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Refining Computerized Physician Order Entry Initiatives in an Adult Intensive Care Unit

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This is to certify that the doctoral study by

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has been found to be complete and satisfactory in all respects,
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Abstract

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MSN, Walden University, 2010

BSN, Macon State College, 2005

Project Submitted in Partial Fulfillment

of the Requirements for the Degree of

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Abstract

Computerized physician order entry (CPOE) is used in healthcare organizations to improve workflow processes and transcription, as well as to prevent prescribing errors. Previous research has indicated challenges associated with CPOE for end-users that predispose patients to unsafe practices. Unsafe CPOE practices can be detrimental within the intensive care unit (ICU) setting due to the complexity of nursing care. Consequently, end-user satisfaction and understanding of CPOE and electronic health record (EHR) functionality are vital to avoid error omissions. CPOE initiatives should be refined post system implementation to improve clinical workflow, medication processes, and end-user satisfaction. The purpose of this quality improvement project was to refine CPOE system initiatives and develop an e-learning educational module to facilitate end-user understanding of and satisfaction with CPOE. The Iowa model of evidence-based practice, Lean methodology, and Provider Order Entry User Satisfaction and Usage Survey (POESUS) were used to guide the study. An e-learning module was implemented to increase staff understanding of the newly implemented CPOE system, and a plan was provided for ongoing data collection and investigation of end-user satisfaction and medication inadequacies with the CPOE system. A mixed-method design was recommended to key stakeholders to identify the impact of the e-learning course and refined CPOE initiatives on both end-user satisfaction and patient outcomes in the medical-surgical ICU. Findings from the study informed the impact of e-learning educational modules with CPOE system implementation. Those in organizations implementing advanced technology such as CPOE and EHR systems in critical care settings will find this paper of interest.

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Dedication

This project is dedicated to my earthly confidant and high-school sweetheart, Keat Fuller. Thank you for being a devoted husband and father, and most importantly, a genuine friend. You have been there during the most challenging and defying moments in my life, and your continued words of encouragement and adoration does not go unnoticed. Words cannot express my gratitude for your unwavering support and listening ear during the many callings placed upon my life. I could not have asked for anyone greater to share my life with … the saga continues!

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To my children, Darius, K'vian, and Keona, your existence, love, and admiration has been the foundation of my future … you all are a true blessing from God, and without each of you providing your own unique petitions, I would not have the drive and ambition to press forward or pursue my dreams. Your existence has granted favor in my life. I love you! To my mother, Arma, thank you for instilling prayer and the word of God … my spiritual faith and guidance have served me well.

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Above all, I would like to give thanks to my Heavenly Father for leading, guiding, and directing my path when I thought the possible was impossible. My spiritual guidance and "mustard seed" faith have kept me grounded and gave me a reason to press forward during the many oppositions of life … He saw the best in me!

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Section 1: Nature of the Evidence-Based Project

Introduction/Background

Computerized physician order entry (CPOE) is an intricate part of electronic health records (EHRs) and physician improvement initiatives that are being implemented among healthcare organizations across the continuum. Legislative mandates and Centers for Medicare and Medicaid (CMS) regulations have required organizations to use certified electronic technology with integration of CPOE systems with meaningful use guidelines for reimbursement incentives. These requirements have advocated that CPOE systems be implemented in healthcare organization in rapid stages, which have placed undue pressure and stress on end-users within various roles (e.g., nurses and ward secretaries). This is particularly challenging for computer-illiterate clinicians such as physicians and nurses who struggle with advanced technology. Clinical workflow and medication processes are affected by CPOE implementation both positively and negatively (Ventura et al., 2011).

Administrative personnel at the medical center that was the focus of this project have taken their current CPOE system to the next phase to meet CMS Meaningful Use specifications to maintain their eligibility for the EHR incentive program. CPOE is used in acute care settings to improve workflow processes and transcription, as well as to prevent prescribing errors (Abramson & Kaushal, 2012). However, the complexity of CPOE poses many challenges for end-users, which predispose patients to treatment delays, order omissions, and unfavorable outcomes. This can be detrimental in any clinical setting, but CPOE misuse in the ICU setting poses greater risks for patients who

require complex and multifaceted care. Although EHRs have the functionality to aid in error omission with CPOE integration, opposition to CPOE workflows and medication processes exists among clinical end-users. This is contradictory to what is expected of the advanced technology. Understanding CPOE functionality, meaningful use guidelines, and evidence-based practices (EBP) can ensure end-user compliance with system practices (Abramson & Kaushal, 2012). Therefore, there was a need for in-depth analysis of CPOE initiatives to gain awareness of clinical workflows, medication processes, and end-user satisfaction for resolutions to combat the negative influences.

Problem Statement

CPOE systems provide many beneficial features for patients in healthcare settings. Although EHRs have functionality to aid in error omission with CPOE integration, literature has proven that CPOE is not without inaccuracies (Agency for Healthcare Research and Quality [AHRQ], 2012). Nursing processes related to CPOE integration are not uniform among the nurses and interdisciplinary team members within the intensive care setting and other units within the organization. This has led to inconsistent and inadequate use of the system, which may have contributed to order omissions, unprocessed CPOE admission orders, medication errors, and treatment delays. Unfavorable workflows, system demands, misunderstanding of system functionality, and computer illiteracy have also posed challenges for clinicians who use the EHRs and CPOE system. These oppositions have led to adverse consequences and safety concerns in relation to patient care.

Purpose Statement

Current research depicts various unintended consequences associated with integrated CPOE systems in healthcare. Despite the many practical issues, unfavorable clinical workflows and end-user compliance appear to be focal concerns. End-user understanding of CPOE and EHR functionality is imperative for error prevention. To further combat problems associated with electronic/computerized orders, CPOE initiatives should be refined post system implementation to improve clinical workflow, medication processes, and end-user satisfaction. Therefore, the purpose of this quality improvement project was to refine CPOE system initiatives and develop an evidence-based e-learning educational module to facilitate end-user understanding of and satisfaction with the advanced technology. A well-organized system design and end-user training should promote optimal CPOE integration in the intensive care unit (ICU) setting (Maslove, Rizk, & Lowe, 2011).

Project Objectives

The overall objective of this project was to maximize patient safety and nursing practices through an advanced educational and training program to increase understanding of CPOE and EHR systems in the ICU setting post Phase I system implementation . Specific objectives of this study were to (a) identify and describe Phase I CPOE medication inadequacies in the ICU setting, (b) develop an evidence-based CPOE educational tool to facilitate end-user knowledge and understanding of electronic order entry; and (c) measure end-user satisfaction with the POESUS post CPOE training and system implementation.

Significance to Practice

CPOE is a technological advancement that delivers real-time electronic prescribing by ordering providers. This high-tech enhancement has proven functionality that is effective in reducing medication errors, which is recognized by the Leapfrog Group (2011) as a national safety standard and by The Joint Commission (TJC) as a national safety enhancement initiative. According to Maslove et al. (2011), the relevance of CPOE systems with critically ill patients is multifaceted. Immediate transmission of orders, allergy identification, drug interactions, and incorporation of management protocols are beneficial aspects of the CPOE system. Improved medication processes with the adoption of electronic ordering are also significant to practice. CPOE systems eliminate handwritten ordering, illegibility issues, transcribing errors, and nonclinical interpretation. They also automatically calculate medication dosages and perform drug-to-drug and drug-allergy interaction checking at the point of electronic order entry, which are all essential medication error prevention strategies (HealthIT.gov, 2014). Additionally, integration of up-to-date practices, enhanced physician-pharmacist communication, and healthcare cost reductions are benefits of its use in healthcare (Leapfrog Group, 2011).

To meet legislative guidelines and CMS CPOE standards, physicians are required to enter "75% of medication orders" in certified prescribing-error prevention software (Leapfrog Group, 2011, p. 2). This assists with error reduction through automated prescribing alerts at the point of provider entry. CPOE also has quality and safety features to assist with decreased length of stay (LOS), order duplications, laboratory turnaround

times, and pharmacy/radiology requests, which are all cost-saving initiatives (Leapfrog Group, 2011).

The Joint Commission (TJC) recognizes several health information technologies (HIT) as sentinel event alerts due to technology-related adverse events. Examples of these technology-related events include errors of omission, commission, human-machine interfaces, system design, misinterpretation, and improper training/implementation (TJC, 2011). These adverse consequences require healthcare organizations to implement, improve, and maintain advanced HIT cautiously. Advanced HIT, such as CPOE, imposes inefficiencies in clinical settings due to the demands placed on end-users and changes in workflow processes (TJC, 2011). Therefore, healthcare organizational leaders and providers must consider the impact HIT has on patient care and workflow processes in the planning, implementation, and evaluation stages. TJC provided a list of suggested actions for healthcare organizations to take to prevent patient harm with implementation of converging technologies such as CPOE systems. Examination of workflow processes/procedures; continuous monitoring of inadequacies, and e-learning/training sessions are outlined measures that are specific to CPOE practices (TJC, 2011). These actions were in line with the stated goals of this project within the critical care setting.

Evidence-Based Significance of the Project

Integration of evidence-based practices (EBPs) in clinical settings has been found to transform research discoveries into practice by decreasing adverse outcomes and inappropriate treatment (Chou, Vaughn, McCoy, & Doebbeling, 2011). American Association of Critical-Care Nurses (AACN's, 2006) *DNP Essential IV* specific aim is to

incorporate "*Information systems and patient care technology for the improvement and transformation of health care" (p.12)*. This *DNP Essential* is vital to healthcare organizations for integration of EBPs with the use of advanced technologies. Specifically, incorporation of CPOE systems with healthcare organizations facilitates EBPs through advanced order entry and medication safety initiatives. It assists providers with making safe ordering decisions through the use of rules-based logics and clinical decision support systems. Best practices, error elimination, enhanced patient safety, variation reduction, and improved efficiency of health care delivery are essential evidence-based functionalities recognized for CPOE systems. CPOE also provides many advantages over paper-based systems through elimination of illegible handwriting and transcription errors; faster pharmacy times; easy integration in patient medical records; correct identification of ordering physician; algorithms that decrease underprescribing/overprescribing; and immediate data analysis (CPOE, 2010).

Various studies have demonstrated the unintended consequences of CPOE for clinical workflows. Maslove et al. (2011) study on CPOE in the critical care environment found that unit workflow and staff relationships are directly affected by advanced technology. Unit-specific designs and order sets can lessen staff workloads, which enhances user acceptance of the integrated system. However, unintended consequences with end-user workflow, staff roles, and patient outcomes were found to be affected by CPOE systems.

Additionally, system usability, computer availability, system alerts, and complexity of the system greatly impact end-user compliance. Case studies of CPOE

integration in the intensive care setting depict both positive and negative outcomes (Maslove et al., 2011). It was found that organizations completely removed CPOE systems post implementation due to related troublesome workflow issues. However, after effective system revisions and re-education, the CPOE system was successfully re-implemented after reconstructing the system to combat workflow issues. Maslove et al. (2011) also found that end-user learning curves associated with CPOE integration affect mortality rates in the ICU setting, which negates further investigation of staff satisfaction, effects on education, and information technology (IT) help desk usage in the ICU setting (Maslove et al., 2011).

Implications for Social Change in Practice

Integration of CPOE systems influences social change in healthcare practices for the betterment of patient outcomes. This advanced patient care technology can change attitudes, behaviors, and practices across the continuum. These advancements are the future of healthcare for proper health maintenance. Therefore, appropriate use and understanding of HIT systems' functionalities are essential. One of the 2-year initiatives launched by the Robert Wood Johnson Foundation (RWJF) and the Institute of Medicine (IOM) in 2008 included full partnership of nurses with healthcare providers for redesigning health care (IOM, 2010). This can be done with advanced patient care technology such as CPOE through collaborative efforts and continuing educational developments refined by clinicians within the healthcare setting. The impact and social changes implied by these processes are boundless, and CMS have set guidelines to ensure compliance.

Meaningful use guidelines developed by CMS (2012) incorporate comprehensive objectives that are aimed at improving patient care across the continuum with CPOE systems in measurable stages. Stage I includes data capture and sharing; Stage II includes advanced clinical processes; and Stage III includes improved patient outcomes. These objectives imply social changes in healthcare practices as patient safety is enhanced with the incorporation of electronic transcribing. Electronic medication reconciliation is a measure addressed under these guidelines that helps to reduce medication errors. Patients who have comorbidities, have multiple risk factors, and use multiple physicians and pharmacies for their healthcare needs are at a greater risk of medication errors. Additionally, CPOE system design contains functionality that includes programmed drug-drug and drug-allergy interaction verification automatically upon electronic transcription entry by the ordering provider. This CPOE safety enhancement decreases drug-related interactions and adverse reactions through automated alerts at the point of entry, which requires physician overrides and comments for prescribing drugs with known interactions. Therefore, these guidelines outlined by CMS not only improve patient safety, but also enhance physician knowledge and awareness of medication transcribing across the continuum (HealthIT.gov, 2014).

Definitions of Terms

Clinical, *clinical workflow*, *CPOE*, *critical care*, *ICU*, *EHR*, *medication processes*, *patient safety*, *research*, *risk*, and unintended consequences are terms that are used throughout the body of the paper. These terms are defined specifically in Table 1 of Appendix A.

