development. These initial findings suggest that nurse continuity and other nurse staffing variables may not be primary factors in HAPU development. Future studies with a multivariate continuity definition and more than one hospital-acquired adverse event are indicated to continue examining the potential influence of nurse continuity on patient outcomes. Understanding the importance of nurse-

staffing variables such as nurse continuity when scheduling nurses and assigning patients may be a critical strategy for nurse leaders seeking to reduce adverse patient outcomes.

I. Introduction

The purpose of this study was to explore the influence of nurse continuity on hospital-acquired pressure ulcers (HAPUs). The central study hypothesis is that when nurse continuity is present there will be fewer pressure ulcers than when nurse continuity is absent. The moderating effect of nurse continuity and other nurse-staffing variables on HAPU development was also studied. The specific aims of this study were: Aim 1 - To determine which patient characteristics in the HANDS database (Age, Skin, Nutrition, Mobility, Hydration, Continence, Cognition, Perfusion) influence pressure ulcer development for the purpose of creating an analytic dataset; and Aim 2 - Using the analytic dataset and controlling for the patient characteristics, determine the influence of nurse continuity (number of consecutive days cared for by the same/single RN) and nurse-staffing variables (worked hours per patient day [whppd], patient-to-nurse ratio, RN experience, RN education, shift length [8- versus 12-hours], and RN work pattern [number of shifts cared for by very part-time {0.3 FTE or less} versus part/full-time staff {>0.3–1.0 FTE}]) on the presence of hospital-acquired pressure ulcers.

The intent of the first manuscript (Chapter 2) is to present the literature support for a new conceptual model of nurse continuity. A review of the literature revealed multiple definitions and measures of continuity, but few nursing studies that sought to measure the influence of nurse continuity on patient outcomes. In addition, most nurse-staffing conceptual models either did not include a nurse continuity variable or did not adequately describe either the direct influence of nurse continuity or the combined influence of nursing continuity and other potentially relevant nurse-staffing variables on patient outcomes.

The new conceptual model presented depicts the relationships: (1) of nurse continuity on patient outcomes, (2) among nurse continuity, nurse characteristics and patient outcomes, (3)

among nurse continuity, unit environment characteristics and patient outcomes, and (4) of patient characteristics on patient outcomes. The first three relationships are based on the hypothesis that nurse continuity is an integral nurse-staffing variable that can both directly influence patient outcomes and moderate other nurse-staffing or unit environment variables to influence patient outcomes, such as fewer hospital-acquired pressure ulcers (HAPUs). Providing patients with consistent nurse caregivers will potentially lead to improved assessments, monitoring, and decision making resulting in more timely interventions and improved patient outcomes. This model served as the conceptual framework for the proposed secondary data analysis with HANDS.

The intent of the second manuscript (Chapter 3) is to present the findings of the secondary data analysis using the Hands on Automated Nursing Data System (HANDS). Data mining was used to create an analytic dataset of 210 HAPUs and 630 matched controls for the study. Data mining was chosen as the strategy for this portion of the analysis because the database contained a very small number of HAPU episodes distributed unevenly over nine clinical units and a large number of variables that could be confounding factors to the research hypothesis. Data mining, specifically cluster mining, helped to identify where the HAPU episodes were located in the original dataset and then to identify similar episodes without HAPUs but having the same risk factors of patient age, unit, and patient characteristics to create the analytic dataset. Cluster mining allowed the creation of an analytic dataset for a proposed regression with a cluster solution that matched episodes with similar risk factors but different HAPU outcomes. A logistic regression was then performed, regressing HAPU outcomes against nurse continuity and other nurse-staffing variables. A second logistic regression introduced interaction terms between nurse continuity and each nurse-staffing variable to examine nurse

continuity as a potential moderator that enhances the influence of other nursing-staffing variables on HAPU development.

Additional documents included in this manuscript as appendices include the letter of waiver for Human Rights Determination from the University of Illinois at Chicago Institutional Review Board (IRB), the Agency for Healthcare Research and Quality (AHRQ) Dissertation Grant Number 1R36HS023072-01 proposal which provided funding to support this research, and my vita.

II. Defining a New Conceptual Model and an Innovative Approach for Measuring the Influence of Nurse Continuity on Patient Outcomes

Introduction

One of the biggest challenges faced by contemporary Chief Nursing Officers (CNOs) is addressing out-of-control healthcare costs even as they balance the imperative of providing safe, high quality patient care. Historically and in this current era CNOs have been confronted with nursing services reorganization efforts (e.g., lowering nurse-to-patient ratios, decreasing registered nurse [RN] care hours)[1] as a means to respond to cost over runs. Implementation of reorganization strategies have occurred in part because nurse leaders have been ineffectual in demonstrating the connection between nursing care delivery and positive care outcomes. One early care model, primary nursing, was a victim of this reorganization, resulting most significantly in the loss of nurse continuity. Nurse continuity or the presence of consistent RN caregivers is a rarely studied nurse-staffing variable, potentially due to difficulty in measuring this concept. This challenge has led many CNOs who value the use of consistent caregivers to none-the-less ignore this facet of nurse staffing when directing resources toward improving patient outcomes. The purpose of this paper is to present literature support for a new conceptual model of nurse continuity and an innovative approach for research to determine the influence of nurse continuity on patient outcomes.

Healthcare is costly with expenditures of 2.6 trillion dollars in 2010, a 10 fold increase since 1980.[2] As the largest hospital operating expense,[3] nurses are viewed as valued but costly resources for safeguarding patients from harm and improving outcomes.[4] Nursing services reorganization strategies with their subsequent influence on care delivery have become the focus

of research as concerns mount over the potential compromise to one of healthcare's most important functions, protecting patients from harm when receiving hospital care.[5]

One important nurse-staffing variable seemingly lost in the changes brought about by nursing services reorganization is nurse continuity, once a critical feature of the primary nursing model. Primary nursing is a care delivery system that makes an RN responsible and accountable 24 hours a day for all nursing care provided to a select group of patients with the goal of fostering both continuity of care and comprehensive patient care management.[6] The primary nursing model stands in stark contrast to our current care delivery model in which patients may see a different nurse every shift in a system characterized by varied shift lengths, nurse schedules, and diverse care providers (e.g., part-time or full-time staff, agency or float nurses).[1] Unfortunately, past research studies on primary nursing have been inconsistent in supporting improved patient outcomes [7, 8] so previous efforts to link the benefits of care continuity to improved patient outcomes remain unsubstantiated.

Literature Review of Care Continuity

An examination of the literature evidence of care continuity reveals a focus on two main topics: (1) definitions and types of continuity and (2) measures of continuity. Continuity definitions include continuity of information, [5, 9] relationships (relational), [9, 10] or management.[9, 11] Information continuity relates to use of the patient's medical record to coordinate care delivery. Relational continuity speaks to the unique therapeutic relationship that develops between a patient and a consistent care provider. Management continuity describes the management of a health condition over time typically found with chronic conditions. The original relational definition of nurse continuity described in the primary nursing model appears to have ceded ground to two additional definitions of care continuity, one that uses the medical

record and the other that reflects the transition of the patient from one unit to the next setting of care whether in the hospital or home.[12] These latter definitions focus more on communication, information transfer, and coordination of care over time[13] versus the therapeutic nurse-patient relationship at the bedside.

A number of diverse continuity measures were found in the literature. These measures include assignment patterns,[14-15] chronological calculations or indices,[16-18] and self-report surveys and questionnaires.[19-21] Assignment pattern instruments such as Munson and Clinton's[14] are used to collect data on the nursing care activities provided for a cross section of patients on a unit. These data are then used to determine the nursing assignments that will best ensure integration, continuity, and coordination of care for those patients. Limitations of the assignment pattern instruments include complexity (number of activities being studied), high completion time, and subjective nature of the nurse continuity assessments.

The primary care literature reports a number of indices[16] (e.g., SECON [Sequential Continuity Index], the UPC [Usual Provider Index], the COC [Continuity of Care Index], and the K Index) that have traditionally been used to chronologically measure the patient's ambulatory care experience by aggregating the pattern of patient visits over time with a primary care provider(s). Chronological calculations are also used in nursing studies and include the Consecutive Care Days Index,[17] a Consistency Index,[17] and the Continuity of Care Index.[18] Though these chronological indices calculate a measure of continuity for patients, they do not independently measure the influence of the nurses' consistent or continuous care on subsequent patient outcomes. To achieve this purpose these chronological measures must be combined with another data source to allow an examination of nurse continuity on patient outcomes.

Finally, several nursing studies[19-21] used a single question to measure perceptions about continuity (i.e., do nurse midwives perceive that the majority of their clients receive continuity of care) [21] as part of a larger self-report survey or questionnaire. These questions provide valuable insights about nurse perceptions or beliefs about care continuity, however, they do not attempt to quantify nurse continuity nor are they able to measure the link between care continuity and potential patient outcomes.

A number of conceptual models were identified that depicted management continuity or the effect of discharge planning and care coordination[22-23] on patient outcomes. Models depicting information continuity in the form of patient handoffs[24] and use of clinical guidelines, workflows, and pathways[25] were also found. However, none of these conceptual models examined nurse continuity as a nurse-staffing variable and thus were insufficient for this inquiry. Similarly, only some of the nurse-staffing models studied[26-29] included nurse continuity as a nurse-staffing variable.[26-27] The Irvine et al.[26] Nursing Role Effectiveness model incorporates nurse continuity as a variable but within the context of management not relational continuity. The O'Brien-Pallas et al.[27] Patient Care Delivery model includes a relational nurse continuity variable within a depiction of other nurse-staffing variables and patient outcomes. Neither model adequately describes either the direct influence of nurse continuity or the combined influence of nursing continuity and other potentially relevant nurse-staffing variables on patient outcomes. Thus, based on the literature review, a new conceptual model emerged, with variables that we believe are important to measure when examining the influence of nurse continuity on patient outcomes.

Literature Support: New Conceptual Model for Nurse Continuity

Our proposed conceptual model (Figure 1) depicts the relationships: (1) of nurse continuity on patient outcomes; (2) between nurse continuity, nurse characteristics, and patient outcomes; (3) between nurse continuity, unit environment characteristics, and patient outcomes; and (4) of patient characteristics on patient outcomes. The first three relationships reflect our belief that nurse continuity is an integral nurse-staffing variable that can either directly influence patient outcomes or moderate other nurse-staffing or unit environment variables leading to improved patient outcomes, such as fewer hospital-acquired pressure ulcers (HAPUs). Our primary hypothesis is that providing patients with consistent nurse caregivers will lead to improved assessments, monitoring, and decision making resulting in more timely interventions and improved patient outcomes. This hypothesis has support from one systematic review[30] that focused on care outcomes from 18 research studies, which examined the association between care continuity with primary care medicine practitioners and patient outcomes. Findings included improved patient satisfaction and decreased hospitalizations and emergency room visits for patients with consistent primary care medicine providers.

Similarly, our examination of the nursing literature revealed three studies with findings that specifically support the first relationship proposed by our new model. Bostrom et al.[17] reported improved patient satisfaction with increased nursing continuity, Russell et al.[31] found a decline in hospitalizations and use of emergent care with continuous home care nurses, and Siow[32] noted a safer environment with more continuous experienced nurses. These study findings support our belief about a positive association between nurse continuity and patient outcomes. However, there were no studies located that examined our proposed second and third relationships suggesting an interactive or moderating effect of nurse continuity as a means to

strengthen the known influence of other nurse-staffing and unit environment characteristics on patient outcomes.

Extensive research documents the influence of individual nurse-staffing variables on patient outcomes including a recent state of the science review[33] of 29 systematic or literature reviews. The evidence currently supports the premise that an increased level of RN education is associated with decreased mortality and odds of failure to rescue.[34] Similarly, mortality rates were found to decline with each additional year of nurse experience in studies conducted in Canadian hospitals.[1] Finally, staff 'churn' or changes in staffing due to use of part-time, float, or agency staff interfered with team functioning and care continuity in a study of 80 medical-surgical units.[35] These three nurse-staffing variables (i.e., nurse education, nurse experience, full versus part-time status) appear as nurse characteristics in our new model.

In addition there are a variety of unit environment characteristics commonly depicted in the patient outcomes literature included in our model (i.e., whppd, nurse-to-patient ratio, and shift length.) Study results indicate significant associations between additional nursing care hours/higher proportion of RN care and reductions in mortality,[36-37] falls,[38] and pressure ulcers.[36, 38] A richer RN skill mix (i.e., a higher RN-to-ancillary personnel ratio) also increases satisfaction.[39] Kane et al.[37] noted that decreasing the number of patients per RN reduced the odds of nosocomial sepsis, cardiac arrest, and medical complications and Aiken et al.[40] learned that the improved nurse-to-patient ratios in Magnet hospitals reduced the odds of dying by one half. There are fewer studies examining the impact of shift length on actual outcomes, with some negative study findings including increased errors [41-42] and performance lags[43] noted with less time spent in direct patient care as the shift lengthens.[44]

Studies examining nurse-staffing and unit environment characteristics tend to examine the direct influence of a single variable on patient outcomes but not the potential interactions between two or more variables with their subsequent influence on patient outcomes. Our proposed model depicts not just the direct influence of these nurse-staffing and unit environment variables on patient outcomes but also the interactive or moderating effect of another nurse-staffing variable, nurse continuity. We propose to examine how a continuous nurse caregiver may positively influence patient outcomes by potentially strengthening the capabilities of a workforce limited by nurses with lesser education, experience, less than full-time status, or operating under a nurse-to-patient ratio or productivity target below the national benchmarks.

The final relationship included in this new model, specific to our plan to examine hospital-acquired pressure ulcers (HAPUs), depicts the influence of patient characteristics on patient outcomes. Pressure ulcers are a prevalent never event (5-10%) [45] and a major nurse-sensitive quality outcome. The literature is replete with factors that contribute to pressure ulcers including impairments of mobility, nutrition, cognition, and continence[45-46] all of which are effected by the quality of nursing assessment, monitoring, decision making, and interventions. Our new model includes patient characteristics as important variables when examining influences on patient outcomes.

Exemplar Measure and Method

As noted above, one of the major barriers to understanding the influence of nurse continuity on patient outcomes has been the absence of robust methods that measure all relevant variables. Fortunately, in recent years a team of investigators at the University of Illinois at Chicago has developed an innovative documentation tool that gathers the variables in the proposed conceptual model and make it possible to comprehensively examine the relationship

between nurse continuity and patient outcomes. The Hands on Automated Nursing Data System (HANDS),[47] is the unique tool and the reliability and validity[48] of its data were previously established.

The HANDS is an electronic documentation tool with standardized nursing terminology. It is used each shift by nurses to enter data that tracks and links a patient's diagnoses (North American Nursing Diagnosis Association International [NANDA-I]),[49] interventions (Nursing Interventions Classification [NIC]),[50] and outcomes (Nursing Outcomes Classification [NOC]) (NNN)[51] with patient demographics and a variety of nurse characteristics.[52] In HANDS information about patient outcomes and the nurse caregivers are captured, linked, and stored through the documentation occurring on each shift. As a result the relationship of nurse characteristics (e.g., RN education, RN experience, RN work pattern [fraction of time status]) to the care provided and the outcomes achieved can be drilled down to the shift level examining the characteristics of the nurses directly caring for an individual patient with the subsequent outcomes rather than stopping at the unit or hospital level as is found with other databases.[53] Historically there has been no data collection system that captured nurse continuity or other factors thought to be moderated by nurse continuity. This measurement gap prevented researchers from comprehensively evaluating the combined impact of patient characteristics and nurse-staffing variables on patient outcomes. The content and structure of the HANDS database thus uniquely allows us to use the standardized data to identify and then control for potentially influential patient level characteristics as well as to examine the influence of a single variable such as nurse continuity on other key nurse-staffing or unit environment variables that may influence patient outcomes.

