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Evaluating the Effectiveness of Nurse-Focused Computerized Clinical Decision Support on Urinary Catheter Practice Guidelines

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by

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Abstract

A growing national emphasis has been placed on health information technology (HIT) with robust computerized clinical decision support (CCDS) integration into health care delivery. Catheter-associated urinary tract infection is the most frequent health care–associated infection in the United States and is associated with high cost, high volumes and determined to be preventable through the application of evidence-based guidelines. The purpose of this quasi-experimental, ex post facto study was to evaluate the impact of an evidence-based practice guideline computerized clinical decision support (CCDS) intervention in patients with a urinary catheter device. Correlational relationships were explored among patient and nurse-specific demographics as related to acceptance or rejection of the CCDS alert and resulting guideline compliance. The CCDS used in this study involved a time-specific, computer-generated workflow alert that appeared on the computer 48 hours after the nurse electronically documented the presence and/or placement of a urinary catheter in the patient's electronic health record (EHR). Compliance with the evidence-based guidelines and patient and nurse-specific demographic data were evaluated through the retrospective EHR review of 311 patients for similar six-month time periods preceding and following the CCDS implementation. Data were analyzed using independent samples t-tests and Pearson's correlation coefficient. The post-implementation group had statistically significant improvement in guideline compliance and positive correlations were shown between the patient's age, care delivery unit and primary diagnosis. There were no statistically significant correlations shown among the other demographics. The role of nurse-focused CCDS is a promising new area in nursing care delivery and warrants further investigation.

Acknowledgements

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CHAPTER I

INTRODUCTION

Catheter-associated urinary tract infection is the most frequent health care–associated infection in the United States with approximately one in every five patients admitted to an acute-care hospital receiving an indwelling catheter (Saint, Meddings, Calfee, Kowalski & Krein, 2009). The Centers for Medicare and Medicaid Services (CMS, 2007a) suggest the incidence of catheter use among the geriatric population is even higher. Because catheter-associated urinary tract infection is common, costly, and believed to be "reasonably preventable," CMS (2007b) chose it as one of the complications for which hospitals no longer receive additional payment to compensate for the extra cost of treatment (as of 1 October 2008). In fact, Tambaya, Knasinski, and Maki (2002), reports each episode of catheter-associated urinary tract infection costs at least $600 and each episode of urinary tract–related bacteremia costs at least $2800, making catheter-associated urinary tract infection an extremely costly complication for patients and hospitals (Wald & Kramer, 2007).

Throughout the past decade, a growing national emphasis has been placed on the importance of health information technology (HIT) with robust computerized clinical decision support (CCDS) and the integration of such systems into health care delivery. According to the Institute of Medicine (IOM 2001), the highest-level goals of this integration are to:

- Enhance evidence-based clinical practices

- Improve quality
- Reduce medical errors

The February 2009 passing of Public Law 111-5, the American Recovery and Reinvestment Act (ARRA), brought both a renewed and unprecedented focus to these goals in the form of electronic health record (EHR) utilization and criteria for the "meaningful use" (MU) of these clinical systems for hospitals and provider practices.

Background

Meaningful Use

The American Recovery and Reinvestment Act (ARRA) through the Health Information Technology for Economic and Clinical Health Act (HITECH Act) authorizes the Centers for Medicare and Medicaid Services (CMS) to provide a $19 billion dollar incentive reimbursement for physician and hospital providers who are successful in becoming "meaningful users" of an electronic health record (EHR) over the next five years. These incentive payments initially began in 2011via a gradual, phased approach to continue through 2015 when providers will be expected to have adopted and be actively utilizing an EHR in compliance with the "meaningful use" definition or be subject to financial penalties under Medicare (CMS, 2009). According to The Centers for Medicare and Medicaid Services (CMS) Fact Sheet on meaningful use issued December 2009, the policies and goals through incentive programs are to expand the meaningful use of certified EHR technology via an initial set of standards, implementation specifications, and certification criteria while advancing the contributions this technology can make toward improving health care quality, efficiency, and patient safety.

For eligible hospitals, The Centers for Medicare and Medicaid Services' (2010) final rule in the first phase outlines twenty-four objectives including fifteen measurable clinical outcomes linked to quality that must be met in order to be deemed a "meaningful" EHR user. Of these fifteen outcomes, hospitals will be required to select at least one outcome in the first phase in which CCDS rules can be designed, implemented and evaluated by phase. The rule selected must be relevant to specialty or high clinical priority, include the ordering of diagnostic tests, and provide the ability to track compliance with those rules. Further, hospitals must have capabilities in place to measure and report on end-user response (e.g. overrides/acceptance) of CCDS suggested actions to demonstrate how often an important problem is being avoided as a result of the alert.

Computerized Clinical Decision Support (CCDS)

Osheroff, Pifer, Teich, Sittig, and Jenders (2005) describe CCDS rules as taking into account a patient's unique clinical data that can also include nationally recommended guidelines in the suggested actions to the clinician. Functions of a CCDS include alerting, reminding, interpreting, predicting, assisting, and suggesting thereby providing the clinician with knowledge and person-specific information, intelligently filtered and presented at the right time to the right person, to enhance health and health care. Osheroff et al. (2005) further describe CCDS design specifically to

- remind the clinician of things they intend to do, but should not have to remember;
- provide information when the clinician is unsure what to do;
- correct errors the clinician has made; or

- recommend that the clinician change his or her plans.

While Garg et al., (2005) found evidence that indicates clinical use of a CCDS can be effective through suggestions; the clinician must filter the information, review the suggestions, and decide whether to take action or what action to take. Computerized Clinical Decision Support (CCDS) systems differ in how much control the user has over the decision to use and these decisions involve not only whether the CCDS is set up to be displayed on demand but also the circumstances under which users can, after viewing the CCDS information, choose to accept it. The two aspects of control are related and they connect with how closely the CCDS advice matches a clinician's intention.

Garg et al., (2005) further report the issue of overriding the advice of the CCDS has been shown for a variety of types of CCDS, including those that provide diagnostic suggestions, evidence-based treatment recommendations, or alerts for potentially dangerous drug interactions. Osheroff et al., (2005) propose the effects of CCDS require careful analysis to ensure their design, implementation and use produce the intended results and that intended improvements are not overlooked or overridden. The clinical setting and the knowledge base related to the clinical arena is extremely dynamic and, therefore, there must be an ongoing analysis to demonstrate clinical processes, workflows, satisfaction, health care outcomes and other measures are achieved as desired.

Until there is a better understanding of why clinicians either do not access, or choose to ignore, the CCDS recommendations, assessing their effect on quality will be very difficult. Because clinician decision-making influences care processes and, therefore, outcomes, it is important to further examine the differences between patient outcomes

where CCDS suggested actions are accepted and patient outcomes where CCDS suggested actions are overridden.

Urinary Catheter-Associated Urinary Tract Infection

As reported by Graves and McGowan (2008), The Deficit Reduction Act of 2005 (Section 5001c) mandated the Secretary of Health and Human Services to identify hospital-acquired complications that were associated with high cost, high volume, or both; that result in the assignment to a diagnosis-related group with a higher payment when present as a secondary diagnosis; and that could have been prevented through the application of evidence-based guidelines. Catheter-associated urinary tract infection is one of the hospital-acquired complications chosen by the Centers for Medicare and Medicaid Services (CMS) for which hospitals no longer receive additional payment for discharges occurring on or after October 1, 2008. The "Hospital-Acquired Conditions Initiative", implemented by CMS, means hospitals will no longer be reimbursed at an extra rate when patients develop specific conditions after hospital admission. This new policy is believed to have an impact of close to $800 million in Medicare payments (Zahn et al., 2008).