Assumptions and Limitations

The assumptions associated with CPOE integration in the medical-surgical ICU setting included the presence of unintended practice issues with clinical workflows and medication processes. This was due to the demands placed on staff with the use of a hybrid system that uses both electronic and paper order entry (TJC, 2011). This adds confusion to the workflow process in determining orders entered via CPOE, end-user entry, and paper system entry. Additionally, constant system changes, lack of understanding of system functionality, workflow disruptions, computer illiteracy, automated alerts, and improper training existed among the healthcare organizations. This increased the introduction of inaccuracies with CPOE and EHR systems. Workflow disruptions and improper HIT training can cause unfavorable outcomes in the delivery of patient care in critical care settings. More importantly, treatment delays and order omissions occur as a direct result of improper training and misuse of HIT (TJC, 2011).

Limitations of the study included partial CPOE workflow representation in the ICU settings due to the inability of the interdisciplinary team to observe all end-users. Additionally, some physicians enter orders from remote locations, while others use the system in-house; these patterns of use have a direct effect on processed CPOE medication orders. Therefore, all CPOE processes were not directly observed, which limited data collection on all procedures involved with CPOE workflows by the interdisciplinary team. The hybrid CPOE system also permits providers to write handwritten orders and enter electronic CPOE orders. This limited CPOE processes, as select physicians elected to perform more handwritten orders than CPOE orders during the defined observation

period. Handwritten and CPOE orders require clarifications, which interrupt the clinical workflow process and limit CPOE workflow analysis by the interdisciplinary team.

Other limitations outlined by the interdisciplinary team included staff availability to process CPOE orders from the patient care status board in the computer during emergencies in the ICU setting. Medications retrieved on override in the Pyxis medication dispensing machine during emergency situations automatically default onto the electronic administration medication record, which interferes with CPOE workflow processes. The interdisciplinary team was aware of the Hawthorne effect during direct observation. Additionally, data collection on workflow processes during different timeframes fluctuates on variable shifts. Staffing differences related to nursing shortages, temporary assignments, per diem employees, and outside contract staff may have affected CPOE system usability. Also, the introduction of new staff and clinicians post project implementation affected outcomes due to novice training and use with the newly integrated HIT. Therefore, variable workflows exist in the system, and the sample population and workflows observed may not fully represent the intended population.

The evidence-based CPOE e-learning educational tool (CEU) was created with organizational professional development software. It was an online self-paced training tool that is available to staff through the organization's Health Stream professional development software, which allowed completion of training in a self-paced environment. Most staff completed the CEU modules during normal working hours. Constant interruptions, unfavorable learning environments, lack of self-discipline and focus, disinterest, inability to answer questions, incompletions, learning curves, and

technology interruptions may have limited end-user knowledge and understanding of the required educational material. Additionally, the lack of nonvisual cues may have introduced misunderstanding of the information. These disadvantages may have impeded end-user understanding of the material, which may have caused continued confusion and misuse of the advanced technology.

Lastly, although the original Provider Order Entry User Satisfaction and Usage Survey (POESUS) questionnaire had a tested reliability (Cronbach's $\alpha = 0.8$) with CPOE technology in the other critical care settings, limitations still exist (Lee et al., 1996). Detailed analysis of the revised POESUS results cannot be completed due to ongoing data collection by the organization's interdisciplinary team. This limits the quantitative measurement, and the degree of reliability and validity of the revised survey cannot be measured. Additionally, the interdisciplinary team may have continued low survey response rates, misinterpretation of questions, lack of context, and the likelihood of socially desirable responses, which can introduce unrepresentative data collection and results for end-user satisfaction with the POESUS. Therefore, the revised POESUS should be measured with future research and projects alike to determine the degree of validity and reliability.

Summary

The expressed importance of CPOE integration and compliance with CMS meaningful use guidelines has informed the organization's guidelines for implementation of the advanced technology in stages. However, the introduction of unintended practices with this advanced technology impacts patient care both positively and negatively

(AHRQ, 2012). Therefore, evaluation of CPOE clinical workflows with complex situations in the ICU setting is essential to identify inefficiencies. Additionally, evaluation of medication processes in the critical care setting with the CPOE system is important to determine safe practices. Assessment of clinician satisfaction with CPOE practices is a critical component of system analysis to identify knowledge and educational needs. Continuing education processes are also essential to assure end-user understanding and compliance with advanced patient technology. Therefore, process improvement measures are vital to ensure that CPOE progressions are refined post system implementation to improve complex clinical processes. This DNP project included a review of integrated CPOE systems in various ICU settings and development of an educational training program aimed at improving awareness. If this project is successful, the organization should experience improved clinical workflows, medication processes, staff satisfaction, and patient outcomes in the ICU setting.

Section 2: Review of Literature and Theoretical and Conceptual Framework

Introduction

Review of scholarly evidence and literature reviews were performed with the Walden University Library's EBSCOhost premium resource database for CINAHL, MEDLINE, and SAGE journals. CPOE terms and key terms (e.g., *computerized physician order entry (CPOE), computerized provider order entry, electronic health record (EHR), order entry, prescribing, ICU, critical care, clinical workflow, CPOE in ICU, medication processes, patient safety, interoperability, collaboration,* and *communication*) were used to identify CPOE evaluations published between January 2009 and July 2013. Twenty articles were originally retrieved on CPOE use and implementation in the healthcare setting. Thirteen articles that focused on CPOE implementation and integration within the ICU setting were selected to guide project development and planning.

Specific Literature

Several research studies specifically illustrated the impact of CPOE on clinical workflow, medication processes, and end-user satisfaction in critical care settings. Unintended consequences related to CPOE workflows were examined by Ash, Sittig, Dykstra, Campbell, and Gauppone (2009) in academic, community, and acute care teaching hospitals. They used a mixed-method approach to identify and categorize various unintended consequences associated with CPOE systems. After conducting oral history reviews, shadowing ordering providers and nurses, and performing over 400 hours of direct observation in the clinical setting, they found workflow to be the greatest

unintended consequence in regard to CPOE. The researchers also used a national survey to measure CPOE complexity and how hospitals recognize and deal with related inefficiencies. Changes in work pace, sequence, and dynamics as well as inadequate workspace negatively affect end-user development and performance with the advanced technology. Human-computer inadequacies, nonapplicable automated alerts, and interface designs were also noted to be key unintended consequences of CPOE systems by the researchers.

CPOE systems can impact nursing workflow negatively when the systems are not designed to meet clinical needs. This is especially true within the critical care setting when complex and intricate nursing care requires distinctive clinical workflows. CPOE systems' effect on a neonatal intensive care unit admission workflow was examined in relation to antibiotic administration (Chapman, Lehmann, Donohue, & Aucott, 2012). A pre-post intervention comparative study of the length of time between admission and administration of initial antibiotics in neonates on a neonatal intensive care unit (NICU) before and after CPOE system implementation was conducted. Although a neonatal population (average 33-week gestational age) was investigated, the data illustrate that the use of CPOE systems within the critical care setting may affect nursing workflows and medication processes both positively and negatively. The mean time for pharmacy verification of CPOE orders was 125 minutes post system implementation, which was due to variable issues associated with provider entry and pharmacy workflows. The complexity of nursing care associated with critical care patients requires reliable CPOE interfaces. System deficiencies, improper system designs, and the lack of reliable CPOE

interfaces can result in unintended outcomes. Therefore, CPOE inadequacies within unique settings alike must be identified post system implementation with evaluation of patient care activities to improve clinical workflows, medication processes, and overall patient care.

The IOM (2011) reported the impact of HIT on patient safety when designed appropriately and strategically. CPOE systems have been specifically identified as a safety improvement initiative by IOM to decrease medication errors with hospital medications. The impact of CPOE processes on patient safety was examined from a nursing viewpoint (Househ, Ahmad, Alshaikh, & Alsuweed, 2013). The researchers completed a literature review that outlined nursing perceptions of CPOE processes, patient safety, and nursing workflow. They reviewed 18 CPOE-related studies and concluded that CPOE systems improve patient care but may negatively impact clinical workflow processes and organizational culture when poorly designed. Thus, they contended that inefficiencies should be identified and improved to promote a culture of safety. Further study of the impact of CPOE processes on nurse workflows necessitates further investigation to determine the direct impact on patient safety (Househ, Ahmad, Alshaikh, & Alsuweed, 2013).

End-user satisfaction is a vital component of HIT implementation in any organization. However, it is of utmost importance in healthcare organizations with the promotion of high-quality patient safety initiatives. Individuals who use HIT tend to avoid technological advances and create work-arounds when they are dissatisfied or unhappy with the system (Hoonakker, Carayon, & Walker, 2010). The importance of

end-user satisfaction with CPOE implementation was identified by Hoonakker, Carayon, and Walker (2010). They suggested the use of mixed methods such as direct observation, interviews with end-users, and end-user questionnaires for data collection. The researchers identified criteria for the selection of a valid and reliable questionnaire to measure end-user satisfaction with CPOE systems. The seven criteria were (a) domain, (b) conceptualization, (c) psychometrics, (d) data for comparison, (e) replication, (f) specificity, and (g) paper/pencil versions vs. web-based surveys (WBS). Based on these criteria, they found the preferred questionnaire for measuring end-user satisfaction with CPOE implementation to be the POESUS, which is specific, is theory based, and has high reliability with a Cronbach's alpha > 0.80. They used the survey to study CPOE implementation in several ICUs in the northeastern part of the United States at a 400-bed rural tertiary care teaching hospital 3 months post system implementation. The ICUs included adult, neonatal, pediatric, and cardiac patient populations that required advanced critical care. The survey was completed by 120 nurses and 57 physicians, who made up 91% of the Caucasian population that worked an average of 41.5-48 hours in 12-hour shifts. The researchers found that the end-users within the study were moderately satisfied with CPOE technology—a result comparable to those of other studies on HIT. This demonstrates that the POESUS will provide useful and reliable data with the project presented.

Health technology is a common practice for healthcare professionals. CPOE systems and EHRs are examples of technological advancements in patient care. However, continuing education, validation of competencies, skill development, and performance

appraisals are annual requirements that are regulated by The Joint Commission (TJC). E-learning is the newfound method used in many healthcare organizations to achieve these requirements. It allows learners to progress based on their ability to complete a skill or competency at their own pace in a flexible format regardless of the environment. Additionally, competency-based e-learning creates a culture of learning with flexibility regardless of the time, place, or pace (U.S. Department of Education, 2013). Pawlyn (2011) completed a two-stage literature review to evaluate the use of e-learning for continuing professional development. Nurses with learning disabilities were recruited via invitation by mail. Six nurses agreed to participate in the research study. They were interviewed by the researcher with questions pertaining to (a) their experience with technology at work, (b) the meaning of continuing professional development to them, (c) the meaning of e-learning to them, and (d) their experience with e-learning for continuing professional development activities. The information collected from the interviews was collated with the application of thematic and descriptive analysis. The researcher concluded that e-learning is a potentially valuable method for healthcare professionals to facilitate continuing education activities. Therefore, an evidence-based e-learning CPOE educational tool will be a beneficial instrument to facilitate end-user knowledge and understanding, which will be created in a PowerPoint format on the company e-learning continuing education software (HealthStream).

General Literature

The impact of CPOE on clinical workflow, medication processes, and end-user satisfaction in critical care settings has been examined by various researchers. Specific

literature outlines the importance of CPOE workflow analysis, identification of unintended consequences, evidence-based e-learning tools, and questionnaires to measure end-user satisfaction with CPOE systems. However, general literature surrounding CPOE systems within the healthcare setting proves that HIT is not without errors.

CPOE patient care systems are designed to facilitate patient safety with automated clinical alerts but cannot do so without proper implementation, system design, and training. CPOE systems can also aid in improved outcomes for patients requiring complex nursing care in acute care units (Maslove et al., 2011). One of the primary reasons for order omission with CPOE systems is automated clinical alerts (Perna, 2012). Clinical alerts are created by IT clinical support to ensure that clinicians and end-users are automatically notified of pertinent results such as critical results, orders entries, drug interactions, and transcriptions. However, clinical alerts can be overwhelming and annoying to the point that clinicians and end-users ignore and/or overlook the alerts. This poses unintended consequences for patient care, which impact outcomes. Critical laboratory results are generated with automated bright red alerts to the nursing care status board for notification. However, a bright red alert is also designed to populate for uncollected specimens. The similarity among the alerts can lead to alert-fatigue and omission by the end-user. This leads to a predisposition to negative consequences for patients who have critical results that require immediate intervention or changes and/or additions to their medication regimen or plan of care. If the clinician or end-user omits automated alerts such as critical lab values, the patient can suffer negative consequences imposed by treatment delays. Such a situation can result in unfavorable or detrimental

outcomes requiring life-saving interventions. Although clinical alerts can lead to end-user fatigue, the system can be designed and programmed to ensure that only pertinent results are automated to lessen the risk of omissions. Thus, end-user understanding of advanced technology such as EHRs and CPOE system functionality through CEUs and continuing professional development tools is important (Maslove et al., 2011).