In a proposed study that is now underway, the linked data in HANDS will allow us to query the database to isolate episodes of care both with and without HAPUs and to measure whether the presence of nurse continuity was instrumental to this outcome. Operational definitions of our selected study variables can be translated into terms that are captured through the raw data available in HANDS (Table I). For example, the nurse continuity variable consecutive days of care by the same/single RN(s), is determined using the total number of days worked by each nurse with the patient during a care episode and then operationalized as the percentage of care days by the same/single RN(s) per patient episode. Similarly, nurse experience is determined by the number of years of experience a nurse possesses and operationalized as the percent of time cared for by a nurse with greater than or equal to two years of experience per patient episode. Finally our patient outcomes variables (i.e., continence, mobility, nutrition) are operationalized using NNN labels (Table II) and thus can be measured based on their occurrence in POC documentation in the HANDS.

Conclusions

Nursing services reorganization remains an ongoing challenge for CNOs as their ability to control most nurse-staffing variables remains elusive. Financial constraints from declining patient volumes; nurse call ins (absences); fluctuations in census; retention of qualified, experienced staff at the bedside; and recruitment of nurses with a minimum of a baccalaureate education are ongoing challenges for CNOs seeking to provide safe staffing for patients in the hospital setting. Efforts to promote nurse continuity in scheduling and assigning patients, though similarly challenging, may actually be a nurse-staffing variable that CNOs can influence with positive repercussions for patient outcomes.

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Tables

TABLE I
RAW DATA IN HANDS AND OPERATIONALIZED DEFINITIONS FOR PATIENT CHARACTERISTICS, NURSE STAFFING, AND CONTINUITY VARIABLES

Variable	Raw Data Found in HANDS	Operationalized Definition
Nurse Staffing		
Shift Length	Number of consecutive hours worked by each RN during a care episode.	% of 8-hour RN care shifts in a patient episode.
RN Work Pattern (Shifts of Care by Part ([PT]/Full-Time [FT] vs. Very Part-Time [VPT] Status Workers)	Fraction of time status (FT, PT, VPT) for each RN who cared for the patient during a care episode.	% of care shifts by very part-time status RNs (0.3 [24 hours] or less) in a patient episode.
Nurse Experience	Years of experience as an RN.	% of time cared for by RNs with ≥ to 2 years of experience in a patient episode.
Nurse Education	Diploma, ADN,[a] BSN,[b] BSN and some additional coursework, Master's degree in nursing, or Doctoral degree in nursing.	% of time cared for by an RN with a BSN or greater in a patient episode.
Patient-to-Nurse Ratio	Actual number of patients cared for by a single RN during a shift.	The average patient-to-nurse ratio over the course of the patient care episode.
Worked hours per patient day	The total number of RN hours on a unit in a 24-hour period divided by the number of patients on that unit at the midnight census.	The average whppd over the course of the patient care episode.
Nurse Continuity		
Number of consecutive days cared for by the same/single RNs	The total number of consecutive care days worked by each RN with the patient during a care episode.	% of consecutive care days by the same/single RNs in a patient episode.
Patient Characteristics		
Nutrition	1 NANDA-I,[c] 5 NOC,[d] 5 NIC[e] Nutrition labels	NNN[f] Nutrition label appearing on the admission POC[g] in the patient's episode
Continence	3 NANDA-I, 4 NOC, 6 NIC Continence labels	NNN Continence label appearing on the admission POC in the patient's episode
Hydration	3 NANDA-I, 3 NOC, 9 NIC Hydration labels	NNN Hydration label appearing on the admission POC in the patient's episode
Mobility	2 NANDA- I, 4 NOC, 5 NIC Mobility labels	NNN Mobility label appearing on the admission POC in the patient's episode

TABLE I
(continued)

Variable	Raw Data Found in HANDS	Operationalized Definition
Perfusion	2 NANDA- I , 4 NOC, 5 NIC Perfusion labels	NNN Perfusion label appearing on the admission POC in the patient's episode
Cognition	4 NANDA- I , 9 NOC, 6 NIC Cognition labels	NNN Cognition label appearing on the admission POC in the patient's episode
Skin	3 NANDA-I, 2 NIC Skin labels	NNN Skin label appearing on at the admission POC in the patient's episode
Age	Age in years	Age in years

[a]ADN = Associate Degree in Nursing
[b]BSN = Bachelor of Science in Nursing
[c]NANDA-I = North American Nursing Diagnosis Association – International
[d]NOC = Nursing Outcomes Classification
[e]NIC = Nursing Interventions Classification
[f]NNN = NANDA-I NOC NIC
[g]POC = Plan of Care

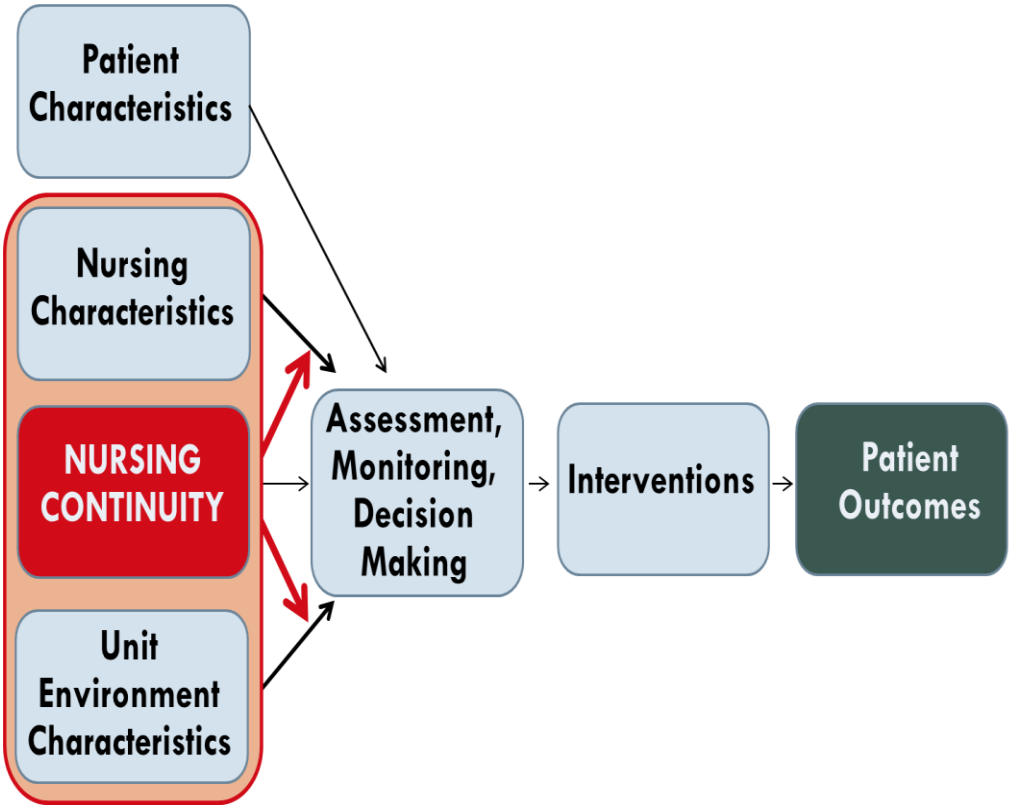
TABLE II
NANDA-I, NIC, AND NOC (NNN) LABELS FOR MOBILITY

NANDA-Is
1. NANDA-I: Impaired Bed Mobility
2. NANDA-I: Risk for Peripheral Neurovascular Dysfunction
3. NANDA-I: Impaired Physical Mobility
NOCs
1. NOC: Mobility
2. NOC: Body Positioning
3. NOC: Neurological Status: Cranial Sensory/Motor Function
4. NOC: Immobility Consequences: Physiological
NICs
1. NIC: Positioning
2. NIC: Positioning: Wheelchair
4. NIC: Bed Rest Care
5. NIC: Positioning: Neurologic
3. NIC: Pressure Management

Figure

Figure 1

Conceptual Model for Studying the Effect of Nurse Continuity on Patient Outcomes



III. Using the Electronic Health Record to Examine the Influence of Nurse Continuity on Hospital-Acquired Never Events

Introduction

Patient safety and superior quality outcomes have become the mantra even as healthcare organizations struggle with declining resources. Healthcare costs have escalated, largely due to negative care associated outcomes including never events (e.g., pressure ulcers, falls); serious, largely preventable adverse outcomes that occur during hospitalization.[1] In one study conducted by the U. S. Department of Health and Human Services[2] approximately 13.5% or 1 in 7 hospitalized Medicare beneficiaries were affected by an adverse event with estimated costs to hospitals of 21 billion dollars annually.[3] One of the primary concerns of nurses is to protect patients from harm while under their care.[4] Nurses can prevent patient harm from adverse events through their ongoing assessments and monitoring, by identifying risks, and selecting appropriate preventive interventions. However, hospital nursing services are increasingly being reorganized to reduce expenses. This reorganization (i.e., decreasing registered nurse [RN] care hours, use of more assistive and temporary nursing personnel) has fragmented staffing practices, affected care continuity, and may be related to poor patient outcomes.

Poor care continuity may be an influential nurse-staffing variable for patient outcomes. Current staffing practices have nurses' frequently assigned to new patients every shift. This practice leaves them with no basis of comparison from the day before and may affect their ability to identify and intervene on ominous changes in patient status. This problem is further magnified with novice or new graduate nurses who have little experiential base to compare their findings. In the current hospital environment nurses are also asked to float between units, agency or part-time nurses are used to fill gaps in the schedule, and nurses are expected to care for a larger

number of patients to address staffing needs. These staffing practices also affect care continuity and may further impair the nurses' ability to recognize and expediently intervene on negative changes in patient status.

Chief Nursing Officers (CNOs) have historically not been able to challenge these staffing practice trends as they have been restricted by the absence of readily available data. A CNO needs data that measures staffing variables such as nurse continuity as well as linked data that can help demonstrate the connection between nurse staffing and patient outcomes. Without that data the reorganization of nursing services, including use of fragmented staffing practices, will continue potentially exacerbating hospital-acquired adverse events. Discovering the hidden knowledge available within electronic health record (EHR) data and then leveraging it to improve nurse staffing and subsequent patient care outcomes may offer an important approach to reduce hospital costs. Thus, we introduce the Hands on Automated Nursing Data System (HANDS),[5] an electronic nursing plan of care (POC) database, as a data source to examine the potential association between nurse continuity and the presence of one never event, hospital-acquired pressure ulcers (HAPUs).

Background

Extensive research has demonstrated the influence of multiple individual nurse-staffing variables on patient outcomes. These studies were compiled in a recent state of the science review[6] of 29 systematic or literature reviews. Significant associations between additional nursing care hours/higher proportion of RN care and patient outcomes including reductions in mortality,[7-8] falls,[9] and pressure ulcers[7, 9] have been documented. Kane et al.[8] noted that reducing the number of patients cared for by each RN reduced the odds of nosocomial sepsis, cardiac arrest, and medical complications. Aiken et al.[10] learned that use of an additional nurse per

patient day reduced the odds of dying within 30 days by more than one half. Additional associations included a richer RN skill mix (i.e., a higher RN-to-ancillary personnel ratio) and increased satisfaction[11] and more RN education and experience, and improved mortality.[12-14] Research studies describing the influence of shift length include some negative outcomes, with longer shift lengths being associated with increased errors[15-16] and performance lags,[17] with less nursing time spent in direct patient care as the shift lengthens.[18] Finally, staff 'churn' or changes in staffing with use of part-time, float, or agency staff on Medical-Surgical units has been found to interfere with team functioning and care continuity[19] with potential negative repercussions for patient outcomes.

There has been little to no research specifically investigating the influence of one nurse-staffing variable, nurse continuity, on patient outcomes. Medical continuity has been examined[20] focusing on patient outcomes generated by care continuity with primary care practitioners. Findings included improved patient satisfaction, and decreased hospitalizations and emergency room visits for patients with consistent primary care physicians.[20] However, only three nursing studies examining nurse continuity were located, with only one considering adverse events.

Bostrom et al.[21] noted increased satisfaction with particular aspects of patient care (e.g., patient and family involvement) when nurse continuity was studied in 116 Medical-Surgical patients discharged from one tertiary medical center. Nurse continuity was measured in terms of constancy and consistency, with constancy defined as the maximum number of consecutive days the patient was cared for by the same nurse.[21] A consistency index for each shift (i.e., days, evenings, nights) was calculated using the number of shifts the patient was hospitalized divided by the number of care providers a patient had on a specific shift. For example, a patient

hospitalized for four day shifts, four evening shifts, and three night shifts who was cared for by three different nurses on the day shift, two different nurses on the evening shift, and three different nurses on the night shift would have consistency indices of 4/3 = 1.3 on days, 4/2 = 2 on evenings, and 3/3 = 1 on nights. Larger consistency index and constancy values were determined to reflect better nurse continuity in this study.[21]

Russell et al.[22] found reduced use of hospitals and emergent care, and improved function in the activities of daily living when studying home health care visits (N=59,854 patients) with consistent nurse care providers from one urban not-for-profit home care agency. In this study continuity of care was measured as consistency of nurse care providers across a series of home health care visits.[22] Each patient was awarded a continuity score using a formula that calculated a score based on the number of care providers, the number of visits by each care provider, and the total number of visits for each patient with all of the care providers. For example, a patient who received all 15 visits by the same nurse would have a score of 1. A second patient, who also received 15 visits, but 11 visits from one nurse and four visits from a second nurse, would have a continuity score of 0.58 as calculated by their formula. Scores ranged from 0-1 with higher scores representing greater continuity in home health care services while lower scores indicated less continuity. [22]

Siow[23] found in a secondary data analysis that greater levels of nurse continuity were associated with a longer length of stay and a greater number of ventilator days in one Pediatric Intensive Care Unit (PICU) (N=332 patients). She found no significant associations between nurse continuity and adverse events or infections acquired during the PICU stay. Continuity was measured using an adapted version of Curley and Hickey's Continuity of Care Index (CCI).[24] Siow reversed the formula so that higher scores represented higher continuity (Curley and

Hickey's CCI=Total number of different nurses/Total number of shifts versus Siow's reverse formula where CCI=1 – Total number of different nurses/Total number of shifts). For example, the CCI for a patient who received care from 6 different nurses over 10 shifts would be calculated as $1 – (6 \div 10) = 0.4$. The CCI scores ranged from a high of one representing strong continuity (if the same nurse cared for the patient every shift) to zero for poor continuity (if different nurses cared for the patient every shift).[23]

Despite nurse continuity once being a critical feature of the primary nurse staffing model it has been infrequently studied, especially in relation to patient outcomes. This lack of study may be attributed to the inconsistent definition of continuity and the absence of reliable and valid evaluation measures that link continuity and patient outcomes. To help demonstrate the connection between nurse staffing and patient outcomes the EHR was used in this study as an untapped data source. The EHR can be a valuable data source for data mining if it contains POC documentation coded in a way that allows easy access and is in a form amenable to analysis. In this study the HANDS was used as a data mining source for examining the influence of nurse-staffing variables, including nurse continuity, and the prevention of one never event, HAPUs.

Stifter et al.[25] recently proposed a new conceptual model for studying the effect of nurse continuity and nurse-staffing variables on patient outcomes (Figure 1). This model serves as the conceptual framework for the present study and depicts the relationships: (1) of nurse continuity on patient outcomes; (2) among nurse continuity, nurse characteristics, and patient outcomes; (3) among nurse continuity, unit environment characteristics, and patient outcomes; and (4) of patient characteristics on patient outcomes. The first three relationships are based on the hypothesis that nurse continuity is an integral nurse-staffing variable that can influence patient

outcomes or moderate other nurse-staffing or unit environment variables leading to improved patient outcomes, such as fewer HAPUs. Providing patients with consistent nurse caregivers will lead to improved assessments, monitoring, and decision making resulting in more timely interventions and better outcomes.

The final relationship included in this new model, specific to our plan to examine HAPUs, depicts the influence of patient characteristics on patient outcomes. Pressure ulcers are a prevalent never event (5-10%)[26] and a major nurse-sensitive quality outcome. The literature is replete with factors that contribute to pressure ulcers including impairments of mobility, nutrition, cognition, and continence[26] all of which are effected by the quality of nursing assessment, monitoring, decision making, and interventions. Our new model therefore includes patient characteristics as important variables when examining influences on patient outcomes.