Over a decade ago, Dumigan, Kohan, Reed, Jekel, and Fikrig (1998) used a multidisciplinary team to develop guidelines for appropriate catheter placement and a protocol enabling nurses to remove unnecessary catheters without a physician order. Following implementation of these guidelines, catheter-associated urinary tract infection rates decreased by 17% to 45%, with rates as low as 8.3 to 11.2 per 1000 catheter-days.

Definition of Terms

For the purposes of this paper, "Health Information Technology (HIT)" is defined using The National Alliance for Health Information Technology definition:

> The technology to create, transmit, store and manage individuals' health data…improving the coordination of care within the health care delivery system by increased sharing of health information among authorized clinicians, providing individuals with electronic access to their own health and wellness information, engaging them in opportunities for improving their health and well-being, and improving the health of the community using aggregated health data for research, public health, emergency preparedness and quality improvement efforts. (NAHIT, 2008, p. 4)

"Meaningful Use" is defined according to Health Care Information and Management Systems Society (HIMSS) in relation to the Electronic Health Record (EHR) as:

> EHR technology is "meaningful" when it has capabilities including e-prescribing, exchanging electronic health information to improve the quality of care, having the capacity to provide clinical decision support to support practitioner order entry and submitting clinical quality measures – and other measures – as selected by the Secretary of Health and Human Services. (HIMSS, 2009, p. 2)

"Active computerized clinical decision support (CCDS)" is defined according to Osheroff, Pifer, Teich, Sittig, and Jenders (2005) as: **"**Providing clinicians or patients with clinical knowledge and patient-related information, intelligently filtered or presented at appropriate times, to enhance patient care"(p. x).

Justification of Project

Historically the use of CCDS has been developed and researched for physicians; however, there is growing interest in expanding this technology to nurses working in the clinical area (Lyerla, 2008). A nursing CCDS is used within the context of nursing to support nursing decision making. Rousseau, McColl, Newton, Grimshaw and Eccles

(2003) found general practitioners suggested nurses might find the guideline content of a CCDS more clinically useful than physicians do and be better prepared to use it.

There are limited, initial findings in the literature where the impact of nurse-focused CCDS in future implementations demonstrates enormous potential towards improving clinical decision-making and quality outcomes for patients. These are new tools for health care delivery in the nursing arena. While nurse-focused CCDS interventions are in their infancy, technological advances are quickly moving development and implementation into clinical practice. These interventions can only be effectively designed with nursing end-user input and feedback. Meaningful use criteria requires implementation and compliance with at least one evidence-based practice rule within the first phase fostering an environment where design and implementation of CCDS can be utilized for further analysis. Implemented as part of a rapid cycle process, data mining and outcomes measurement can be achieved and evaluated quickly post implementation to further build the evidence base.

There has been a growing national emphasis placed on the importance of health information technology (HIT) with robust computerized clinical decision support (CCDS) and the integration of such systems into health care delivery throughout the past decade. However, there is a significant gap in the knowledge base regarding implementation of evidence-based CCDS into nursing workflow. More research is needed towards CCDS development and implementation as interactive, action-driven triggers with measurable and meaningful patient outcomes. The use of computers to aid in nursing practice decision-making is an exciting area and is just at the beginning of

exploration for potential benefit. More research is needed to demonstrate nurse-focused CCDS as an efficient and effective tool in quality patient outcomes.

Problem Statement

Goud et al., (2009) report one of the primary challenges to modern health care is the application of evidence-based practice to routine care. While evidence-based care guidelines are meant to improve effectiveness and efficiencies, utilization in practice is often poor. In fact, McGlynn et al., (2009) describe the care delivered to American adults is only about half the recommended care based on current evidence and knowledge. Goud et al. explain this phenomenon as having a direct relationship to paper-based practice guidelines which have generally proven to be ineffective and inefficient when used as a lone source of decision making support.

"Patient tailored computerised [*sic*] decision support to individual professionals at the point of care is one of the most effective methods of improving decision making" (Goud et al., 2009, p. 1440). Studies of similar interest related to computerized and automated physician-focused CCDS have been shown to aid and improve physician decisions, and thus patient outcomes, in areas such as: screening for cancer (Burack, Gimotty, Simon, Moncrease, & Dews, 2003); seasonal vaccination administration (Dexter et al. (2001); diabetes management (Filippi et al. (2003); and venous thromboembolism prophylaxis (Kucher et al., 2005).

While the volume of articles and information regarding ARRA and electronic health records, CCDS and the seeking of MU criteria continues to grow, relatively few studies exist that look at the effectiveness and efficiency of nurse-focused CCDS. In 2008,

Anderson and Willson found during a synthesis analysis of 183 articles written on the subject, only seventeen met criteria for their research purposes and of those, only six focused on nurse-driven clinical decision support. The primary focus of articles found emphasis on physician-driven clinical decision support and/or process improvement and compliance. There are limited findings related to the study of nurse-focused clinical decision support and even further limited findings related to patient outcomes, thus demonstrating a gap in the knowledge of how nurse-focused CCDS may impact overall patient outcomes with implementation.

Research Question

The purpose of this study was to evaluate the impact of an evidence-based practice guideline CCDS intervention designed to meet meaningful use as one of the mandatory clinical rules in patients with a urinary catheter device. This study primarily sought to answer the clinical question: "Is there a positive effect on guideline compliance among patients with a urinary catheter device following implementation of a nurse-focused computerized clinical decision support actionable alert?" Additional correlational relationships were explored as predictors among patient and nurse-specific demographics as related to acceptance or rejection of the CCDS alert and resulting guideline compliance.

Assumptions

The following assumptions were made regarding the use of a nurse-focused CCDS in patient care delivery:

1. There is a national emphasis on health information technology and CCDS towards efforts to enhance evidence-based clinical practices, population health and health care delivery quality outcomes.

2. Nurse-focused CCDS is designed specifically for nurses to remind them of pertinent clinical information or tasks they may forget to complete, provide expert advice to influence decision making, and/or recommend a course of action or correction in the delivery of patient care.

3. Nurse-focused CCDS is effective in improving adherence to urinary catheter device evidence-based care clinical guidelines.

4. Patient and nurse-specific demographics serve as predictors in utilization of CCDS and evidence-based guidelines adherence.

Theoretical Framework

This study was conceptualized using the Nursing Role Effectiveness Model (NREM) developed by Irvine, Sidani and Hall (1998a). Their model was derived from Donabedian's 1980 Model of Quality Health Care and adapted as a way to relate nursing-sensitive patient outcomes as a means for quality improvement. The NREM proposes rising healthcare costs and patient outcomes serve as key indicators for quality improvement processes and reasons the model provides direction to communicate the nursing related contributions for quality assurance purposes. Quality improvement is a major focus in healthcare and outcomes monitoring is the foundation for measuring system effectiveness (Irvine, Sidani and Hall, 1998b).