Legislative mandates and integration of CMS meaningful use guidelines are being used by many healthcare organizations to ensure that patient care is optimized with EBPs. This is especially important for IT personnel and clinicians within the healthcare setting to ensure that CPOE systems are properly designed and programmed for delivery of safe and effective nursing care (Perna, 2012). Khajouei and Jaspers (2010) examined the impact of CPOE designs for medication ordering on system usability, workflows, and order entry. They concluded that CPOE system design is important for end-user adoption and error reduction, which can be done through system redesigns and refresher courses post implementation. Suggested CPOE redesigns include system alerts, visibility, icons, drop-down lists/menus, safeguards, screen displays, and auxiliary functions (Khajouei & Jaspers, 2010). However, end-user workarounds must be considered with system redesigns. Niazkhani, Pirnejad, van der Sijs, and Aarts (2011) evaluated medication processes post CPOE implementation and found that end-users bypass safety features that are integrated into technology designed to eliminate workflow disruptions. This imposes unintended risks that jeopardize patient safety and treatment modalities. Thus, stakeholders must consider all negative aspects of the system design when implementing solutions.

Despite the many positive aspects of CPOE integration, there are many challenges that exist with its processes and workflows. Defining system efficiencies and inefficiencies with technological advances in any clinical setting is vital to ensure quality and safe practices while eliminating system error. Additionally, understanding end-users' knowledge of system practices and identifying ways to improve clinical workflows with the incorporation of EBP practices can improve patient outcomes. Practices tailored to critical care workflows and processes may also provide advantageous outcomes with end-user satisfaction. This, in turn, may result in projected improvements in patient care initiatives, safety standards, and anticipated outcomes.

Theoretical Framework/Evidence Practice Model

The National Institute for Health and Care Excellence (NICE, 2013) suggests the use of specific steps to guide practice changes. The steps include (a) identification and understanding of barriers that need to be changed, (b) selection of barriers to change, and (c) finding ways to overcome the barriers to the selected change (NICE, 2013). Identification of CPOE barriers and understanding of unintended workflow processes in the critical care setting are the initial steps taken for this project. Barriers include, but are not limited to, the use of two different ordering systems (hybrid system); inexperienced and uneducated end-users; constant system changes; and lack of physician buy-in. Finding ways to overcome the barriers with practice and process changes through the incorporation of evidence-based practices is essential in the planning phase. Additionally, identification of key stakeholders, staff requirements, equipment, networks, and educational needs is fundamental.

The Iowa model of evidence-based practice (IMEBP) promotes quality care initiatives in a step-by-step format that assists with meeting the defined goals. IMEBP outlines a step-by-step methodology that assists with implementation of EBPs for practice changes. This theoretical framework was used to guide investigative research by the interdisciplinary team with the CPOE processes effectively. It assists the organization with facilitating systematic decisions among CPOE initiatives in the critical care setting. IMEBP was developed by Marita Titler and her colleagues in 2001 for change implementation among healthcare organizations. The five steps are (a) problem identification, b. team formation, c. literature review, d. practice change implementation, and e. dissemination of findings (Titler et al., 2001).

The first step coincides with the steps suggested by NICE (2013) for identification and selection barriers. This step is outlined in the PICO (patient, intervention, comparison, and outcome) format as follows: (P) The critical care setting is the selected patient population; (I) The analysis of clinical workflows, medication processes, and implementation of a CPOE e-learning course are the intended intervention; (C) Assessment of clinical workflow, medication processes, and end-user understanding/satisfaction pre and post interventions are the intended comparisons; and (O) The intended outcomes are improved clinical workflows, medication processes, end-user understanding/usability and system compliance post training and e-learning completion /CPOE alterations. An interdisciplinary team was formed based on the IMEBP practice guidelines to assist with development, implementation, and evaluation of the practice change (Jones & Bartlett, 2009). These members included key stakeholders

with active roles in change processes among the organization such as the chief nursing officer (CNO), vice president of patient care services, director of nursing (DON), critical care nurses, IT analysts, unit clinical coordinators, and nurse managers.

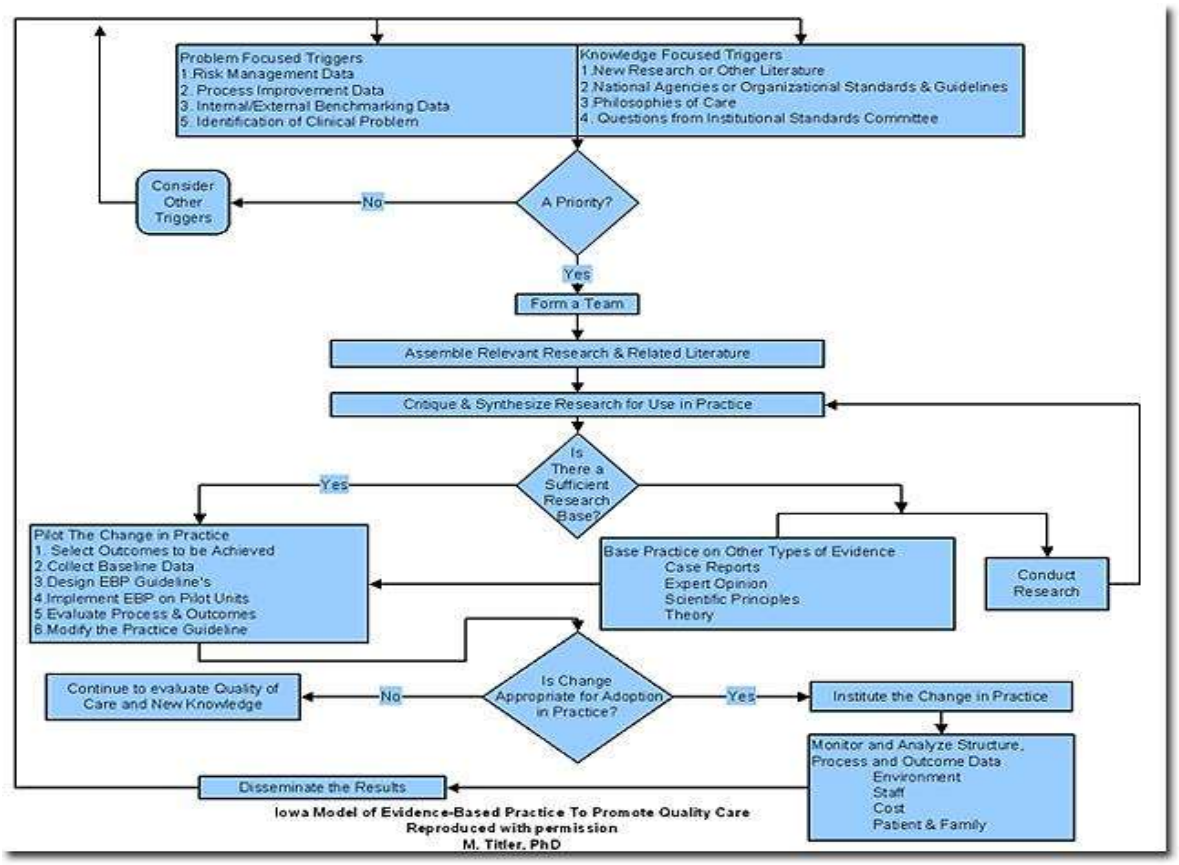

Figure 1. Evidenced practice model: The Iowa model of evidence-based practice. From "The Iowa model of evidence-based practice to promote quality care," by M. G. Titler et al., 2001, *Critical Care Nursing Clinics of North America, 13*, p. 499. Reprinted with permission.

To gain a detailed understanding of the current CPOE workflow and associated issues, Lean principles and guidelines were used during the development phase of the change process. Lean is a quality improvement methodology that was derived from the

Toyota Production System for automobile assemblies by W. Edwards Deming and Henry Ford (Toyota Motor Corporation, 2009). Lean methodology is being used in healthcare organizations for quality improvement initiatives. Specifically, it is a five-step thought process that guides the implementation of processes that maximize value for customers with fewer resources through waste elimination. These principles allowed careful identification of CPOE workflow and medication issues through a step-by-step value stream process (Lean.org, 2013).

A Lean A3 report tool was utilized for identification of the current CPOE condition in the ICU setting and the target condition. The one-page report tool allowed detailed documentation of pertinent information to be condensed on a single document for progress reporting and decision-making. An A3 flow chart was developed and published on the company intranet to illustrate and depict the current CPOE workflow processes (See Appendix D). Steps that did not have value in the workflow processes was eliminated and revamped to ensure value was added to the processes to eliminate waste, prevent unintended consequences, and improve patient outcomes. Value stream mapping and root-cause-analysis was also completed with Lean principles. This allowed identification of waste and invaluable processes with the incorporation of waste elimination and removal of unnecessary processes (Lean.org, 2013).

Section 3: Methodology

Introduction

Change implementation with workflow processes, system design, education, and policy development is required for refining CPOE processes post system implementation. These initiatives enhance not only system performance, but also end-user satisfaction. The purpose of this quality improvement project was to refine CPOE system initiatives and develop an e-learning educational module to facilitate end-user understanding and satisfaction with the advanced technology. Hoonakker et al. (2010) supported organized educational and training sessions that contributed to professional development, end-user satisfaction, and improved outcomes with the CPOE system.

Methods

Project Design

The purpose of the this quality improvement initiative was to provide an analysis of the impact of refined CPOE initiatives and an e-learning educational module/training program on clinical workflow and end-user satisfaction in the ICU setting based on the Iowa model of evidence-based practice and Lean methodology. The organization will be continuing the implementation of the Quality Improvement (QI) program and engaging in ongoing data analysis at the conclusion of the DNP project.

The organization will require multiple methodological approaches to achieve the defined goals and objectives successfully. A mixed-methods approach will be used by the organization to achieve data collection and analysis for the CPOE system in the critical care setting. This will allow the organization to use both quantitative and qualitative data,

which will strengthen data collection (Allyn & Bacon Companion Website, 2012). The assimilation of the exploratory mixed method design outlined in the project will allow the ongoing collection of qualitative data to facilitate organizational quantitative data collection. Specifically, this will allow the organization to continue data collection and analysis from end-users to evaluate understanding, satisfaction, and improved workflow processes associated with the CPOE system. End-user knowledge of CPOE processes and electronic order entry will be captured by the organization with both data collection methods. Suggestions have been given to the interdisciplinary team to collect qualitative data with the use of the Provider Order Entry User Satisfaction and Usage Survey (POESUS) from both shifts (dayshift and nightshift end-users) before CPOE system Phase II implementation (after end-user training), and 6 months post CPOE implementation. Additionally, recommendations for quantitative data collection have been provided to achieve goals with data analysis of current medication inadequacies with the current CPOE/EHR system. Specifically, ongoing analysis of the quantity of omitted CPOE medications, unscanned medications, medications retrieved on override, and undocumented pending medications will be performed by the interdisciplinary team with the use of data repository reports. The combination of these methods will guide continuous implementation of advanced technological programs centered on evidence-based practices (Leapfrog, 2011).

Questionnaire

The POESUS questionnaire, developed by Lee et al. (1996), was provided and will be used by the organization's interdisciplinary team to measure end-user satisfaction

with the CPOE system. The POESUS contains questions centered on end-users' personal experience with order entry. As the targeted end-users consist of nurses and secretaries, the survey was revamped for the intended participants (see Appendix B). It includes 16 questions based on end-users' personal experience with order entry, with scoring on a Likert scale (1 to 7) in regard to systems performance, productivity, and overall satisfaction. Items 17-27 and Part 2 of original POESUS were removed because it pertains specifically to physicians/residents, and the target population for the organization is nurses and secretaries. Instead, 8 questions 17-25 were added to the survey to gain feedback from end-users in regard to the EHR, which is an important component of the organization's CPOE system. The original developers of the POESUS, Lee et al. (1996), could not be located, and the public domain could not be uncovered. However, the POESUS was redeveloped by Hoonakker et al. (2010) to measure CPOE end-user satisfaction successfully. The original questionnaire has been tested for reliability (Cronbach's $\alpha = 0.8$) and provides specific nontheoretical criterion and construct validity, as well as comparable data that have been used in follow-up studies. Validity was not recalculated post revision of the survey due to ongoing data collection by the organization. The POESUS has been used in similar settings with CPOE technology to measure system performance and end-user satisfaction (Hoonakker et al., 2010). The institution is a private organization, and data collection procedures will be conducted and examined by the key stakeholders.

Setting and Population

The QI project was implemented at a 237-bed community hospital in the southeastern region of the United States on a 32-bed intensive care unit (14 intermediate care and 18 medical-surgical critical care beds). The EHR system implemented in the organization in November 2011 was used. The hybrid CPOE system integrated in the medical-surgical ICU in 2012 (Phase I) was used for development of the e-learning educational module. Super-users (ANMs, charge nurses, and clinical coordinators) attended a 4-hour classroom CPOE training session prior to the hybrid CPOE system implementation. Additionally, CPOE system changes and updates were sent via e-mail to all end-users by the ICU clinical coordinator. Hospitalists and midlevel providers (residents) also received classroom and hands-on training session prior to system implementation. None of the clinicians or providers had used the newly implemented CPOE system prior to implementation in 2012.