Our study aims are**:** (1) to determine which patient characteristics in the HANDS database (Age, Nutrition, Mobility, Hydration, Continence, Skin, Perfusion, Cognition) influence the presence of HAPUs for the purpose of creating an analytic dataset and (2) using the analytic dataset which controls for the patient characteristics, determine the influence of nurse continuity (number of consecutive care days by the same/single RN) and nurse staffing variables (worked hours per patient day [whppd], patient-to-nurse ratio, RN experience, RN education, shift length, RN work pattern [number of shifts cared for by very part-time versus part/full-time staff]) on the presence of HAPUs.

Methods

Study Design

A comparative secondary analysis of the HANDS database was performed. Two protocols were designed to help achieve the study aims. The Aim 1 protocol included the use of

association and cluster data mining techniques and statistical analysis to determine patient characteristics leading to pressure ulcers and to help create an analytic dataset for examining the influence of nurse continuity. The Aim 2 protocol employed logistic regression to determine the influence of nurse continuity and additional nurse-staffing variables on HAPUs.

Setting

The HANDS is an electronic documentation tool with standardized nursing terminologies (SNTs) used by nurses to enter data each shift that tracks a patient's diagnoses (North American Nursing Diagnosis Association International [NANDA-I]),[27] interventions (Nursing Interventions Classification [NIC]),[28] and outcomes (Nursing Outcomes Classification [NOC]),[29] patient demographics, and a range of nurse characteristics.[5] The HANDS is a valid and reliable database[30-32] containing 42,403 hospitalizations during which 787 nurses provided care on nine units in four hospitals for 12 or 24 months. The four hospitals included two large community, one university, and one small community settings with the units representing a diverse population including Critical Care, General Medicine, Neuro Surgery, Cardiac Surgery, and Gerontology patients. The nine units employed a diverse population of RN caregivers with differing education and experience levels, variable shift lengths, work schedules, and employment status all captured in the HANDS database.[30]

Sample

The available HANDS dataset resides in a relational database consisting of 89 tables and 747 columns of data collected over two years. The existing database contains 42,403 hospitalizations on the study units called episodes of care (Table I). Episodes of care are defined as a continuous patient stay on a single hospital unit and consist of all POCs entered at admission, the end of each shift, and discharge.[31] For this study the original HANDS dataset was

reduced to 24,609 episodes to: (1) eliminate pressure ulcers present upon admission, (2) eliminate one duplicate HAPU episode, (3) eliminate repeat visits so that each episode was associated with a unique patient, (4) eliminate POC episodes for patients aged < 18 years, and (5) remove episodes with a length of stay that was too short (less than 4 shifts) to reflect a meaningful continuity measure. The study analyses were then conducted on a subset of HAPU episodes (n=210) with matched controls (n=630) derived from the reduced dataset.

Procedure

Creating the original HANDS dataset. The HANDS POC documentation method was implemented and tested in four hospitals over 12–24 months during the timeframe from 2005-2008.[30] Nurses on the study units used HANDS for either one or two years. A training program was instituted with unit champions to orient all nurse users to the HANDS method. Nurse users were competency validated on creating admission POCs as well as updating POCs using NANDA-I, NOC, and NIC (NNN) terminologies.[30]

As described by Keenan et al.[30] documentation in the HANDS starts with the admission POC for an episode submitted at the first nursing handoff. This POC includes critical nursing diagnoses, outcomes, and interventions (delineated with NNN labels) that are identified during the initial shift. The POCs to follow build on the initial plan and include any NNN label additions, deletions, or resolutions that occur during the time period since the last POC submission. The current status of all NOC outcomes on a POC are rated (or re-rated) at each handoff. When a NOC outcome label is first added to a POC an expected NOC rating (goal at discharge from a unit) is also identified. The entry of a current NOC status rating at each handoff and the expected NOC outcome rating make it possible to gauge progress toward meeting outcome goals during an episode. All NOC outcomes are scored on a rating scale ranging from

1-5, with a 5 representing the best outcome.[30] The reliability and validity of the NOC outcomes ratings were established in prior studies.[33-34]

Creating the analytic dataset for the current study. Cluster mining of the HANDS dataset was performed to create the control group for the analytic dataset. Clustering is a machine learning algorithm that groups observations into multiple clusters, with each cluster different from another, but the members within each cluster consisting of observations of similar characteristics.[35] The objective was to identify matched controls for HAPU episodes in the database; therefore, clustering was an ideal tool to group episodes with similar risk factors for pressure ulcers together.

To utilize clustering to accomplish our goal, we defined a similarity measure based on variables predictive of pressure ulcers, including NOC ratings for the seven patient characteristics (i.e., Nutrition, Mobility, Hydration, Continence, Skin, Perfusion, and Cognition), patient age, and the unit of the hospitalization. The variables were weighted using a Weight by Uncertainty operator,[36] which assigns higher weights to variables that are more predictive (and therefore reduce more uncertainty) of the HAPU outcome to ensure that the similarity measure closely reflects the similarity in HAPU risks between episodes.

A range of cluster solutions was examined to identify the solution which created the best balance between the HAPU and control episodes. For each cluster solution, we randomly selected for each HAPU episode, three matched control episodes from the same cluster but without pressure ulcers. Our goal was to locate a cluster solution with clusters that contained highly similar members based on the NOC ratings for the patient characteristics, patient age, and/or units that either led to HAPUs or did not lead to HAPUs (the matched controls). As the number of clusters increased the episodes within each cluster became more similar allowing us to

achieve a better balance between the control and HAPU cases. For example in the five cluster solution (Table II) the episodes were clustered primarily by unit designation and there were significant differences in the mean NOC outcome ratings of five out of seven of the patient characteristics (e.g., nutrition, skin, mobility, cognition, and perfusion) and age comparing HAPUs and controls (Table III).

As the number of clusters increased the differences in the mean NOC outcome ratings for some of the patient characteristics and age decreased when comparing the HAPU episodes and matched controls (e.g., the p values for the perfusion characteristic t tests went from 0.00 in the 5 cluster solution to 0.43 in the 18 cluster solution), however, not all of the characteristics reflected that same level of improvement. For example, in the 18 cluster solution presented in Table IV, for the characteristics of nutrition, mobility, and cognition, and for patient age there continued to be significant differences in the NOC outcome ratings between the HAPU episodes and the matched controls (Table V). Therefore, we continued to increase the number of clusters upwards of 200 clusters, at which time we noted that there were no statistically significant differences in HAPU versus matched control episodes with the seven patient characteristics and patient age as measured by the independent t test ($p < 0.05$) (Table VI). Furthermore, as depicted in Table VII there was no difference in the distribution of HAPU and non-HAPU episodes across the nine clinical units (Fisher's Exact Test, $p = 1.000$). The 630 matched control cases selected from this cluster solution along with the 210 HAPU cases comprised the analytic dataset for the proposed regression analysis.

Measures

Definition of HAPUs. Structured query language (SQL) commands were developed to locate and extract all **hospital-acquired pressure ulcer (HAPU)** episodes of care in the

HANDS database. The HAPU episodes were defined as all episodes in which the label NIC: Pressure Ulcer Care was placed on the patient's POC at least 24 hours after admission. Episodes in which this NIC was placed on a patient's POC within 24 hours of admission were considered as **admission pressure ulcers (APU)**. This definition ensured that pressure ulcers present on admission that were identified and documented by the nurse within the first 24 hours of care were not included as HAPUs. Using this definition, a total of 896 pressure ulcers were located in the original database (N=42,403) with 685 classified as APU and 211 as HAPUs (Table I).

Patient risk factors. Eighteen NANDA-I, 29 NOC, and 39 NIC labels (Table VIII) were selected by the primary investigator to identify patient characteristics that predispose pressure ulcers in the 42,403 episodes of care in HANDS. Two methods were used to elicit these labels. The first method was to examine common labels for these patient characteristics using the NANDA-I to NOC and NOC to NIC linkages that are available in the HANDS system and in the NNN literature.[37] Next, a list of all NNN labels present on the POCs for the 896 pressure ulcer episodes were reviewed to narrow down the most consistently used labels for these patient characteristics. The final list of 86 NNN labels (Table VIII) proposed for use in this study was validated by a clinical nurse expert with extensive experience and research in the use of SNTs. As depicted in Table VIII these NNN labels fall under seven distinct categories: Nutrition, Mobility, Hydration, Continence, Skin, Perfusion, and Cognition, each representing a risk factor that contributes to vulnerability to pressure ulcers. For each patient episode, we examined the admission POC and extracted the relevant NOC ratings to indicate the patient condition in each of these seven categories.

Nurse staffing. Nurse-staffing variables were operationalized using the raw data available in the HANDS (Table IX). For the HAPU episodes nurse-staffing variables were

examined on the shifts leading up to the ulcer occurrence. For this study the variable nurse continuity was calculated using the total number of consecutive days worked by each RN with the patient and operationalized as the percent of consecutive care days by the same/single RNs in a patient episode. For example, the same nurse(s) providing care for four consecutive care days out of a potential seven would achieve a continuity index of .57 for that episode (Figure 2). Nurse experience was calculated using the number of years RNs reported being in the nursing profession and operationalized as the percent of time a patient was cared for by RNs with at least two years of experience. Nurses with at least two years of experience were considered to be experienced and nurses with less than two years of experience to be inexperienced. The nurse education variable was determined by using the highest nursing degree reported and operationalized as the percent of time a patient was cared for by RNs with a BSN or greater in a patient episode.

The shift length variable was calculated using the number of consecutive hours worked by each RN with the patient and operationalized as the percent of 8-hour RN care shifts in a patient episode. The RN work pattern variable (full, part, or very part-time status) was calculated using the actual hours worked as a fraction of full-time status (80 hours) for each RN caring for the patient in an episode. Very part-time status was defined as any nurse who worked less than or equal to 24 hours (0.3) per pay period (pay period = 80 hours over a 2 week time period) with part-time to full-time status classified as greater than 0.3–1.0. The RN work pattern variable was operationalized as the percent of very part-time RNs caring for a patient.

To determine the average patient-to-nurse ratio across a patient episode, we computed for each four hour window the patient-to-nurse ratio on the unit and averaged the ratios of all windows spanned by the patient episode. Finally, worked hours per patient days (whppd) were

determined by calculating an average whppd over the course of a patient care episode. The whppd definition used in this study was the total number of RN hours on a unit in a 24 hour period divided by the number of patients on that unit at the midnight census.

Analysis

Analyses for this study included descriptive statistics (frequencies, means, and standard deviations) to obtain an understanding of the patient characteristics associated with HAPUs in the HANDS database. Descriptive statistics (frequencies) were also calculated for the nurse staffing variables by patient unit. A logistic regression using the STATA 12 statistical software package[38] was performed regressing HAPUs against nurse continuity and six nurse staffing variables (worked hours per patient day [whppd], patient-to-nurse ratio, RN experience, RN education, shift length, RN work pattern [number of shifts cared for by very part-time versus part/full-time staff]). A second logistic regression introduced interaction terms between nurse continuity and each nurse-staffing variable to evaluate whether nurse continuity exhibited a moderating effect, enhancing the influence of other nurse-staffing variables on HAPU outcomes.

Results

The average age of patients with HAPUs in this dataset was 68.9 (15.3) years as compared to 65.1 (18.2) years for episodes without HAPUs (Table X). The mean NOC outcome ratings were noted to be higher for all seven patient characteristics in the non-HAPU versus HAPU episodes. The results were statistically significant at a $p < 0.05$ for all but the cognition and continence patient characteristics (Table X).

On aggregate (all unit) examination of the episodes, HAPU episodes had a higher percentage of BSN nurses ($p < .001$), a lower percentage of eight hour shifts ($p < .001$), a lower patient-to-nurse ratio ($p < .001$), and a higher whppd ($p < .001$) (Tables XI and XII). The

differences in the percentage of very part-time nurses (p=.07) and in the percentage of experienced nurses (p=.32) were not significant. Since different units likely had very different staffing characteristics, we also examined these variables for four individual units with a substantial number of (at least 15) HAPU episodes (Tables XI and XII). We did not observe a consistent trend across units for any of the above variables, indicating that the significance we found above is likely caused by unit confounding.

The regression analysis revealed that continuity was not significantly associated with the HAPU outcome both when it was the only predictor (p = 0.50) (Table XIII) and when we controlled for other nurse-staffing variables (p = 0.37) (Table XIV). In addition, none of the nurse-staffing variables entered in the logistic regression reached statistical significance with HAPU outcomes. In a second logistic regression that introduced six interaction terms created by combining nurse continuity and each nurse-staffing variable (i.e., Cont*bsn = interaction term for nurse continuity and RN education) no statistically significant relationships with HAPU outcomes were found (Table XV).

Discussion

Nurse continuity is an understudied nurse-staffing variable in part due to difficulties in defining and measuring the concept. Consequently, research examining the influence of continuous nurse care providers on patient outcomes is limited. In this study we used the HANDS, an EHR with linked data to operationalize and measure nurse continuity. Our continuity definition was based on consecutive nurse care days and examined the influence of nurse continuity and several other nurses-staffing variables on HAPUs. Unfortunately, we were unable to demonstrate statistically significant relationships between continuity and HAPUs or with nurse continuity as a moderator of other nurse-staffing variables and HAPU development.

This nursing study was informative however for two other reasons: (1) we elected to use data mining to create the analytic dataset for our regression analysis and (2) we attempted to examine nurse staffing and patient outcomes at the patient episode rather than hospital level. We chose data mining as a strategy to create our data analytic set because we had a very small number of HAPU episodes distributed unevenly over nine clinical units and a large number of variables that we felt could be confounding factors to our research hypothesis. To be successful in demonstrating a potential influence of nurse continuity on such a small number of outcome (HAPU) episodes we realized that we were going to have to control to the greatest extent possible for the influence of factors other than nurse staffing.

Data mining, specifically cluster mining, was noted to be an effective strategy for identifying not only where the HAPU episodes were located in the original dataset but then to help identify similar episodes without HAPUs but having the same risk factors of patient age, unit, and patient characteristics. Cluster mining allowed us to create an analytic dataset for our proposed regression with a cluster solution that matched episodes with similar risk factors but different HAPU outcomes. We were able to successfully create an analytic dataset with a large enough cluster solution to demonstrate a balance between these two types of episodes so that patient characteristics or unit differences would not confound the HAPU outcomes. The rigor of the process taken to create our 200 cluster solution allowed us to move into the regression analysis with greater confidence that the influence we would be measuring would be based on our nurse-staffing variables and not the other confounding variables.

The second unique feature of this study was our attempt to examine a specific patient outcome, a hospital-acquired pressure ulcer, and link it back to the nurse staffing provided for a patient over the course of a hospital episode. Though the National Database for Nursing Quality

Indicators (NDNQI) is available to comparatively display nursing quality indicators across hospital units,[39] at this juncture databases such as NDNQI are unable to connect patient specific outcomes with individual nurse characteristics. The availability of the HANDS and the use of data mining allowed us to drill down and uncover the HAPU episodes in the dataset as well as operationalize the characteristics of the nurse caregivers over the course of the episode. We were able to examine whether the percentage of experienced or more educated nurses, or the average patient load carried by the RN caregivers influenced pressure ulcer development over the course of the hospitalization. However, one limitation we noted in using episodes and examining a critical incident such as a HAPU never event, is that HAPUs do not typically develop over the course of a hospitalization but can develop on a single shift. The level of our current analysis was not granular enough to allow us to determine if the care was inadequate on one particular shift or whether insufficient nurse staffing over the course of several shifts resulted in creating the vulnerability that led to ulcer development.

Several additional limitations may have influenced our study outcomes. Hospital never events, though an important nurse-sensitive indicator, occur infrequently, potentially making it difficult to demonstrate a significant relationship between nurse staffing and these patient outcomes. Next, this study was a secondary data analysis and therefore limited our inquiries to the available data. For example, the HANDS method currently incorporates only POC documentation by RNs which omits the contributions of assistive nursing personnel who assume a large responsibility for the physical care of hospitalized patients. Similarly, while we were able to account for patient characteristics confounding variables, we were not able to control for all nurse interventions or nurse demographics with this dataset. These nurse interventions may have included use of particular NIC labels arising from available standardized POCs for select nursing

diagnoses. The confounding influence of specialty nursing certification on RN practice and POC development also could not be accounted for as this data was not collected.