More specifically the model describes application to quality improvement during a patient's hospitalization. The NREM is designed to demonstrate value to the services provided by nurses coupled with the positive patient care outcomes they were able to achieve based upon the relationships of structure, process and outcome described by the model. It identifies nurses' contributions in terms of the three key roles they assume in health care; specifically, an independent, dependent, and interdependent role. Pringle and Doran (2003) detail how the model proposes a set of relationships between the structural variables, nurses' role functions, and patient and system outcomes:

- Structure
    - Patient – Personal and health characteristics affecting delivery of care and/or outcomes
    - Nurse – Professional characteristics of experience, knowledge and skill influencing quality of nursing care
    - Organization – Environmental aspects directly affecting the delivery of nursing care
- Process
    - Nurses' independent role – Autonomous actions initiated by the professional nurse
    - Nurses' medical-care related role – Actions initiated by the nurse in response to a medical order including clinical judgment and evaluation of outcomes

    - Nurses' interdependent role – Shared functions with other members of the health care team
- Outcome
    - Nursing-sensitive patient outcomes – Six categories of patient-specific outcomes including cost

In applying the NREM model to utilization of nurse-focused computerized clinical decision support and quality outcomes for the purposes of this project, the nurse identifies the patient's immediate needs through assessment and collection of clinical data in the process component of the independent role. As a result of the computer's recognition of the clinical data (presence of urinary catheter greater than 48 hours) collected by the nurse, the CCDS fires an actionable alert identifying a problematic situation through the structure components of patient and organization. This activates the nurse's medical-care related role. The function of professional nursing continues with investigation and validation via clinical judgment for application of the urinary catheter clinical guidelines. This will then determine the nurse's clinical judgment response according to Irvine, Sidani and Hall (1998b) through the interdependent role. The nurse validates their response through interdisciplinary team collaboration with Infection Prevention Specialists and Clinical Quality Performance Improvement Specialists. Once the patient validation process has occurred, the nurse makes the decision to either accept or override the suggested actions of the CCDS.

The outcome component categories of prevention of complications such as nosocomial infections (catheter-associated urinary tract infection, CAUTI), functional health outcomes (reduction of urosepsis), and cost allow for evaluation of nursing-

sensitive patient outcomes. Specific to the delivery of nursing care and professional nursing practice, outcome evaluation methods include utilization of clinical guidelines, utilization of CCDS intervention, decreased CAUTI, avoidance of CMS "Never Event" related to CAUTI, and decreased cost related to ongoing care of patients with this complication. Figure 1 illustrates the conceptual, theoretical, and empirical (C-T-E) linkages.

Figure 1. Conceptual- Theoretical- Empirical Framework

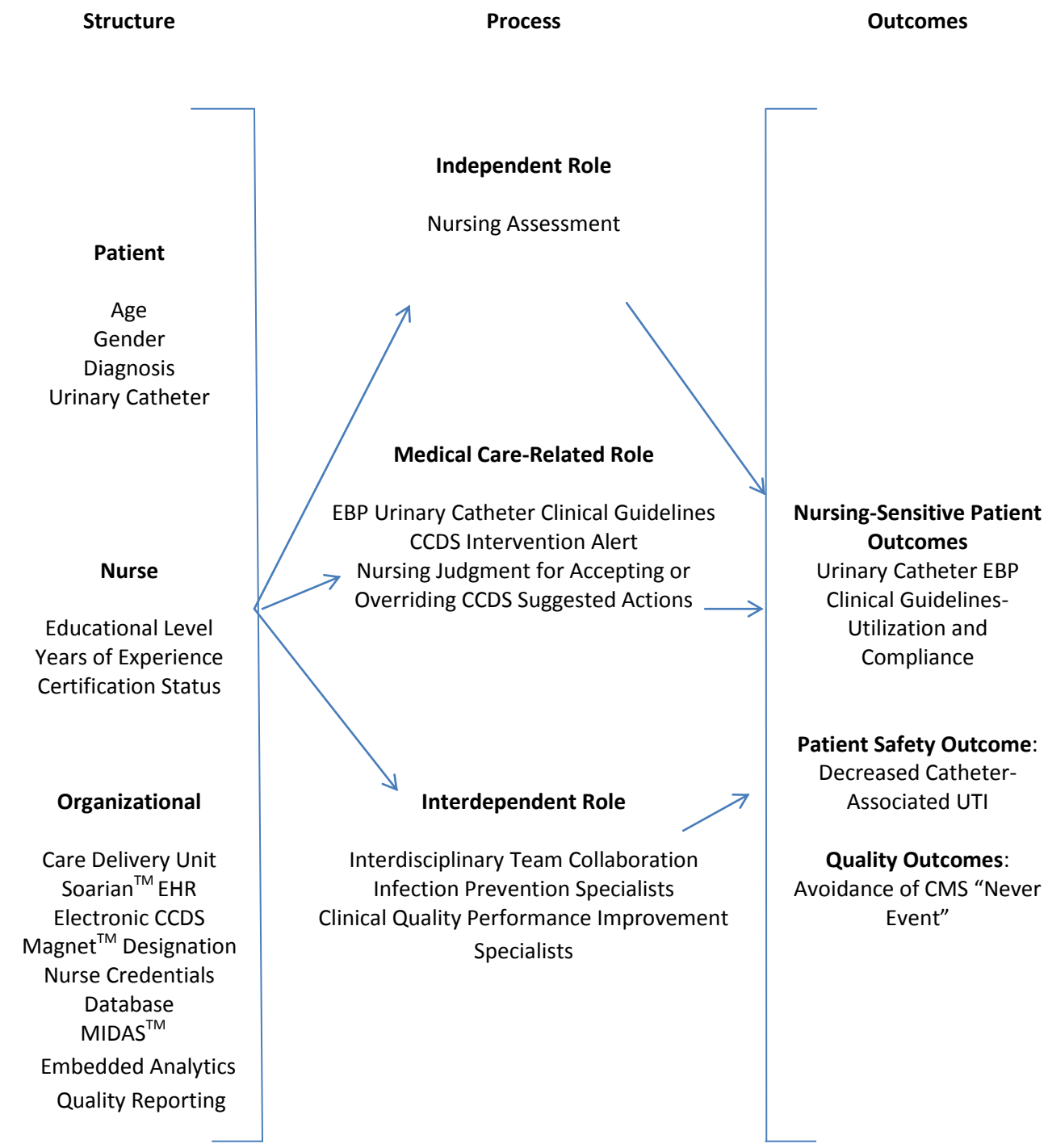

Figure 1. Illustrates the conceptual, theoretical, and empirical (C-T-E) linkages for the current stud to The Nursing Role Effectiveness Model adapted from Irvine, Sidani and Hall (1998a).

Chapter II

REVIEW OF THE LITERATURE

Methods

An automated literature search was completed. Search terms included: *Urinary Catheter-Associated Urinary Tract Infection (CAUTI), Urinary Catheter Evidence-Based Guidelines, Computerized Clinical Decision Support (CCDS), Evidence Based Practice and Nursing, and Meaningful Use*. For purposes of this review, CCDS was defined as any computerized aid or electronic guideline designed to assist in clinician decision-making at the point of care.