Sample

The organization's ongoing interdisciplinary team will complete a convenience sample collection, which will be used in the critical care setting exclusively for initial data collection. There are 65 nurses, eight secretaries, one clinical coordinator, four assistant nurse managers, and one nurse manager who work in the ICU. Recommendations were outlined for the organization to include these individuals in the convenience sample size with the ongoing data collection procedures and questionnaire. This sample size exclusive to the medical-surgical ICU setting has provided reliable data results in similar settings (Hoonakker et al., 2010).

Data Collection Procedures

Data collection is ongoing by the organization through direction observation, record review, and survey analysis. Direct observation of end-users' workflow processes with the CPOE system allows the organization's interdisciplinary team to gain information on clinical workflows during variable conditions. Direct observation of hospital staff and physician interaction with the CPOE system without intimidation and interruptions allows the organization to gain firsthand information on system and workflow processes. A set of open-ended questions was created for the organization's interdisciplinary team in in regard to the CPOE system, computer use, and organizational training (see Appendix C). Ongoing informal discussions were conducted by the interdisciplinary team with IT analysts, super-users, and system champions. Recommendations were provided to the hospital for organization and analysis of the data with qualitative and quantitative software for proper collation and coding of the information, which will assist with precision of data entries (Hughes & Silver, 2008).

A champion physician was used as an expert system operator to gain specific task-related information with the CPOE system. This allows ongoing evaluation of provider clinical workflow with the system and attainment of CPOE inefficiencies in the critical care setting by the interdisciplinary team. Ongoing data repository reports for medication inefficiencies (e.g., unscanned medications) are extracted from the electronic database based on the organization's needs. Review of the existing CPOE system took place in the ICU setting, with special attention given to layout, design, physician alerts, and electronic orders. The patient care status board was used to analyze electronic order

entry and automated alerts to gain data on CPOE order entries, computerized alerts, and nursing usability. This allowed analysis of CPOE clinical workflows and identification of CPOE inefficiencies with the current system in Phase I. Changes were refined and implemented based on findings by the organization.

The POESUS questionnaires were produced for organizational use and will be distributed to all nurses and unit secretaries who use the EHR and/or CPOE system in the critical care setting by the interdisciplinary team. The organization will distribute the survey based on the DNP project recommendations and guidelines (before and 6 months after Phase II system implementation). The organization will determine the best method of administering the surveys to the end-users. However, recommendations were provided to the organization for ongoing data collection to achieve optimal results with survey completion. Proper administration and collection of surveys will assist the organization with evaluation of end-user feedback, responsiveness, and higher response rates with reputable data (Hoonakker et al., 2010).

Protection of Human Rights

Approval from the Institutional Review Board (IRB) of Walden University (approval # 04-25-14-0149263) and the medical center was obtained prior to implementation of the project (see Appendix E). Authorization and permission to proceed with the project were obtained from the chief nursing officer, who also serves as the vice president of patient care services. The policies and procedures governed by the IRB process were completed in compliance with Walden University IRB guidelines. The IRB Request for Review Form was completed in its entirety with the inclusion of information

required for the principal investigator, interdisciplinary team, project title, and the type of review desired for the study. All pertinent details of the project were also included, with attention given to application requirements for the research's significance to practice, methods, and research status. All participants in the project are over the age of 19. Therefore, sensitive categorical requirements were excluded, and the project was considered an expedited-middle status (NIH, 2013).

Although there were no identifiable risks associated with participation in the study, ethical issues were addressed at each phase of the study. Ethical considerations and confidentiality concerns were addressed at each phase in the research and project design. A letter was created for the organization's use to inform ICU staff of the survey for data collection (see Appendix B). The POESUS presents a statement of participant anonymity with completion. All participants and sources used for the study were treated in accordance with the ethical guidelines outlined by the Walden University IRB.

No apparent risks to the subjects were identified during the reflective medical record review process completed by the organization. All information obtained will be used exclusively by the organization per project recommendations. Recommendations and guidelines were provided to the interdisciplinary team for quantitative data collection and ongoing analysis of system inefficiencies (e.g., unscanned, undocumented, and overridden medications) with the omission of patient identifiers. The organization was provided guidelines for the use of identifiers and numerical coding for returned surveys. The use of fictitious names was recommended to the interdisciplinary team for interview responses and confidentiality conservation with all data collection methods, report

assemblies, and sampling with participant anonymity. EHR and CPOE system anonymity was maintained through the body of the project and published results. Organization anonymity is also maintained through the use of unidentified settings and locations within published manuscripts. A confidentiality and research agreement statement was completed with the selected organization for approval based on IRB guidelines. These methods assisted in protecting the organization's integrity and reputation, as well as the rights of human subjects.

Data Analysis

The organization was provided recommendations and guidelines for data analysis. Data analysis concerning CPOE clinical workflows, medication inefficiencies, and end-user satisfaction is ongoing at the medical center. A qualitative data procedure was outlined for categorical depiction via a grounded theory approach with a categorization scheme for unintended CPOE inefficiencies and workflow processes. A recommendation for in-depth analysis of unintended inefficiencies was also outlined for collation and categorization of the data with the use of axial coding procedures with application of organizational findings into subcategory themes. Quantitative data will be collated based on individual POESUS items. A scale was created to depict end-users' overall satisfaction with the CPOE system, and a sample scale score was created for the interdisciplinary team to use for participants who respond to a minimum of 50% of the survey questions. A user satisfaction scale was also developed for the team to depict low (0) to high (100) satisfaction scores. A Wilcoxon ranking order test was recommended for items across time and groups for mean item different effect size (d) calculations. All

data analysis, organization, collection, transcribing, and theme development will be completed by the organization's key stakeholders and interdisciplinary team. Additionally, all associated materials and costs are covered per organizational in-kind contributions.

Project Evaluation Plan

The Iowa model of evidence-based practice and Lean methodology were appropriate to evaluate how refined CPOE processes and the e-learning course impact workflow processes and end-user satisfaction. The Lean A3 report (see Appendix D) was used as an evaluation tool for the current CPOE system and development of the educational tool to achieve future target conditions. The project evaluation plan includes procedures to determine progress toward the defined goals and outcomes. Data collection is ongoing and will be conducted by the organization to evaluate the effectiveness of the educational training and e-learning tool. The purpose of integrating Lean methodology in the evaluation plan was to provide the organization with an outline of required activities to achieve optimal results. The U.S. Department of Education (2013) outlines the success associated with competency-based e-learning, which allows adult learners to optimize skill sets through a culture of learning at their own pace.

The organization will evaluate the outcome of the project 3 to 6 months post Phase II system implementation. The POESUS will be redistributed to ICU staff as described in the data collection section to evaluate end-user satisfaction post education and system changes. Additionally, evaluation of CPOE medication inefficiencies is ongoing with the use of data repository reports generated from the EHR system. The

organization will analyze reports specific to medication processes and CPOE orders at 3 and 6 months post system implementation. Organizational meaningful use progression and attestation per CMS guidelines are evaluated at each stage to determine the success of the second phase of CPOE system integration. Feedback was attained from leadership to determine educational successes, failures, and continued CPOE improvement initiatives and training.

Summary

The methodology outlined for this project was intended to assist with successful integration of outlined goals and objectives to improve patient care initiatives in the medical-surgical ICU setting with CPOE system integration. The selected project design allows ongoing collection of quantitative and qualitative data that will strengthen current workflows, medication processes, and user satisfaction with CPOE implementation. Gaining an understanding of end-user satisfaction with the current CPOE system and processes with the POESUS provides valuable information to determine system successes and failures (Lee et al., 1996). Additionally, the chosen setting, population, and sample size will provide the organization with data required to move forward with e-learning training and CPOE system changes. Data collection and data analysis procedures were outlined in compliance with organizational policies and procedures, IRB guidelines, and Health Insurance Portability and Accountability Act (HIPPA) regulations.

Section 4: Findings, Discussion, and Implications

Introduction

CPOE systems are used in acute care settings to improve workflow processes and transcription, as well as to prevent prescribing errors. The complexity of CPOE poses many challenges for end-users, which predispose patients to treatment delays, order omissions, and unfavorable outcomes (Abramson & Kaushal, 2012). End-user understanding of CPOE and EHR functionality is imperative for error prevention. The purpose of this quality improvement project was to refine CPOE system initiatives and develop an e-learning educational module to facilitate end-user understanding and satisfaction with the advanced technology. A well-organized system design and end-user training program promote optimal CPOE integration in the ICU setting (Maslove et al., 2011).

The overall objective was to maximize patient safety and nursing practices through an advanced educational and training program to increase understanding of CPOE and EHR systems in the critical care setting. The Agency for Healthcare Research and Quality outlines key tips for preventing medical errors and promoting patient safety through quality improvement initiatives. To accomplish goals associated with the purpose and goals of the project, specific objectives were developed to promote quality improvement initiatives, which were to (a) identify and describe Phase I CPOE medication inadequacies in the critical care setting, (b) develop an evidence-based CPOE educational tool to facilitate end-user knowledge and understanding of electronic order entry; and (c) measure end-user satisfaction with the POESUS post CPOE training and

system implementation. An educational e-learning module was developed along with in-class training sessions to increase staff knowledge and understanding of the newly implemented CPOE system. Additionally, EHR and CPOE system initiatives were refined to improve functionality and end-user understanding with automated alerts. Analysis of medication inadequacies and POESUS collection are ongoing within the organization.

Summary and Evaluation of Findings

Value stream mapping and root-cause-analysis were completed with Lean principles and the use of a Lean A3 report worksheet. According to Lean.org (2013), identification of waste and invaluable processes with the use of Lean methodology permits waste elimination and removal of unnecessary processes for quality improvement initiatives. The Lean A3 report was developed to depict and illustrate the current condition with target goals for future conditions to improve quality outcome with the use of the CPOE system. The POESUS questionnaire, developed by Lee et al. (1996), was provided to the organization's interdisciplinary team to measure end-user satisfaction with the CPOE system. This survey is one of the preferred questionnaires suggested by Hoonakker et al. (2010) to measure CPOE end-user satisfaction due to its high level of reliability and validity. An online evidence-based HealthStream e-learning module was also developed to enhance end-user understanding of the EHR and CPOE system. The Lean A3 report, POESUS, and e-learning educational module were created to meet the outlined goals and objectives. These tools are currently in use by the interdisciplinary team at the organization for ongoing CPOE analysis and end-user evaluation.

Discussion of Findings

Demonstration of CPOE system functionality with the patient care status board was presented to end-users at an annual skill fair in preparation for the CPOE system Phase II go-live, which allowed the attainment of feedback in regard to end-user understanding and usage of the system. End-users verbalized appreciation of the system in patient care, but many expressed concerns regarding the limited and inadequate education received during Phase I of the CPOE system implementation. This information was used to devise the e-learning educational module and in-class training sessions. An A3 report, revised POESUS, and online HealthStream e-learning module were developed with theoretical underpinning and evidence-based strategies.

A traditional meeting and PowerPoint presentation were utilized to disseminate the findings of the A3 report, review the POESUS, and provide an outline of the online HealthStream e-learning module to key stakeholders. Key stakeholders include the CNO, DON, unit managers, and clinical coordinators who embody the professional development council for continuing education and quality improvement initiatives. The presentation illustrated an overview of the CPOE system along with its advantages, disadvantages, and significance to the organization in relation to the ICU setting. The identified problems (order omissions, medication errors, treatment delays, and unprocessed or unacknowledged CPOE orders), purpose, objectives, and associated questions as they related to the DNP project were presented in a clear and succinct manner. The identified framework and methodologies were also presented with the Lean A3 worksheet, which depicted the issues associated with the CPOE system from the

patient's perspective (see Appendix D). Intended quality improvement outcomes were also presented, which included improved CPOE system design, improved clinical workflows, improved CPOE processes, physician and end-user compliance, reduction in medical errors, reduction in order omission, successful integration of CMS meaningful use guidelines, and improved patient outcomes. Positive feedback was received on project goals and objectives from leadership. Plans were made to move forward with the educational program.

The Lean A3 report tool (see Appendix D) was developed to illustrate Phase I CPOE medication in adequacies and conditions in the medical-surgical ICU setting. The one-page A3 report included detailed problem analysis of the five key CPOE inadequacies identified in the ICU setting, which were as follows: a) the CPOE system was confusing to end-users; b) delays occurred with patient treatment; c) CPOE orders remained unacknowledged on the status board; d) nurses/end-users did not fully understand the CPOE system automated alerts; and e) STAT orders were not addressed in a timely manner. The current workflow condition in the ICU setting as it relates to CPOE orders with the hybrid system was illustrated on the report. Additionally, detailed explanation and rationales associated with each inadequacy were depicted on the report in a succinct manner for clear communication with key stakeholders. The proposed target condition and workflow were also illustrated on the A3 report, which included completion of mandatory e-learning HealthStream module, in-class CPOE refresher training, and full CPOE system implementation during Phase II of the program. An implementation plan of what, who, when, and associated outcomes along with associated

costs, benefits, waste recognition, and a follow-up plan were also explained in detail within the report. The information contained in the report was presented to key stakeholders during a professional development meeting for key leaders in the organization.