Nurse charting may also be a confounding factor when using POC documentation as the means to examine interactions between nurse staffing and patient outcomes. Medical record documentation is frequently incomplete (20-30% of records)[40] and of poor quality.[41-43] In one study examining nursing documentation of pressure ulcers pre- and post-EHR implementation only 28% (N=20/71 records) demonstrated full documentation of a nursing problem, nursing interventions, and nursing outcomes using the electronic system.[43] In a second study of 161 records from a Swedish community health care center, nursing care plans were rarely found and when present none of the plans included complete documentation of a problem, interventions, and outcomes.[41] Thus, missing information in the EHR can have an impact on the validity of the study findings.

In this study we had strong nursing POC documentation on nine clinical units in four hospitals. However, we measured gaps in documentation, defined as missing POCs within a patient care episode and found that among the 24,609 episodes used for clustering, the average percentage of gap was 11%. This number is consistent with the 78-92% compliance rate noted by Keenan et al. [30] using the entire HANDS database. For this analysis we included all POCs that were available for review. However, we recognized that the documentation gaps were clearly a limitation to our study of consecutive RN care days, as missing POCs made it impossible to identify and account for the nurses caring for the patients on those shifts.

Two final study limitations may have been our continuity and pressure ulcer definitions. Previously, as noted in the literature review, nurse continuity was studied using consistency indices looking at the number of repeat days by the same nurses over the course of the

hospitalization.[21, 23] It was noted early in our inquiry that this type of continuity measure was confounded by length of stay (LOS) and therefore we created a new definition that defined continuity as the number of consecutive care days by the same nurse. If a nurse missed a consecutive care day but was assigned to the patient again at a later point in the episode that day was not weighted in our definition. In retrospect this definition might not have been broad enough and in light of our current shorter hospital LOS may have increased our difficulty in discerning an influence from continuity. For future studies we may need to approach continuity as a multidimensional construct that might be better measured by several rather than a single variable. As was noted in the Bostrom et al.[21] article continuity might be best reflected as a combination of not just consecutive care days, but also measured in terms of consistency, whether consistency is defined as consistent caregivers across different shifts, across an entire episode, or at particular, critical times in the care trajectory (e.g., at discharge or on readmission).

This study also used a very conservative pressure ulcer definition (prevalence = 0.7% as compared to 5-10%[26] in published research) as we selected a specific label, NIC: Pressure Ulcer Care, to increase our certainty that included cases reflected only the presence of HAPUs. Using a broader definition to include the additional label, NIC: Pressure Management, would have increased our case count by 1,000 (prevalence = 2.1%) but without further study it is unclear that this less specific term applies only to HAPUs. We acknowledge the possibility that pressure ulcer cases may have existed and gone unrecognized in our matched controls due to our conservative definition. Future studies with a more expansive continuity definition and including more than one hospital-acquired adverse event may be indicated to better understand the potential influence of nurse-staffing variables on patient outcomes.

Conclusions

In this study we demonstrated use of a large EHR database**,** the HANDS, as a data mining source for practice-based research. We set out to measure and explore the influence of nurse continuity, an understudied nursing-staffing variable, on the prevention of a common never event, HAPUs. Despite the absence of significant study findings on nurse continuity we are encouraged by the potential use of data mining to allow us to drill down into data sets such as the HANDS and explore the implications of nursing staffing practices during a hospitalization and their influence on patient outcomes. These studies are urgently needed so that hospital administrators can make informed decisions about nurse staffing and patient care, contributing to a safer future for hospitalized patients without hospital-acquired adverse events.

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Tables

TABLE I
NUMBER OF AVAILABLE EPISODES WITH PRESSURE ULCERS BY UNIT (N = 42,403)

Hospital and Unit	Number of Nurses by Unit[a]	Total Episodes of Care by Unit	Pressure Ulcers Present on Admission (APO)	Hospital-Acquired Pressure Ulcers (HAPUs)
LCH1: General Medicine	113	5640	194	46
LCH1: MICU	54	1228	27	13
LCH1: Gerontology	80	9565	91	31
SCH: Medicine	63	4881	1	1
LCH2: Medicine	59	3432	16	6
LCH2: Gerontology	25	1673	41	13
UH: Neuro Surgery	181	8216	2	3
UH: Cardiac Surgery	210	6112	59	59
UH: ICU	66	1656	254	39
Total	787	42403	685	211

[a] The sum of the number of nurses for all units is actually 851 due to 64 nurses who worked on multiple units. 787 reflect the total # of unique nurses.

TABLE II
FIVE (5) CLUSTER SOLUTION (N = 24,609)

Cluster	Unit	Control Cases	Pressure Ulcers	Percent Pressure Ulcers
0	UH:ICU	737	39	5.29%
1	UH:Neuro	4741	3	0.06%
2	SCH: Med	2244	1	0.04%
3	LCH1: ICU	487	13	2.67%
4	Remaining Units	16,400	154	0.94%

TABLE III
PATIENT CHARACTERISTICS AND HAPU VS. NON-HAPU EPISODES IN A 5 CLUSTER SOLUTION (N = 840)

	HAPUs Mean (S.D.)	Non-HAPUs Mean (S.D.)	T test (P value)
Nutrition	4.35 (1.27)	4.55 (1.03)	0.02
Mobility	4.10 (1.25)	4.32 (1.07)	0.01
Cognition	4.57 (1.02)	4.76 (0.75)	0.00
Perfusion	3.94 (1.29)	4.24 (1.10)	0.00
Continence	4.83 (0.66)	4.86 (0.58)	0.48
Hydration	4.12 (1.17)	4.27 (1.12)	0.09
Skin	4.10 (1.29)	4.36 (1.05)	0.00
Age	68.9 (15.3)	65.9 (17.2)	0.02

TABLE IV
EIGHTEEN (18) CLUSTER SOLUTION (N = 24,609)

Cluster (n)[a]	Unit	Hydration	Perfusion	Skin	Nutrition	Mobility	Cognition	Continence	Age	%PU (n)
0 (519)	UH:ICU	3.0	**2.3 (1-3.5)**[b]	4.0	4.9	3.7	4.8	5.0	59	6.36% (13)
15 (218)	UH:ICU	4.1	4.3 (2.7-5)	4.1	4.5	3.8	4.6	4.8	60	2.75% (6)
8 (487)	LCH1:ICU	4.0	4.6	4.9	3.6	3.8	3.6	4.9	64	2.67% (13)
17 (3294)	UH:Neuro	4.9	**4.7 (3.5-5)**[c]	4.3	**5.0 (3-5)**	4.4	4.7	4.8	52	0% (0)
14 (385)	UH:Neuro	5.0	**5.0 (3-5)**	2.4	**1.6 (1-3)**	4.9	3.0	5.0	59	0.26% (1)
5 (1062)	UH:Neuro	4.9	**2.7 (1-3.5)**	4.3	4.5	3.5	2.9	5.0	55	0.19% (2)
3 (246)	SCH:Med	**3.2 (1-4.2)**	4.4	5.0	3.8	4.9	4.9	4.9	74	0.41% (1)
4 (1998)	SCH:Med	**5.0 (4-5)**	4.8	4.8	4.9	4.8	4.9	5.0	67	0% (0)
9 (561)	LCH1:Med, LCH1:Geron, LCH2:Med, LCH2:Geron, UH:Cardiac	**2.7 (1-3.5)**	**2.7 (1-4)**	4.5	4.8	4.5	4.6	4.8	67	2.32% (13)
16 (1796)	LCH1:Med, LCH1:Geron, LCH2:Med, LCH2:Geron, UH:Cardiac	**2.6 (1-3.7)**	**5.0 (3.3-5)**	4.7	4.4	4.8	4.9	4.7	71	0.83% (15)
2 (662)	LCH1:Med, LCH1:Geron, LCH2:Geron	**4.9 (4-5)**	**2.6 (1-3.6)**	4.2	4.9	4.5	4.7	4.9	73	1.66% (11)
13 (1270)	UH:Cardiac	**5.0 (3.5-5)**	**2.9 (1-3)**	3.7	4.9	4.6	4.9	4.9	63	1.73% (22)
6 (431)	LCH2:Med	**4.5 (3-5)**[d]	**2.9 (1-4)**	4.9	4.2	4.9	4.9	5.0	65	0.23% (1)
7 (1193)	UH:Cardiac	**5.0 (3-5)**	**4.9 (4-5)**	**2.6 (1-3.8)**	4.8	4.3	4.9	4.9	60	1.84% (22)
10 (880)	UH:Cardiac	**4.9 (3.3-5)**	**4.7 (3.8-5)**	**4.8 (3.8-5)**	4.9	4.5	4.8	4.8	61	0.68% (6)
1 (5889)	LCH1:Geron, LCH2:Geron	**5.0 (4-5)**	**5.0 (3.7-5)**	4.8	4.7	4.4	4.7	4.8	75	0.53% (31)
11 (2097)	LCH1:Med	**4.6 (3-5)**	**4.9 (3.6-5)**	4.9	4.9	4.7	4.7	5.0	65	1.38% (29)
12 (1621)	LCH2:Med	**4.9 (3.2-5)**	**4.9 (4-5)**	4.9	3.8	4.9	4.9	4.9	61	0.25% (4)

Note: Numbers in cells for the seven patient characteristics reflect NOC outcome ratings scored on a scale from 1-5
[a] Cluster (n) = Cluster identifier and the number of matched control episodes
[b] **Red font** represents low or poorly met NOC outcome ratings and the (NOC range) for the patient characteristic.
[c] **Green font** represents high or well met NOC outcome ratings and the (NOC range) for the patient characteristic.
[d] **Blue font** represents partially met NOC outcome ratings and the (NOC range) for the patient characteristic.
[e] %PU (n) = Percent and number of Pressure Ulcers per cluster

TABLE V
PATIENT CHARACTERISTICS AND HAPU VS. NON-HAPU EPISODES IN AN 18 CLUSTER SOLUTION (N = 840)

	HAPUs Mean (S.D.)	Non-HAPUs Mean (S.D.)	T test (P value)
Nutrition	4.35 (1.27)	4.60 (0.98)	0.00
Mobility	4.10 (1.25)	4.29 (1.10)	0.04
Cognition	4.57 (1.02)	4.71 (0.84)	0.05
Perfusion	3.95 (1.29)	4.02 (1.19)	0.43
Continence	4.83 (0.66)	4.88 (0.55)	0.22
Hydration	4.12 (1.17)	4.11 (1.18)	0.92
Skin	4.10 (1.29)	4.24 (1.11)	0.12
Age	63.9 (15.3)	65.5 (16.7)	0.00

TABLE VI
PATIENT CHARACTERISTICS AND HAPU VS. NON-HAPU EPISODES IN A 200 CLUSTER SOLUTION (N = 840)

	HAPUs Mean (S.D.)	Non-HAPUs Mean (S.D.)	T test (P value)
Nutrition	4.35 (1.27)	4.42 (1.16)	0.46
Mobility	4.10 (1.25)	4.20 (1.15)	0.30
Cognition	4.57 (1.02)	4.62 (0.94)	0.51
Perfusion	3.95 (1.29)	3.96 (1.26)	0.91
Continence	4.82 (0.66)	4.87 (0.56)	0.34
Hydration	4.12 (1.17)	4.16 (1.13)	0.70
Skin	4.10 (1.29)	4.42 (1.16)	0.46
Age	68.9 (15.3)	66.5 (16.3)	0.06

TABLE VII
HAPU VS. NON-HAPU EPISODES BY UNITS (N = 840)

		LCH1: Geron	LCH1: ICU	LCH1: Med	LCH2: Geron	LCH2: Med	SCH: Med	UH: Cardiac	UH: ICU	UH: Neuro	Total
Total											
630	0	91	39	139	37	18	3	177	117	9	24, 399
75.00		74.59	75.00	75.14	75.71	75.00	75.00	75.00	75.00	75.00	99.15
210	1	31	13	46	12	6	1	59	39	3	210
25.00		25.41	25.00	24.86	24.49	25.00	25.00	25.00	25.00	25.00	0.85
Total											
24, 609		122	52	185	49	24	4	236	156	12	24, 609
100.00		100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

P=1.000

TABLE VIII
NANDA-I, NOC, AND NIC (NNN) LABELS USED TO IDENTIFY PATIENT CHARACTERISTICS

Category	NANDA-I	NOC	NIC
Continence	• Impaired Urinary Elimination • Bowel Incontinence • Diarrhea	• Bowel Elimination • Bowel Continence • Urinary Continence • Urinary Elimination	• Urinary Incontinence Care • Self-Care Assistance: Toileting • Diarrhea Management • Urinary Elimination Management • Bowel Incontinence Care • Bowel Management
Mobility	• Impaired Bed Mobility • Impaired Physical Mobility	• Mobility • Body Positioning: Self-initiated • Neurological Status: Cranial Sensory/Motor Function • Immobility Consequences: Physiological	• Positioning • Positioning: Wheelchair • Pressure Management • Bed Rest Care • Positioning: Neurologic
Nutrition	• Imbalanced Nutrition: Less Than Body Requirements	• Nutritional Status • Nutritional Status: Energy • Nutritional Status: Nutrient Intake • Nutritional Status: Food and Fluid Intake • Nutritional Status: Biochemical Measures	• Nutritional Monitoring • Enteral Tube Feeding • Nutrition Management • Total Parenteral Nutrition Administration • Nutrition Therapy

TABLE VIII (continued)

Category	NANDA-I	NOC	NIC
Hydration	• Deficit Fluid Volume • Risk for Deficit Fluid Volume • Risk for Imbalanced Fluid Volume	• Hydration • Electrolyte & Acid/Base Balance • Fluid Balance	• Electrolyte Management • Fluid Management • Intravenous (IV) Therapy • Hypovolemia Management • Electrolyte Management: Hypernatremia • Fluid and Electrolyte Management • Fluid Resuscitation • Electrolyte Monitoring • Fluid Monitoring
Perfusion	• Ineffective Tissue Perfusion: Peripheral • Risk for Peripheral Neurovascular Dysfunction	• Neurological Status: Cranial Sensory/Motor Function • Tissue Perfusion: Peripheral • Circulation Status • Cardiac Pump Effectiveness	• Circulatory Care: Arterial Insufficiency • Lower Extremity Monitoring • Hemodynamic Regulation • Invasive Hemodynamic Monitoring • Circulatory Precautions • Circulatory Care: Venous Insufficiency

TABLE VIII (continued)

Category	NANDA-I	NOC	NIC
Cognition	• Disturbed Sensory Perception: Tactile • Disturbed Thought Processes • Acute Confusion • Chronic Confusion	• Neurological Status: Consciousness • Information Processing • Cognitive Orientation • Communication • Communication: Expressive • Distorted Thought Self Control • Tissue Perfusion: Cerebral • Cognition • Neurological Status	• Communication Enhancement: Speech Deficit • Dementia Management • Reality Orientation • Delirium Management • Sedation Management • Delusion Management
Skin	• Impaired Skin Integrity • Risk for Impaired Skin Integrity • Impaired Tissue Integrity		• Skin Surveillance • Pressure Ulcer Prevention

TABLE IX
RAW DATA IN HANDS AND OPERATIONALIZED DEFINITIONS FOR PATIENT CHARACTERISTICS, NURSE STAFFING, AND CONTINUITY VARIABLES

Variable	Raw Data Found in HANDS	Operationalized Definition
Nurse Staffing Variables		
Shift Length	Number of consecutive hours worked by each registered nurse (RN) during a care episode.	% of 8-hour RN care shifts in a patient episode.
RN Work Pattern (Shifts of Care by Part Time [PT]/Full Time [FT] vs. Very Part Time [VPT] Workers)	Fraction of time status (FT, PT, VPT) for each RN who cared for the patient during a care episode.	% of care shifts by very part time status RNs (0.3 [24 hours] or less]) in a patient episode.
Nurse Experience	Years of experience as an RN.	% of time cared for by RNs with ≥ to 2 years of experience in a patient episode.
Nurse Education	Diploma, ADN,[a] BSN,[b] BSN and some additional coursework, Master's degree in nursing, or Doctoral degree in nursing.	% of time cared for by RNs with a BSN or greater in a patient episode.
Patient-to-Nurse Ratio	Actual number of patients cared for by a single RN during a shift.	The average patient-to-nurse ratio over the course of the patient care episode
Worked hours per patient day (whppd)	The total number of RN hours on a unit in a 24-hour period divided by the number of patients on that unit at the midnight census.	The average whppd over the course of the patient care episode
Nurse Continuity Variable		
Number of consecutive days cared for by the same/single RNs	The total number of consecutive care days worked by each RN with the patient during a care episode.	% of consecutive care days by the same/single RNs in a patient episode.
Patient Characteristics		
Nutrition	1 NANDA-I,[c] 5 NOC,[d] 5 NIC[e] Nutrition labels	NNN[f] Nutrition label appearing on the admission POC[g] in the patient's episode
Continence	3 NANDA-I, 4 NOC, 6 NIC Continence labels	NNN Continence label appearing on at the admission POC in the patient's episode
Hydration	3 NANDA-I, 3 NOC, 9 NIC Hydration labels	NNN Hydration label appearing on the admission POC in the patient's episode