The literature was reviewed to identify the use of computerized clinical decision support in nursing practice, nursing process, and/or nursing workflow during the years 2005 to present. Inclusion criteria were any studies evaluating the use of CCDS in a physical clinical setting; by registered nurses; directly involved in patient care; with assessment of improvement in practice through patient outcomes; or through process improvement. Exclusion criteria were CCDS studies aimed strictly toward clinician perceptions, attitudes or acceptance of use of CCDS and those studies directly aimed at physicians and/or physician workflow. Of the potentially relevant articles screened, 31 studies met inclusion and exclusion criteria with six specific for nurse-focused CCDS. Table 1 describes the characteristics of the included studies which were reviewed utilizing O'Mathuna, Fineout-Overholt, and Johnston's (2010) Rapid Critical Appraisal Checklists.

Summary of the Evidence Base

Guideline Improvements

In an effort to demonstrate how CCDS can influence significant improvements following implementation, Lyerla, LeRouge, Cooke, Turpin, and Wilson (2010) studied patients receiving mechanical ventilation and the compliance with best-practice guidelines for head-of-bed (HOB) position at, or greater, than 30 degrees over a six month period. They performed a modified interrupted time-series design collecting data on 43 patients and 33 nurses in three phases in a 12-bed Intensive Care Unit before and after implementation of a nurse-focused CCDS pop-up alert window reminding the nurse of the HOB recommendation. Descriptive statistics were calculated demonstrating less than half of the pre-intervention HOB measurements were 30 degrees or greater. Post-implementation in phases two and three found significantly different means for HOB greater than 30 degrees as compared to pre-implementation of the CCDS alert.

Dong et al. (2005) were further able to demonstrate significant differences when comparing nurse memory-based triage scoring versus triage scores utilizing a CCDS triage tool in the Emergency Department (ED) setting. Over a five-week period, 722 ED patients were assessed by a triage nurse using memory-based scoring and concurrently by a nurse using CCDS to calculate the score. There was a significant down-triaging trend of patients without the CCDS triage tool.

Nurse-Patient Interactions, Decision-Making and Advising

Dowding et al. (2009) explored how nurses use CCDS in clinical practice in nurse-patient interactions, decision-making, advising, and the factors that influence use. They

performed a multiple case site study of four sites using non-participant observation of 115 nurse/patient consultations and 55 direct interviews with nurses. Nurses used CCDS in a variety of ways and previous experience with the decision and/or the technology affected how they used the CCDS and whether or not they over-rode recommendations made by the system. Nurses in these settings primarily utilized CCDS following the patient intervention to confirm recommendations given.

Nurse-patient interactions and advising was further evaluated by Im and Chee (2006) whose study evaluated a nurse-focused CCDS for cancer pain management and recommendations for interventions. The study aimed to evaluate the use, accuracy and acceptance of the CCDS recommendations among 122 nurses working with patients with cancer. The CCDS was available as an adjunct to the nurses' pain assessment findings and was only available away from the bedside on a separate Internet website, outside of the clinical system used for documentation. Nurses were enrolled to access the system for up to three sessions and used the system one time on average during the study period. Accuracy of the suggested actions for pain at 88% acceptable was evaluated; however, their overall satisfaction with the system was rated at 75% due to inability to access at the bedside.

Capture of Significant Clinical Data

In a randomized controlled trial, Lee, Currie, Hall, John, and Bakken (2009) found the improved capture of quality patient-specific clinical data was best supported when utilizing CCDS features at the point of care. Eight hundred and seven patient encounters whose nurses had the benefit of obesity-related diagnosis CCDS at the point of care was

compared to 997 patient encounters whose nurses utilized standard paper documentation without CCDS. The experimental group had significantly more (11.3%) documentation of obesity-related diagnoses than the control group (1%).

Alexander (2008) further suggested CCDS systems have a potential to positively affect the capture of significant clinical data and the ability to plan for early interventions. He evaluated CCDS in three nursing home settings during the initial roll-out of a new clinical documentation system. Triggers were implemented for early detection and intervention for: decline in condition, constipation, dehydration, loss of skin integrity, and weight loss among residents. Documented assessment findings triggered alerts to the staff to guide further investigation. Staff then chose whether or not to take clinical actions. The most frequent triggers were found to be related to dehydration and skin integrity but no true pattern of clinical interventions emerged as a result of the CCDS and this was felt to be related to dual implementation of the new clinical documentation system.

Findings

Strengths

Studies evaluating the impact of guideline compliance following the implementation of nurse-focused CCDS demonstrate both significant differences and improvements pre- and post- implementation (Dong et al., 2005; Lyerla et al., 2010). Other studies found evidence-based care recommendations presented via nurse-focused CCDS at the point of care improved nurse-patient interactions, decision-making, advising and care-planning (Dowding et al., 2009; Im & Chee, 2006). Additionally, the improved capturing of

important, and often critically important, patient data at the point of history-taking and ongoing assessment via nurse-focused CCDS reminder demonstrates the potential to improve the quality of patient-specific, individualized care (Alexander, 2008; Lee et al., 2009). The findings of these studies support the enormous potential impact nurse-focused CCDS has on driving evidence-based practice, quality patient care and improved patient outcomes.

Garg et al. (2005) found widespread enthusiasm for incorporating technology supported clinical decision-making into clinical practice. The potential for improving compliance with evidence-based practice guidelines, nursing performance measures and patient quality outcome measures are all drivers toward improving efficiency, reducing costs and improving overall health quality. Early studies demonstrate findings which support significant improvement in practitioner performance when aided by interactive CCDS. These improvements in performance translate into decreased omissions and redundancies in direct patient care leading to improved patient outcomes.

Limitations

The research on CCDS has noteworthy limitations as described by Anderson and Willson (2008). First, although a number of CCDS studies have been published, few are randomized controlled trials (RCT). Second, most research has examined the effects of CCDS on the process of care and has focused primarily on physician decision-making. In fact, of the 100 studies reviewed by Garg et al. (2005), 92% enrolled physicians as the primary end-users. Finally, results have been mixed in terms of the effectiveness of CCDS for quality outcomes pointing to significant gaps in the literature.

The literature review for this study demonstrated similar limiting findings with only one pre-post implementation study, small sample sizes, convenience sample sets, and CCDS as an additional system for access rather than a built-in, interactive support to nursing clinical practice, decision-making and workflow. These findings indicate a significant gap in the knowledge base. This study sought to add to the knowledge base through the incorporation of urinary catheter device nurse-focused CCDS into clinical practice. Further studies were needed to support this new technology - particularly as related to nurse-focused/nurse-directed CCDS - which was lacking description in the literature.