E-learning is the newfound method used in many healthcare organizations to achieve continuing education, validation of competencies, skill development, and performance appraisal requirements, which are regulated by The Joint Commission. This form of education allows learners to progress based on their ability to complete a skill or competency at their own pace in a flexible format regardless of the environment. Additionally, competency-based e-learning creates a culture of learning with flexibility regardless of the time, place, or pace (U.S. Department of Education, 2013). An educational e-learning module was developed, and training sessions were conducted to increase staff knowledge and understanding of the newly implemented CPOE system. The evidence-based CPOE e-learning educational tool was created with the organization's HealthStream professional development software. The online self-paced training tool is available to staff through the organization's HealthStream software, which allows completion of training in a self-paced environment that is accessible off-site. The e-learning module consists of two tests (Part I and Part II) that require successful completion of an untimed electronic test at the conclusion of each module. Each test contained 25 questions that consisted of multiple choices, true/false, and/or matching selections (see Appendix F).

As a DNP student, I was responsible for developing and designing the educational material, A3 Lean report, and in-class training session for the CPOE system. I created an e-learning module for staff to complete prior to attending the in-class training sessions. I also designed the POESUS based on the original format by Lee et al. (1996) for the organization's ongoing analysis of end-user understanding and satisfaction with the CPOE system in the ICU setting. The organization is responsible for attaining and evaluating quantitative data from end-users in the critical care setting. Ongoing analysis of CPOE medication inefficiencies (e.g., unscanned, undocumented, and overridden medications) with the use of the EHR system data repository reports were recommended monthly for the first 6 months post system implementation and then every 3 to 4 months thereafter. The collected data (surveys and repository reports) can be used by the professional development committee and nursing leadership to evaluate patient safety initiatives as well as successes and failures of the CPOE system in the critical care setting. The organization will also attain ongoing qualitative data analysis through direct observation of clinical workflows and end-user interaction with the CPOE system, which is recommended at 60-day intervals. The Lean A3 report will also be used by the organization for ongoing analysis of project success to ensure that waste and invaluable processes are eliminated from the clinical workflow.

Other insights gained from this quality improvement project include the lack of physician buy-in with the newly implemented system and end-user adoption of system workarounds. Moniz (2009) outlined examples of workaround practices with CPOE systems that include data omission, overriding alerts, and manual imputation of incorrect

medication dosages. These practices can lead to adverse patient consequences and fatal errors, which is an opposition of the system design. Perna (2012) supported one of the primary reasons for order omission with CPOE systems to be automated clinical alerts. Recommendations were given to the organization for monthly data repository reports that depict end-user compliance with medication processes in the CPOE system. Plans to improve end-user knowledge, understanding, and satisfaction with the system support evidence-based practices and end-user compliance with system practices (Abramson & Kaushal, 2012). Pawlyn (2011) completed a literature review and found e-learning to be a potentially valuable method for healthcare professionals to facilitate continuing education activities. The educational program and ongoing analysis of the system's successes and failures will assist the organization in optimizing its use in patient care.

Implications

Policy

This quality improvement project can be used in healthcare organizations for policy development that supports the use of technological advancements and education. A structured training program and e-learning module for newly hired staff and annual CEU e-learning module for established users can promote understanding and compliance with system usage. Development of a policy in relation to CPOE and EHR system usage will outline protocols and procedures to guide objective and subjective decisions with advanced technology in patient care. A CPOE/EHR policy will also assist the organization where the project was implemented with standardizing procedures and making important organizational decisions based on financial, managerial, and safety

needs. Additionally, end-users will have access to the policy that outlines the purpose of the CPOE/EHR system, scope of practice, effective date, and responsibilities associated with its usage in patient care (Feltus, 2008).

Practice

CPOE systems are technological advancements that deliver real-time electronic prescribing by ordering providers. This technological advancement has proven functionality that is effective in reducing medication errors and optimizing patient safety. Maslove et al. (2011) supported the relevance of CPOE system usage among critically ill patients, which is a multifaceted process. Implementation of the recommended quality improvement project can provide an organizational framework for the safe integration of advanced patient technologies within the critical care setting. Immediate transmission of orders, allergy identification, drug-interaction identification, and incorporation of management protocols are a few of the beneficial aspects of the CPOE system outlined by Leapfrog Group (2011). The integration of up-to-date practices, improved physician-pharmacist communication, and reduction in healthcare costs with the omission of errors and adverse effects are added benefits of its technological advancements in healthcare (Leapfrog Group, 2011). A 1-year plan for full implementation of Phase II CPOE system is outlined by the organization that includes the A3 report tool, educational module, and training sessions developed by me.

Research

CPOE systems provide many benefits for patients in healthcare settings. However, despite the system's functionality to aid in error omission, literature has proven

that CPOE is not without inaccuracies (AHRQ, 2012). Inconsistent and inadequate use of the system can lead to order omissions, unprocessed CPOE orders, medication errors, and treatment delays. Additionally, unfavorable workflows, system demands, misunderstanding of system functionality, and computer literacy impose oppositions for clinicians who use the advanced technology (cpoe.org, 2014). These oppositions can lead to adverse consequences in patient care. Therefore, continued research should focus on education and CPOE integration/implementation in acute care settings in regard to patient outcomes and end-user satisfaction.

Social Change

Integration of CPOE systems influences social change in healthcare practices for the betterment of patient outcomes. Meaningful use guidelines developed by CMS (2012) incorporate comprehensive objectives that are aimed at improving patient care across the continuum with CPOE systems in measurable stages. These objectives involve social changes in healthcare practices with patient safety enhancements. Patients with comorbidities, multiple risk factors, and polypharmacy are greater risk of medication errors. Electronic medication reconciliation and drug-drug/drug-allergy interaction verification at the point of order entry assist providers with safe medication transcription for this patient population. CPOE safety enhancements not only decrease drug-related interactions and adverse reactions through automated alerts at the point of entry, but also require physician comments for prescribing drugs with known interactions. These safety features not only create social change, but also enhance physician knowledge and awareness of evidence-based practices across the continuum (HealthIT.gov, 2014).

Project Strengths and Limitations

Strengths

Project strengths include the use of evidence-based practices to improve clinical workflows and understanding of the advanced CPOE system post refined changes and end-user training. Identification of medication insufficiencies pre and post system implementation will provide evidence of project successes and/or failures. Improved medication processes with the adoption of electronic ordering are also strengths and added benefits of the project. CPOE systems have technological advancements with proven safety functionality that is effective in reducing medication errors, which is recognized nationwide by the Leapfrog Group and TJC as a national safety enhancement initiative. CPOE systems eliminate handwritten ordering, illegibility issues, transcribing errors, and nonclinical interpretation when implemented and used correctly. The use of e-learning in the healthcare organization allows learners to progress based on their ability to complete a skill or competency at their own pace in a flexible format regardless of the environment. Easy access to e-learning material and resources in an online format grants point-of-care access for users who require retrieval of educational resources (Pawlyn, 2011). Improved understanding of CPOE and EHR processes through e-learning is an additional strength and benefit of the project. Additionally, examination of workflow processes and procedures; continuous monitoring of medication inadequacies, and e-learning/training sessions are outlined measures that are specific to CPOE practices (TJC, 2011).

Limitations

Limitations of the project include partial CPOE workflow representation in the ICU settings due to the inability of the interdisciplinary team to observe all end-users. Many physicians enter electronic CPOE orders from remote locations while others utilize the system within the organization, which all have a direct effect on clinical workflows and processing CPOE orders. Therefore, all CPOE processes cannot be observed directly, which limits data collection of all procedures involved with CPOE workflows by the interdisciplinary team. The hybrid CPOE system permits providers to write hand-written orders and enter electronic CPOE orders. This limits CPOE processes and introduces deviations from the clinical workflow. The use of hand-written despite integration of the CPOE system requires continued clarification as end-users are required to decipher the differences of the ordering sources, which interrupts the clinical workflow process and limits on-going CPOE workflow analysis by the interdisciplinary team.

Detailed analysis of POESUS results cannot be completed due to ongoing data collection by the organization's interdisciplinary team. Data collection will be completed by the interdisciplinary team at 6 and 12-month intervals post system implementation. Additionally, the lack of physician buy-in with full system utilization imposes continued barriers for end-users that impacts satisfaction with the system. The lack of physician buy-in with full CPOE system utilization creates continued confusion and disruption in clinical workflows with the use of a hybrid system. Additionally, it creates continued confusion for both end-users and pharmacists with physician orders. Therefore, the validity of the revamped POESUS cannot be measured successfully.

Other limitations of the project are staff availability to process CPOE orders from the patient care status board in the computer during emergencies in the critical care setting. Medications retrieved as overrides from the Pyxis medication dispensing machine during emergency situations automatically defaults onto the electronic administration medication record, which also interferes with the CPOE workflow processes and data repository reports.

End-users are allowed to complete the e-learning modules during normal working hours. Constant interruptions, unfavorable learning environments, lack of self-discipline and focus, disinterest, inability to answer questions, incompletions, learning curves, and technology interruptions can limit end-user knowledge and understanding of the required educational material. Additionally, the lack of non-visual cues may have introduced misunderstanding of the information. These disadvantages may have impeded end-user understanding of the material, which can cause continued confusion and misuse of the CPOE advanced technology.

Staffing differences in relation to nursing shortages, temporary nursing assignments, per diem employees, and outside contract staff may affect CPOE system usability, which will have an impact on project results.

Recommendations

Recommendations for continued success include on-going analysis of system usability and functionality in the ICU setting with on-going revisions and changes. Development of unit-specific designs and critical care order sets can also lessen staff workloads and enhance user acceptance of the newly integrated system (Maslove et al.,

2011). Mandated usage of the CPOE system by all practioners with the elimination of the hybrid system that allow hand-written ordering will eliminate errors and confusion associated with written orders. Continued annual e-learning refresher courses with electronic testing on system functionality and usability will provide ongoing education and continuing professional development. Additionally, continued utilization of Lean methodologies will aid in quality improvement initiatives with ongoing clinical decision support systems and IT availability to assist with technological needs for optimal project success.

Analysis of Self

As a Scholar and Practitioner

Implementation and dissemination of any project applies scholar-practitioner and nurse leadership skills. This relates to my personal development as a scholarly practitioner through leadership skills with the use of organizational management, communication, analysis, creativity, and vision. The use of these skills has allowed me to dig deep into a complex issue and provide a vision based on evidence to incorporate practices that will improve quality initiatives and patient outcomes. The ability to think like a scholar and practitioner was required for successful development of this quality improvement project. I have attained knowledge and skills required to demonstrate understanding of established information with implied research specific to my area of study and discipline. My ability to communicate key issues verbally and in writing has allowed me to master critical thinking, information literacy, and writing skills that are required for a scholarly practitioner. I have in-depth knowledge and understanding of

underlying principles, rules, and concepts required to conduct research studies within my field of study. The interpersonal and communication skills I've acquired as a scholar and practitioner has enabled me to communicate both technically and effectively with colleagues at all levels. My writing, speaking, and listening skills also assist me with presenting information in a logical and organized manner to a broader audience.

As a Project Developer and Professional

Successful development of a quality improvement project requires professionalism, leadership, management skills, and understanding of research procedures. I have attained skills to exercise creativity with the exploration of new areas and ideas, which has allowed me to develop keen problem solving skills as a project developer. Understanding of ethical and legal practices required to conduct research has enhanced my awareness of regulations, policies, statutes, and guidelines that govern research that are essential for project development. Additionally, my collaborative efforts within teams and organizations have granted me the ability to facilitate effective teamwork that is essential for successful project development. The attainment of all these skills not only assisted me with thinking "outside the box", but allowed me to construct a quality improvement project through the use of advanced patient care technology. The implementation of advanced patient care technology such as CPOE with collaborative efforts and continuing educational developments refined by clinicians within the healthcare setting will facilitate quality improvement changes. I was able to develop a project that supports the two-year initiatives launched by RWJF and IOM that include

full partnership of healthcare providers for redesigning health care (IOM, 2010). This proves my ability to think critically and logically with project development.

Summary and Conclusion

IOM (2010) reports some 98,000 patients die each year in a hospital in the U.S. due to medical errors. The CPOE system ability to prevent, reduce, or eliminate medical errors and adverse effects is paramount (Leapfrog, 2011). The use of Lean methodology (A3 report), POESUS surveys, and e-learning with theoretical underpinning and evidence-based strategies provides a solid foundation for quality improvement initiatives. Ongoing analysis of current conditions with target goals with the incorporation of continuing education strategies provides successful integration of advance technology in patient care settings. The Leapfrog Group (2011) identified advanced technologies such as CPOE systems to be one of the major patient care and safety standards implemented among healthcare organizations. The CPOE system ability to detect common medication errors and facilitate decision-making optimizes the use of evidence-based practices in healthcare. Configuration of electronic orders reduces unnecessary variations in patient care and improves efficiency of health care delivery through electronic ordering (Leapfrog, 2011). The advantages not only enhance patient safety, but CPOE systems add value to organizations through decreased operational and medical costs. Lean A3 methodology allows ongoing analysis of project success to ensure elimination of waste and invaluable processes from the clinical workflow. The ability to improve quality of health care, decrease medical errors, reduce health disparities, and improve continuity of

care across the continuum with advanced technology demonstrates its significance to practice.