TABLE IX (continued)

Variable	Raw Data Found in HANDS	Operationalized Definition
Mobility	2 NANDA- I, 4 NOC, 5 NIC Mobility labels	NNN Mobility label appearing on the admission POC in the patient's episode
Perfusion	2 NANDA-I, 4 NOC, 5 NIC Perfusion labels	NNN Perfusion label appearing on the admission POC in the patient's episode
Cognition	4 NANDA-I, 9 NOC, 6 NIC Cognition labels	NNN Cognition label appearing on the admission POC in the patient's episode
Skin	3 NANDA-I, 2 NIC Skin Labels	NNN Skin label appearing on the admission POC in the patient's episode
Age	Age in years	Age in years

[a]ADN = Associate Degree in Nursing
[b]BSN = Bachelor of Science in Nursing
[c]NANDA-I = North American Nursing Diagnosis Association – International
[d]NOC = Nursing Outcomes Classification
[e]NIC = Nursing Interventions Classification
[f]NNN = NANDA-I NOC NIC, POC
[g]POC = Plan of Care

TABLE X
PATIENT CHARACTERISTICS AND HAPU VS. NON-HAPU EPISODES
(N = 24,609)

	HAPUs Mean (S.D.)	Non-HAPUs Mean (S.D.)	T test (P value)
Nutrition	4.35 (1.27)	4.62 (0.94)	0.00
Mobility	4.10 (1.25)	4.49 (0.98)	0.00
Cognition	4.57 (1.02)	4.64 (0.85)	0.26
Perfusion	3.95 (1.29)	4.49 (0.92)	0.00
Continence	4.83 (0.66)	4.88 (0.54)	0.20
Hydration	4.12 (1.17)	4.60 (0.86)	0.00
Skin	4.10 (1.29)	4.47 (1.01)	0.00
Age	68.9 (15.3)	65.1 (18.2)	0.00

TABLE XI
NURSE EDUCATION, EXPERIENCE, AND SHIFT LENGTH: HAPU VS. NON-HAPU EPISODES (N = 24,609)

	non HAPU			HAPU		
	BSN[a]	Experienced[b]	Eight hour shifts[c]	BSN	Experienced	Eight hour shifts
Overall	46.4%	73.8%	56.5%	53.3%	75.3%	44.9%
LCH1: Med	50.8%	72.1%	39.7%	45.8%	73.7%	39.9%
LCH1: Geron	42.7%	87.2%	93.8%	42.8%	89.3%	97.5%
UH: Cardiac	55.6%	57.0%	32.3%	60.0%	55.9%	34.3%
UH: ICU	61.6%	91.6%	24.6%	59.5%	90.3%	22.9%

[a] BSN $p < .001$
[b] Experienced $p = .32$
[c] Eight hour shifts $p < .001$

TABLE XII
VERY PART TIME (VPT), WORKLOAD, AND WORKED HOURS PER PATIENT DAY (WHPPD): HAPU VS. NON-HAPU EPISODES (N = 24,609)

	non HAPU			HAPU		
	Workload[a]	Whppd[b]	% VPT[c]	Workload	Whppd	% VPT
Overall	4.4	6.6	3.2%	3.6	8.3	3.9%
LCH1: Med	3.6	7.1	2.3%	3.5	7.2	2.2%
LCH1: Geron	5.9	4.6	1.4%	5.9	4.6	1.0%
UH: Cardiac	3.5	7.8	4.3%	3.5	7.8	6.4%
UH: ICU	2.2	12.7	7.2%	2.0	12.8	5.7%

[a] Workload $p < .001$
[b] Whppd $p < .001$
[c] % Very part-time $p = .07$

TABLE XIII
REGRESSING NURSE CONTINUITY ON HOSPITAL-ACQUIRED PRESSURE ULCERS (HAPUs) (N = 840)[a]

Outcome	Predictor	Coefficient	SE	z	P > [z]
HAPUs	Nurse Continuity	.24	.37	0.67	0.50

[a]Analytic dataset contains episodes with and without HAPUs (matched controls) using the patient characteristics, units, and patient age as the similarity measure

TABLE XIV
REGRESSING NURSE CONTINUITY AND NURSE STAFFING VARIABLES ON HOSPITAL-ACQUIRED PRESSURE ULCERS (HAPUs) (N = 840)[a]

Outcome	Predictor	Coefficient	SE	z	P > [z]
HAPUs	Nurse Continuity	.35	.39	0.90	0.37
	Experience	-.09	.40	-0.23	0.82
	BSN[b]	-.14	.37	-0.38	0.70
	Load (patient-to-nurse ratio)	-.06	.12	-0.47	0.64
	Eight-hour shifts	.22	.30	0.73	0.46
	Very part-time	1.09	1.24	0.88	0.38
	Whppd[c]	-.00	.05	-0.02	0.98

[a]Analytic dataset contains episodes with and without HAPUs (matched controls) using the patient characteristics, units, and patient age as the similarity measure
[b]BSN = Bachelor of Science in Nursing
[c]whppd = Worked hours per patient day

TABLE XV
REGRESSING NURSE CONTINUITY, NURSE STAFFING VARIABLES, AND INTERACTION TERMS ON HOSPITAL-ACQUIRED PRESSURE ULCERS (HAPUs) (N = 840)[a]

Outcome	Predictor	Coefficient	SE	z	P > [z]
HAPUs	Nurse Continuity	.42	.40	1.06	0.29
	Experience	-.09	.41	-0.23	0.82
	BSNs[b]	-.25	.38	-0.67	0.51
	Load (patient-to-nurse ratio)	-.06	.12	-0.49	0.63
	Eight-hour shifts	.30	.31	0.98	0.33
	Very part-time	1.26	1.32	0.96	0.34
	Whppd[c]	.00	.05	0.02	0.98
	Cont*bsn[d]	1.83	1.54	1.19	0.23
	Cont*exp	1.38	1.77	0.78	0.43
	Cont*load	.14	.50	0.29	0.77
	Cont*whppd	.07	.19	0.38	0.70
	Cont*eight hours	-1.02	1.28	-0.80	0.42
	Cont*vpt	-2.48	5.26	-0.47	0.64

[a]Analytic dataset contains episodes with and without HAPUs (matched controls) using the patient characteristics, units, and patient age as the similarity measure
[b]BSN = Bachelor of Science in Nursing
[c]whppd = Worked hours per patient day
[d] Interaction Term Cont*bsn created by combining the variables for nurse continuity and RN education variable to test for moderating effect of nurse continuity on other nurse staffing variables and HAPU outcomes

Figures

Figure 1
Conceptual Model for Studying the Effect of Nurse Continuity on Patient Outcomes

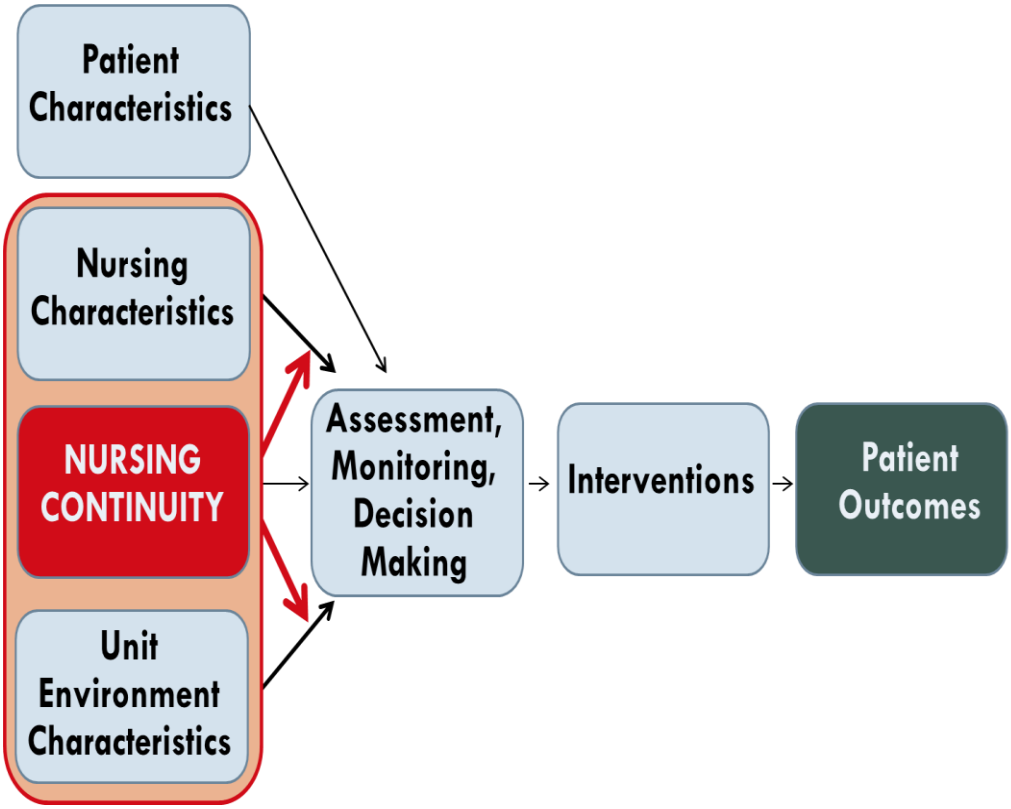


Figure 2 Continuity Index Calculation

Shift	Day 1	Day 2	Day 3	Day 4	Day 5
7 am – 7 pm	Nurse 1 →	Nurse 1	Nurse 4 →	Nurse 4 →	Nurse 4
7 pm – 7 am	Nurse 2	Nurse 3 →	Nurse 3	Nurse 5	

4 consecutive care days out of a potential 7: Nurse 1, Day 1 and Day 2
Nurse 3, Day 2 and Day 3
→ = 4 consecutive care days Nurse 4, Day 3 and Day 4
Nurse 4, Day 4 and Day 5

⌒ = 7 potential care days (from one 7a-7p to the next 7a-7p or from one 7p-7a to the next 7p-7a)

4/7 = .57 continuity index

APPENDICES

UNIVERSITY OF ILLINOIS
AT CHICAGO

Office for the Protection of Research Subjects (OPRS)
Office of the Vice Chancellor for Research (MC 672)
203 Administrative Office Building
1737 West Polk Street
Chicago, Illinois 60612-7227

APPENDIX A
Determination Notice
Research Activity Does Not Involve "Human Subjects"

September 17, 2013

Janet Stifter, MS, RN
Health Systems Science
10800 S. Le Claire Avenue
Oak Lawn, IL 60453
Phone: (773) 616-4500 / Fax: (312) 996-1819

RE: Research Protocol # 2013-0853
"Using an Electronic Health Record to Examine Nurse Continuity and Pressure Ulcers"

Sponsor:	AHRQ
PAF#:	2014-00498
Grant/Contract No:	R36HS023072-01
Grant/Contract Title:	Using an Electronic Health Record to Examine Nurse Continuity and Pressure Ulcers

Dear Ms. Stifter:

The UIC Office for the Protection of Research Subjects received your "Determination of Whether an Activity Represents Human Subjects Research" application, and has determined that this activity **DOES NOT meet the definition of human subject research** as defined by 45 CFR 46.102(f)/ 21 CFR 50.3(g) and 21 CFR 56.102(e)/ 38 CFR 16.102(f).

It is understood that this activity will involve a secondary analysis of existing de-identified data only.

You may conduct your activity without further submission to the IRB.

If this activity is used in conjunction with any other research involving human subjects or if it is modified in any way, it must be re-reviewed by OPRS staff.

APPENDIX B

Project Title: Using an Electronic Health Record to Examine Nurse Continuity and Pressure Ulcers (Agency for Healthcare Research and Quality Grant Number: 1R36HS023072-01)

My long term goal is to ensure Hospital Administrators have readily accessible, meaningful data to support cost effective staffing decisions that ensure the best outcomes for patients. Healthcare costs have escalated, largely due to negative care-associated outcomes such as never events (e.g., pressure ulcers, falls). Historically nursing services were reorganized to counteract these costs. Reorganization efforts included use of lower nurse-to-patient ratios, decreasing RN care hours, and replacing RNs with less educated assistive personnel. This reorganization has resulted in a care delivery system that is increasingly fragmented by varied shift lengths, nurse schedules, and diverse care providers leading to a loss of care continuity and compromising one of healthcare's most important functions, protecting patients from harm when they receive hospital care. Researchers have examined several RN staffing variables integral to reorganization efforts such as nursing education, experience, or nurse-to-patient ratios but failed to demonstrate convincing evidence to explain how changes in nurse staffing may influence care associated outcomes such as never events. An examination of nurse continuity may provide the missing link to demonstrate that connection. The purpose of this study is to examine the relationship between nurse continuity and hospital-acquired pressure ulcers. For this study nurse continuity is defined as a consistent nurse caregiver who provides care to the patient during the hospitalization. **By virtue of the coordinated, seamless care resulting from nurse continuity, the central study hypothesis is that when nurse continuity is present there will be fewer pressure ulcers than when nurse continuity is absent.** The nurse staffing variable *number of shifts cared for by the same/single RN* is used to measure **nurse continuity.** The innovative Hands on Automated Nursing Data System (HANDS) with its standardized nursing data will allow the examination of the influence of nurse continuity because a variety of nurse staffing measures, including nurse continuity, are linked with an individual patient's predictors and pressure ulcer outcomes across the hospitalization. The **specific aims of this study** are: **Aim 1** To determine which **patient predictors** in the HANDS database (*Age, Nutrition, Mobility, Hydration, Continence*) influence pressure ulcer development for the purpose of creating an analytic dataset; and **Aim 2** Using the analytic dataset and controlling for the **patient predictors,** to determine the influence of **nurse continuity** (*number of shifts cared for by the same/single RN)* and **nurse staffing variables** (*worked hours per patient day, nurse-to-patient ratio, RN experience, RN education, shift length* [8 versus 12 hours], and *number of shifts cared for by very part time [.3 FTE or less] versus part/full time staff [.5 – 1.0 FTE]* on the presence of hospital-acquired pressure ulcers. The study findings are urgently needed because future nursing services reorganization could adversely affect patient safety and care, unless health services scientists demonstrate a clear link between nurse continuity and improved patient outcomes.

Specific Aims

My long-term goal is to ensure that Hospital Administrators have readily accessible, meaningful data to support cost effective staffing decisions that ensure the best outcomes for patients. Healthcare costs have escalated with expenditures of 2.6 trillion dollars in 2010,[1] in part due to negative care-associated outcomes including never events (e.g., pressure ulcers, falls) that cost 21 billion annually.[2] Never events are serious, largely preventable adverse outcomes that occur during hospitalization.[3] Historically nursing services were reorganized using lower nurse-to-patient ratios, decreasing RN care hours, and replacing RNs with less educated assistive personnel to counteract this cost.[4] Nursing services are costly (> 1/3 of a hospital's expenses[5]) but this reorganization has resulted in a care delivery system that is increasingly fragmented by varied shift lengths, nurse schedules, and diverse care providers[4] leading to a loss of care continuity and compromising one of healthcare's most important functions, protecting patients from harm when receiving hospital care.[6] Researchers have examined other nurse staffing variables integral to reorganization efforts such as nursing education, experience, or nurse-to-patient ratios but failed to demonstrate convincing evidence to explain how changes in nurse staffing may influence negative care associated outcomes such as never events. An examination of nurse continuity may provide the missing link to demonstrate that connection. The study purpose is to examine the relationship between nurse continuity and hospital-acquired pressure ulcers.