Table 1

Summary of the Evidence Base

Source	**Variables**	**Design and Sample**	**Study Conclusions**
Alexander, 2008	Conditions of Decline in Nursing Home Patients	Pre-Post Study including Three Nursing Homes Implementing New Electronic Documentation System	No Improvement in Rate of Clinical Interventions
Dong et al., 2005	Triage Assessment Score	Observational Study Blinded 693 Emergency Room Patients	Significant Discrepancy Between Memory-Based Triage Scores and CCDS Triage Scores
Dowding et al., 2009	CCDS in telephone advising	Direct Observation of 115 Nurse/Patient Interactions in Four Sites and 55 Direct Nurse Interviews	Improvement in Patient-Nurse Interactions, Decision-Making, and Advising

Im and Chee, 2006	Cancer Pain Management CCDS Suggested Actions and System Usability	Convenience Snowball Sampling. 122 Nurses in Oncology Nursing	Accuracy of CCDS at 88% for Suggested Actions Rated Overall Satisfaction with Use of System at 75%
Lee et al., 2009	Obesity-Related Diagnosis Data	Two group RCT 1874 Encounters	Significantly more Obesity-Related Diagnoses Captured
Lyerla et al., 2010	Head of Bed (HOB) Position in Ventilated Patients	Interrupted Time Series Design Descriptive Statistics Pre-Post Test. 43 Patients/33 Nurses	Statistically Significant Improvement in HOB Position

Chapter III

OBJECTIVES AND METHODOLOGY

Objectives

A CCDS alert was designed, implemented and evaluated in the form of an electronic reminder with notification capabilities within the nursing assessment. The primary objective was to determine the effect of the nurse-focused CCDS on the use of evidence-based practice in the early removal of urinary catheters within 48 hours of insertion. The secondary objective was to determine any correlational relationships among nurse-specific demographics such as education level, years of experience and certification with patient age, diagnosis and unit location in the utilization of the CCDS alert and resulting improvement in evidence-based guidelines compliance.

Study Design, Setting and Sample

A pre and post-intervention evaluation was performed in this quasi-experimental, ex post facto (correlational) study. Non-equivalent, non-randomized subjects were obtained through 331 retrospective records review of adult patients (greater than age 18) who were hospitalized in a 440-bed acute-care community hospital over two, similar six-month time periods beginning October 1, 2008 through March 31, 2009 and patients during the time period of November 1, 2009 and April 30, 2010 who had a urinary catheter device either present on admission or inserted during hospitalization. Demographic data including age, gender, primary diagnosis and hospital unit location were collected. Patients admitted for terminal care/comfort care, those patients who expired during hospitalization and those hospitalized for a period shorter than 48 hours were excluded

from the data collection and evaluation. Additionally nurse-specific demographics of subjects' primary nurses were collected including years of experience, highest nursing degree, and any specialty certification.

Sample size was determined by a statistical priori power analysis using the G*Power 3.1.3 software (Faul, Erdfelder,Lang & Buchner, 2007). Desired power was determined by setting a two-tailed alpha at 0.05 with a probability of rejecting the null hypothesis at 0.5 thus utilizing a medium effect size necessitating a sample size of 210. A small effect size (r = 0.2) would have demanded a sample size of 1302 which as prohibitive for the scope, resources and time constraints of this study.

Instruments

For the time periods of October 1, 2008 through March 31, 2009 and November 1, 2009 through April 30, 2010, clinical data entered into the patient's electronic health record (EHR) as part of the patients' registration and the nurses' admission assessment and/or the ongoing shift-to-shift assessment were collected and entered into the hospital EHR, Soarian ®. Additionally these data were extracted and stored in the clinical data warehouse, Embedded Analytics and MIDAS clinical data reporting module. Data captured included: patient age, gender, presenting diagnosis, presence of urinary catheter on admission, insertion of urinary catheter on admission, date and time of insertion of urinary catheter post admission, urinary catheter device days, date and time of removal of urinary catheter and clinical indications for continued use of urinary catheter past 48 hours. Utilization logs specifically related to the CCDS alert capture alert "fires" and

resulting acceptance and/or override of the suggested actions associated with the clinical guidelines for removal of the urinary catheter.

For the same time periods nurse-specific credentials and demographic data including: years of experience, highest level of nursing education obtained and specialty certifications were entered into a database using Microsoft Access and Microsoft Excel 2007 (Microsoft Corp., Redmond, Washington) for Magnet™ certification.

Procedures

Intervention

Concurrent with this Magnet™ facility's organizational goals towards national recognition for quality outcomes and patient safety, each patient care department (in conjunction with the Infection Prevention specialists) collected and reported each month urinary catheter device days and any catheter associated urinary tract infections (CAUTI) as one of the nurse-sensitive quality indicators. While overall CAUTI rates for the organization in 2008 were 3.68 per 1000 device days, there were inconsistencies and fluctuations in and among the patient care areas with some reporting rates as high as 11.78 per 1000 device days. Pending the new classification of CAUTI as a CMS "Never Event", strategic plans were implemented to hard-wire nursing interventions aimed toward the utilization of evidence-based clinical guidelines for the prevention of CAUTIs through the early removal of indwelling urinary catheters when utilized.

The CCDS used in this study involved the development of a time-specific, computer-generated workflow alert that appeared on the computer 48 hours after the nurse electronically documented the presence and/or placement of a urinary catheter within the

genitourinary system's tubes and drains section in the patient's EHR. If the urinary catheter was removed or replaced during the initial 48-hour period, the internal computer clock either stopped the alert workflow or started the 48 hour countdown over and the alert did not become visible until the subsequent 48 hours was reached. The CCDS workflow alert provided the nurse with the "suggested actions" for the early removal of the urinary catheter and an electronic link to the patient care policy and clinical guidelines**.** Because of system requirements for capture of discreet data elements, the alert workflow could only be started when the parameters of "present" or "placed" were documented within the appropriate tubes and drains status field in the genitourinary chapter of the EHR. Additionally, the workflow alert could only be made to stop firing by the appropriate documentation of the parameter "removed" in the same field. Documentation of indwelling urinary catheter status - whether insertion or removal - within the free-text clinical notes had no ability to trigger the alert workflow and subsequent notification of the nurse.

Education of nursing staff surrounding the patient care policy and paper-based evidence-based guidelines had previously been completed utilizing the train-the-trainer approach. Following the successful design, build and testing of the CCDS, a "go-live" date was set and nursing staff training was completed again utilizing the train-the-trainer approach through assistant nurse managers and charge nurses.

Protection of Human Subjects

The appropriate Hospital Institutional Review Board and the Institutional Review Board of Gardner-Webb University approvals (Appendices A and B) were obtained for

the purpose of this study. The requirement to obtain informed consent and/or authorization for use and disclosure of protected health information was waived as there was minimal risk to the rights or welfare of the participants. Confidentiality of patients and nurses was maintained through the use of patient encounter numbers and encoded nurse identifiers for the time periods specified.

Data Collection

For the time periods of October 1, 2008 through March 31, 2009 and November 1, 2009 through April 20, 2010, clinical data entered into the patient's electronic health record as part of the patients' registration and the nurses' admission assessment and/or the ongoing shift-to-shift assessment were collected and entered into the hospital EHR, Soarian®. Additionally these data were extracted and stored using both Soarian Embedded Analytics ™ and MIDAS™ clinical data reporting modules. Data captured include (a) patient age, (b) gender, (c) presenting diagnosis, (d) unit of care delivery, (e) presence or insertion of urinary catheter on admission, (f) date and time of insertion of urinary catheter post admission, (g) urinary catheter device days, and, (h) date and time of removal of urinary catheter. Utilization logs specifically related the CCDS alert captured alert "fires" for the suggested actions associated to the clinical guidelines for removal of the urinary catheter.

For these same time periods nurse-specific demographic data including (a) years of experience, (b) highest level of nursing education obtained, and (c) specialty certifications were entered and stored in a credentials database using Microsoft Access and Microsoft Excel (Microsoft Corp, 2003, Redmond, Washington) for Magnet™

certification. Access to each of these databases for data aggregation and reporting for the purposes of this study was approved through the organization and university Institutional Review Boards and through the organization's shared governance Council for Research and Evidence-Based Practice.