Section 5: Scholarly Product

Executive Summary

Refining Computerized Physician Order Entry Initiatives in an Adult Intensive Care Unit

Chevita Fuller, MSN, RN

DNP Doctoral Project

Introduction

This report provides an overview of the DNP project that examines quality improvement initiatives with refined CPOE systems in the medical-surgical ICU setting. The overall objective of the DNP project was to maximize patient safety and nursing practices through an advanced educational and training program to increase understanding of CPOE and EHR systems in the critical care setting. Lean methodology and development of an e-learning educational module with in-class training facilitate end-user understanding and satisfaction with the advanced technology while improving patient outcomes. A well-organized system design and end-user training should promote optimal CPOE integration in the ICU setting (Maslove et al., 2011).

Research draws attention to integrated CPOE systems with electronic health records (EHR) with proven safety and enhanced patient outcomes, which are being implemented among healthcare organizations across the continuum. Legislative mandates and Centers for Medicare and Medicaid (CMS) regulations have required organizations to utilize certified electronic technology with integration of CPOE systems with meaningful use guidelines for reimbursement incentives. These requirements have advocated CPOE systems to be implemented in healthcare organization in rapid stages,

which have placed undue pressure and stress for end-users within various roles (e.g. nurses and ward secretaries). This is particularly challenging for computer illiterate clinicians such as physicians and nurses that struggle with advanced technology. Clinical workflow and medication processes are affected by CPOE implementation both positively and negatively (Ventura et al., 2011).

CPOE is used in acute care settings to improve workflow processes, transcription, and prescribing errors (Abramson & Kaushal, 2012). However, the complexity of CPOE poses many challenges for end-users, which predisposes patients to treatment delays, order omissions, and unfavorable outcomes. This can be detrimental in any clinical setting, but CPOE misuse in the critical care setting poses greater risks for patients that require complex and multifaceted care. Understanding CPOE functionality, meaningful use guidelines, and evidence-based practices (EBP) can ensure end-user compliance with system practices (Abramson & Kaushal, 2012).

Purpose of the Project

The purpose of this quality improvement project was to refine CPOE system initiatives and develop an e-learning educational module/training program to facilitate end-user understanding, satisfaction and patient outcomes with a newly implemented CPOE system. The IOM (2011) reports the impact of HIT on patient safety when designed appropriately and strategically. CPOE systems have been specifically identified as a safety improvement initiative by IOM to decrease medication errors with hospital medications. However, current research depicts various unintended consequences associated with integrated CPOE systems in healthcare. Despite the many practical

issues, unfavorable clinical workflows and end-user compliance appears to be focal concerns. End-user understanding of CPOE and EHR functionality is imperative for error prevention. To further combat problems associated with electronic and computerized orders, CPOE initiatives should be refined post system implementation to improve clinical workflow, medication processes, and end-user satisfaction.

Project Outcomes

Objectives and goals designed to maximize patient safety and nursing practices through refined CPOE system changes and an advanced educational program include mandating completion of an e-learning module and CPOE training sessions for all end-users in the ICU and other clinical settings prior to system implementation.

Specific outcomes of this project were to:

- Identify and describe Phase I CPOE medication inadequacies in the critical care setting with the use of Lean A3 methodology
- Refine CPOE system initiatives to improve clinical workflows in the ICU.
- Develop an evidenced-based educational tool to facilitate end-user knowledge and understanding of electronic order entry and CPOE system usage.
- Measure end-user satisfaction and understanding of the CPOE system post Phase II system implementation and training via POESUS analysis.
- Ongoing data analysis of CPOE medication processes at 60-day intervals.

Literature Review

The literature review demonstrated the impact of CPOE systems on clinical workflow, medication processes, and end-user satisfaction in critical care settings. These areas have been examined by various researchers, and specific literature outlines the importance of CPOE workflow analysis, identification of unintended consequences, evidenced-based e-learning tools, and questionnaires to measure end-user satisfaction with CPOE systems. Despite the many attributes associated with CPOE integration, there are many challenges that exist with it processes and workflows. The need for CPOE system changes and end-user education pre and post system implementation is essential. According to Chapman, Lehmann, Donohue, and Aucott (2012), CPOE systems can impact nursing workflow negatively when the systems are not designed to meet clinical needs. This is especially true within the critical care setting when complex and intricate nursing care requires distinctive clinical workflows. The complexity of nursing care associated with critical care patients requires reliable CPOE interfaces. System deficiencies, improper system designs, and the lack of reliable CPOE interfaces can result in unintended outcomes. Therefore, CPOE inadequacies within unique settings alike must be identified post system implementation with evaluation of patient care activities to improve clinical workflows, medication processes, and overall patient care (Chapman, Lehmann, Donohue, and Aucott, 2012).

Specific literature supported the impact of CPOE on clinical workflows in a study with the use a mixed-method study design. Ash, Sittig, Dykstra, Campbell, and Gauppone (2009) examined unintended consequences related to CPOE workflows in

academic, community, and acute care teaching hospitals. They used a mixed-method approach to identify and categorize various unintended consequences associated with CPOE systems. They conducted oral history reviews, shadowed ordering providers, nurses, and performed over 400 hours of direct observation in the clinical setting, and found workflow to be the greatest unintended consequence in regard to CPOE. The researchers also utilized a national survey to measure CPOE complexity and how hospitals recognize and deal with related inefficiencies. They found changes in the work pace, sequence, dynamics, and inadequate workspace negatively affect the end-user development and performance with the advanced technology. Additionally, human-computer inadequacies, non-applicable automated alerts, and interface designs were noted to be key unintended consequences with CPOE systems by the researchers.

Niazkhani, Pirnejad, van der Sijs, and Aarts (2011) evaluated medication processes post CPOE implementation, and found that end-users bypass safety features that are integrated among technology designed to eliminate workflow disruptions. This imposes unintended risks that jeopardize patient safety and treatment modalities. Therefore, stakeholders must consider all negative aspects of the system design when implementing solutions. Defining system efficiencies and inefficiencies with technological advances in any clinical setting are vital to ensure quality and safe practices while eliminating system error. Additionally, understanding end-users knowledge of system practices and identifying ways to improve clinical workflows with the incorporation of EBP practices can improve patient outcomes. Practices tailored to critical care workflows and processes may also provide advantageous outcomes with end-

user satisfaction. This, in turn, may result in projected improvements in patient care initiatives, safety standards, and anticipated outcomes.

Model

The Iowa Model of Evidence-Based Practice (IMEBP) promotes quality care initiatives in a step-by-step format that assists with meeting defined quality improvement goals. It was developed by Marita Titler and her colleagues in 2001 for change implementation among healthcare organizations. The model outlines a step-by-step methodology that assists with implementation of EBPs for practice changes. Problem identification, team formation, literature review, practice change implementation, and dissemination of findings are the five steps outlined with the IMEBP model (Titler et al., 2001). Jones and Bartlett (2009) reinforce the use of an interdisciplinary team to assist with development, implementation, and evaluation of practice changes.

Lean methodology also assists with quality improvement initiatives in healthcare. Lean principles are a quality improvement methodology that was derived from the Toyota Production System for automobile assemblies by W. Edwards Deming and Henry Ford (Toyota Motor Corporation, 2009). Lean methodology is being utilized in healthcare organizations for quality improvement initiatives. Specifically, it is a five-step thought process that guides implementation of processes that maximize the value for customers with fewer resources through waste elimination. These principles allow careful identification of CPOE workflow and medication processes through a step-by-step value stream process (Lean.org, 2013). The Lean A3 report tool was used to illustrate current CPOE in adequacies and conditions in the ICU setting. The one page A3 report included

detailed problem analysis of the five key CPOE inadequacies identified in the medical-surgical ICU setting, which were: 1) the CPOE system was confusing to end-users; 2) delays occurred with patient treatment; 3) CPOE orders remained unacknowledged on the status board; 4) nurses/end-users did not fully understand the CPOE system automated alerts; and 5) STAT orders were not addressed in a timely manner. The current workflow condition in the ICU setting as it relates to CPOE orders with the hybrid system was illustrated on the report. Additionally, detailed explanation and rationales associated with each inadequacy was depicted on the report in a succinct manner for clear communication with key stakeholders. The proposed target condition and workflow was also illustrated on the A3 report, which included completion of mandatory e-learning HealthStream module, in-class CPOE refresher training, and full CPOE system implementation during Phase II of the program. An implementation plan of what, who, when, and associated outcomes along with associated costs, benefit, waste recognition, and a follow-up plan were also explained in detail within the report. The information contained in the report was presented to key stakeholders during a professional development meeting to key leaders among the organization.

E-learning is the newfound method utilized in many healthcare organizations to achieve continuing education, validation of competencies, skill development, and performance appraisals requirements, which is regulated by The Joint Commission. This form of education allows learners to progress based on their ability to complete a skill or competency at their own pace in a flexible format regardless of the environment. Additionally, competency-based e-learning creates a culture of learning with flexibility

regardless of the time, place, or pace (U.S. Department of Education, 2013). An educational e-learning module was developed and training sessions were conducted to increase staff knowledge and understanding of the newly implemented CPOE system. The evidenced-based CPOE e-learning educational tool was created with the organization's HealthStream professional development software. The online self-paced training tool is available to staff through the organization's HealthStream software, which allows completion of training in a self-paced environment that is accessible off-site. The e-learning module consists of two tests (Part I and Part II) that required successful completion of an untimed electronic test at the conclusion of each module. Each test contained 25 questions that consist of multiple choices, true/false, and/or matching selections.

Implications for Practice

This quality improvement project focused on education, advanced technology system changes, and end-user satisfaction, which are all essential for optimal patient outcomes. Integration of CPOE systems influences social change in healthcare practices for the betterment of patient outcomes. Advanced patient care technology can change the attitudes, behaviors, and practices across the continuum. Technological advancements such as CPOE and EHR systems are the future of healthcare to aid in proper health maintenance for optimal outcomes. Therefore, appropriate use and understanding of HIT systems functionalities are essential. One of the two-year initiatives launched by the Robert Wood Johnson Foundation (RWJF) and the Institute of Medicine (IOM) in 2008 included full partnership of nurses with healthcare providers for

redesigning health care (IOM, 2010). This can be done with advanced patient care technology such as CPOE through collaborative efforts and continuing educational developments refined by clinicians within the healthcare setting. The impact and social changes implied with these processes are boundless, and CMS have set guidelines to ensure compliance for enhanced patient outcomes.

Meaningful use guidelines developed by CMS (2012) incorporates comprehensive objectives that are aimed at improving patient care across the continuum with CPOE systems in measurable stages. CPOE system design contains functionality that includes programmed drug-drug and drug-allergy interaction verification automatically upon electronic transcription entry by the ordering provider. This safety enhancement decreases drug-related interactions and adverse reactions through automated alerts at the point of entry, which requires physician overrides and comments for prescribing drugs with known interactions. Therefore, these guidelines outlined by CMS not only improve patient safety, but enhances physician knowledge and awareness of medication transcribing across the continuum (HealthIT.gov, 2014).

Recommendations

Based on this quality improvement project to improve clinical workflow and end-user satisfaction in the ICU, recommendations are to refine CPOE system processes post system implementation and mandate continuing e-learning educational units before and after system integration. On-going analysis of CPOE medication inefficiencies (e.g. unscanned, undocumented, and overridden medications) with the use of the EHR system data repository reports and Lean methodology are recommended monthly for the first 6-

months post implementation then every 3 to 4 months thereafter. End-users that lack computer literacy and have difficulty with self-paced e-learning modules should be offered in-class training sessions that include hands-on practice. Additionally, end-users can benefit from a formal introduction and education course of new technology and computer practice, which will equip them with skills required to utilize advanced technology through the use of computers and internet or intranet services (Chudasama, Godara, & Srivastava, 2008).

Gaining an understanding of end-user satisfaction with the current CPOE system and processes with the POESUS provides valuable information to determine system success and failures. The POESUS was modeled after Lee, et al (1996) original survey, which is a great tool to measure end-user satisfaction and understanding of the CPOE system (see Appendix B). The original survey was developed by Lee, et al (1996) was designed to measure systems performance, productivity, and overall satisfaction among physicians/residents, which was later used by Hoonakker, Carayon, and Walker (2010) to measure CPOE end-user satisfaction among ICU physicians and nurses. Both studies provide favorable results with end-user satisfaction in regard to system functionality and productivity. This evaluation tool can be completed by end-users at intervals based on integration and redesign of the CPOE system with on-going analysis of outcomes. On-going development, dissemination, and analysis of the project will be conducted by the organization.

Development of unit-specific designs and critical care order sets can also lessen staff workloads and enhance user acceptance of the newly integrated system (Maslove et

al., 2011). Mandated usage of the CPOE system by all practitioners with the elimination of the hybrid system that allow hand-written ordering will eliminate errors and confusion associated with written orders. Continued annual e-learning refresher courses with electronic testing on system functionality and usability will provide ongoing education and continuing professional development. Additionally, continued utilization of Lean methodologies will aid in quality improvement initiatives with ongoing clinical decision support systems and IT availability to assist with technological needs for optimal project success.