Nursing services reorganization has been the cost containment option of choice for two reasons. First, research studies of the influence of nurse staffing variables on patient outcomes are numerous but inconsistent regarding the outcomes secondary to nursing's unique role. Of six multi-hospital studies,[7-12] and several systematic reviews and meta-analyses[13-16] some results indicate significant associations between nurse staffing variables (e.g., nurse-to-patient ratio or RN education or experience) and mortality,[7, 8, 11, 12, 14, 17] pressure ulcers,[8, 18] and pneumonia,[10, 14] while other studies[8, 12, 19-21] do not. One possible interpretation for the inconsistency is that not all critical variables were considered. For example, nurse continuity, once a hallmark of the primary nurse staffing model[22-24] has been infrequently studied, especially in relation to its influence on patient outcomes. This omission may be attributed to both an inconsistent definition of nurse continuity and the absence of evaluation measures that link continuity and patient outcomes. For the proposed study **nurse continuity** is defined as a consistent nurse caregiver who provides care to the patient during the hospitalization. **By virtue of the coordinated, seamless care resulting from nurse continuity, the central hypothesis of the proposed study is that when nurse continuity is present there will be fewer pressure ulcers than when nurse continuity is absent.** Fortunately, the innovative Hands on Automated Nursing Data System (HANDS) with its standardized nursing data[25] will allow the examination of the influence of nurse continuity because a variety of nurse staffing measures, including nurse continuity, are linked with an individual patient's predictors and pressure ulcer outcomes across the hospitalization.

A comparative secondary data analysis of the HANDS database is proposed. The valid and reliable database[25-27] contains 42,403 hospitalizations during which 787 nurses provided care on nine units in four hospitals.[28] This study will include two parts: 1) creating an analytic dataset containing 3,300 patients (of which 300 have hospital-acquired pressure ulcers) with relevant patient-level predictors as documented in the HANDS database and then 2) using the analytic dataset to determine the influence of the nurse continuity variable, *the number of shifts cared for by the same/single RN*, on hospital-acquired pressure ulcers. Diagnoses recorded as NANDA-I labels[29] (Nutrition, Mobility, Hydration, Continence) and patient age, could contribute to

pressure ulcers[30-33] and will be examined as **patient**-level **predictors** of hospital-acquired pressure ulcers. Data mining techniques and logistic regression analysis will be used to achieve the study aims. The **specific study aims are:**

Aim 1: To determine which **patient predictors** in the HANDS database (*Age, Nutrition, Mobility, Hydration, Continence*) influence the presence of hospital-acquired pressure ulcers for the purpose of creating an analytic dataset.

Aim 2: Using the analytic dataset and controlling for the **patient predictors,** to determine the influence of **nurse continuity** (*number of shifts cared for by the same/single RN*) and **nurse staffing variables** (*worked hours per patient day, nurse-to-patient ratio, RN experience, RN education, shift length [8 versus 12 hours], number of shifts cared for by very part time [.3 FTE or less] versus part/full time staff [.5 – 1.0 FTE]*) on the presence of hospital-acquired pressure ulcers.

Findings will inform future nursing services reorganization to reduce adverse effects on patient safety and care.

Research Strategy

SIGNIFICANCE

Healthcare is costly with expenditures of 2.6 trillion dollars in 2010, a 10-fold increase since 1980.[1] Despite escalating expenditures, patient outcomes do not reflect a positive return on investment. Never events (adverse events affecting patients during hospitalization that are serious and largely preventable) [3] alone generate $21 billion dollars of non-reimbursed hospital costs[2] and are an important target for nursing care quality improvement efforts. As the largest hospital operating expense[5] nurses are viewed as valued but costly resources for safeguarding patients from harm and improving outcomes.[34] Nurses comprise over one third of the hospital employees and more than 50% of the expense.[5] It is not surprising, therefore, that nursing services are targeted for reorganization efforts to reduce hospital expenses.[4] Efforts to contain costs by reorganizing nursing services were first introduced in the 1980s[4] and continued through the nursing shortage of the 1990s[35] with workforce transformation an ongoing focus of healthcare administrators, including Chief Nurse Executives (CNEs).[36] Reorganization strategies included replacing RNs with less educated assistive personnel, use of lower nurse-to-patient ratios, and decreasing RN care hours.[4] Recent healthcare reorganization has been associated with the development of a care delivery system increasingly fragmented by varied shift lengths, nurse schedules, and diverse care providers[4] leading to a loss of care continuity and compromising one of healthcare's most important functions, protecting hospitalized patients from harm.[6]

Researchers have examined nursing services re-organization with mounting evidence that nurse staffing variables have a strong influence on patient outcomes. Researchers have conducted six multi-hospital studies [7-12] and several systematic reviews and meta-analyses [13-16] that include patient outcomes related to the nurse-to-patient ratio, education, or experience of RN care providers. Study results indicate significant associations between additional nursing care hours/higher proportion of RN care and patient outcomes including reductions in pressure ulcers.[8, 18] A richer RN skill mix increases satisfaction[37] and more educated and experienced RN providers have improved mortality outcomes.[11, 38, 39] Results are suggestive that investment in additional RNs with more education and hours of care at the bedside would result in reduced incidence of negative patient outcomes. However, this connection is inconsistently demonstrated. Institution of mandatory RN staffing ratios generated no significant improvement in pressure ulcer prevalence.[19] Additional researchers found no connection between RN staffing and incidence of pressure ulcers[20] and no differences in patient mortality with either increased RN experience[12] or education levels.[8, 12, 21] One possible interpretation of this inconsistency may be that not all critical staffing variables have been examined. Nurse continuity, once a hallmark of the primary nurse staffing model, [22-24] has been infrequently studied, especially in relation to its influence on patient outcomes.

This gap in the health services literature may be attributable to both the inconsistent definition of continuity and the absence of reliable and valid evaluation measures that link continuity and patient outcomes. Common continuity descriptions include informational,[6, 40, 41] interpersonal,[40-43] and management.[40, 42, 44] Continuity measurements include instruments to measure assignment patterns,[45-46] chronological calculations,[23, 47] self report surveys and questionnaires,[48-51] and indices[52, 53] which are seldom used in nursing research.[54]

Despite the value the primary nursing model invested in continuity there are few patient outcome studies underscoring the value of nurse continuity. Only three studies were found that include nurse continuity and patient outcomes, none addressing never events. Bostrom et al.[47]

reported improved patient satisfaction, Russell et al.[55] found reduced use of hospitals and emergent care, and Siow[56] noted a safer environment with experienced nurses when increased nurse continuity was present. Notably, in the early 2000s eight federally funded studies commissioned to direct public policy around nurse staffing and patient outcomes did not include nurse continuity as a critical staffing variable.[57]

The inconsistent definition of continuity and the absence of reliable and valid evaluation measures have lead to a lack of substantive data that healthcare administrators such CNEs can use to develop a convincing argument linking the influence of nursing services reorganization and subsequent RN staffing changes with patient outcomes.[57] The diversity of definitions and measurements make it difficult for CNEs to compare studies to their actual practice setting and to reach conclusions linking continuity in nurse staffing with patient outcomes. The challenge for health services researchers is to define and use a consistent continuity measure across care settings to demonstrate the value to patients of having continuous nurse providers within the context of nurse staffing variables while controlling for patient variables.

The CNE needs but currently lacks efficient, effective, and readily available[58] data to connect nurse staffing variables such as nurse continuity with patient outcomes**.** To create an effective argument CNEs must have meaningful, real time evidence from a source that is specific to their own patient and nursing populations.[59] The ideal source should not add cost and must be easily explained to other hospital administrators.[58] The electronic health record (EHR) is proposed in this study as an untapped resource for helping to demonstrate the connection between nurse staffing and patient outcomes. The EHR can be a valuable data source if it contains nursing plan of care (POC) documentation coded in a way that allows easy access and is in a form amenable to analysis. In this study HANDS[25] is such a resource and used as an exemplar data source for examining the nurse staffing variable, nurse continuity, and its connection with the prevention of one never event, hospital-acquired pressure ulcers.

INNOVATION

This study is innovative in that a novel nursing EHR system will be used to demonstrate how a readily accessible, effective data source can be used to examine the relationship between nurse continuity, nurse staffing variables, and patient outcomes. The National Database for Nursing Quality Indicators (NDNQI) is one available standardized database that comparatively displays nursing quality indicators across hospital units.[60] However, variable unit definitions can make the database challenging to interpret and use comparatively. In addition, databases such as NDNQI focus on hospital and unit level variables but are unable to connect patient specific outcomes with individual nurse characteristics. The HANDS database proposed for use in this study has already been successfully deployed in clinical practice and shown to generate standardized nursing care data that can be statistically analyzed and mined for best practices[25] as well as translated into evidence based decision support for end-of-life pain management. [26-27] The HANDS database uniquely allows delineation of associative patterns that can be drilled down to the shift-level with linked data for the individual nurse providing care and the patient receiving care. This level of inquiry makes my study innovative as I will examine the influence of number of shifts cared for by the same/single RN into the evidence about hospital-acquired pressure ulcers. Possessing data at this level will equip CNEs with rationale for the optimal nurse staffing resources needed at the bedside to prevent hospital-acquired pressure ulcers.

This study focus is also innovative in that we will use the standardized data collected with HANDS to examine the influence of nurse continuity controlling for associated patient-level

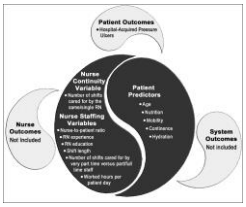
predictors and including nurse continuity and nurse staffing variables collected at the point of care and that have not previously been available in nursing documentations systems. Twelve-hour shifts were initially introduced as a cost cutting measure for hospitals and to enhance the quality of RN work/life balance through a reduced work week.[49] There is some debate, however, about the impact of these shifts on patient care quality and whether working fewer shifts per week is balanced out by having staff spending longer periods of time with patients during a single day.[61] Studies including 8- and 12-hour shifts typically document positive nurse perceptions about fatigue levels,[16, 62-64] satisfaction,[50, 64-66] planning and documenting care,[51, 63, 65] patient communication,[51, 65, 67] and continuity of care [49, 65-66] with the 12-hour shifts. Research studies including the influence of shift length on actual outcomes are limited, depicting some negative findings including increased errors,[68, 69] needle stick injuries,[70] pneumonia deaths,[71] and performance lags[72] with less time actually spent in direct patient care as the shift lengthens.[73] Only one research team [64] attempted to correlate shift length with three adverse patient outcomes (medication errors, falls, and pressure ulcers) using incident reports but was unsuccessful in demonstrating a relationship.

This study is unique because HANDS affords a consistently defined and measured set of predictor and outcome variables that will allow an investigation of whether a measure of nurse continuity has any influence on preventing hospital-acquired pressure ulcers. Pressure ulcer development is a prevalent never event (5-10%),[30] very costly to hospitals ($8.5– $11.0 billion dollars/year),[32] and a major nurse-sensitive outcome.[74] Excellent skin care is a hallmark of nursing care quality.[31] A connection between improved pressure ulcer outcomes and the vigilant care and preventive actions fostered by nurse continuity [33] could provide meaningful evidence for CNEs when discussing changes to nursing services delivery with other hospital administrators.

Summary. Current evidence about nurse-to-patient ratio, RN education, or RN experience is inconclusive regarding the connection between nursing staffing and improved patient outcomes. Examination of nurse continuity along with nurse staffing variables and controlling for patient predictors may provide the supportive evidence to demonstrate that connection. With the ongoing financial pressures faced by hospitals the erosion of nursing services will continue unless there is evidence of a clear relationship between nurse continuity and improved patient outcomes. Research findings are urgently needed to facilitate understanding of the true consequences and economic implications of nurse resource deployment decisions on patient outcomes.[18]

APPROACH

Conceptual Framework: The American Association of Critical Care Nurses (AACN) Patient-Nurse Synergy Model was developed to link nursing practice with patient outcomes.[75] It was originally used as a framework for critical care certification[75] and has been used for diverse application in studies across healthcare settings,[76-77] specialties,[78-79] personnel,[80-82] and practices.[83-85] For the proposed study the model depicts the interaction of my **patient predictors** (*Age, Nutrition, Mobility, Continence, Hydration*), my **nurse continuity variable** (*number of shifts cared for by the same/single RN*), and several **nurse staffing variables** *(nurse-to-patient ratio, RN experience, RN education, shift length, number of shifts cared for by very part time [.3 FTE or less] versus part/full time staff [.5 – 1.0 FTE], worked hours per patient day)* that may contribute to improved **patient outcomes** (*hospital-acquired pressure ulcers*). The selected patient predictors for this study have been shown to influence pressure ulcer development in previous research.[30-31, 86-88] This framework underscores the



hypothesis that a consistent nurse caregiver, regardless of patient predictors and staffing variables such as nurse education, level of experience, nurse-to-patient ratio, shift length, full or part time status, or worked hours per patient day will have a better understanding over time of the patient and his/her typical responses[89] leading to better change recognition and more prompt intervention to prevent hospital-acquired pressure ulcers.[58]

METHODS AND ANALYSIS

Study Design: A comparative secondary analysis of the HANDS database is proposed. The valid and reliable database[25-27] contains 42,403 hospitalizations during which 787 nurses provided care on nine units in four hospitals for 12 or 24 months.[28] Two protocols have been designed to help achieve the study aims. The Aim 1 protocol includes the use of maximal association and cluster data mining techniques and statistical analysis to determine patient-level predictive relationships leading to pressure ulcers and to help create an analytic dataset for examining the influence of nurse continuity. The Aim 2 protocol employs logistic regression to determine the influence of a nurse continuity variable and nurse staffing variables on hospital-acquired pressure ulcers, controlling for the patient-level predictors identified in Aim 1.

Setting: HANDS is an electronic documentation tool with standardized nursing terminology used by nurses to enter data each shift that tracks a patient's diagnoses (North American Nursing Diagnosis Association International [NANDA-I]), interventions (Nursing Interventions Classification [NIC]), and outcomes (Nursing Outcomes Classification [NOC]), patient demographics, and a range of nurse characteristics.[28] The data to be used for the proposed study were gathered at four hospitals; two large community, one university, and one small community. The units represent a diverse population of patient types and acuity, nurse-to- patient ratios, and include Critical Care, General Medicine, Neuro Surgery, Cardiac Surgery, and Gerontology. Finally, the nine units employed a diverse population of RN caregivers with differing education and experience levels, variable shift lengths, work schedules, and employment status all captured in the HANDS database.

Sample: The available HANDS dataset is a relational database that consists of 89 tables and 747 columns of data collected over two years on nine clinical units. The database contains 42,403 hospitalizations on the study units called episodes of care (Table 1). Episodes of care are defined as a continuous patient stay on a

Table 1. Number of Available Episodes with Pressure Ulcers by Unit

Hospital and Unit	Number of Nurses by Unit*	Total Episodes of Care by Unit	Pressure Ulcers Developed Post Admission^	Percent of 12 hour shifts/month
LCH1: General Medicine	113	5640	56	54-64%
LCH1: MICU	54	1228	21	43-63%
LCH1: Gerontology	80	9565	48	5-18%
SCH: Medicine	63	4881	1	0-19%
LCH2: Medicine	59	3432	8	62-85%
LCH2: Gerontology	25	1673	19	43-75%
UH: Neuro Surgery	181	8216	3	37-54%
UH: Cardiac Surgery	210	6112	73	58-76%
UH: CICU	66	1656	71	Not available
Total	787	42403	300	

***** The sum of the number of nurses for all units is actually 851 due to 64 nurses who worked on multiple units. 787 reflect the total # of unique nurses; ^Determined by use of NIC: Pressure Ulcer Care on any POC excluding those with Pressure Ulcer Care on the admission plan.

single hospital unit and consist of all POCs entered at admission, the end of each shift, and discharge.[26] For this study hospital-acquired pressure ulcers were identified by writing SQL queries to locate and extract all episodes of care in the HANDS database in which the NIC: Pressure Ulcer Care was placed on the patient's POC at least 24 hours after admission. As shown in Table 1, 300 patients developed a pressure ulcer after admission.

Approach for Aim 1: To determine which **patient predictors** in the HANDS database (*Age, Nutrition, Mobility, Hydration, Continence*) influence the presence of hospital-acquired pressure ulcers for the purpose of creating an analytic dataset.