Reports were requested from the systems analysts in the organization's Clinical Performance Improvement Department and the Information Systems Department for the time periods specified for the respective variables to be studied. Reports were returned electronically in Microsoft Excel (Microsoft Corp, 2007, Redmond, Washington) to allow for sorting and organization of records that met inclusion criteria for the study. There were 512 records which met initial inclusion criteria for having had an indwelling urinary catheter documented in the inpatient record for the time periods specified. All records were included for review of inclusion criteria. During this review, the potential for a false positive effect was noted due to the high volume of post-operative cases where the urinary catheter was discontinued within the guideline timeframes of 48 hours. Further scrutiny revealed each of these records contained pre-printed physician order sets directing the discontinuation of the urinary catheter on post-op day one. While the workflow alert clock was initiated with the documentation of the presence of the urinary catheter in the post-operative assessment, the alert would not ever be triggered because of the standing urinary catheter removal order. The listwise methodology was utilized for missing data either surrounding the documentation of the urinary catheter or the demographic information of the nurse. Subsequently an additional 201 records were excluded from the study due to either this newly identified delimitation or due to missing data.

Records were reviewed and data aggregated for pre-implementation analysis (n=161) for the first six-month time period based on patient demographics and insertion and removal dates of indwelling urinary catheters indicating level of compliance with evidence-based guidelines prior to the CCDS intervention. The second six-month time period was selected for the post-implementation record analysis (n=150) and included the nurse-specific demographics for level of education, years of experience and specialty certifications held by the nurse. Comparison of indicators of compliance with urinary catheter guidelines for two different periods was performed in order to make assumptions regarding any changes in guideline compliance rates following the implementation of a nurse-focused CCDS.

Data Analysis

Data were aggregated and coded then transferred into an electronic file using the Statistical Package for the Social Sciences (SPSS) version 20.0 (IBM SPSS Inc., Chicago, IL). Independent samples *t*-tests were conducted to evaluate the hypothesis a nurse-focused computerized clinical decision support alert as an intervention improved guideline compliance with removal of urinary catheters within the recommended 48 hour time interval. Additional independent *t*-test comparisons were made to determine any differences of means in device days before and after the implementation of the CCDS. A two-tailed alpha level of significance was set at $<.05$ with a power of .80 and Levene's test for equality of variances was performed.

Descriptive statistics were utilized for patient and nurse-specific demographics including calculations for frequencies, ranges, percentages, means, and standard deviations. Correlations between patients' age, gender, primary diagnoses, care delivery

unit, nurses' years of experience, nurses' educational level, and nurses' certification status were explored to identify any correlational relationships related to evidence-based guideline compliance. Correlations were evaluated using Pearson's co-efficient at alpha level of 0.5.

Two categories were collapsed to facilitate data analysis including primary diagnosis and care delivery units. Cardiac diagnoses included coronary artery disease, chest pain, myocardial infarction, heart failure and coronary artery procedures including bypass graft. Respiratory diagnoses included pneumonia, chronic obstructive pulmonary disease (COPD) and respiratory failure. Orthopedic diagnoses included procedures for total joints and spine-related procedures. Diabetes and endocrine diagnoses included diabetes and thyroid disorders. Renal diagnoses included renal failure and dialysis. Injury and poisoning included trauma. Gastrointestinal diagnoses included hemorrhage and liver disorders including failure. Neurological diagnoses included cerebral vascular attacks and intracranial procedures. Infectious disease diagnoses included sepsis and cellulitis. Genitourinary disorders included reproductive system procedures. Substance abuse diagnoses included overdose and drugs and alcohol abuse. Care delivery units were categorized as acute critical care, telemetry, medical/surgical, geriatrics unit (Nurses Improving Care for Healthsystem Elders, NICHE unit), Orthopaedic/Neurology or Oncology.

Chapter IV

RESULTS

Characteristics of the Sample

Table 2 (Appendix C) is a summary of the characteristics of both patients and nurses. Patient ages ranged between 23 years old to 97 years old, with a mean age of 66.7 years (SD, 14.5). More than half of patients were women (n=174; 56%). The most common primary diagnosis was cardiac in nature (n=139; 45%) and, as suggested by the most common primary admission diagnosis, the most common care delivery unit was telemetry (n=136; 44%).

The nurses in the study (n=81) had nursing experience that ranged from new graduates to those with 33 years of nursing experience. Mean value for experience was 9.31 (SD, 7.83). More than half held Associates Degrees and/or Diplomas (n= 53; 65%) and ten percent (n= 8) held specialty certifications.

Impact of the Nurse-Focused CCDS

The difference between mean scores was tested for meeting the evidence-based practice guidelines for indwelling catheter removal within 48 hours when indicated. The results of the *t*-test indicated a statistically significant difference between the pre-implementation and post-implementation groups. As a result of the data collected to investigate guideline compliance with the removal of the urinary catheter within the specified time frame, both urinary catheter insertion dates and removal dates were captured thus providing an additional, useful area of investigation. Additionally, the

difference between mean scores was tested for total indwelling catheter days. The difference between groups for dwell time was not statistically significant. Levene's test for equality of variances was not significant (p> .05) among the groups indicating homogeneity among them. The statistical results are shown in Table 3.

Table 3

Post Intervention Scores for Differences Between Groups

Variable	Intervention Mean (SD)	Comparison Mean (SD)	*t* value
Evidence-Based Guidelines	.53 (.501)	.39 (.503)	-2.448*
Dwell Time	3.91 (4.596)	4.68 (4.242)	1.524

*p<.05, two-tailed

Patient and Nurse Characteristics as Predictors

Bivariate correlations among patient-specific and nurse-specific demographics were explored. Specifically age, gender of the patient, primary diagnoses, care delivery unit, nurses' years of experience, nurses' educational level, and nurses' certification status were tested to identify any correlational relationships related to evidence-based guideline compliance in the CCDS environment. Correlations were evaluated using Pearson's co-efficient at alpha level of 0.5. The statistical tests for Pearson's support statistically significant positive correlations between the patient's age (the strongest correlation), care

delivery unit and primary diagnosis with evidence-based guidelines compliance; however, there were no statistically significant correlations shown between patient gender, nurse education level, years of experience or holding specialty certification and evidence-based guideline compliance as shown in Table 4.

Table 4

Correlations Among Patient and Nurse-Specific Demographics on Compliance with Evidence-Based Guidelines for Early Indwelling Urinary CatheterRemoval

Variable	Value
Patient Age	-.203**
Patient Gender	.075
Primary Diagnosis	-.124*
Care Delivery Unit	-.139*
RN Education Level	-.076
RN Years of Experience	-.013
RN Specialty Certification	-.046

*p<.05, **<.01. N = 311 for patient-specific demographic analysis and n = 81 for nurse specific demographic analysis

Chapter V

DISCUSSION

There are limited, initial findings in the literature where the impact of nurse-focused CCDS in future implementations demonstrates enormous potential towards improving clinical decision-making and quality outcomes for patients. This study, while limited to one acute care community hospital, demonstrated the promising benefits of a nurse-focused CCDS in the care of patients with indwelling urinary catheters. Feasibility of designing, building and implementing an electronic alert workflow within the EHR and nursing workflow to support the delivery of guideline-driven, evidence-based care was also confirmed. These findings are promising as similar alerts and rules could potentially reduce the disparity between the care evidence recommends and the care delivered in routine practice.