The use of CPOE and EHR systems are recommended in the acute care setting due to the ability to integrate up-to-date practices, enhance physician-pharmacist communication, and reduce healthcare costs. Specifically, integration of CPOE systems eliminates hand-written orders, illegibility issues, transcribing errors, and non-clinical interpretation. CPOE systems also have functionality that permits immediate transmission of orders, allergy identification, drug interactions, and utilization of management protocols at the point of electronic order entry, which is vitally important in a complex critical care setting (HealthIT.gov, 2014). Therefore, on-going monthly collaboration with IT analysts, champion physicians, and key stakeholders for CPOE system changes is recommended during the first 12-months post system implementation. This will employ interdisciplinary and collaborative efforts for refining CPOE system initiatives to meet clinical needs and improve system performance (Leapfrog Group, 2011).

Plan for Dissemination

The purpose of dissemination of this project is to engage and inform key stakeholders of project objectives and goals. The key stakeholders for this project include the CNO, Director of Nursing, IT analysts, and Clinical Coordinators, which will be included in the dissemination procedures. Plans for dissemination include a cluster meeting with the use of a PowerPoint presentation to disseminate project findings and outcomes to key stakeholders. This will allow engagement and connection with the intended audience in an informal approach, which will allow open communication and feedback. Additionally, a poster board presentation revealing on-going CPOE medication processes pre and post system implementation will be posted in the unit meeting room for end-user awareness. Identification of end-user compliance and understanding of the CPOE system in the ICU setting prior to program completion may be an effective strategy to outline an on-going plan for organizational use that will optimize outcomes and staff satisfaction. Therefore, a post implementation test will be developed and administered by the ICU clinical coordinator along with monthly CPOE medication data repository reports that depicts on-going process improvements.

The Lean A3 report tool utilized for identification of the current CPOE and target conditions will also be disseminated to key stakeholders and published on the company intranet. The one-page report tool depicts detailed documentation of pertinent information that is condensed on a single document for progress reporting and decision-making (See Appendix D). Steps that do not have value in the workflow processes is

eliminated from the workflow and revamped to ensure value is added to the processes to eliminate waste, prevent unintended consequences, and improve patient outcomes.

Dissemination of this project is aimed at increasing awareness of CPOE systems use in critical care settings and its impact on clinical workflows, which affects end-user satisfaction. Implementation of projects alike among healthcare organizations will improve the use of technological advances in patient care for optimal system integration and patient outcomes. Many organizations are implementing CPOE systems and EHRs to meet legislative mandates. Enhanced understanding of CPOE functionality, meaningful use guidelines, and evidence-based practices has been associated with improved end-user compliance with system practices and satisfaction (Abramson & Kaushal, 2012). Therefore, various organizations will find this project beneficial with the integration of technological advancements among patient care.

Summary

Investments in advanced patient care technologies such as EHRs and CPOE systems are becoming the future of healthcare. These advancements have proven benefits for both end-users and consumers when integrated and utilized appropriately. The use of these advanced technologies can change attitudes, behaviors, and practices across the continuum for both healthcare professionals and patients. Therefore, appropriate use and understanding of HIT systems are essential. Interdisciplinary teams, collaborative efforts, and continuing educational developments refined by clinicians' pre and post system integration in acute care settings can optimize patient outcomes. However, end-user satisfaction and understanding is essential for compliance with system usage and safe

practices. Chou, Vaughn, McCoy, and Doebbeling (2011) supports the notion that integration of evidence-based practices in clinical settings has proven transformation of research discoveries into practice through decreased adverse outcomes, inappropriate treatment, and enhanced patient outcomes. Educational training and programs alike can assist with successful and safe integration of HIT systems within the acute care setting. A program that analyzes end-user understanding and satisfaction along with workflow and medication processes post system implementation can capitalize with a great investment.

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Appendix A: Definition of Terms

Term	Definition
Clinical	Of, relating to, or conducted in or as if in a clinic: as involving direct observation of the patient (The FreeDictionary online, 2013).
Clinical Workflow	Modular sequence of tasks, with a distinct beginning and end, performed for the specific purpose of delivering clinical care (HealthIT.gov, 2010).
CPOE	Computerized Physician/provider Order Entry: any system in which clinicians directly enter medication orders and/or tests and procedures into a computer system that is directly transmitted to applicable departments (e.g. pharmacy, laboratory, radiology, etc.) for the treatment of patients (AHRQ, 2012).
Critical Care	The specialized care of patients whose conditions are life-threatening and who require comprehensive care and constant monitoring, usually in intensive care units. Also known as intensive care (The FreeDictionary online, 2013).
EHR	Electronic Health Record: longitudinal electronic record of patient health information generated by one or more encounters in any care delivery setting. It allows easy sharing of medical information among stakeholders with ability of patient's information to follow him or her through the various modalities of care (HealthIT.gov, 2010)
ICU	Intensive therapy or treatment unit also known as critical care unit where specialized care is provided through intensive care medicine (The FreeDictionary online, 2013).
Medication Processes	Ordering, transcription, dispensing, administration, and systems management and control (The Joint Commission, 2012).
Patient Safety	Actions taken by individuals and organizations to protect patients from being harmed by the effects of health care services (prevention of harm to patients). Emphasis placed on systems of care delivery that prevents errors; learns from the errors that occur, and is built on a culture of safety that involves health care professionals, organizations, and patients (IOM, 2012)
Quality	An optimal balance between possibilities realized and a framework of norms and values (IOM, 2012).
Research	A systematic investigation designed to develop or contribute to generalizable knowledge (Merriam-Webster.com, 2013).
Risk	The probability of harm or injury (physical, psychological, social, or economic) occurring as a result of introduction of processes (Merriam-Webster.com, 2013).
Safety Standard	Norms and values designed to ensure the safety of projects, activities, or processes through performance expectations, structures, or processes that must be in place in an organization to enhance quality of care (IOM, 2012).
Unintended Consequences	Outcomes that are not the outcomes intended by a particular action. The unintended outcomes may be positive or negative (The FreeDictionary online, 2013).

Appendix B: Physician Order Entry User Satisfaction and Usage Survey for ICU Staff

Letter to Medical Center Intensive Care Unit Staff

Dear Medical Center ICU Staff,

The medical center is examining the impact of Computerized Physician Order Entry (CPOE) on clinical workflows in the ICU setting. To do this, we are investigating how refining CPOE initiatives will improve clinical workflow and end-user satisfaction post system implementation. This survey is part of an effort to evaluate the technology before and after implementation. As with any technological advancement in patient care, the use of CPOE systems and Electronic Health Record (EHR) may impose unintended consequences for both end-users (staff) and patients. Please complete this survey to help me assess the positive and negative implications of using the Meditech CPOE system. This will aid in the ongoing task of making the CPOE system, EHR system alerts, and patient care status board more efficient and useful for you.
We will be collecting survey data two times:

- before implementation of phase II of the CPOE system (after staff training)
- six months after implementation of Phase II of the CPOE technology

Your response for each survey time period is appreciated.

Completion of the survey is strictly voluntary. We are collecting information about your job, quality of job functionality, your view and perception of the current technology, and associated training. The questionairre will take about 5-minutes to complete. You can omit any questions you do not want to answer, and NO ONE at your work place will ever see your answers. Your responses are strictly confidential and will be closely guarded for your anonmity. Your name and other identifying information will not be associated with your survey answers. All results of this survey will be reported in the cumulative format to ensure no one can be identified. No answers of individuals will ever be released.

It is our hope that the information obtained from the survey will grant enhanced understanding of your views and the impact of the CPOE system on your clinical workflow. Thank you for your consideration.

Sincerely,

Chevita Fuller, MSN, RN
Walden University DNP Student for the Medical Center
We appreciate your time and willingness to complete this questionairre, and our hope is that the informaiton obtained will help us better understand how new CPOE technology influences clinical workflow and end-user satisfaction in the ICU setting.

Instructions

When completing the survey, you can leave any questions you do not want to answer blank. Remember that your responses are strictly confidential and will be closely guarded with anonmity. This questionairre is designed to obtain information about your job, the CPOE system and EHR you use, associated training, satisfaction, and your perception on advanced technology.

Physician Order Entry User Satisfaction and Usage Survey (POESUS)

The original Physician Order Entry User Satisfaction and Usage Survey (POESUS) [3] contains several parts. The first part (questions 1-16) contains the questions about end-user satisfaction used in this paper.

Based on your experience, please indicate whether the following statements about order entry are true on a scale from Never (1) –Always (7)								
	Never			Varies			Always	
1 The order entry system is reliable – it does its job consistently.	□1	□2	□3	□4	□5	□6	□7	
2 Order entry improves my productivity.	□1	□2	□3	□4	□5	□6	□7	
3 Order entry has a negative impact on patient care.	□1	□2	□3	□4	□5	□6	□7	
4 Order entry reduces patient care errors.	□1	□2	□3	□4	□5	□6	□7	
5 The order entry system is easy to use.	□1	□2	□3	□4	□5	□6	□7	
6 Compared to paper ordering, order entry slows me down.	□1	□2	□3	□4	□5	□6	□7	
7 Order entry gives me the information I need to write better orders.	□1	□2	□3	□4	□5	□6	□7	
8 I feel I had adequate training on order entry.	□1	□2	□3	□4	□5	□6	□7	
9 Order entry improves the quality of patient care.	□1	□2	□3	□4	□5	□6	□7	
1 System response time on order entry is slow.	□1	□2	□3	□4	□5	□6	□7	
1 When I have a problem with order entry, I just ask someone for help.	□1	□2	□3	□4	□5	□6	□7	
1 I feel that I can benefit from refresher classes on order entry.	□1	□2	□3	□4	□5	□6	□7	
1 When I need help on order entry, I can find it.	□1	□2	□3	□4	□5	□6	□7	
1 Overall, order entry improves the safety of care I provide.	□1	□2	□3	□4	□5	□6	□7	
1 Overall, order entry saves me time.	□1	□2	□3	□4	□5	□6	□7	
1 Overall, I am satisfied with the order entry system.	□1	□2	□3	□4	□5	□6	□7	
Please rate the following characteristics of the EHR								
17. Learning to operate the system	**Difficult**	□1	□2	□3	□4	□5	□6	□7 **Easy**
18. Exploring new features by trial and error	**Difficult**	□1	□2	□3	□4	□5	□6	□7 **Easy**
19. Remembering names and use of commands	**Difficult**	□1	□2	□3	□4	□5	□6	□7 **Easy**
20. Correcting your mistakes	**Difficult**	□1	□2	□3	□4	□5	□6	□7 **Easy**
21. The electronic medication administration record (eMAR) functions as I expect	**Never**	□1	□2	□3	□4	□5	□6	□7 **Always**
22. Experienced and inexperienced users' needs are taken into consideration	**Never**	□1	□2	□3	□4	□5	□6	□7 **Always**
23. Tasks can be performed in a straightforward manner	**Never**	□1	□2	□3	□4	□5	□6	□7 **Always**
24. Supplemental reference/training materials	**Confusing**	□1	□2	□3	□4	□5	□6	□7 **Clear**

Appendix C: End-User Questions

CPOE/Refresher Training End-User Questions	
1.	What does CPOE mean to you?
2.	How does CPOE affect your job performance in the ICU?
3.	What is the impact of CPOE on your workflow, workload, and team communication in the ICU?
4.	What are three things you like the most about CPOE order entry?
5.	What are three things you like to change about CPOE order entry to make it better?
6.	What types of clinical decision supports are available, and are they effective or ineffective?
7.	How many years of computer experience do you have?
8.	Can you describe your proficiency and competency with the computer system used to perform your job?
9.	Can you describe the training you received on CPOE order entry?
10.	What are three things you like the most about the professional development and training offered by your organization?
11.	What are three things you like to change about your professional development and training offered by your organization?
12.	What does e-learning mean to you?
13.	Describe your experience with e-learning for continuing educational and professional development?
14.	How do you feel about e-learning modules, are they beneficial to your professional development?
15.	What, if anything, would you change about the continuing educational training provided by you at this organization?