Step 1. Descriptive statistical analysis will be conducted to include means, medians, modes, standard deviations and graphing of data (histograms) to obtain an initial understanding of the 300 pressure ulcer episodes in the HANDS database we will be using to allow the examination of the influence of nurse continuity. The descriptive analysis will provide insight into the most frequent age range for ulcer development and what are the most common NOC outcome status ratings (e.g., 1 [worst], 2, 3, 4, or 5 [best] at the end of each shift within the episode of the ulcer development) for each predictor. Categories for each of the proposed pressure ulcer predictors (e.g., Age, Nutrition, Mobility, Continence, and Hydration) will be established based on the frequency of occurrence in the 300 episodes of care from HANDS as well as clinical judgment. The statistics derived from this analysis will guide the discretization of predictors with a range of continuous values (i.e., Age) into a finite number of possible values (i.e., young, middle age, elderly).

Step 2. Data mining using Rapid Miner will be used to explore associations between the patient predictors and the presence or absence of pressure ulcers in all 42,403 episodes of care for the hospitalized patients in the HANDS database. Data mining extends traditional statistical techniques and includes data analysis tools to describe patterns and relationships that emerge from data. Maximal association mining, specifically A Priori Association rule analysis, will be used to identify regularities in patterns of activities with the proposed patient predictors and pressure ulcer development and to discover rules about items that appear together.[90] These rules include looking at both the frequency of the association appearing in the database (support of prevalence) as well as the relative frequency of the occurrence of the items and their combinations (confidence).[90] A possible rule this study could include is the presence of NANDA-I: Nutrition: Imbalanced, Less than Body Requirements and NANDA-I: Impaired Bed Mobility implies the presence of impaired skin integrity. These rules will be reviewed by the principal investigator, other nursing clinical domain experts, and the data mining experts for the purpose of determining the critical patient predictors of pressure ulcers for moving forward to the third step of the Aim 1 protocol.

Step 3. Statistical significance of the predictive rules identified in Step 2 deemed to be clinically appropriate for pressure ulcer development will be determined. The chi square test will be used to discern statistically significant associations. Those statistically significant predictors will be included in the Aim 2 analysis.

Step 4. The K-means cluster analysis will be performed on the 42,403 care episodes from the HANDS database, both those with pressure ulcers and those without pressure ulcers, using the patient predictors as the attributes to form the basis for comparison to create the matched cases (control group) for the analytic dataset. K-means cluster analysis is a standard approach for creating an analytical sample for planned analyses using a weighted distance measure for the case control matching.[91] Episodes that have predictors leading to pressure ulcers will be matched

with episodes having the same predictors but do not lead to pressure ulcer development. For example, one cluster may contain episodes with the predictors NANDA-I: Nutrition: Imbalanced, Less than Body Requirements and NANDA-I: Impaired Bed Mobility on POCs for patients aged 65-75 years. Within this cluster some patients will have developed pressure ulcers post admission while other patients did not. By adjusting the parameters of the K-means algorithm, we aim to retain around 3,000 unique control cases without pressure ulcers to be compared with the 300 unique cases with pressure ulcers (10 control cases: 1 pressure ulcer case) for the proposed logistic regression analysis. (The actual ratio we will use depends on the outcome of the cluster analysis. Essentially we want to include as many control cases as possible without having to include episodes too dissimilar to the pressure ulcer episodes.)

Approach for Aim 2: Using the analytic dataset of 3,300 unique patient care episodes and controlling for the **patient predictors** to determine the influence of **nurse continuity** (*number of shifts cared for by the same/single RN*) and **nurse staffing variables** (*worked hours per patient day, nurse-to-patient ratio, RN experience, RN education, shift length [8 versus 12 hours], number of shifts cared for by very part time [.3 FTE or less] versus part/full time staff [.5 – 1.0 FTE])* on the presence of hospital-acquired pressure ulcers.

Step 1. Key nurse staffing variables from attributes available in the HANDS dataset will be computed for each patient episode included in the analytic dataset. This step involves translating the raw data elements available in the database into the variables to be studied (Table 2). For example, the nurse continuity variable *shifts of care by the same/single RN* will be determined using the total number of shifts worked by each nurse with the patient during a care episode and operationalized as the percentage of care shifts by the same/single RN per patient episode.

Step 2. Using the analytic dataset, logistic regression, controlling for the statistically significant patient predictors, will be performed to determine the effect of nurse continuity (number of shifts cared for by the same/single RN) and the nurse staffing variables (worked hours per patient day, nurse-to-patient ratio, years of experience, education level, shift length, number of shifts cared for by very part time versus part/full time staff) on the presence or absence of hospital-acquired pressure ulcers. An examination of full and nested models will be performed to determine the independent as well as the interactive effect of nurse continuity with the other staffing variables on pressure ulcer outcomes in hospitalized patients. The specific analytic model that will be tested with logistic regression is as follows: **Hospital-Acquired Pressure Ulcers** = **Nurse Continuity Variable** (*number of shifts cared for by the same/single RN*) + **Nurse Staffing Variables** (*worked hours per patient day, nurse-to-patient ratio, RN experience, RN education, shift length [8 versus 12 hours], number of shifts cared for by very part time [.3 FTE or less] versus part/full time staff [.5 – 1.0 FTE])* and controlling for **Patient Predictors** (*Age, Nutrition, Mobility, Hydration, Continence*).

Table 2. Patient Predictors, Nurse Staffing and Continuity Variables

Variable	Raw Data Found in HANDS	Operationalized Definition
Nurse Staffing Variables		
Shift Length	Number of consecutive hours worked by each nurse during a care episode.	% of 8-hour RN care shifts per patient episode.
Shifts of Care by Part/Full Time vs. Very Part Time Status	Fraction of time status (FT, PT, VPT) for each nurse who cared for the patient during a care episode.	% of care shifts by part time to full time status RNs (.5 – 1.0) per patient episode.
Nurse Experience	Years of experience as a nurse.	% of time cared for by a nurse with ≥ to 2 years of experience per patient episode.

Nurse Education	Diploma, ADN, BSN, BSN and some additional coursework, Master's degree in nursing, or Doctoral degree in nursing.	% of time cared for by a nurse with a BSN or greater per patient episode.
Nurse-to-Patient Ratio	Actual number of patients cared for by a single nurse during a shift.	% of time cared for by a nurse on a shift with a good nurse-to-patient ratio (at or below benchmark) per patient episode.
Worked hours per patient day	The total number of full and part time RNs in a 24-hour day multiplied by their shift hours worked and then divided by the number of patients care for in that same 24-hour period.	% of time cared for by a nurse on a shift with a good whppd (at or above the benchmark) per patient episode.
Nurse Continuity Variable		
Number of shifts cared for by the same/single RN	The total number of shifts worked by each nurse with the patient during a care episode.	% of care shifts by the same/single RN per patient episode.
Patient Predictors		
Nutrition	NANDA-I Nutrition	NANDA-I Nutrition appearing on at least 1 POC in the patient's episode
Continence	NANDA-I Continence	NANDA-I Continence appearing on at least 1 POC in the patient's episode
Hydration	NANDA-I Hydration	NANDA-I Hydration appearing on at least 1 POC in the patient's episode
Mobility	NANDA- I Mobility	NANDA-I Mobility appearing on at least 1 POC in the patient's episode
Age	Age in years	% of patients classified as young, middle aged, or elderly.

Missing Data: An algorithm for managing missing data will be applied to our analytic dataset. Missing data are inevitable in a longitudinal study such as the one that resulted in the collection of the HANDS dataset that will be utilized in the proposed study. The longer the data collection persisted, potentially the greater the chance for nurses to have either missed documenting a POC or for POCs to be incomplete. For example, updating POCs at every handoff was a rule during the HANDS study, producing the data used in this proposal. Such factors as patient load, patients being off the unit during handoffs, and length of stay are likely reasons that there are occasional missing POCs in patients' episodes. Deleting episodes with missing data is not the preferred approach due to the limited number of pressure ulcer episodes available to study in the HANDS database. Instead the use of multiple imputation[92] will be considered for items such as missing NOC outcome ratings to retain as many pressure ulcer episodes as possible for the final analysis.

Power Analysis: The outcome variable of interest in this study is the presence or absence of hospital-acquired pressure ulcers. The Aim 1 and 2 protocols examine the influence of nurse continuity and nurse staffing on hospital-acquired pressure ulcers while controlling for significant patient covariates. We have identified 300 unique patient episodes in the HANDS database in which pressure ulcers developed post admission, and the analytic dataset will also include 3,000 unique patient episodes without pressure ulcers. Assuming that p% of pressure ulcers had good continuity and that (p + d)% of non pressure ulcers had good continuity, with our sample size we will be able to detect a difference of d% = 10% or larger with greater than 80% power assuming a 2 sided alpha of 0.05. For example if 30% of pressure ulcers had good

continuity and 40% of non pressure ulcers had good continuity we would be able to demonstrate that the 10% difference in pressure ulcer outcomes was due to the presence of our continuity variable with greater than 80% power.

Strengths: The first major strength of this study is the availability and proven effectiveness of the HANDS database for this purpose. The HANDS database provides access to recent data (collected 2005-2008) that can be used to measure nurse continuity, a variable either not noted or available in an easily measured format in earlier studies. This database allows the addition of nurse continuity to the evidence about patient outcomes and nurse staffing using the measure of number of shifts worked by the same/single nurse. This unique database contains covariate, independent, and outcome variables and employs standardized nursing terminology allowing for common variable definitions and easier comparative analysis. The use of HANDS on multiple units in community and university hospitals (e.g., medical, surgical, ICUs, gerontology) further strengthens potential comparisons of effectiveness. With the HANDS database this examination takes place at the nurse-patient episode of care level linking the influence of individual nurse's staffing and continuity patterns to specific pressure ulcer outcomes. Study results could serve as the basis for future queries using EHRs with standardized nursing data to study a variety of nurse staffing variables and additional adverse patient outcomes. This work may also re-energize discussions about the importance of appropriate nurse staffing when examining the economic influence that nurse resource decisions can have on patient outcomes.[18]

Limitations/Analysis: Two of the most significant limitations of a secondary data analysis are the use of an existing dataset to answer a new research question and whether retrospective data can address a current issue.[93] The challenges of nurse staffing and the potential association with adverse patient outcomes has been a critical issue throughout this past decade and findings to date remain inconclusive. The HANDS database is a readily available and viable data source for new inquiries such as this proposed examination of nurse continuity and hospital-acquired pressure ulcers. Another potential limitation of this study is the use of HANDS to examine only a few of several possible definitions of nurse continuity. However, another continuity measure, the Continuity of Care (COC) Index, a chronological calculation examining the chronology of patient contact with healthcare providers over time, is being studied elsewhere.[94] This study also uses a very conservative definition of pressure ulcers (prevalence = 0.7% as compared to 5-10%[30] in published research) as we selected a specific label, Pressure Ulcer Care, to increase our certainty that included cases reflected **only** the presence of **hospital-acquired pressure ulcers**. Using a broader definition to include the additional label, Pressure Management, would increase our case count by 1,000 (prevalence = 2.1%) but without further study it is unclear that this less specific term applies only to hospital-acquired ulcers. For the purpose of this study these 1,000 cases will be excluded as control cases for the data analysis. Finally, there is the issue of unit specific structural variables potentially influencing study outcomes including patient assignment/acuity systems, mandated floating, contract agency, a patient centered care philosophy, model of care, individual or unit commitment to care continuity, and length of stay for individual patients. This issue has been factored into the study's design as the HANDS database allows for an examination and comparison of individual patient outcomes within the same unit, mitigating the confounding effects of unit specific structural variables.[94]

Timeline: The proposed timeline (Table 3) for this study is estimated to take 17 months to complete.

Table 3. Timeline for Proposed Study

	Months								
Phase:	1-2	3-4	5-6	7-8	9-10	11-12	13-14	15-16	17
Data Preparation									
Data Queries									
Data Mining									
Data Analysis									
Interpretation									
Final Report									
Manuscripts									

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EDUCATION

2014 (Anticipated)	PhD in Nursing, University of Illinois at Chicago
1987	Master of Science in Nursing, University of Wisconsin, Madison
1981	Bachelor of Science in Nursing, University of Illinois at Chicago

PROFESSIONAL EXPERIENCE

2013 – Present	Magnet Coordinator, Advocate Condell Medical Center, Libertyville, IL
2011 – Present	Research Assistant, Health Systems Sciences Department, University of Illinois at Chicago, College of Nursing
2003 – 2011	Vice President, Patient Care Services and Chief Nursing Officer, Saint Joseph Hospital Resurrection Health Care, Chicago, IL
2002 – 2003	Director of Systems Quality and Outcomes Management Services, Saint Joseph Hospital Resurrection Health Care, Chicago, IL
2001 – 2002	Director of Nursing Education and Nursing Quality Management, Saint Joseph Hospital Resurrection Health Care, Chicago, IL
2000	Interim Nurse Manager 8Stone Medical Unit, Advocate Illinois Masonic Medical Center, Chicago, IL
1995 – 2000	Director of Nursing Quality Management, Advocate Illinois Masonic Medical Center, Chicago, IL
1992 – 1995	Staff Development Coordinator for Maternal-Child Nursing, and Instructor, College of Nursing Rush University, Rush Presbyterian-St. Luke's Medical Center, Chicago, IL
1990 – 1992	Clinical Nurse Specialist, Pediatric Intensive Care, Rush Presbyterian-St. Luke's Medical Center, Chicago, IL
1988 – 1990	Pulmonary Clinical Nurse Specialist, La Rabida Children's Hospital and Research Center, Chicago, IL
1987	Project Assistant, Pediatric Pulmonary Center, University of Wisconsin-Madison
1983 – 1986	Clinical Educator, Pediatric Intensive Care Unit, University of

	Illinois, Chicago
1982 – 1983	Staff Nurse, Pediatric Intensive Care Unit, University Of Illinois, Chicago
1981 – 1982	Staff Nurse, Pediatric Intensive Care Unit, Christ Hospital, Oak Lawn, IL

HONORS AND AWARDS

2014	Research Award 2014 from the Alpha Lambda Chapter of Sigma Theta Tau International
2014	Recipient of the College of Nursing PhD Student Research Award, University of Illinois at Chicago
2007	Power of Nursing Leadership Pinnacle Award, Resurrection Saint Joseph Hospital
1996	Nominee for the Nursing Spectrum's Nurse of Excellence Award, Illinois Masonic Medical Center
1991	MCN Nurse of the Year, Rush-Presbyterian St. Luke's Medical Center
1986	Fully Funded Graduate Traineeship, Pediatric Pulmonary Center, University of Wisconsin-Madison
1983	CARE Award, University of Illinois at Chicago Hospital
1982	Ruth Anthony Memorial Education Fund, Christ Hospital

RESEARCH FUNDING

2014	**Stifter, J.** (PI), Yao, Y., Dunn Lopez, K., Khokhar, A., Wilkie, D. J., & Keenan, G. Using an Electronic Health Record to Examine Nurse Continuity and Pressure Ulcers R36 Grant from the Agency for Healthcare Research and Quality (Grant # 1R36HS023072-01) ($40,192)
2014	Research Award 2014 from the Alpha Lambda Chapter of Sigma Theta Tau International ($1000)
2014	College of Nursing PhD Student Research Award, University of Illinois at Chicago ($1000)

PUBLICATIONS (*Denotes peer reviewed manuscripts, + Denotes senior/lead author)

*+Lodhi, M.K., Cheema, U.I., **Stifter, J**., Wilkie, D.J., Keenan, G., Yao, Y., Ansari, R., & Khokhar, A. (2014, in press). Hospitalized end-of-life patients' death anxiety captured from a structured electronic health record: Differences by patient and nurse characteristics. *Research in Gerontological Nursing*.

***+**Linch, G. F., Rabelo-Silva, E. R., Keenan, G. M., Moraes, M. A., **Stifter, J**., & Muller-Staub, M. (2014, in press). Validation of the quality of diagnoses, interventions, and outcomes (Q-DIO) instrument for use in Brazil and the United States.