In this study, evidence-based guideline compliance was evaluated based on urinary catheter device insertion and removal dates and resulting adherence to the forty-eight hour removal recommendations within the guidelines both before and after the design and implementation of a nurse-focused CCDS within the EHR. Retrospective records review (n = 311) found a significant difference in guideline compliance mean scores between the pre-implementation records (n = 161, M=.39, SD = .503) and the records reviewed post nurse-focused CCDS implementation (n = 150, M=.53, SD = .501), thereby supportively answering the proposed clinical project question and affirming there is a positive effect on guideline compliance among patients with a urinary catheter device following implementation of a nurse-focused CCDS.

Patient and nurse-specific demographics were also examined as potential predictors for guideline adherence in the post-implementation group. Specifically examined for patients were age, gender, diagnosis, and care delivery unit. Patient age, primary diagnosis and care delivery unit were found to be significantly correlated to guideline adherence meeting the assumption that these variables could serve as predictors for improved adherence to evidence-based care guidelines in urinary catheter care. However, these correlations may be explained by commonalities operating as mediating variables in patient demographics for age, chest pain diagnosis and critical care admissions. Nurses in these areas have operationalized expertise in utilization of evidence-based protocols and guidelines in clinical practice (i.e. chest pain guidelines, rapid response, ventilator bundles, etc…) and function with a smaller nurse-to-patient ratio potentially explaining the positive correlational relationship and improved adherence to urinary catheter evidence-based guidelines among this patient population.

Demographics examined among the nurses in the study were education level, years of experience and specialty certification. There were no statistically significant correlations found failing to meet the assumption that nurse-specific demographics in these areas serve as predictors for utilization of CCDS and improved adherence to evidence-based practice guidelines. Nonetheless, these findings may be attributed to the large proportion of nurses with Associates Degrees and/or Diplomas (n = 53; 65%) and small proportion of specialty certification (n=8, 10%) and should continue to be further evaluated in future studies by future investigators.

The results from this study are encouraging as outlined by Rousseau et al., (2003) who suggested nurses would find the guideline content of a CCDS useful and be prepared to

utilize it when presented within the EMR. These results further support the findings of Lyerla et al., (2010) who found significant improvements in compliance with head-of-bed positioning in ventilator-associated-pnuemonia (VAP) bundle patients when a nurse-focused CCDS reminder for head-of-bed position was incorporated into the electronic flowsheet.

Application to Theoretical Framework

Possible explanations for these results may be found through Irvine, Sidani and Hall's (1998a) Nursing Role Effectiveness Model (NREM) theoretical framework toward the nurse-sensitive indicators as predictors for quality outcomes as this model formed the framework for this study. As proposed by the theory, the structure variables of the nurse and organization influenced both the process and outcome variables while further linking outcomes to the nurse's roles in healthcare. Specific to this study were the linkages of the structure variables of nurse (education, experience and certification) and organization (EHR with CCDS technology-supported environment) to the process variables of the nurses' independent and medical-care related roles. Through the independent nursing assessment and medical-care related utilization of the nurse-focused CCDS the nursing-sensitive patient outcomes in the safety/adverse occurrences realm are proposed to have been impacted by the improved compliance with urinary catheter device evidence-based clinical guidelines.

Project Limitations

Positive and encouraging findings notwithstanding, limitations must be noted. Primarily, because the experience surrounding the decision-making processes by the

nurse is a dynamic process, it may not be adequately reflected in this short period of time wherein data were collected and analyzed for this study - specifically as it relates to the subtleties of accepting or rejecting the suggested actions and recommendations of nurse-focused CCDS toward meeting evidence-based practice guidelines. While electronic documentation is not new to the practice arena, the technology supporting and presenting evidence at the point of care somewhat is. End-user engagement in the adoption, first of the guidelines and second of the technology, is of the utmost importance in garnering trust of the "system" and acceptance of the suggested actions and recommendations presented by the CCDS. In fact, the positive results demonstrated in this study may have been impacted by other variables not collected or measured as a part of this investigation. Examples include guideline awareness education by the Infection Preventionists, focused education in the care delivery settings with higher rates of CAUTI, and heightened computer literacy and competency in some areas above others.

Importantly, limitations surrounding initial and ongoing computer and health information technology literacy and competencies must be considered. The most sophisticated and highly robust CCDS rules and alert workflows lose all value when the end-user lacks the knowledge to trigger the alert and then access and/or respond to the recommendations when presented electronically. Initial training, follow-up and ongoing competency education and support are keys to ensuring the workflow rule is functioning as designed with the positive outcome desired all the while operating seamlessly into the routine workflow of the nurse.

Implications for Nursing Practice

For more than a decade evidence-based clinical guidelines have been shown to decrease the incidence of catheter-associated urinary tract infection and prevent the associated high cost/poor outcomes of prolonged urinary catheter utilization (Dumigan et al., 1998). Unfortunately, one of the primary challenges recognized in modern health care is the application of evidence-based practice into routine care (Goud et al., 2003). In fact, McGlynn et al., (2009) suggest the care currently delivered in practice is only about half the recommended care based on current evidence and knowledge.

The incorporation and integration of health information technology into clinical practice with EHRs designed with robust CCDS holds tremendous promise as demonstrated in prior studies where physician-focused CCDS has been utilized and in the emerging knowledge base surrounding nurse-focused CCDS. As in this study, there are findings which support when nurse-focused CCDS is implemented into practice significant improvement in practitioner performance translates into improved patient outcomes in direct patient care.

These are new tools designed for health care delivery in the nursing arena. While nurse-focused CCDS interventions are in their infancy, technological advances are quickly moving development and implementation into clinical practice with positive initial findings. The potential benefits to nursing practice and quality outcomes in patient care are limited only to the pace at which these interventions are designed and implemented.

Implications for Future Research

There has been a growing national emphasis placed on the importance of health information technology (HIT) with robust computerized clinical decision support (CCDS) and the integration of such systems into health care delivery. However, there is a significant gap in the knowledge base regarding implementation of evidence-based CCDS into nursing workflow and how such CCDS impacts nursing-sensitive patient outcomes. Future studies in the areas specific to measured clinical and cost outcomes are needed to provide support for the resources necessary to design, build, train and implement nurse-focused CCDS into nursing practice. Further research is also needed towards incorporation of evidence-based clinical guidelines and nurses' acceptance and utilization of nurse-focused CCDS as interactive, action-driven triggers within practice.

The use of computers to aid in nursing practice decision-making and workflow is an exciting area and is just at the beginning of exploration for potential benefit. More research is needed to demonstrate nurse-focused CCDS is an efficient and effective tool in quality patient outcomes.

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Appendix A

Gaston Memorial Hospital Institutional Review Board Approval

CaroMont Health

CaroMont Health Institutional Review Board
2525 Court Drive, Gastonia, NC 28054
FWA0005497

March 5, 2012

Robin Lang, MSN, MBA, RN-BC
Gaston Memorial Hospital
2525 Court Dr.
Gastonia, NC 28054

IRB# 2012-03-004
Study title: Evaluating the Effectiveness of Nurse-Focused Computerized Clinical Decision Support on Urinary Catheter Practice Guidelines

Dear Ms. Lang,

The above project was reviewed and approved by the Chair of the CaroMont Health Institutional Review Board as an expedited review (category #5). The requirement to obtain informed consent and/or authorization for use and disclosure of protected health information form has been waived, as this research was determined to be minimal risk and the waiver for informed consent and authorization for use and disclosure of protected health information form will not adversely affect the rights or welfare of the participants. This action will be reported to the committee at its meeting on 3/15/2012.