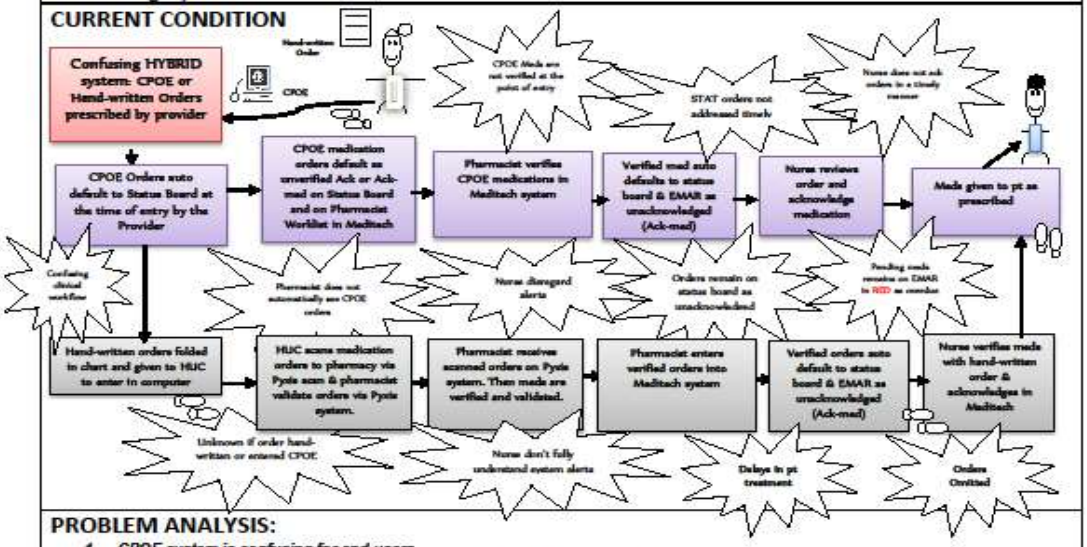
Appendix D: Lean A3 Report

A3 PROBLEM SOLVING WORKSHEET

ISSUE FROM PATIENT'S PERSPECTIVE: Delay in patient treatment with safety compromised due to misunderstanding of CPOE, EHR, and status board functionality resulting in order omissions, unacknowledged/ unverified orders, medication errors, and interruptions in clinical workflow in the ICU setting.

BACKGROUND/SIGNIFICANCE OF ISSUE: Current Hybrid CPOE system is not fully understood resulting in unacknowledged/unverified orders, omitted orders/medications, medication errors, unacknowledged critical results, and disruptions in clinical workflow in the ICU setting that results in medical errors and delays in patient treatment. It may take several hours or days before CPOE orders and/or medications are verified, acknowledged, and documented.

CURRENT CONDITION



PROBLEM ANALYSIS:

1. *CPOE system is confusing for end-users*
   - *Why? Hybrid system consists of hand-written and computerized order entry*
     - *Why? Organization in transitional phase of CPOE implementation with select physicians trained on use*
       - *Why? Patient safety*
       - *Why? Lack of physician buy-in*
   - *Why? A limited number of physicians are entering CPOE orders with more hand-written orders prescribed*
     - *Why? CPOE is not mandatory for physician order entry*
     - *Why? Organization in Phase I of CPOE meaningful use per CMS guidelines*
   - *Why? Limited training provided to end-users during phase I of CPOE go-live*
     - *Why? Training provided to select departmental super-users to train other staff*
       - *Why? Cost containment*
       - *Why? Super-users provide more in-depth departmental based CPOE updates and resources to other staff*
         - *Why? Super-users available to provide departmental CPOE related hands-on training and updates*
2. *Delays in patient treatment*
   - *Why? Orders are not noted or acknowledged by nurses in a timely manner*
     - *Why? Nurse does not immediately see new orders*
       - *Why? Nurses are not in front of computers at the time of order entry*
         - *Why? Providing care to patients*
         - *Why? Computers are logged off when not in use*
     - *Why? Nurse clears alerts from status board without thoroughly reviewing orders*
       - *Why? Nurse focus on clearing alerts vs. reviewing actual orders*

Appendix E: Walden University IRB Approval

Dear Ms. Fuller,

This email is to serve as your notification that Walden University has both approved your doctoral project proposal and confirmed that the project meets the university's ethical standards. As such, you are approved by Walden University to conduct the project.

Please contact the Office of Student Research Administration at dnp@waldenu.edu if you have any questions.

Congratulations!

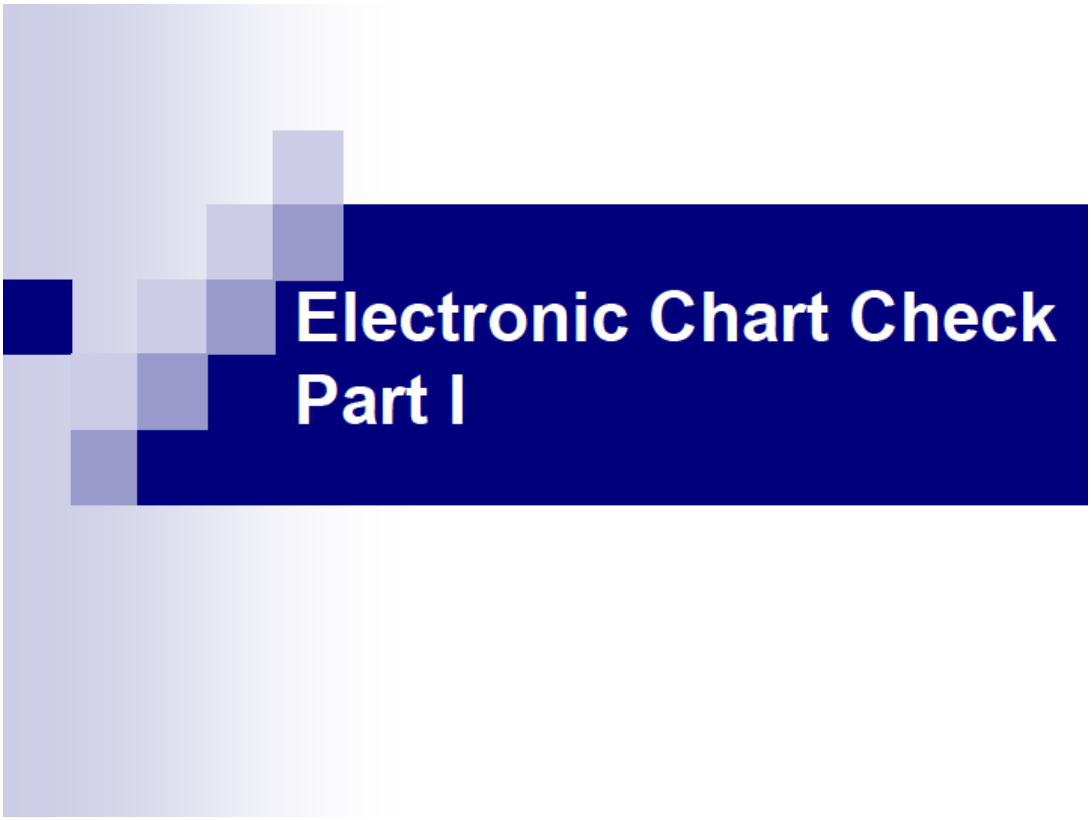
Jenny Sherer

Associate Director, Office of Research Ethics and Compliance

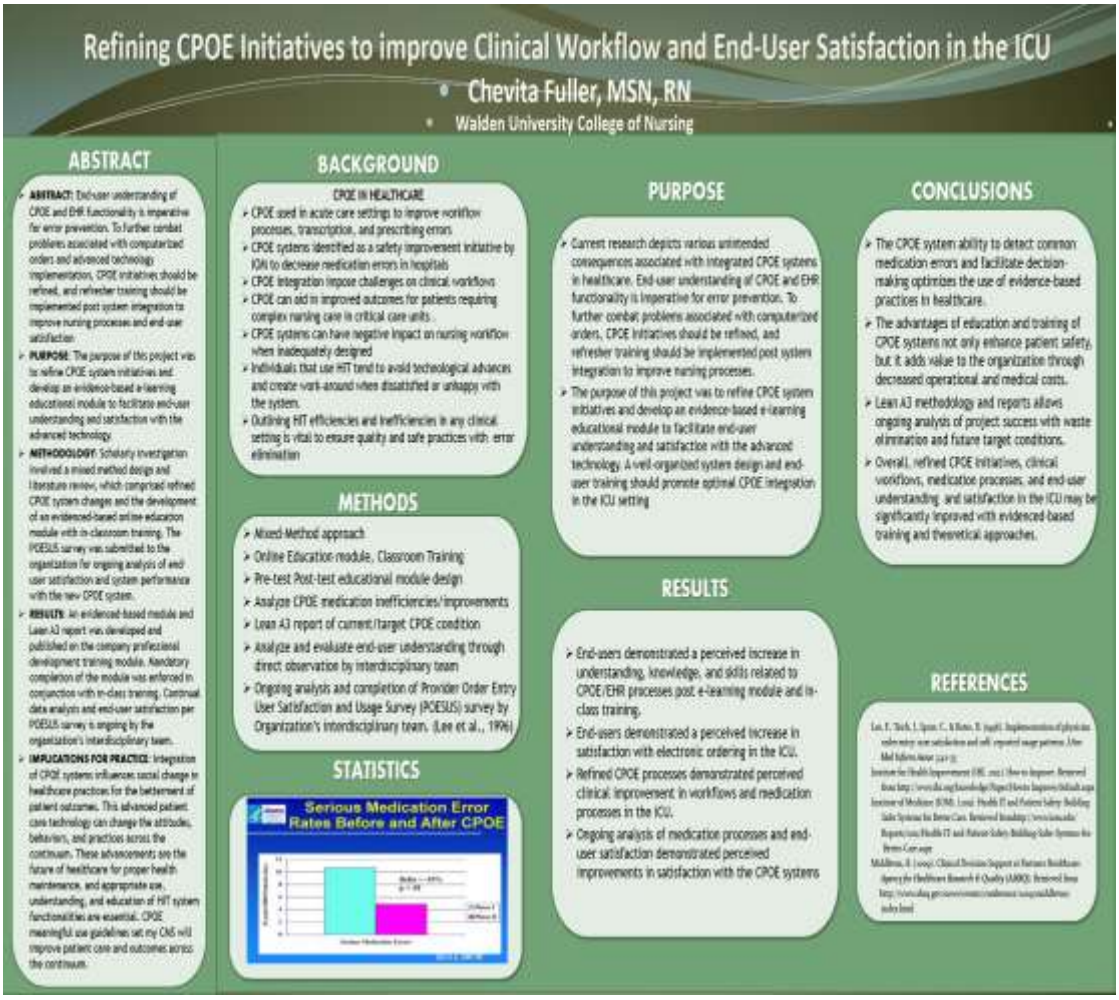
Leilani Endicott

IRB Chair, Walden University

Appendix F: Part I e-Learning Module



Appendix G: Poster Presentation



Appendix H: Permission to Use The Iowa Model

Subject : **Permission to Use and/or Reproduce The Iowa Model**

Date : Fri, Mar 21, 2014 10:25 AM CDT

From : Kimberly Jordan - University of Iowa Hospitals and Clinics <noreply@qemailserver.com>

To : <chevita.Fuller@waldenu.edu>

You have permission, as requested today, to review/use *The Iowa Model of Evidence-Based Practice to Promote Quality Care (Titler et al., 2001).* Click the PDF file below to download the model.

Copyright of the Iowa Model of Evidence-Based Practice to Promote Quality Care will be retained by The University of Iowa Hospitals and Clinics.

Permission is not granted for placing the Iowa Model on the internet (world-wide web).

The Iowa Model

In written material, please add the following statement:

- *Used/Reprinted with permission from the University of Iowa Hospitals and Clinics and Marita G. Titler, PhD, RN, FAAN. Copyright 1998. For permission to use or reproduce the model, please contact the University of Iowa Hospitals and Clinics at (319)384-9098.*

If you have questions, please contact Kimberly Jordan at 319-384-9098 or kimberly-jordan@uiowa.edu.

Curriculum Vitae

Chevita Fuller, MSN, RN
PO BOX xxxx Atlanta, GA xxxx
xxxxxx@gmail.com

EDUCATION:

YEAR	INSTITUTION – CITY, STATE	DEGREE/MAJOR
2012-2014	**WALDEN UNIVERSITY** |Minneapolis, MN Dissertation: *Refining Computerized Physician Order Entry Initiatives in an Adult Intensive Care Unit.* Chair: Dr. Mercy Popoola, Committee: Dr. Mary Verklan, Dr. Andrea Jennings, and Dr. Nancy Moss	DNP
2008-2010	**WALDEN UNIVERSITY |** Minneapolis, MN	MSN Nursing
2004-2005	**MACON STATE COLLEGE |** Macon, GA	BSN Nursing
2000-2002	**HOPKINSVILLE COMMUNITY COLLEGE|** Hopkinsville, KY	ASN Nursing
1996-1998	**MOULTRIE COLLEGE |** Moultrie, GA	Practical Nursing

PROFESSIONAL EXPERIENCE:

YEAR	ORGANIZATION – CITY, STATE	POSITION
2008 – Present	Medical Center, Georgia	ICU STAFF/CHARGE NURSE
2005 - 2007	Medical Center, Georgia	Per Diem ER Staff Nurse
2003 - 2009	Medical Center, Georgia	Cardiac/PCI Recovery Nurse
1999 - 2003	Health Services, Tennessee	Home Health/LTC LPN

PROFESSIONAL ACTIVITIES:

Advanced Cardiac Life Support Certified (ACLS)	Active Certification (2016)
Pediatric Advanced Life Support Certified (PALS)	Active Certification (2016)
Basic Life Support Certified (BLS)	Active Certification (2016)
American College of Nurse Practitioners (ACNP)	Active Membership (2015)
Robert Wood Johnson Foundation (RWJF)	Active Membership (2015)