*+Tastan, S., +Lynch, G., Keenan, G., **Stifter, J**., McKinney, D., Fahey, L., Dunn-Lopez, K., Yao, Y., & Wilkie, D.J. (2014). Evidence for the existing American Nurses Association-recognized standardized nursing terminologies: A systematic review. *International Journal of Nursing Studies,* 51 (8) 1160–1170. doi:10.1016/j.ijnurstu.2013.12.004.

*+**Stifter, J**., & Culbreath-Burks, P. At the crossroads: Reconciling patient and staffing needs. *Nursing Management.* 2011, 42(5), 38–41.

*+Kowalski, K., MacMullen, N., **Stifter, J**., Brundage, J., Slack, J., Strodtbeck, F., & Broome, M. The high-touch paradigm: A 21st century model for maternal-child nursing. *MCN*. 1996, 21, 43–50.

*+**Stifter, J**., & Shanahan, N. The I.V. bubbles and boards – a method to improve clinical practice. *Journal of Pediatric Nursing,* 1994, 9(6), 417-419.

*+Kraus, D., **Stifter, J**., & Hatoum, H.T. Program to improve nurses' knowledge of pediatric emergency medications. *American Journal of Hospital Pharmacy*. 1991, 48(1), 97-101.

PUBLICATIONS SUBMITTED UNDER REVIEW (*Denotes peer reviewed manuscripts, + Denotes senior/lead author)

*+Yao, Y., **Stifter, J**., Ezenwa, M. O., Lodhi, M., Khokhar, A., Ansari, R., Keenan, G., Wilkie, D.J. (In review, May 2014). Infomarkers for transition to palliative care in patients close to death. *Journal of the American Medical Informatics Association.*

*+Dunn-Lopez, K., Febretti, A., **Stifter, J.**, Johnson, A., Wilkie, D.J., & Keenan, G. (In review, April 2014). Towards more robust and highly efficient methods to develop usable and useful clinical decision support from electronic health record data. *Journal of the American Medical Informatics Association.*

***+Stifter, J**., Yao, Y., Dunn Lopez, K., Khokhar, A., Wilkie, D.J., & Keenan, G. Defining a new conceptual model and an innovative approach for measuring the influence of nurse continuity on patient outcomes. (In review, August 2014). *Journal of Advanced Nursing.*

PRESENTATIONS (+Presenting author(s), ^Presented at a professional meeting)

+^Lodhi, M. K., **Stifter, J.**, Wilkie, D. J., Keenan, G. M., Yao, Y., Ansari, R., & Khokhar, A. (2014- In review). Predictive Modeling for End-of-Life Pain Outcomes Using Electronic Health Records. 12th Australian Data Mining Conference.

+^**Stifter, J.,** Yao, Y., Lodhi, M. K., Dunn Lopez, K., Khokhar, A., Wilkie, D. J., & Keenan, G. M. (2014 – Accepted). Creating a Comparable Control Group Using Standardized NANDA-I,

NOC, and NIC (NNN) Terminologies to Examine the Influence of Nurse Staffing on Patient Outcomes. International Conference on Nursing Knowledge, Porto, Portugal, September 2014.

+^Keenan, G. M., Yao, Y., **Stifter, J**., Ezenwa, M. O., Lodhi, M. K., Khokhar, A., Ansari, R., & Wilkie, D. J. (2014 - Accepted). Using NNN to Identify Nursing Markers Signaling Care Goal Changes for End-of-Life Patients. International Conference on Nursing Knowledge, Porto, Portugal, September 2014.

+^Febretti, A., Dunn-Lopez, K., **Stifter, J**., Johnson, A., Keenan, G., & Wilkie, D. Evaluating a Clinical Decision Support Interface for End-of-Life Nurse Care. Paper presented at Association for Computing Machinery, Special Interest Group on Computer-Human Interaction, Conference on Human Factors in Computing Systems, Toronto, Canada, May 2014.

+^Stifter, J., Yao, Y., Lodhi, M.K., Cheema, U.I., Dunn Lopez, K., Khokhar, A., Wilkie, D.J., & Keenan, G. An Innovative Study to Link Patient Outcomes and Individual Nurse Continuity Using Practice Based Evidence. Midwest Nursing Research Society, St. Louis, Missouri; March 2014.

+^Martinez Soto, E., Dunn Lopez, K., Kennedy, M., **Stifter, J.,** Wilkie, D.J., Johnson, A., Febretti, A., & Keenan, G. Differentiating between Novice and Expert Nurses' Clinical Decision Support Needs. Midwest Nursing Research Society, St. Louis, Missouri; March 2014.

+^Dunn-Lopez, K., Febretti, A., Yao,Y**., Stifter, J**., Johnson, A., Wilkie, D.J., & Keenan, G. Clinical Decision Support Alert Forms: Nurse Preferences and Relationships with Nurse Characteristics. AMIA Conference, Washington, D. C.; November 2013.

+^Febretti, A., Lopez, K., **Stifter, J.**, Johnson, A., Keenan, G., & Wilkie, D.J. A Component Based Evaluation Protocol for Clinical Decision Support Interfaces. Human-Computer Interaction (HCI) International Conference, Las Vegas, Nevada; July 2013.

^Keenan, G., +**Stifter, J**., & +Yao,Y. Lessons Learned from Standardized Nursing Data Using HANDS. The Tenth Institute on Nursing Informatics and Classification, Iowa City, Iowa; June 2013.

+^Linch, G., Muller-Staub, M., Keenan, G., Moraes, M.A., **Stifter, J.,** & Rabelo, R. Validation of the Quality of Diagnoses, Interventions, and Outcomes Instrument (Q-DIO) for use in Brazil and the United States. ACENDIO Conference, Dublin, Ireland; March 2013.

+^Yao, Y., Keenan, G., **Stifter, J**., Dunn-Lopez, K., Khokhar, A., Ansari, R., & Wilkie, D.J. Practice-based Evidence from an Electronic Health Record (EHR): Insights for Improving Pain Management at the End-of-Life (EOL). Midwest Nursing Research Society, Chicago, Illinois; March 2013.

+^Dunn-Lopez, K., **Stifter, J**., Febretti, A., Johnson, A., Wilkie, D.J., & Keenan, G. Improving Usability of Evidence Based Information in Clinical Decision Support. Midwest Nursing Research Society, Chicago, Illinois; March 2013.

+^Lodhi, M.K., Cheema, U.I., **Stifter, J**., Yao, Y., Dunn-Lopez, K., Keenan, G., Ansari, R., Wilkie, D.J., & Khokhar, A. State of Nursing Care for Patients with Anticipatory Grieving: Lessons Learned from Standardized Nursing Data. Midwest Nursing Research Society, Chicago, Illinois; March 2013.

+^Cheema, U.I., Lohdi, M.K., **Stifter, J.,** Yao, Y., Dunn-Lopez, K., Keenan, G., Ansari, R., Wilkie, D.J., & Khokhar, A. Nursing Care of End-of-Life Patients Facing Death Anxiety. Midwest Nursing Research Society, Chicago, Illinois; March 2013.

+^Keenan, G., Yao, Y., Dunn-Lopez, K., **Stifter, J.,** & Wilkie, D.J. (2013). Use of the Electronic Health Record to Monitor Unit Based Practice Patterns. Midwest Nursing Research Society, Chicago, Illinois; March 2013.

+Stifter, J. Care for Patients with Alzheimer's disease in the Hospital Setting. Greater Illinois Chapter of the Alzheimer's Association, Chicago, Illinois; February 2011.

+^**Stifter, J**. JCAHO Staffing Variance Standards. Illinois Association for Healthcare Quality Conference, Illinois; May 2003.

+^**Stifter, J.** JCAHO Preparation: Developing Competencies for Critical Care Nursing Staff. American Association of Critical Care Nurses Midwest Conference, Illinois; March 1996.

+^**Stifter, J.** The I.V. Bubbles and Boards – A Method to Improve Clinical Practices. I.V. Nursing Society Meeting, Denver, Colorado; May 1994.

+^**Stifter, J.** The Roller Coaster of BPD: The Continuum of Care. The 9th Annual Pediatric Nurses Conference, Chicago, Illinois; October 1993.

+^**Stifter, J.** Bronchopulmonary Dysplasia: Chronic Obstructive Lung Disease Throughout the Life Cycle. Nursing Assembly of the American Lung Association of Metropolitan Chicago, Chicago, Illinois; October 1993.

+^**Stifter, J**. Venous Access in Children, Part I.: The Risks and the Need and Venous Access in Children, Part II.: Critical Analysis of Protocols and Equipment. MCN Convention, Florida; March 1993.

+**Stifter, J.** The Respiratory System: Specialty Review for Pediatric Critical Care Nurses. National Center for Advanced Medical Education; Chicago, Illinois; June 1992.

+**Stifter, J**. Pediatric Head Trauma. American Healthcare Institute, Illinois; August, 1991.

+Stifter, J. Pulmonary and Gastrointestinal Assessment. Business and Professional Institute of the College of DuPage, Glen Ellyn, Illinois; August 1991.

+Stifter, J. What's New in Pediatric Nursing? American Healthcare Institute; May and June, 1991.

+^Stifter, J. Educational Resources and Social Support for Children with Asthma. Chicago Lung Association, Chicago, Illinois; October, 1990.

POSTER PRESENTATIONS (+Presenting author, ^ Presented at a professional meeting)

+^ **Stifter, J.**, Yao, Y., Lodhi, M.K., Cheema, U.I., Dunn Lopez, K., Khokhar, A., Wilkie, D.J., & Keenan, G. An Innovative Study to Link Patient Outcomes and Individual Nurse Continuity Using Practice Based Evidence. The National Pediatric Nurse Scientist Collaborative Nursing Research Fly-in 2014, Milwaukee, Wisconsin, May 2014.

+^Stifter, J., Yao, Y., Lodhi, M.K., Cheema, U.I., Dunn Lopez, K., Khokhar, A., Wilkie, D.J., & Keenan, G. An Innovative Study to Link Patient Outcomes and Individual Nurse Continuity Using Practice Based Evidence. 2nd Annual Advocate Nursing Research Symposium, Chicago, Illinois, April 2014.

^Keenan, G., **Stifter, J.,** Febretti, A., Dunn Lopez, K., Johnson, A., Khokhar, A., Ansari, R., & Wilkie, D. J. Well Tested Electronic Care Planning System Produces Powerful Evidence for Nursing Care Decisions. 2nd Annual Advocate Nursing Research Symposium, Chicago, Illinois, April 2014.

+^Stifter, J., Dunn Lopez, K., Febretti, A., Johnson, A., Wilkie, D.J., & Keenan, G. Identifying Nurse Preferences for Presentation of Evidence Based End-of-Life (EOL) Pain Management Information in Clinical Decision Support (CDS) Systems. Midwest Nursing Research Society, Chicago, Illinois, March 2013.

+^Stifter, J., Keenan, G., Yakel, E., Yao, Y., Xu, D., Szalacha, L., Tschannen, D., Ford, Y., Chen, Y-C, Johnson, A., Wilkie, D.J. Will Use of HANDS Enhance Nursing Compliance and Satisfaction with Plan of Care Documentation? Midwest Nursing Research Society, Dearborn, Michigan; April 2012.

+^Stifter, J., & Shanahan, N. The I.V. Bubbles and Boards – A Method to Improve Clinical Practice. The Society of Pediatric Nurses' Conference, Denver, Colorado; March 1994.

TEACHING EXPERIENCE

Academic:

2013-2014	MSN Student Mentor, Olivet Nazarene University
2008	Guest Lecturer, Information Systems and the Role of the Nursing Administrator, West Suburban College of Nursing
2007 – 2008	Guest Lecturer, The Role of the Chief Nurse Executive, Truman College
2003 – 2011	MSN Student Mentor, Resurrection University

1992 – 1995	Instructor, College of Nursing, Rush University

Non-Academic:

2013-2014	Nurse Research Fellowship Mentor, Advocate Condell Medical Center
2001 – 2002	Coordinated and lectured in the Nursing Orientation Program, Preceptor Program, Nursing Grand Rounds, and Nursing Annual Competency Days at Resurrection, Saint Joseph Hospital. Coordinated student placements for 6 nursing schools.
1992 – 1995	Coordinated and lectured in the Nursing Orientation Program to the Women's and Children's Department and to the Nursing Division for Rush Presbyterian- St. Luke's Medical Center.
1992 – 1995	Coordinated and lectured in two Women's and Children's Department programs "Navigating Change" and "Powerful Presentations".
1990 – 1992	Developed, coordinated and lectured in the PICU's Nursing Orientation, Preceptor, and Transport Programs
1990 – 1995	Instructor, Pediatric Advanced Life Support, American Heart Association
1988- 2000	Instructor, Basic Cardiac Life Support, American Heart Association
1988 – 1990	Provided nursing orientation lectures on Chronic Pulmonary Illnesses to new hires and nursing students at La Rabida Children's Hospital.

RESEARCH ASSISTANT EXPERIENCE

2011 – Present	Research Assistant on NINR RO1NRO12949 "Describing, Contrasting, and Visualizing End of Life Care in the 21rst Century" Drs. Gail Keenan, Diana J. Wilkie, and Yingwei Yao (PIs)

Selected Accomplishments:

Usability team: coordinated subject recruitment, screening, consent process, conducted usability interviews, coded data (supported by Morae Software), calculated inter-rater reliability statistics, participated in iterative design of clinical decision support screens

Statistical and data mining team: participated in the interpretation of statistical and data mining results and development of cycle summary reports

General: co-author of multiple team manuscripts and presentations; supported other students (national and international) on the team

PROFESSIONAL AND COMMUNITY SERVICE ACTIVITIES

UIC Internal Committees:

2013	DNP and MSN Administrative Tract Revisions Advisory Group
2012 – Present	Student Representative to the College of Nursing Research Committee

Abstract Reviews:

2014	AMIA Annual Symposium
2014	2nd Annual Advocate Nursing Research Symposium

Selected Hospital Committees and Accomplishments:

2008	Member of the Licensing Committee for the rewriting of the Illinois Nurse Practice Act
2007	Developed a business proposal and oversaw the construction of the Bernard Gordan Skill Lab and Education Resource Center at Resurrection, Saint Joseph Hospital
2004	Chaired a task force and oversaw implementation of a standardized nursing orientation process for the Resurrection Healthcare System
2003 – 2011	Member, Institutional Review Board, Resurrection, Saint Joseph Hospital
1998	Developed and implemented a Nursing Professional Advancement Program (Clinical Ladder), Illinois Masonic Medical Center.
1997	Developed and Implemented a Latex Sensitivity Program, Illinois Masonic Medical Center.
1996	Served as a Program Development Consultant to the planning committee for Misericordia Home's 2nd Annual Conference on Developmental Disabilities
1995	Served as a Program Development Consultant to the planning committee for Misericordia Home's 1st Annual Conference on Developmental Disabilities

1994 – 1995	Participated on a Task Force dedicated to curriculum development for the Pediatric Acute Care Nurse Practitioner Program for Rush University.
1994	Chaired a task force that developed and implemented a house wide education program for Personal Protective Equipment as part of the OSHA Bloodborne Pathogen, Rush-Presbyterian-St. Luke's Medical Center.
1993	Member of the Planning Committee for the 9th Annual Pediatric Nursing Conference, Chicago, Illinois
1992 – 1995	Member and then Chairperson, Professional Nursing Staff Educational Programs Committee, Rush-Presbyterian-St. Luke's Medical Center.
1990 – 1992	Member and Representative for Women's and Children's Services to the Nursing Executive Committee, Rush-Presbyterian-St. Luke's Medical Center.

PROFESSIONAL MEMBERSHIPS

2013 - Present	American Nurses Association
2012 – Present	American Medical Informatics Association (AMIA)
2011 – Present	Midwest Nursing Research Society
2003 - Present	American Organization of Nurse Executives (AONE)
2000 – Present	National Association of Healthcare Quality (NAHQ)
2000 – 2012	Illinois Association for Healthcare Quality (IAHQ)
1988 - Present	Sigma Theta Tau Nursing Honor Society, Beta Eta Chapter

CERTIFICATIONS AND LICENSURE

2002 – Present	Certified as a Practitioner of Healthcare Quality (CPHQ)
1981 - Present	Illinois Registered Nurse
1981 - Present	Basic Cardiac Life Support Provider