NOTE:

- ALL of the materials (data, documents, records, or specimens) to be utilized in this project must "have been collected, or will be collected solely for nonresearch purposes (such as medical treatment or diagnosis)" [Expedited category description as revised, effective November 9, 1998].
- All information - that which is pertinent to the research project and that which is incidental to the project - must be handled at all times in a manner to protect patient confidentiality and privacy.

This includes approval of all submitted material including:

APPROVAL DATE: **3/05/2012**
EXPIRATION DATE: **3/04/2013**

The Protocol and all materials are approved for a period of up to one year from the date of the meeting. This approval is in effect until the expiration date listed below, unless the IRB notifies you otherwise.

It is the responsibility of the Principal Investigator to submit the required materials to initiate the re-approval process at least a month prior to the expiration date shown above.

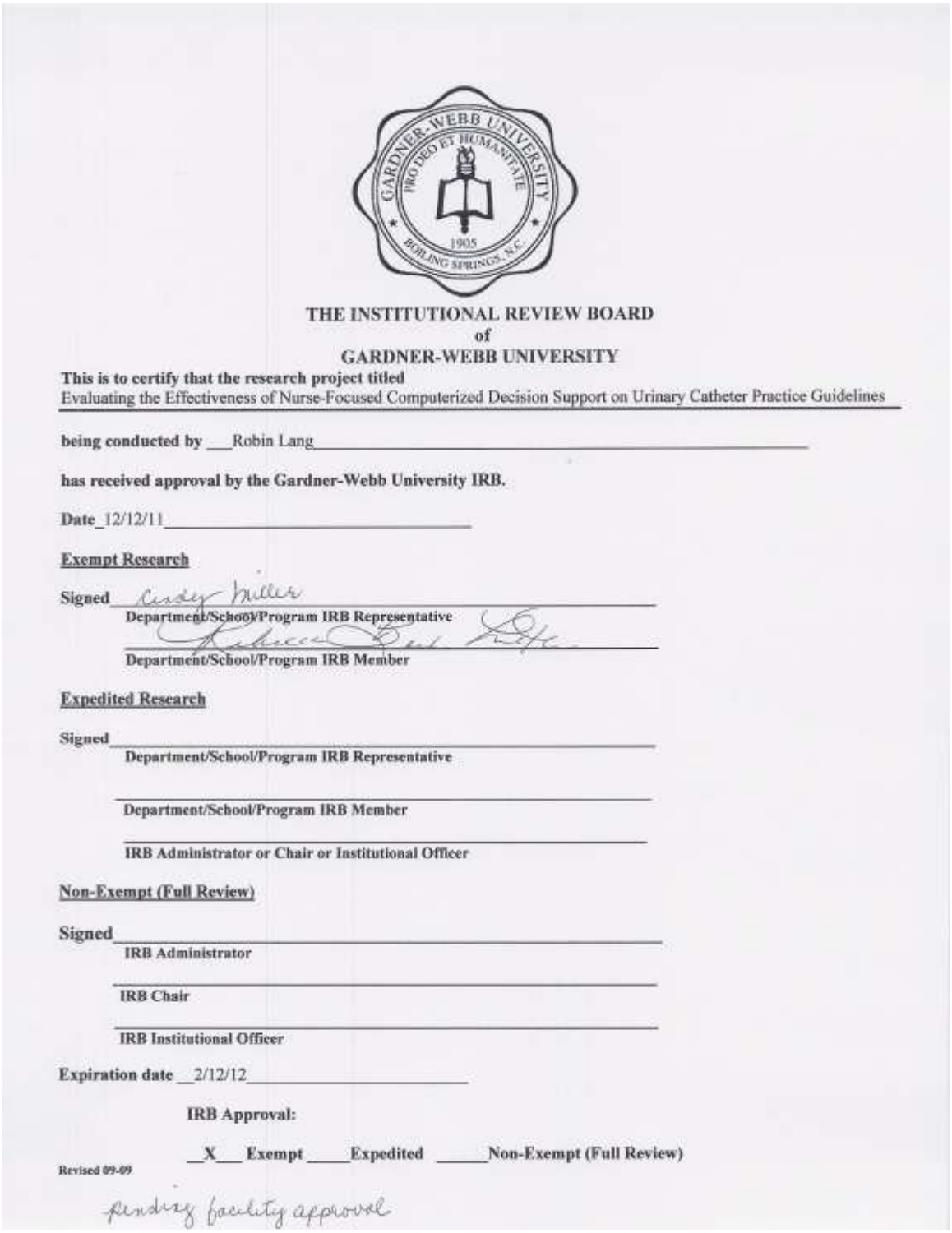
If you have any questions or concerns, please call Michelle Cook, Director, Human Research Ethics at 704-834-3891 or email at michelle.cook@caromonthealth.org.

Sincerely,

Paul Cheifetz, MD
Vice-Chair, Institutional Review Board

Appendix B

Gardner-Webb University Institutional Review Board Approval



THE INSTITUTIONAL REVIEW BOARD
of
GARDNER-WEBB UNIVERSITY

This is to certify that the research project titled
Evaluating the Effectiveness of Nurse-Focused Computerized Decision Support on Urinary Catheter Practice Guidelines

being conducted by Robin Lang

has received approval by the Gardner-Webb University IRB.

Date 12/12/11

Exempt Research

Signed Cindy Miller
Department/School/Program IRB Representative

Department/School/Program IRB Member

Expedited Research

Signed
Department/School/Program IRB Representative

Department/School/Program IRB Member

IRB Administrator or Chair or Institutional Officer

Non-Exempt (Full Review)

Signed
IRB Administrator

IRB Chair

IRB Institutional Officer

Expiration date 2/12/12

IRB Approval:

_X_ Exempt _____Expedited _____Non-Exempt (Full Review)

Revised 09-09

pending faculty approval

Appendix C

Table 2

Characteristics of the Sample

Characteristic	**Value**[a]
Patients (n=311)	
Age, mean (SD), range	66.68 (14.5), 23 – 97
Gender	
Male	137 (44)
Female	174 (56)
Primary Diagnosis	
Cardiac	139 (44.7)
Infectious Disease	44 (14.1)
Gastrointestinal	27 (8.7)
Respiratory	26 (8.4)
Neuro	22 (7.1)
Diabetes/Endocrine	17 (5.5)
Ortho	12 (3.9)
Renal	8 (2.6)
Genitourinary	6 (1.9)
Cancer	3 (1)
Injury	3 (1)
Substance Abuse	
Care Delivery Unit	
Telemetry	136 (43.7)
Med/Surg	74 (23.8)
Oncology	42 (13.5)
Ortho/Neuro	19 (6.1)
NICHE/Geriatrics	3 (1.0)
Critical Care	
Nurses (n=81)	

Education Level	
ADN/Diploma	53 (65.4)
BSN	28 (34.6)
Years of Experience	9.31 (7.83), 1 - 33
Specialty Certification	
Yes	8 (9.9)
No	73 (90.0)